

CONTRIBUTIONS TO THE KNOWLEDGE OF MARINE PHYTOPLANKTON OF TURKEY

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Abstract

The present paper reports three species of dinoflagellates viz., *Ceratium deflexum* (Kofoid) Jörgensen, *Ceratium longissimum* (Schröder) Kofoid, *Triposolenia bicornis* Kofoid and three species of diatoms viz., *Lyrella lyra* (Ehrenberg) Karajeva, *Pleurosigma reversum* Gregory, *Trachyneis aspera* (Ehrenberg) Cleve, all belonging to marine phytoplankton for the first time from coastal waters of Turkey. *Ceratium deflexum* was also new record for the Aegean Sea and *Pleurosigma reversum* for the Eastern Mediterranean. Original photographs and some ecological and morphological characteristics of six phytoplankton species are given.

Introduction

The Island Bozcaada is located between 25°57'48"E-26°05'00"E longitudes and 39°47'18"N-39°50'54"N latitudes in the northeast Aegean Sea with an area of 42 km². In the Aegean Sea, there are three various water masses viz., surface water, an intermediate layer and deep water. The northern surface waters in the Aegean Sea, where Bozcaada is located, are under the effect of the Black Sea waters which display the characteristics of brackish water. The salinity is 26-35 p.s.u. The southern and middle parts are affected by the Mediterranean waters (Yüce, 1995).

Most of the studies were carried out in the middle and southern parts of the Aegean Sea in Turkish coastal waters. But, there is no detailed information on phytoplankton and their ecological features in northern part. Only, Balkis & Koray (2001) reported the presence of *Pyrophacus vancamptoe* (Rossignol) Wall & Dale in northern part of the Aegean Sea previously unknown from the Eastern Mediterranean Sea.

In this study, 6 phytoplankton species are reported for the first time in Turkish coastal waters. According to present literature, one of these was new record for the Aegean Sea and another one for the Eastern Mediterranean. This study has contributed some more species to the regional check-list of the phytoplankton species of Turkish seas (Koray, 2001).

Materials and Methods

This research was carried out in neritic water of Bozcaada Island between 2000-2001 (Fig. 1). The samples were collected seasonally with horizontal tows from the subsurface (0.5 m) with a 55 µm plankton net. Material was fixed with neutral formaldehyde 4% solution and observed under inverted phase-contrast microscope equipped with a microphotosystem at a magnification of X400. Species were identified after reference to Van-Heurck (1896); Kofoid & Swezy (1921); Wood (1954, 1968); Trégouboff & Rose (1957); Hendey, (1964); Abe, (1967); Subrahmanyam, (1968); Taylor, (1976); Rampi & Bernhard, (1980); Dodge, (1982); Thronsdon, (1983); Foged, (1985); Ricard, (1987) and Round *et al.*, (1990).

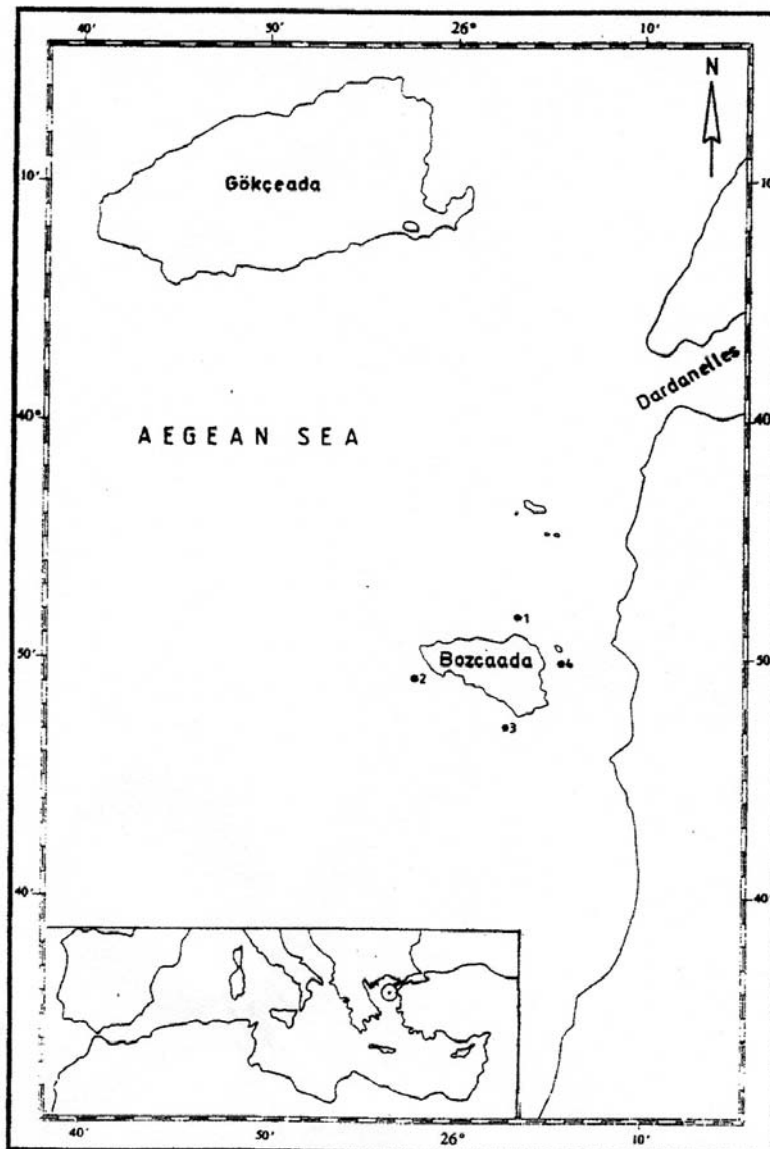


Fig. 1. Research stations in neritic water of Bozcaada Island.

At each sampling points measurements of salinity (p.s.u.), temperature ($^{\circ}\text{C}$) and dissolved oxygen (mg l^{-1}) were performed with a 3 l water sampler. The Mohr-Knudsen method (Ivanoff, 1972) was used to measure salinity values, and the Winkler method (Winkler, 1888) for dissolved oxygen (DO) values.

Diagnostic morphological characters of these species are described and their original photographs are given (Fig. 2 a-f).

Results

Six species of marine phytoplankton were observed for the first time from the coastal water of the Bozcaada Island, Turkey. Three belonged to dinoflagellates viz., *Ceratium deflexum* (Kofoid) Jörgensen, *Ceratium longissimum* (Schröder) Kofoid, *Triposolenia bicornis* Kofoid. The other three belonged to the diatoms viz., *Lyrella lyra* (Ehrenberg) Karajeva, *Pleurosigma reversum* Gregory, *Trachyneis aspera* (Ehrenberg) Cleve. Of these, four species are new to the Turkish seas, one species (*Ceratium deflexum*) to the Aegean Sea and another one species (*Pleurosigma reversum*) to the Eastern Mediterranean. Round *et al.*, (1990), Hasle & Syvertsen (1997) and Steidinger & Tangen (1997) were used in classification of species. These species are listed below:

Class: DINOPHYCEAE

Order: Gonyaulacales F.J.R. Taylor

Family: Ceratiaceae Lindemann

Genus: *Ceratium* Schrank

Ceratium deflexum (Kofoid) Jörgensen (Fig. 2 a)

Ceratium deflexum, Subrahmanyam, 1968: 78, text-fig. 146.

Ceratium recurvatum, Taylor, 1976: 74, pl. 21, fig. 209.

Body small. Epitheca slightly oblique. Hypotheca is a little longer than epitheca. It has long horns. Left antapical horn arises posteriorly and it turns to the right distally.

Distribution: August 2000 (station 2; 22.0 °C; 33.7 p.s.u.; 7.90 mg L⁻¹), September 2001 (station 2; 22.0 °C; 35.3 p.s.u.; 9.30 mg L⁻¹, station 4; 22.0 °C; 33.7 p.s.u.; 8.62 mg L⁻¹).

Arabian Sea, East of Ceylon, Indian Ocean, Eastern Australia, Great Barrier Reef, South and East China Sea, Pacific Ocean, Western Mediterranean (Subrahmanyam, 1968; Travers, 1975; Taylor, 1976).

Ceratium longissimum (Schröder) Kofoid (Fig. 2 b)

Ceratium longissimum, Wood, 1954: 299, fig. 228; Taylor, 1976: 85, pl. 17, fig. 175; Rampi & Bernhard, 1980: 63, tav. 28.

Ceratium longissimus, Subrahmanyam, 1968: 63, text-fig. 111.

Body small. Epitheca oblique, strongly convex left and slightly convex right contour. Base contour not depressed, weakly convex. Hypotheca somewhat longer, very obliquely placed left side contour. Horns are very long. Apical horn slightly bent. Antapical horns sharply bent round forwards, more or less parallel to the apical horn. Left antapical horn obliquely directed backward. The right horn transverse, somewhat longer than left.

Distribution: November 2000 (station 3; 16.7 °C; 36.2 p.s.u.; 9.46 mg L⁻¹).

Indian Ocean, Atlantic Ocean, Pacific Ocean and Mediterranean Sea (Balear, Tyrrhenian, Ligurian, Ionian, Adriatic, Aegean, Levantine) (Travers, 1975; Taylor, 1976; Revelante, 1985/1986; Gómez, 2003).

Order: Dinophysiales Lindemann

Family: Amphisoleniaceae Lindemann

Genus: *Triposolenia* Kofoid

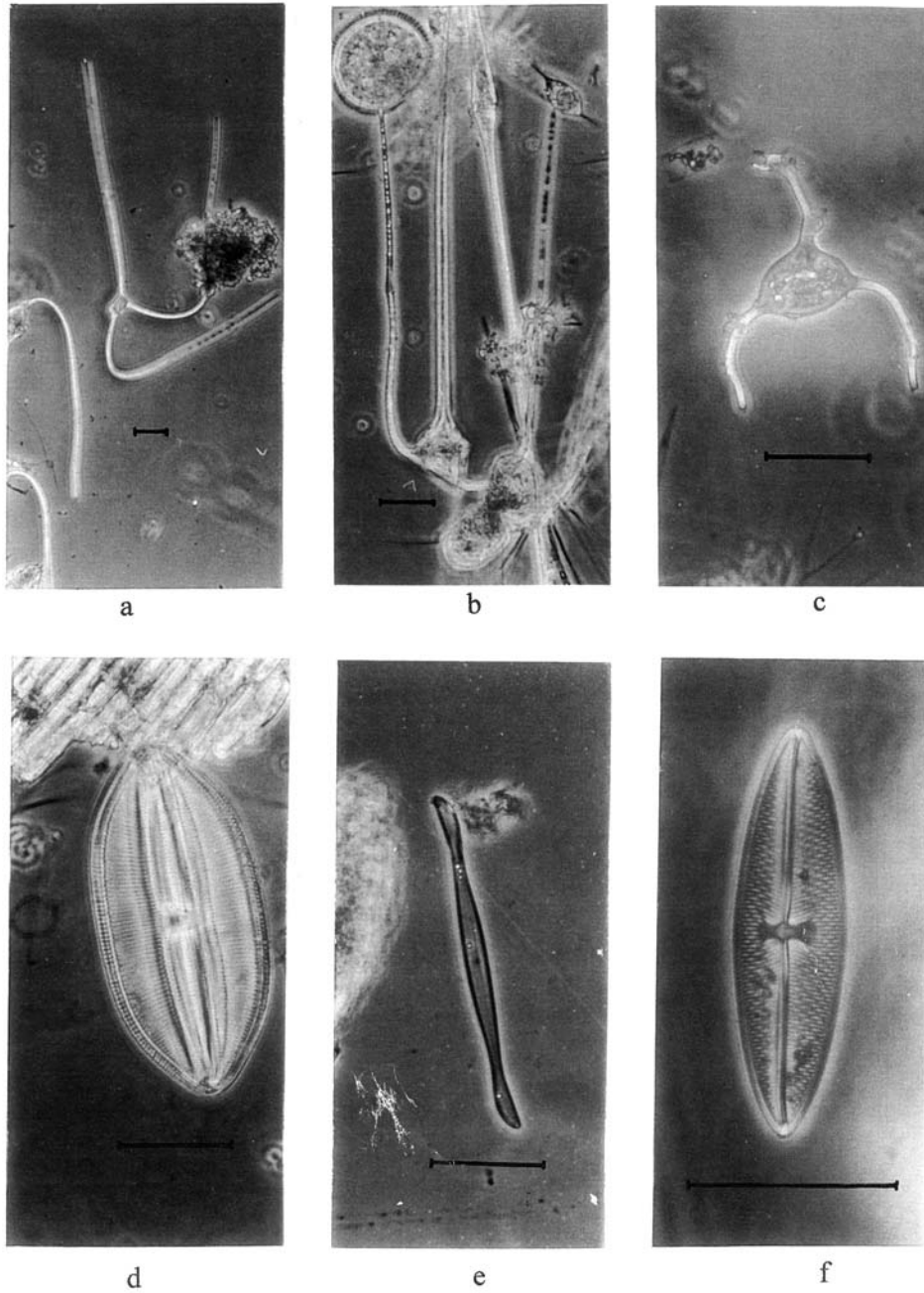


Fig. 2 a- *Ceratium deflexum*, b- *Ceratium longissimum*, c- *Triposolenia bicornis*, d- *Lyrella lyra*, e- *Pleurosigma reversum*, f- *Trachyneis aspera* (Scale bar: 40 μ m).

Triposolenia bicornis Kofoid (Fig. 2 c)

Triposolenia bicornis, Abe, 1967: 114, fig. 45; Wood, 1968: 128, fig. 400; Taylor, 1976: 31, pl. 3, fig. 33; Rampi & Bernhard, 1980: 183, tav. 88.

Epitheca small and slightly convex. Neck elongate. Antapical horns are bent and there are small processes on the each sides.

Distribution: February 2001 (station 2; 13.7 °C; 37.5 p.s.u.; 7.72 mg L⁻¹).

Indian Ocean, Mediterranean Sea (Balear, Tyrrhenian, Ligurian, Ionian, Adriatic, Aegean), Atlantic Ocean and Pacific Ocean (Wood, 1968; Taylor, 1976; Gómez, 2003).

Class: BACILLARIOPHYCEAE

Order: Lyrellales D. G. Mann

Family: Lyrellaceae D. G. Mann

Genus: *Lyrella* N. I. Karajeva

Lyrella lyra (Ehrenberg) Karajeva (Fig. 2 d)

Lyrella lyra, Ricard, 1987: 95, figs. 735-736; Round *et al.*, 1990: 460, figs. a-j.

Navicula lyra, Van-Heurck, 1896: 202, pl. 4, fig. 161; Hendey, 1964: 209, pl. 33, fig. 2.; Foged, 1985: 41, pl. 11, fig.1.

Valve with coarse puncta and broadly elliptic. Valve surface striae. Raphe system central and surrounded by a narrow hyaline zone.

Distribution: February 2001 (station 2; 13.7 °C; 37.5 p.s.u.; 7.72 mg L⁻¹, station 3; 13.7°C; 37.6 p.s.u.; 7.78 mg L⁻¹), June 2001 (station 3; 19 °C; 36.4 p.s.u.; 7.61 mg L⁻¹), September 2001 (station 1; 21.8 °C; 33.8 p.s.u.; 9.13 mg L⁻¹), December 2001 (station 3; 14.8 °C; 36.9 p.s.u.; 7.80 mg L⁻¹, station 4; 14.7 °C; 37.0 p.s.u.; 7.55 mg L⁻¹).

North Sea, Mediterranean Sea (Adriatic, Aegean, Levantine), Black Sea, Atlantic Ocean (Van-Heurck, 1896; Hendey, 1964; Salah & Tamas, 1970; Travers, 1975; Foged, 1985; Revelante, 1985/1986; Zaitsev & Alexandrov, 1998; Moita & Vilarinho, 1999).

Order: Naviculales Bessey

Family: Pleurosigmataceae Mereschkowsky

Genus: *Pleurosigma* W. Smith

Pleurosigma reversum Gregory (Fig. 2 e)

Pleurosigma reversum, Van-Heurck, 1896: 256, pl. 28, fig. 797.

Rostrum very narrow. The median portion and apices of valve are inflated.

Distribution: February 2001 (station 4; 13.8 °C; 37.4 p.s.u.; 7.47 mg L⁻¹).

North Sea (Van-Heurck, 1896), Corsica (Koray, T personal communication).

Order: Naviculales Bessey

Family: Naviculaceae Kützing

Genus: *Trachyneis* (Ehrenberg) Cleve

Trachyneis aspera (Ehrenberg) Cleve (Fig. 2 f)

Trachyneis aspera, Hendeby, 1964: 236, pl. 29, fig. 13; Foged, 1985: 57, pl.13, fig. 8; Ricard, 1987: 100, figs. 834-839; Round *et al.*, 1990: 568, figs. a-j.

Navicula aspera, Van-Heurck, 1896: 205, pl. 4, fig. 165.

Valve elliptic to linear lanceolate. Valve face curved and apparently covered with coarse puncta. Raphe system central and surrounded by a narrow hyaline zone.

Distribution: May 2000 (station 3; 17.5 °C; 34.5 p.s.u.; 9.41 mg L⁻¹)

Atlantic Ocean, North Sea, Mediterranean (Adriatic, Aegean), Black Sea (Hendeby, 1964; Travers, 1975; Foged, 1985; Revelante, 1985/1986; Zaitsev & Alexandrov, 1998; Moita & Vilarinho, 1999).

Discussion

So far, a total of 7 Prokaryote and 485 Eucaryote taxa has been reported from the Turkish coastal waters (Koray, 2001). Six species of this study were previously identified from the Mediterranean Sea. But, *Ceratium deflexum* is new record for the Aegean Sea and *Pleurosigma reversum* for the Eastern Mediterranean. *Ceratium deflexum* is very rare (Taylor, 1976). Taylor (1976) stated that there is a marked resemblance in the body shape and the formation of the right antapical horn to *C. trichoceros* and *C. contrarium* and this taxon is a conglomerate of several species exhibiting a particular type of horn aberration. *Pleurosigma reversum* is rarely reported and information on its ecology and distribution is scarce. This species was firstly described from the North Sea (Van-Heurck 1896) and Professor Dr T. Koray mentioned its presence from Corsica in a personal communication. There is not any record of this species from Eastern Mediterranean Sea.

Most of the species were obtained under thermophilic conditions (summer-autumn). Throughout the sampling period these new recorded species were found in the range of 13.7-23.0°C, 32.2-37.6 p.s.u. and 7.47-9.67 mg l⁻¹.

The occurrence of these species for the first time in this study may be related to the lack of adequate studies in this region. It is possible that these species may have recently been transported to the area by current systems and ballast waters may have caused the transportation of marine organisms from one site to another. According to Halim (1990) the Suez Canal plays a major role in the migration to the Mediterranean of Red-Sea and Indo-Pacific dinoflagellates. Moreover, the North Aegean Sea is influenced by the colder and less saline Black Sea water passing through the Dardanelles straits and receiving the outflow of several rivers discharging along the North coast (Poulos *et al.*, 1997; Pitta & Giannakourou, 2000).

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References

- Abe, T.H. 1967. The armoured dinoflagellata: II. Procentridae and Dinophysidae (C)-*Ornithocercus*, *Histioneis*, *Amphisolenia* and others. *Publ Seto mar Biol Lab.*, 15(2): 79-116.

- Balkis, N. and T. Koray. 2001. About the presence of genus *Pyrophacus* Stein, 1883 with special emphasis on *Pyrophacus vancampoae* (Rossignol) Wall and Dale (Dinophyceae) in Eastern Mediterranean. *E. U. Journal of Fisheries and Aquatic Sciences*, 18(3-4): 541-545.
- Dodge, J.D. 1982. *Marine Dinoflagellates of the British Isles*. Her Majesty's Stationery Office, London, 301 pp.
- Foged, N. 1985. *Diatoms in Kos and Kalymnos two Grek islands in the Aegean*. Bibliotheca Diatomologica, Germany, 105 pp.
- Gomez, F. 2003. Checklist of Mediterranean free-living dinoflagellates. *Bot. Mar.*, 46: 215-242.
- Halim, Y. 1990. On the potential migration of Indo-Pacific plankton through the Suez Canal. *Bull. Inst. Oceanog.*, 7: 11-27.
- Hasle, G.R. and E.E. Syvertsen. 1997. Marine Diatoms. In: *Identifying marine phytoplankton*. (Eds.): C.R. Tomas. Academic Press a division of Harcourt Brace and Company, San Diego, USA, chapter 2, pp. 5-385.
- Hendey, N.I. 1964. *An introductory account of the smaller algae of the British coastal waters*. Part V: Bacillariophyceae (Diatoms). Fishery investigations, ser.4. Her Majesty's Stationery Office, London, 317 pp.
- Ivanoff, A. 1972. *Introduction al'océanographie*. Tome I. Librairie Vuibert, Paris, 208 pp.
- Kofoed, C.A. and O. Swezy. 1921. *The free-living unarmored dinoflagellata*. Vol. 5, University of California Press Berkeley, California, 538 pp.
- Koray, T. 2001. Türkiye denizleri fitoplankton türleri kontrol listesi. *E U Journal of Fisheries and Aquatic Sciences*, 18(1-2): 1-23.
- Koray, T. 2004. Personal communication. Ege University, Faculty of Fisheries, Department of Hydrobiology, 35100 Bornova-Izmir, Turkey. E-mail: koray@sufak.ege.edu.tr
- Moita, M. and M.G. Vilarinho. 1999. Checklist of phytoplankton species off Portugal: 70 years (1929-1998) of studies. *Portugaliae Acta Biologica*, 18(1-4): 5-50.
- Pitta, P. and A. Giannakourou. 2000. Planktonic ciliates in the oligotrophic Eastern Mediterranean: vertical, spatial distribution and mixotrophy. *Mar. Ecol. Prog. Ser.*, 194: 269-282.
- Poulos, S.E., P.G. Drakopoulos and M.B. Collins. 1997. Seasonal variability in sea surface oceanographic conditions in the Aegean Sea (Eastern Mediterranean): an overview. *J. Mar. Syst.*, 13: 225-244.
- Rampi, L. and R. Bernhard. 1980. Chiave per la determinazione delle Peridinee pelagiche Mediterranee. *Comi Naz Energia Nucleare*. CNEN-RT/B10, 80, 8, Roma, 71 pp.
- Revelante, N. 1985/1986. A catalogue of phytoplankton reported from the Rovinj area of the Northern Adriatic. *Thalassia Jugoslavica*, 21/22 (1/2): 139-169.
- Ricard, M. 1987. *Atlas du phytoplancton marin*. Vol. 2: Diatomophyceés. Centre National de la Recherche Scientifique, Paris, 297 pp.
- Round, F.E., R.M. Crawford and D.G. Mann. 1990. *The diatoms*. Biology and morphology of the genera. Cambridge University Press, USA, 747 pp.
- Salah, M. and G. Tamas. 1970. General preliminary contribution to the plankton of Egypt. *Bull. Inst. Ocean. Fish.*, 1: 307-337.
- Steidinger, K.A. and K. Tangen. 1997. Dinoflagellates. In: *Identifying marine phytoplankton*. (Eds.): C.R. Tomas. Academic Press a division of Harcourt Brace and Company, San Diego, USA, Chapter 3, pp. 387-584.
- Subrahmanyam, R. 1968. *The Dinophyceae of the Indian Seas*. I. Genus *Ceratium* Schrank. Marine Biological Association of India, India, 129 pp.
- Taylor, E.J.R. 1976. *Dinoflagellates from the international Indian Ocean expedition*. A report on material collected by the "Anton Bruun" 1963-64, 132, Stuttgart, 234 pp.
- Throndsen, J. 1983. Ultra-and nanoplankton flagellates from coastal waters of Southern Honshu and Kyushu, Japan (including some results from the western part of the Kuroshio off Honshu). (Eds.): Mitsuo Chihara and Haruhiko Irie. Gakujutsu Tosho Printing Co. Ltd., Tokyo, Japan, 62 pp.
- Travers, M. 1975. Inventaire des protistes du Golfe de Marseille et de ses parages. *Ann. Inst. Océanogr.*, 51(1): 51-75.

- Trégouboff, G. and M. Rose. 1957. *Manuel de Planctonologie Méditerranéenne*, Tome I-II, Centre National de la Recherche Scientifique, Paris, 587 pp.
- Van Heurck, H. 1896. *A treatise on the Diatomaceae*. William Wesley and Son, 28, Essex street, Strand, W.C., London, 556 pp.
- Winkler, L.W. 1888. The determination of dissolved oxygen in water. *Berlin Deut. Chem. Ges.*, 21: 2843-2855.
- Wood, E.J.F. 1954. Dinoflagellates in the Australian region. *Aust. J. Mar. Freshw. Res.*, 5(2): 171-351.
- Wood, E.J.F. 1968. *Dinoflagellates of the Caribbean Sea and adjacent areas*. University of Miami Press, Coral Gables, Florida, 143 pp.
- Yüce, H. 1995. Northern Aegean water masses. *Estuarine, Coastal and Shelf Science*, 41: 325-343.
- Zaitsev, Y.P. and B.G. Alexandrov. 1998. *Black Sea biological diversity*, Ukraine. Black Sea environmental series, 7, United Nations Publications, New York, 351 pp.

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