Turkish J.Marine Sciences : 8:165-178 (2002)

New record of the heterotrophic Ebridian microflagellate *Hermesinium adriaticum* Zach. in the eutrophic Izmir Bay (Aegean Sea, Turkey).

Ötrofik İzmir Körfezi'nden yeni bir kayıt, Heterotrofik Ebridiyan mikroflagellat *Hermesinium adriaticum* Zach. (Ege Denizi, Türkiye).

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Abstract

Hermesinium adriaticum ZACH. 1906, as a rare non-photosynthetic flagellate was identified for the first time in the eutrophic Izmir Bay and along the coasts of Turkey, *i.e.*, southern Black Sea, eastern Mediterranean Sea and Aegean Sea. It has internal siliceous skeleton. For the first time in Izmir Bay, it was found in the surface water (up to max. 14.250 cells/l) during the sampling in September 1998 in the Middle and Outer Bay when the water temperature was maximum. Water quality parameters in September 1998 were also recorded and presented to elucidate in which the conditions presumably favored by *Hermesinium adriaticum*. In contrast to *H. adriaticum*, another ebridian species; *Ebria tripartita* was observed (up to max. 410.150 cells/l) throughout the bay not only in September but also in April and November 1998 without showing any correlation with temperature.

Key words: *Hermesinium adriaticum*, *Ebria tripartita*, eutrophication, Izmir Bay, new record, Aegean Sea.

Introduction

Hermesinium adriaticum ZACH.is a rare non-photosynthetic flagellate with an internal siliceous skeleton (Deflandre 1952; Preisig 1994; Throndsen 1997). Although its taxonomic position

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is uncertain (Corliss, 1994), Vilicic *et al.*, (1997) have emphasized that it was recently classified within the Order Ebriales of Dinoflagellata. However, Throndsen (1997) presented Ebriida in zooflagellates (Phylum Zoomastigophora) after Lee *et al.*, (1985) (cited in Throndsen, 1997). The problems in identification are mainly related to the great variation in the silica structures (Throndsen, 1997).

H. adriaticum was first described in the northern Adriatic Sea by Zacharias in 1906 (Vilicic *et al.*, 1997). It is known as a neritic species distributed in tropical and temperate seas (Sournia 1986). It has been found in summer season in the Black Sea (Bodeanu, 1969; cited in Vilicic *et al.*, 1997), southern Mediterranean Sea (Halim, 1960), in Narragansett Bay (Hargraves and Miller, 1974).

In this study, the distribution of *H. adriaticum* in the eutrophic Izmir Bay has been presented and the probable influences of environmental conditions have also been discussed on its appearance.

Study area

Since 1980, Izmir Bay became one of the most polluted areas in the Mediterranean Sea due to discharged untreated wastewaters (Kocatas *et al.*, 1987; Koray and Buyukısık, 1988; Koray, 1990; Cirik *et al.*, 1992; Aksu *et al.*, 1998; Bizsel and Uslu, 2000). The pollution in Izmir Bay and its biological effects were recorded as early as in the beginning of seventies (Geldiay and Kocatas, 1973; Geldiay and Kocatas, 1979; Geldiay *et al.*, 1979). In the beginning of nineties, considerable changes in both nutrient levels and phytoplankton biomass were recorded (Bizsel, 1996).

The average salinity of the surface layer in the bay varies seasonally between 37.02 psu (in January) and 39.16 psu (in October). The average temperature of the surface has its minimum 11.2 °C in January and maximum 26.6 °C in July (Bizsel, 1996).

Izmir Bay can be divided into three parts; hypereutrophic inner bay, eutrophic middle bay and relatively oligotrophic outer bay (Figure 1). The increase in toxic, noxious or harmful algal blooms (HABs) that is occuring worlwide has also been observed in Izmir Bay. The first records were given in the middle 1950's as a red tide event (Numann, 1955; Acara *et al.*, 1960). Phytoplankton blooms in every spring, including harmful red tides, are currently spreading and increasing their frequency of occurrence along the coasts of the bay. Today, different kinds of environmental disorders, such as anoxic outbreaks and fish kills, are not unusual. Red tide events are in increasing trend in terms of frequency particularly during the last two decades (Koray *et al.*, 1999). *Noctiluca scintillans* Macartney very often forms red tide, but *Prorocentrum micans* Ehrenberg, *P. triestinum* Schiller, *Alexandrium minutum* Halim, *Gymnodinium simplex* Lohmann, *Scrippsiella trochoidea* Stein, *Ceratium sp.*, *Nitzschia sp.*, *Pseudo-nitzschia sp.*, *Thalassiosira sp.*, and *Mesodinium rubrum* Lohmann are also potent causative organisms (Koray *et al.*, 1992; Koray *et al.*, 1999).

Materials and Methods

Samples were collected from 10 stations selected considering the hydrodynamic features of the bay (Figure 1) on April 2, 15, 21, 24 during the red tide period, September 2, November 25, 1998 and January 8, 1999. Phytoplankton samples taken from surface waters (0,3-0,5 m) were preserved with lugol. After sedimentation, they were concentrated to 10 ml and counted by the single drop technique (Semina, 1978). Each sample was counted at least five times. Different sources were used for the identification of phytoplankton (Nezan, 1996; Nezan and Piclet, 1996; Throndsen, 1997; Sournia, 1986).

The time plan of the survey and the dominant phytoplankton species were shown in Table 1. *In situ* measurements of temperature and salinity were done by using Sea-Bird CTD system. Discrete samples were analyzed for dissolved oxygen (DO) by using the Winkler method, and for macronutrients by using the methods described in Koroleff (1983), after filtering sea water through GF/F filter. Chl-a samples were collected on GF/F filters and extracted with 90% acetone solution (Strickland and Parsons, 1972).

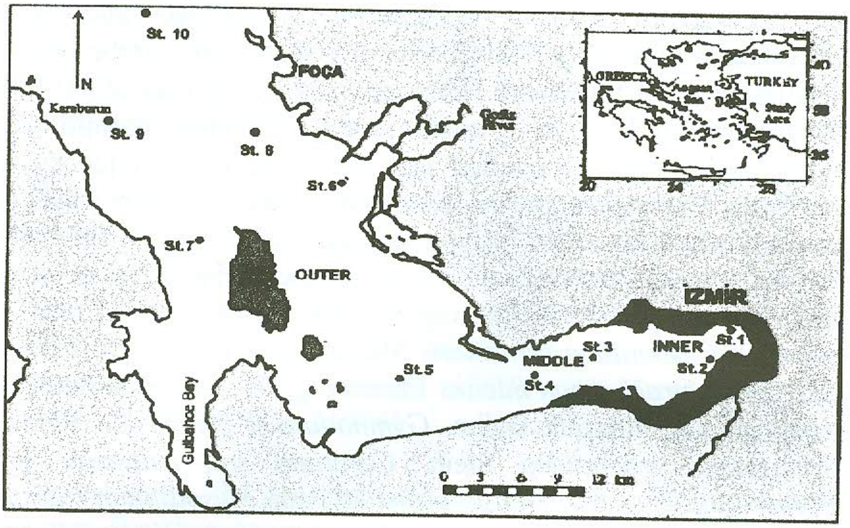

Figure 1. Locations of sampling stations in İzmir Bay.

The fluorescence intensity of Chl-a extracts was then measured using Turner Design spectrofluorometer. The samples taken for particulate organic carbon (POC) and particulate organic nitrogen (PON) were measured with Carlo Erba EA 1108 model CHN analyzer.

Result and Discussion

In the Order Ebriida, the biology of genera *Hermesinium* Zacharias and *Ebria* Borgert are incompletely known (Rhodes and Gibson 1981). Both are colorless, biflagellated unicellular organisms. The siliceous internal skeleton is surrounded by cytoplasmic constituents (Figure 2).

H. adriaticum cells observed in the outer bay (Figure 1) are about 50 μm length (Figure 3A) and 42 μm length (Figure 3B) and 28μm at the widest points at station 7 and 8 respectively on September 2, 1998. The width is larger than that of the original

Table 1. Sampling surveys and the dominant species of the study.

DATE	Dominant species in the section of the Bay **INNER** >100.000 cells/l	 **MIDDLE** >100.000 cells/l	 **OUTER** >10.000 cells/l	**Explanations**
2 April 1998	*Thalassiosira rotula* *Thalassiosira sp.* Cryptophyceae *closterium*	*Thalassiosira sp.* Cryptophyceae *Pyramimonas sp.* Ciliata	Naviculoid Caloneis *Cylindrotheca* *Nitzschia sp.*	In the begining of red tide
15 April 1998	*Noctiluca scintillans* Cryptophyceae *Pyramimonas sp.* *Eutreptiella gymnastica* Ciliata	Cryptophyceae *Pyramimonas sp* *Eutreptiella gymnastica*	*Thalassiosira sp.* Naviculoid *Nitzschia sp.* *Alexandrium minitum* Cryptophyceae	Dense red tide
15 April 1998	Cryptophyceae *Pyramimonas sp.* *Eutreptiella sp.* Ciliata	------------ ------------ ------------ ------------	------------ ------------ ------------ ------------	Brown tide patch
15 April 1998	*Noctiluca scintillans* Cryptophyceae *Pyramimonas sp.* *Eutreptiella sp.* Tintinnida	------------ ------------ ------------ ------------ ------------	------------ ------------ ------------ ------------ ------------	Red tide patch
21 April 1998	*Thalassiosira* sp. *Pseudo-nitzshia pungens sp.* *Gymnodinium* sp. Cryptophyceae *Pyramimonas* sp. *Eutreptiella gymnastica* Ciliata	——— ——— ——— ——— ——— ——— ———	——— ——— ——— ——— ——— ——— ———	The first record of fish death
1-2 September 1998	*Thalassiosira sp.* *Bellerochea horologicalis* *Cyclotella sp.* *Nitzschia longissima* *Gymnodinium sp.* *Prorocentrum triestinum* *Heterosigma akashiwo* Cryptophyceae *Pyramimonas sp.* *Eutreptiella sp.*	*Thallassiosira sp.* *Bellerochea horologicalis* *Cyclotella* *Nitzschia longissima* *Gymnodinium sp.* Cryptophyceae *Eutreptiella sp.*	*Rhizosolenia alata* *Gymnodinium sp.*	No discolouration
25 November 1998	*Prorocentrum triestinum* *Pyramimonas sp.*	*Bacteriastrum sp.* Cryptophyceae	Not sampled	No discolouration (after red tide sampling)
8 January 1999	*Thalassiosira rotula* *Thalassiosira sp.* Cryptophyceae	*Thalassiosira sp.* *Thalassiosira anguste-lineata*	*Thalassiosira sp.* *Chatoceros sp.* *Bacteriastrum sp* *Pseu-nitz pungens sp.* Ciliata	No discolouration (before red tide sampling)

description given by Zacharias (1906), which is cited in Rhodes and Gibson, 1981.

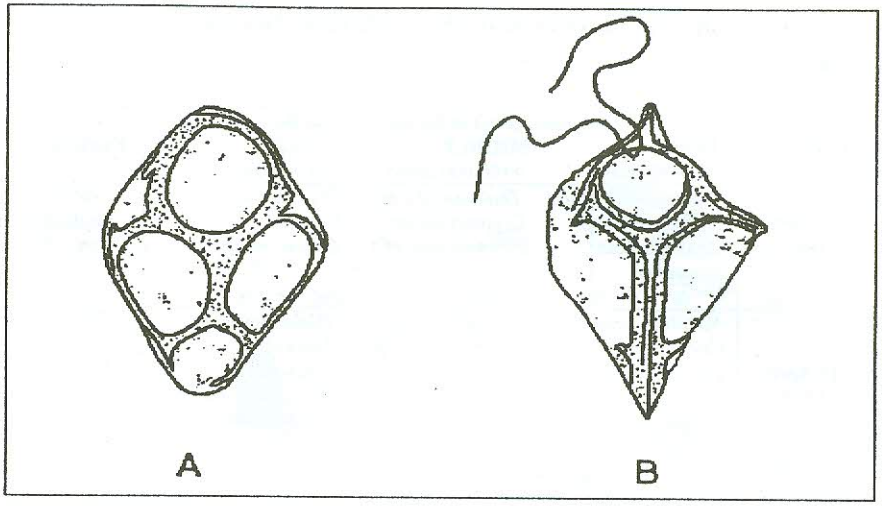

Figure 2. *Ebria tripartita* (A) 30-40 µm, *Hermesinium adriatic* (B) 45-50 µm (from Trondsen, 1997).

Dense population of *H. adriaticum* at the surface layers was not observed. Although the aggregations in the halo- and thermo-cline in a stratified ecosystem were reported by Rhodes and Gibson (1981) and the stratification was expectedly occured during summer throughout the bay, *i.e.*, thermo- and halo-cline depth was around 30-40 m in the outer bay in September 1998 (DEU-DBTE, 1999), the samples were only collected from surface layer during this study, and hence, it is not possible to give any statement on the population density in the water column.

The water quality parameters (Table 2) show that salinity was higher than 39 psu in the middle and outer bay during September 1998. However, in Chesapeake Bay *H. adriaticum* and *Ebria tripartita* Schumann were reported in low saline water (14.4 psu-23.2 psu) (Rhodes and Gibson, 1981). Whilst *H. adriaticum* could only be observed particularly in the outer bay during September 1998, the other Ebridian algae; *Ebria tripartita* (35 µm length- 30 µm width) (Figure 4) could be sampled more dense in the inner and middle bay during April,

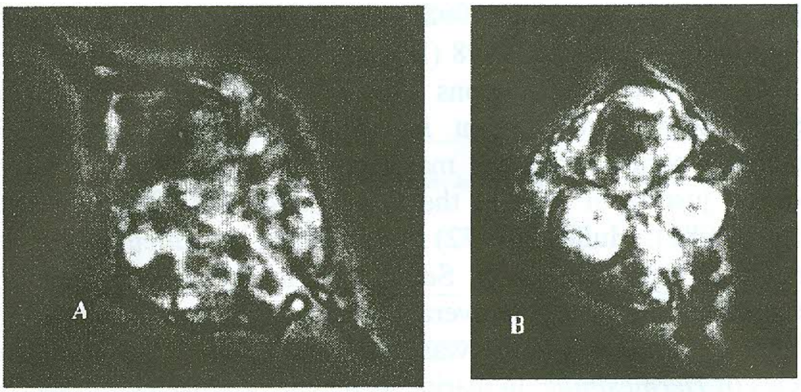

Figure 3. The Ebridian *Hermesinium adriticum* at station 7 (50 μL-28 μW) (A) and at station 8 (42 μL-28 μW) (B) in September 1998.

Figure 4. The Ebridian *Ebria tripartita* at station 4 in November 1998 (35 μL-30 μW).

September and November 1998, but not in the outer bay except at station 7 on April 15, 1998 (Figure 5). As illustrated in Figure 5, the seasonal distributions of *H. adriaticum* and *Ebria tripartita* were quite different. *H. adriaticum* was only observed during the period when the maximum water temperature were recorded just so it was in the Chesapeake Bay (Rhodes and Gibson, 1981). Mulford (1972) had found *H. adriaticum* to have a maximum population in September in the upper part of Chesapeake Bay when the average water temperatures was 26.9 °C and the average salinity was 14.6 psu. Other studies on the species of *Hermesinium* in marine waters are Zacharias (1906),

Table 2. Water quality parameters Hermesinium adriaticum *in September 1998.*

PARAMETERS	September 1998		
	INNER	MIDDLE	OUTER
Temperature	24.5	25	23.6
Salinity	------	39.29	39.16
Secchi Dics depth (m)	1.24	4.83	18.6
TSS (mg/l)	11	7	2.42
DO (ml/l)	2,93	3,83	4.50
Chl-a (µg/l)	15	10	0.06
NO_3^- (µM)	0,71	5,35	6.27
NH_4^+ (µM)	3,9	0,27	BDL*
PO_4^{3-} (µM)	4,14	1,44	0.05
Particle Organic Carbon-POC (µM)	190	104	8.86
Particle Organic Nitrogen-PON (µM)	31,86	17,95	1.22

*BDL-Below Detection Limit

Frenguelli (1938) and Ivanov (1964), El-Maghraby and Halim (1965), Rhodes and Gibson (1981), Vilicic *et al.*,(1997).

The results given in Table 2 and those of Vilicic *et al.*,(1997), who reported the presence of *H. adriaticum* in the offshore waters of Adriatic Sea in winter when the temperature and salinity were higher 13.8 °C and 38.60 psu, respectively, support the conclusion that "*H. adriaticum* is apparently a warm-water, eurohaline organism" in contrast to that of stated by Hargraves and Miller (1974) and Rhodes and Gibson (1981) who defined *H. adriaticum* as "stenohaline".

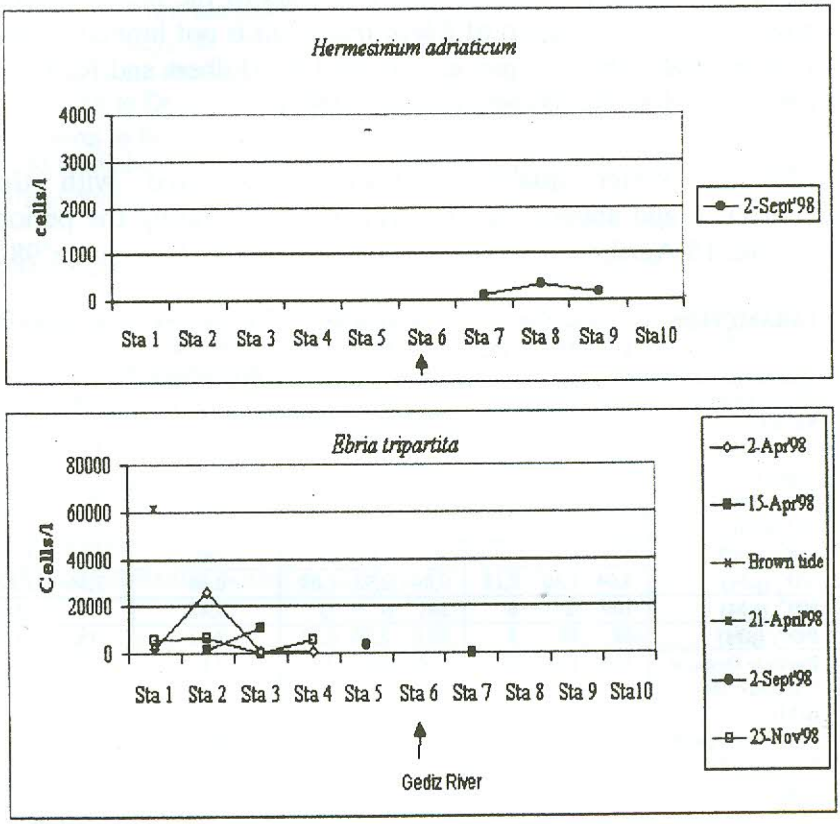

Figure 5. The distribution of *Hermesinium adriaticum* and *Ebria tripartita*.

The other Ebridian species, *Ebria tripartita*, was found almost throughout the year (except in January 1998) in spite of a wide temperature range as mentioned by Rhodes and Gibson (1981). This pattern is completely contrast to that of *H. adriaticum* which was only found in September 1998. Table 3 shows the water quality parameters associated with the occurrence and abundance of *Ebria tripartita*. It is remarkable that the higher population density was observed particularly in the inner bay where salinity is relatively lower than that in the outer bay. The horizontal distribution pattern of *Ebria tripartita* suggests that it is able to live over a wide temperature range and hence, is an euryhaline organism (Figure 5). The results of the present study show that the distribution of *Ebria tripartita* is not limited by the salinities lower than 34 psu as reported by Hulbert and Rodman (1963) (cited in Rhodes and Gibson, 1981).

Table 3. Water quality parameters associated with the occurrence and abundance of *Ebria tripartita* during the period of 2 and 15 April, brown patch (15 April) and 25 November'98.

PARAMETERS	2April'98			15April'98			15 April'98	November'98	
	I	M	O	I	M	O	INNER BrownPatch	I	M
Temperature	13,5	13,7	14,9	18,6	18,2	18,1	17,9	15	17
Salinity	—	38,8	39,0	37,7	38,6	39,0	—	—	—
Secchi Dics depth (m)	2,0	3,5	14,0	1,7	5,4	17,5	2	1,68	3,70
TSS (mg/l)	26,5	34,3	10,0	50,0	15,7	3,3	5,4	8	3,5
DO (ml/l)	4,39	5,90	4,60	6,18	6,08	5,54	8,51	3,31	4,41
Chl-a (μg/l)	151	121	1	76	21	2	90	3,25	1,21
NO_3^- (μM)	8,04	1,40	7,18	0,84	2,92	1,68	0,38	2,36	7,52
NH_4^+ (μM)	100	2	6	281	5	3	7,42	76	38
PO_4^{3-} (μM)	68	10	9	20,0	2,50	0,54	3,41	18	12
Particle Organic Carbon-POC (μM)	136	110	16	214	48	16	112	131	23
Particle Organic Nitrogen-PON (μM)	18	16	2	33	6	2	18,82	21	3,36

Özet

Daha önce Türkiye sularında kaydedilmeyen, nadir ve fotosentetik olmayan kamçılı *Hermesinium adriaticum* ZACH. 1906, ötrofik İzmir Körfezi'nde su sıcaklığının maksimuma ulaştığı Eylül 1998 de orta ve dış kesimde yüzey suyunda (maksimum 14.250 hücre/l) gözlenmiştir. Silisli bir iskelete sahip olan *Hermesinium adriaticum* un hangi şartlarda gözlendiğini göstermek için Eylül 1998 de su kalite parametreleri de ölçülmüştür. *Hermesinium adriaticum* un dağılımına zıt olarak, diğer bir ebridiyan türü olan *Ebria tripartita* su sıcaklığına bağlı olmayan dağılım göstermiştir (maksimum 410.150 hücre/l). *Ebria tripartita* Eylül 1998 in dışında Nisan ve Kasım 1998 aylarında tüm körfez boyunca gözlenmiştir.

Acknowledgements

Turkish Scientific and Technical Research Council (TUBITAK-YDABCAG-618G) supported this study. The authors would like to thank the Institute of Marine Sciences and Technology of Dokuz Eylul University in Izmir-Turkey, for the generous support given, specifically for the provision of the research vessel R/V Piri Reis and laboratory facilities. We are grateful to Dr. Elizabeth Nezan from IFREMER, Concarneau (France) for guiding us in identification of phytoplankton species. The authors would like to thank to Aydın ÜNLÜOĞLU, Barış AKÇALI for their assistantship during data collection and technical aspects.

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Accepted:08.02.2002
Received:25.09.2002