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Species of Genus *Tintinnopsis* Stein, 1867 in Turkish Coastal Waters and New Record of *Tintinnopsis corniger* Hada, 1964

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Abstract.- This study reports *Tintinnopsis corniger* Hada, 1964 for the first time from the Turkish coastal waters and contributes to the regional check-list of the plankton species in the Turkish seas. This species has generally been reported from the Japanese waters. It has also been reported from the Gulf of Mexico, the Atlantic Ocean, northern Mediterranean, Italy and Egypt. The specimens were collected in August and October 2010 from subsurface (0.5m) neritic waters in the Gulf of Gemlik, the Sea of Marmara. The primary hydrographic parameters, such as temperature (18-28ºC), salinity (16-18 ppt) and dissolved oxygen (7.96-13.10 mg l^{-1}) were recorded at the sampling stations. Thirteen species belonging to genus *Tintinnopsis* were recorded from the Turkish seas with the contribution of this study.

Keywords: *Tintinnopsis corniger,* Gulf of Gemlik, planktonic ciliates.

INTRODUCTION

Tintinnids constitute one major component of marine planktonic ciliates and their distribution in seas and oceans displays a cosmopolitan character (Marshall, 1969), but most genera and species have distinct geographic distributions (Pierce and Turner, 1993). They form an essential link between autotrophic organisms and higher level heterotrophic ones (Middlebrook *et al.*, 1987; Pierce and Turner, 1992). The genus *Tintinnopsis* is common in both temperate and tropical coastal systems (Dolan *et al.*, 2006). According to Pierce and Turner (1993), genus *Tintinnopsis* is neritic and may be restricted to shallow waters. In the recent studies, 64% of the recorded tintinnid species are neritic and of the neritic genera, *Tintinnopsis* has been represented by the greatest number of species (Pierce *et al.*, 1997). In addition, *Tintinnopsis* can produce resting cysts (Pierce and Turner, 1993; Dolan *et al*., 2006; David *et al.*, 2007).

In recent years, the phylogenetic analysis of *Tintinnopsis* have been carried out based on the SSU rRNA gene (Strüder-Kypke and Lynn, 2003; Agatha and Strüder-Kypke, 2007; Sacca *et al*., 2007; Li *et al*., 2009). Although the lorica is till now used for systematic status determination of genera and species, it should not be forgotten that tintinnids loricae present a high level of polymorphism (Laval-Peuto and Brownlee, 1986), and molecular and cell morphological information should be taken into account as a more natural and better classification of the paraphyletic genus *Tintinnopsis* (Strüder-Kypke and Lynn, 2003; Li *et al*., 2009).

Qualitative and quantitative studies of tintinnids have been conducted since 1960 in the Turkish coastal waters and all species were listed by Koray *et al*. (1999). Most of the studies on tintinnids have been conducted in the Turkish coastal waters of the Aegean Sea, but there isn't sufficient data about the case of the Sea of Marmara.

This paper reports the new record species *Tintinnopsis corniger* Hada, 1964 for the first time in the Turkish coastal waters and contributes to the regional check-list of the plankton species in the Turkish seas.

MATERIALS AND METHODS

Located in the south-eastern part of the Sea of Marmara, the Gulf of Gemlik is represented by stratified water layers that consist of low salinity (23-29 ppt) Black Sea waters and high salinity (38.5 ppt) Mediterranean waters (Ünlü *et al*., 2008).

In this study, plankton samples were collected in August and October 2010 as horizontal tows from subsurface (0.5 m) at two stations, which have depths of about 90-100 m, in the Gulf of Gemlik (Fig. 1). The maximum depth in the Gulf is about

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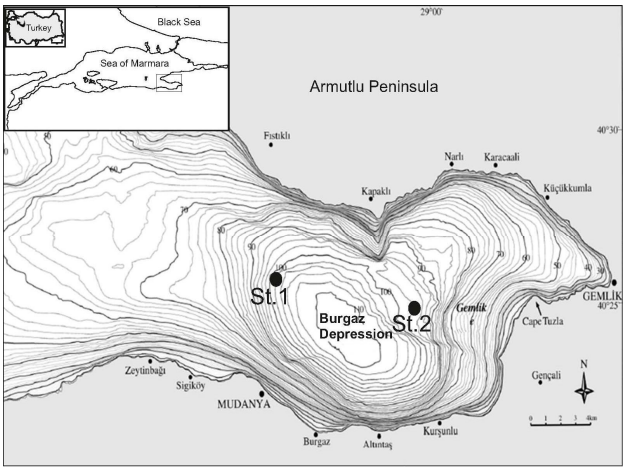

Fig. 1. Research stations in the Gulf of Gemlik (bathymetric map by Kuşçu *et al.*, 2009).

110 m. The deeper part of the Gulf is the Burgaz depression, which is located along the southern shore and in the central part among Kapaklı, Burgaz, and Kursunlu. Each of the two stations is suitable for sedimentation and cyst deposition due to the depression where finer materials can accumulate. Besides, Station 2 is located in the offshore of the Gemlik Port where international shipping traffic is very heavy.

A 3l Ruttner water sampler with a thermometer was used for water analyses at each sampling point. Salinity was determined by the Mohr-Knudsen method (Ivanoff, 1972) and dissolved oxygen (DO) by the Winkler method (Winkler, 1888). A standard plankton net with 40 µm mesh size was used and the samples were preserved in a 4% neutral formaldehyde solution. Organisms were concentrated by settling from 3 l water and examined in a Sedgwick-Rafter chamber. Observations and quantitative analyses were performed through an inverted phase contrast microscope equipped with a microphoto system at a magnification of 400x.

For the identification of the *T. corniger* and the species belonging to the genus *Tintinnopsis* which were found in the studies conducted in the Turkish waters and listed in Table I, the descriptions by Jörgensen (1924), Kofoid and Campbell (1929, 1939), Campbell (1942), Balech (1959), Hada (1964) were utilized.

RESULT

Tintinnopsis corniger Hada, 1964 was observed for the first time from the Turkish coastal waters.

Tintinnopsis corniger Hada, 1964 (Fig. 2):

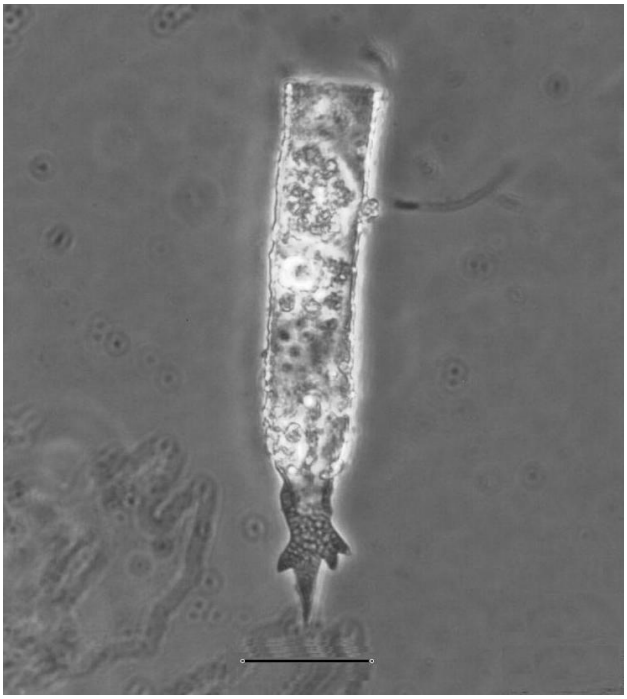

Fig. 2. *Tintinnopsis corniger* from Gulf of Gemlik. Scale bar: 40 µm.

Lorica 165-170 µm (mean 167±1.9 µm) long, opening diameter 30-33 µm (mean 31±1.1 µm); long, slender, mostly cylindrical, agglomerated, with branched aboral horn. Aboral horn 40-45 µm (mean 43±2 µm) long, without foreign particles, with 1-4 branches and fine reticulation.

Distribution

August 2010 (station 1: 28°C, 17 ppt, DO 8.9 mg l^{-1}; station 2: 28°C, 17 ppt, DO 7.96 mg l^{-1}; approximately concentration 400 ind.l^{-1}), October 2010 (station 1: 18°C, 16 ppt, DO 8.2 mg l^{-1}; station 2: 19°C, 18 ppt, DO 13.1 mg l^{-1}; approximately concentration 850 ind.l^{-1}).

Table I.- Distribution of *Tintinnopsis* species in Turkish coastal waters and literature sources for this checklist.

	Black Sea	Sea of Marmara	Aegean Sea	Levantine Sea
Tintinnopsis beroidea Stein	4, 7, 10, 11, 12		2, 3, 8, 12, 13	12, 14, 15
Tintinnopsis bütschlii Daday			2, 3, 8	15
Tintinnopsis campanula (Ehr.) Daday	4, 7, 10, 11, 12		1, 2, 3, 8, 9, 12, 13, 18, 19	12, 14, 15
Tintinnopsis compressa Daday	11, 12		3, 12	12, 15
Tintinnopsis corniger Hada		20		
Tintinnopsis cylindrica Daday	4, 5, 10, 11, 12		2, 3, 6, 8, 9, 12, 13, 17, 18, 19	12, 14, 15
Tintinnopsis lobiancoi Daday	4, 10		2, 3, 8, 13, 18	15
Tintinnopsis nana Lohmann			3	15
Tintinnosis nucula (Fol) Brandt	4, 7, 10			
Tintinnopsis plagiostoma Daday			3	15
Tintinnopsis radix (Imhof) Brandt	4, 10	16	3, 12, 13, 17, 19	12, 14, 15
Tintinnopsis strigosa Meunier	4, 10			
Tintinnopsis tocantinensis Kofoid & Campbell				15

Abbreviations used: **1**, Acara & Nalbantoğlu, 1960; **2**, Ergen, 1967; **3**, Koray & Özel, 1983; **4**, Benli, 1987; **5**, Feyzioğlu, 1990; **6**, Koray *et al*., 1992; **7**, Uysal, 1993; **8**, Koray & Kesici, 1994; **9**, Koray *et al*., 1994; **10**, Öztürk, 1999; **11**, Türkoğlu and Koray, 2000; **12**, Koray *et al.*, 2000; **13**, Çolak-Sabancı & Koray, 2001; **14**, Polat *et al.*, 2001; **15**, Polat *et al.*, 2002; **16**, Balkıs, 2004; **17**, Balkıs & Wasik, 2005; **18**, Temizkan , 2008; **19**, Balkıs & Toklu-Alıçlı, 2009; **20**, This study.

In addition, a checklist of 13 *Tintinnopsis* species from the Turkish seas is provided (Table I). There are few data on obtained species from the Sea of Marmara because of the limited studies in this region.

DISCUSSION

The period of tintinnid occurrence seems to be species-specific, and neritic tintinnids can survive under unfavorable conditions by forming resting cysts (Pierce and Turner, 1993; Kamiyama *et al.*, 1995; Dolan *et al.*, 2006). Hada (1964) described a new tintinnid, *Tintinnopsis corniger*, from Japanese waters. Then, this species was frequently reported in later studies (Nomura *et al.*, 1992; Kamiyama, 1994; Kamiyama and Tsujino, 1996; Kamiyama *et al.*, 2001; Kamiyama and Matsuyama, 2005; Nakane *et al.*, 2008). It was also reported from the Gulf of Mexico, Atlantic Ocean (Balech, 1968), Coos Bay, Oregon, USA (Pierce *et al.*, 1997), Thau Lagoon, the northern Mediterranean (Lam-Hoai *et al.*, 1997; Dupuy *et al.*, 2000; Lam-Hoai and Rougier, 2001; Collos *et al.*, 2005), Lake Faro Sicil, Italy (Sacca *et al.*, 2008), and Damietta Harbor, Egypt (Dorgham *et al.*, 2009).

Hada (1964) stated that this species can be found at low salinities. According to the following studies salinities of up to 30 ppt favour the developement of *T. corniger* (Kamiyama and Tsujino, 1996; Kamiyama *et al.*, 2001, Kamiyama and Matsuyama, 2005; Nakane *et al.*, 2008). In previous studies (Godhantaraman and Uye, 2003; Nakane *et al*., 2008), the maximum density of *T. corniger* was between 10 ind. l-1 and 100 ind. l^{-1} and the salinity of the brackish-water lagoonal system ranged between 20 and 32 ppt. However, Sacca *et al.* (2008) reported the abundance of *T. corniger* as $4.52x10^3$ ind. l^{-1} at the salinity higher than 30 ppt. Salinity of surface water in the Sea of Marmara is significantly influenced by the Black Sea characterized with brackish water (22-26 psu) (Ünlüata *et al.*, 1990).

The Sea of Marmara has many ports open for national and international shipping. It is known that in shipping, organisms are transferred with ballast water in tank sediments and attached to the ships' hull or sea chests (David *et al.*, 2007). The genus *Tintinnopsis* is neritic and this restricts its distribution for long distance in natural pathways. The presence of *T. corniger* in ballast water samples suggests that this is a possible mechanism of transport for this species (Pierce *et al.*, 1997). The fact that *T. corniger* has been reported in most of the studies conducted in these regions suggests that transport via ballast water may be the sources of its

presence in the Sea of Marmara. Detailed studies on tintinnids were not carried out in Turkish waters. Possibly, that species could be obtained previously if more studies had been achieved. Additionally, this genus can form cysts and cysts may serve as dispersal forms (Gavrilova and Dolan, 2007). While planktonic species are investigated throughout the water column, detailed cyst analyses should be also conducted on the sediment samples. If the cyst of this species in the sediment had been reported previously, a more precise result could have been obtained about the way of transport for *T. corniger* to the Sea of Marmara.

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