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SHORT PAPER

First Report of a New Invasive Species *Oithona davisae* Ferrari and Orsi, 1984 (Copepoda: Cyclopoida) in the Sea of Marmara

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Abstract

Oithona davisae (Copepoda: Cyclopoida) is reported for the first time from the Marmara Sea and added to the regional check-list of plankton species of Turkish seas. Seasonal abundances of the recent invasive *O. davisae* were investigated in Büyükçekmece Bay from March 2014 to February 2015. *O. davisae* was more abundant at the coastal area of the bay with a peak abundance reached in September 2014. While the average abundance of *O. nana* was maximum in September 2014, the highest average abundance of *O. similis* was in June 2014.

Keywords: *Oithona davisae*, invasion, Marmara Sea, zooplankton.

Yeni Bir İstilaci Tür Olan *Oithona Davisae* Ferrari and Orsi, 1984 (Copepoda: Cyclopoida)'nin Marmara Denizi'nde İlk Kaydı

Özet

Bu çalışma ile *Oithona davisae* (Copepoda: Cyclopoida) ilk kez Marmara denizinden kayıt edilmiş ve Türkiye Denizlerinin plankton türlerinin bölgesel kontrol listesine eklenmiştir. İstilacı tür *O. davisae*'nin mevsimsel bolluğu Büyükçekmece Körfezinde Mart 2014 - Şubat 2015 tarihleri arasında araştırılmıştır. *O. davisae* körfezin kıyısal bölgelerinde daha bol miktarlarda gözlenmiş ve maksimum bolluğu (3740 ind.m^{-3}) Eylül 2014 tarihinde tespit edilmiştir. *O. nana*'nın ortalama bolluğu Eylül 2014 tarihinde maksimum değerdeyken, *O. similis*'in en yüksek ortalama bolluğu Haziran 2014'tür.

Anahtar Kelimeler: *Oithona davisae*, istila, Marmara Denizi, zooplankton.

Introduction

Büyükçekmece Bay is located in the north-east of the Sea of Marmara. This bay is oceanographically an extension of the Sea of Marmara, having a strong and permanent salinity stratification created by the low-saline waters of Black Sea origin, flowing over the highly saline waters coming from the Mediterranean (Balkıs, 2003).

Biodiversity of the Sea of Marmara has been changing under eutrophication, climate change and invasion of alien species as well. The number of new records in this Sea is still being increasing (Isinibilir *et al*., 2010; 2015). The copepod *Acartia tonsa* Dana, 1849, the ctenophores *Mnemiopsis leidyi* A. Agassiz, 1865, *Beroe ovata* Bruguiere, 1789, *Liriope tetraphylla* Chamisso and Eysenhardt, 1821 (Isinibilir, 2012; Isinibilir *et al*., 2010; 2011) were the most probably brought into the Sea of Marmara by different vectors of introduction.

O. davisae inhabits eutrophic bays (Uye and Sano, 1995; Almeda *et al*., 2010) and is indigenous to Japan and China Seas, and other coastal areas (Hirakawa, 1988). It is an invasive species along the west coast of the US (Ferrari and Orsi, 1984) and is established in the Mediterranean (Saiz *et al*., 2003) and the Black (Mihneva and Stefanova, 2013) Seas.

O. davisae had not previously been reported from the Sea of Marmara. So, particular attention was paid to the study of the ecology of *O. davisae* in a new habitat for this species.

Materials and Methods

Samples of zooplankton were monthly collected during March 2014-February 2015 from six stations located in Büyükçekmece Bay (Figure 1). Samples were typically collected by vertical hauls from the

interface (18-20 m), to the sea surface using a WP2 closing net (200 µm mesh, 0.5 m mouth diameter). Samples were fixed with 4% formaldehyde solution and subsampled. Identification of specimens was carried out under a stereomicroscope using a Bogorov–Rass counting chamber. Temperature was measured with multi-probe system in surface water.

Results

Three copepod species were identified in the region: *Oithona nana* Giesbrecht, 1893, *Oithona similis* Claus, 1866, and *Oithona davisae* Ferrari and Orsi, 1984. *O. davisae* was not known to be present in Turkish coastal area before this study. Abundances (ind.m^{-3}) of all three species are shown in Table 1. While the average abundance of *O. davisae* was maximum (1998.5 ind.m^{-3}) in September 2014 with a mean temperature of 23.4 °C, the highest average abundances of *O. nana* and *O. similis* were recorded in May 2014 (3299.5 ind.m^{-3}) with a temperature of 20.7 °C and in June 2014 (67.1 ind.m^{-3}) with a temperature of 23.3 °C, respectively.

Subclass: Copepoda
Order: Cyclopoida
Family: Oithonidae
Genus: Oithona

Oithona davisae Ferrari and Orsi, 1984 (Figure 2C)

Oithona davisae had a total length ranging between 0.49-0.60 mm. They possess a strong and ventrally curved, sharply pointed rostrum. Anterior margin of prosome was rounded in lateral view

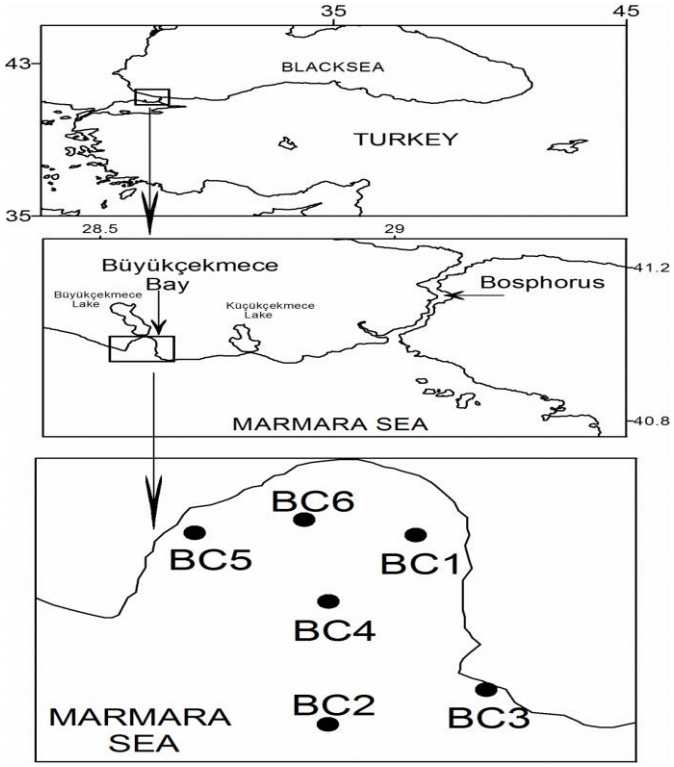

Figure 1. Positions of the sampling stations in Büyükçekmece Bay.

Table 1. Average abundance (ind.m^{-3}) of *O. nana, O. similis, O. davisae* and average water temperatures in the studied area

	O. nana	*O. similis*	*O. davisae*	T (°C)
March 2014	256.4	10.9	25.6	13.2
April 2014	1009.2	4.1	59.4	15.2
May 2014	3299.5	61.2	208.0	20.7
June 2014	2349.3	67.1	127.9	23.3
July 2014	2802.3	0.0	248.7	25.8
August 2014	2778.3	2.6	1174.6	24.9
September 2014	1507.7	0.0	1998.5	23.4
October 2014	0.0	0.0	0.0	18.6
November 2014	16.3	0.0	0.0	13.0
December 2014	3.5	0.0	0.0	12.1
January 2015	25.9	1.4	2.9	9.1
February 2015	16.1	1.1	0.0	8.5

(Figure 2C; 3A). The distal spine on the first inner lobe of the maxillule was very long, ca. 2.5 times as long as the next spine (Figure 3B, arrow); the endopod of the mandible bore 4 setae (Figure 3C).

During the period of our study, individuals of *O. davisae* (10-74 ind.m^{-3}) were first found at stations BC1, BC4, and BC5 in March 2014 in the Büyükçekmece Bay coast. Two months later, at the end of May 2014, more than 370 ind.m^{-3} of *O. davisae* in the central and coastal areas of the Bay were found (Figure 4). Intensive development of *O. davisae* population started in June and lasted until the end of September 2014, when its abundance had reached 3740 ind.m^{-3} in the central part of the Bay. In October 2014, this species was entirely absent and appeared again as very small amounts in November 2014 and January 2015 outside and at the mount of bay, respectively.

Throughout the period of study, the abundance of *O. davisae* gradually increased in the central locations compared to the mouth of the bay. At the station outside the bay (in more than 32 m water depth), the abundance of *O. davisae* was considerably less than inside the bay, over the entire period of study. From August until the end of September the contribution of *O. davisae* to total copepod numbers was calculated as 14 - 44% (Figure 5). During this study, the copepodite stages of *O. davisae* were observed at all seasons, but in higher quantity in August and September 2014.

Discussion

O. similis and *O. nana* are the most common species in the Sea of Marmara, found both in upper and lower layers of this sea (Isinibilir *et al*., 2008; 2011). *O. davisae* occurs only in the upper water layer of Sea of Marmara and can easily be differentiated from *O. similis* and *O. nana* (Figure 2): In *O. similis*, the rostrum is pointed ventrally, but much smaller. *O. nana* does not have a rostrum.

The introduction of *O. davisae* in the Sea of Marmara probably occurred through the upper layer flow of the Bosphorus, since the species is already

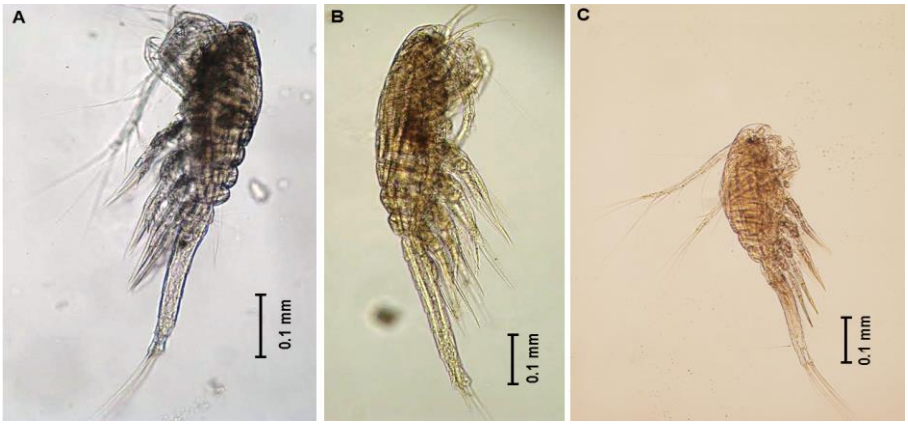

Figure 2. Left lateral views of *Oithona* species of the Sea of marmara showing form of rostrum: **A**. *O. nana*, female; **B**. *O. similis*, female; **C**. *O. davisae*, female.

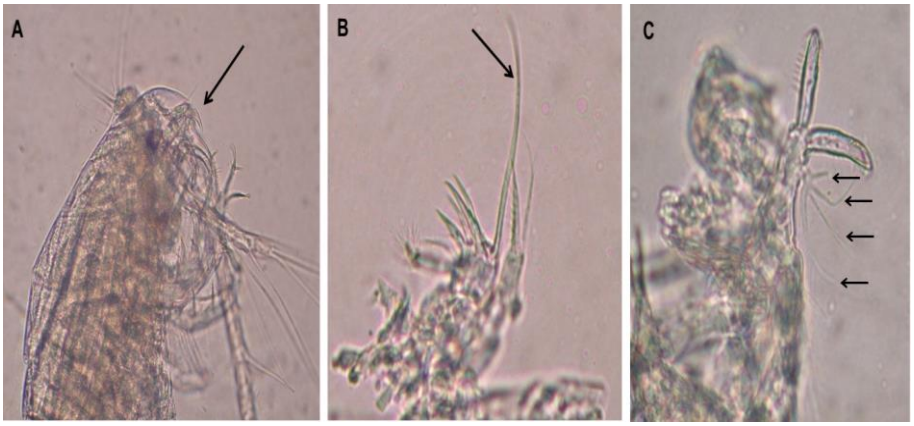

Figure 3. Photographs of *Oithona davisae* collected from the Sea of Marmara in the present study. A, rostrum, lateral view (arrow); B, maxillule, focusing on long distal-most spine (arrow) on the first inner lobe; C, mandible, focusing on setae on the endopod (arrows).

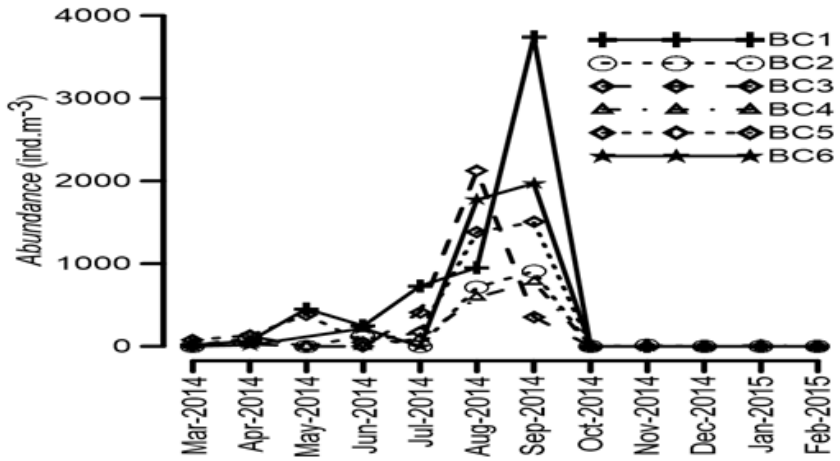

Figure 4. Seasonal variation in *O. davisae* abundance at six stations in Büyükçekmece Bay.

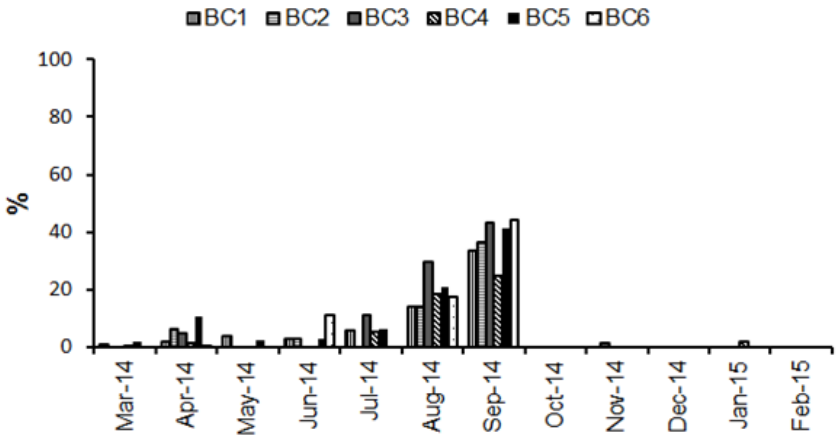

Figure 5. Seasonal changes of contribution (%) of *O. davisae* to total copepod abundance at six stations in Büyükçekmece Bay between March 2014 and February 2015.

present in the western Black Sea (Mihneva and Stefanova, 2013). On the other hand, ballast waters may also act as an important vector in introduction of this species. For a better understanding of the current status of *Oithona* species in the Sea of Marmara and the history of their introduction, it is necessary to re-examine the samples previously collected from the Sea of Marmara, directly examine the copepod species in ballast waters of ships arriving at ports in the Sea of Marmara, and inquire into the historical records of the ballast water' origins and destinations, on the basis of precise species identifications.

A zooplankton net with >200 µm mesh could be more suitable for small-sized copepod sampling, especially for the genera *Oithona* (Calbet *et al*., 2001, Altukhov *et al*., 2015). Although the mesh size of zooplankton net used for sampling in this study was not very suitable for small-sized copepods, high numbers of *Oithona* spp. were found in the upper water of Büyükçekmece Bay in spring–early autumn (especially in May, August and September). The seasonal abundance of *Oithona* spp. revealed that the highest numbers of *Oithona davisae* were found in August and September. However the peak of *Oithona nana* in Büyükçekmece Bay was in May and began to decrease till September. We suppose that *O. davisae* may compete with *O. nana* in Büyükçekmece Bay zooplankton. These related species are ecologically similar and they also have the same body size (Altukhov *et al*., 2014). Like *O. davisae*, *O. nana* is a eurythermic species and this species is present in the Sea of Marmara plankton all year round (Isinibilir *et al*., 2008). According to Isinibilir (2009), the highest numbers of *O. nana* were recorded in September-November, and the minimal densities occurred between February and June. So, both the biological features of *O. davisae* and the susceptibility of the native zooplankton community to invasion may favour the success of establishment of this species in the Marmara Sea.

As a result, *O. davisae* was reported for the first time from the Sea of Marmara and added to the regional check-list of zooplankton species of Turkish seas with this study. The peak abundance of *O. davisae* in Büyükçekmece Bay was registered in September 2014. Most likely, *O. davisae* will be the dominant copepod species in Büyükçekmece Bay in autumn hence forth.

Acknowledgments

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