

Marine harpacticoid (Copepoda, Harpacticoida) fauna of the Dilek Peninsula (Aydın, Turkey)

Alp ALPER^{1*}, Serdar SÖNMEZ², Serdar SAK¹, Süphan KARAYTUĞ³

¹Department of Biology, Faculty of Science and Literature, Balıkesir University, Çağış Campus, Balıkesir, Turkey

²Department of Biology, Faculty of Science and Letters, Adıyaman University, Adıyaman, Turkey

³Department of Biology, Faculty of Art and Science, Mersin University, Çiftlikköy Campus, Mersin, Turkey

Received: 28.05.2014

Accepted/Published Online: 16.12.2014

Printed: 30.07.2015

Abstract: Interstitial and phytal harpacticoid fauna of the mediolittoral zone of the Dilek Peninsula within the border of Aydın Province in Turkey was investigated. Harpacticoid copepods were collected from 7 different localities between 2012 and 2013. As a result, a total of 78 species and subspecies belonging to 48 genera in 18 families were determined. In terms of species richness, the family Miraciidae ranked first with 17 species, followed by Ameiridae with 12 species; Laophontidae with 11 species; Ectinosomatidae with 6 species; Dactylopusiidae, Harpacticidae, Paramesochridae, and Tisbidae with 4 species each; Arenopontiidae and Thalestridae with 3 species each; Peltidiidae and Tetragonicipitidae with 2 species each; and Canthocamptidae, Darcythompsoniidae, Latiremidae, Louriniidae, Parastheneliidae, and Porcellidiidae with 1 species each. Based on the published records, it has been determined that the families Darcythompsoniidae, Peltidiidae, and Porcellidiidae, and hence their genera and species, as well as 24 other species and 1 subspecies, are recorded here for the first time from the Turkish seas. On the other hand, all identified taxa are new records for the study area. In addition, 8 species and 1 subspecies (*Ameira tenuicornis*, *Psyllocamptus tahuesensis*, *Harpacticus* aff. *obscurus*, *Harpacticus pacificus*, *Laophonte plana*, *Laophonte lignosa*, *Paramesochra helgolandica*, *Phyllopodopsyllus gracilipes*, and *Scutellidium longicaudum acheloides*) are recorded for the first time from the Mediterranean Sea.

Key words: Fauna, Harpacticoida, Dilek Peninsula, Mediterranean Sea

1. Introduction

The order Harpacticoida is one of the 10 orders of subclass Copepoda (Martin and Davis, 2001) and contains approximately 6000 species in 645 genera, which belong to 59 families (Ahyong et al., 2011). Marine harpacticoids are mostly benthic microcrustaceans, although a few are planktonic or are symbiotic with other animals. They are commonly the second most abundant taxon after nematodes in marine sediments (Coull, 1977; Giere, 2009; Mascart et al., 2013). Harpacticoids also inhabit phytal habitats and show high diversity and greater abundance than the other meiofaunal elements (Kito, 1975; Gheerardyn et al., 2009; Jayabarathi et al., 2012).

Biodiversity is a general term used to describe the degree of variation of life on earth, but specifically this refers to genetic variation, species variation, or ecosystem variation within an area. Global biodiversity is being lost at an unprecedented rate as a result of human activities, and decisions must be taken now to battle this trend (De Biaggi et al., 2010). Taxonomy provides greater understanding

about biodiversity in order to make effective decisions for sustainable use of natural resources and conservation of biodiversity (Ojaveer et al., 2014). Indeed, taxonomy is the key tool for improving knowledge on biodiversity. Taxonomic information is also essential for authorities in detecting, managing, and controlling invasive species. Effective control and management measures can only be implemented when species are correctly and promptly identified (Granjou et al., 2014). In developing countries, especially those with great biodiversity, the number of protected areas has increased rapidly (Naughton-Treves et al., 2005). However, without knowing what is protected, it is impossible to decide where to establish protected areas. Dilek Peninsula National Park, which is located between the Didim and Kuşadası districts of Aydın Province, is an important protected area of Turkey. The peninsula was announced as a national park in 1966 (Özenoğlu and Gökler, 2002).

The first study concerned with the marine harpacticoid fauna of Turkey was performed by Noodt (1955); 52

* Correspondence: alpalper80@gmail.com

species and subspecies were reported from the littoral zone of the Sea of Marmara. Subsequent records of the Turkish marine harpacticoid fauna between 1955 and 2014 were summarized by Sönmez et al. (2014).

2. Materials and methods

Harpacticoids were collected from 7 stations (Figure; Table) along the shore of the peninsula between May 2012 and June 2013. Interstitial samples were collected using the Karaman–Chauppis method (Delamare Deboutteville, 1954). Macroalgae were collected from the splash zone of rocky shores by bare hand to determine the phytal harpacticoids. Collected samples were preserved in 4% formalin solution in seawater. In the laboratory, harpacticoids were extracted from detritus using a Pasteur pipette under an OLYMPUS SZX-12 stereomicroscope and placed in 5-mL glass tubes with 70% ethanol. Specimens were prepared using the method described by Karaytuğ and Sak (2006) and were identified under an Olympus BX-50 microscope equipped with a differential interference contrast attachment. Huys et al. (1996), Wells (2007), and other relevant literature were used for identification. Specimens were deposited in the Zoology Museum of Mersin University, Faculty of Science and Art, Department of Biology.

3. Results

A total of 78 species/subspecies within 18 families were identified. Identified taxa are as follows:

Order: HARPACTICOIDA Sars, 1903

Suborder: OLIGOARTHRA Lang, 1944

Family: AMEIRIDAE Monard, 1927

Ameira atlantica Noodt, 1958

Material examined: (II). 56: 2♀♀.

Distribution in Turkey: Mediterranean Sea (Alper et al., 2010).

Ameira parvula (Claus, 1866)

Material examined: (I). Y10: 1♀, 1♂; (II). 57: 4♀♀; (III). 57: 5♀♀; 60: 6♀♀.

Distribution in Turkey: Sea of Marmara (Noodt, 1955; Karaytuğ and Sak, 2006), Mediterranean Sea (Karaytuğ and Sak, 2006; Alper et al., 2010).

Ameira tenuicornis Scott T., 1902

Material examined: (I). 60: 1♀.

Distribution in Turkey: New record.

Ameira sp. 1.

Material examined: (I). 58: 1♀; 60: 4♀♀; Y10: 5♀♀. (II). 56: 2♀♀, 1♂; 59: 2♀♀; 60: 1♀; 61: 2♀♀; Y10: 2♀♀. (III). 59: 2♀♀, 1♂; 60: 1♀; 61: 3♀♀.

Ameira sp. 2.

Material examined: (II). 56: 1♀.

Filexilia marinovi Conroy-Dalton & Huys, 1997

Material examined: (II). 61: 1♀ (dissected in 6 slides); (III). 61: 1♀.

Distribution in Turkey: New record.

Leptomesochra sp.

Material examined: (II). 56: 2♀♀.

Nitokra sp.

Material examined: (I). Y10: 3♀♀, 1♂.

Nitokra typica Boeck, 1865

Material examined: (III). 60: 3♀♀.

Distribution in Turkey: New record.

Psyllocamptus eridani Ceccherelli, 1988

Material examined: (II). 58: 2♀♀; (III). 58: 4♀♀; 59: 6♀♀.

Distribution in Turkey: New record.

Psyllocamptus propinquus (Scott T., 1895)

Material examined: (III). 57: 1♀ (dissected in 6 slides).

Distribution in Turkey: New record.

Psyllocamptus tahuesensis Gómez, 2002

Material examined: (I). Y10: 1♀.

Distribution in Turkey: New record.

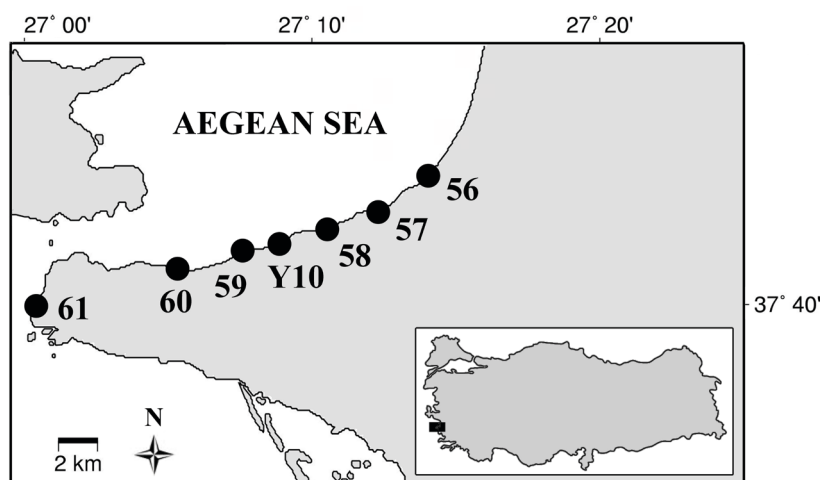


Figure. The sampling stations and the study area.

Table. Coordinates and sampling dates of the stations.

| Station no. | Locality | Beach sediment | Sampled habitat | Coordinates | Sampling dates | | |
|-------------|--------------------|----------------|-----------------------------|------------------------------|----------------|------------|------------|
| | | | | | I | II | III |
| 56 | Venüs beach | Sand | Interstitial | 37°43'33.8"N 27°14'08.6"E | | | |
| 57 | İçmeler beach | Sand + pebble | Interstitial, macroalgae | 37°42'29.4"N 27°12'18.4"E | | | |
| 58 | Aydınlık beach | Sand + pebble | Interstitial, macroalgae | 37°42'00.8"N 27°10'32.8"E | | | |
| Y10 | Kavaklıburun beach | Sand + pebble | Interstitial | 37°41'33.4"N 27°08'56.8"E | 22.05.2012 | 25.10.2012 | 14.06.2013 |
| 59 | Karasu beach | Pebble | Interstitial | 37°41'23.1"N 27°07'43.5"E | | | |
| 60 | Mersin deresi | Pebble | Interstitial, macroalgae | 37°40'52.5"N 27°05'20.7"E | | | |
| 61 | Dipburun | Sand + pebble | Interstitial, macroalgae | 37°39'48.3"N 27°00'32.6"E | | | |

Family: ARENOPONTIIDAE Martínez Arbizu & Moura, 1994

Arenopontia nesaie Cottarelli, 1975

Material examined: (II). 56: 6♀♀ (1 dissected in 6 slides); 61: 1♀, 1♂.

Distribution in Turkey: Sea of Marmara (Sak et al., 2008).

Neoleptastacus acanthus Chappuis, 1954

Material examined: (II). 56: <100♀♀, <30♂♂; 59: 5♀♀; (III). 59: 2♀♀.

Distribution in Turkey: Mediterranean Sea (Alper et al., 2010).

Psammoleptastacus barani Sak, Huys & Karaytuğ, 2008

Material examined: (II). 58: 1♂.

Distribution in Turkey: Black Sea (Sak et al., 2008).

Family: CANTHOCAMPTIDAE Brady, 1880

Mesochra pygmaea (Claus, 1863)

Material examined: (I). 60: 1♀.

Distribution in Turkey: Sea of Marmara (Noodt, 1955).

Family: DACTYLOPUSIIDAE Sars, 1905

Dactylopusia tisboides (Claus, 1863)

Material examined: (I). 58: 1♀; (II). 58: 2♀♀, 1♂; 61: 3♀♀; (III). 58: 9♀♀, 10♂♂; 60: 11♀♀; 61: 4♀♀.

Distribution in Turkey: Sea of Marmara (Noodt, 1955), Mediterranean Sea (Pulat et al., 2009; Alper et al., 2010).

Diarthrodes aegidius (Brian, 1927)

Material examined: (II). 57: 5♀♀, 1♂♂; 58: 5♀♀, 2♂♂; (III). 56: 1♀; 58: 1♂.

Distribution in Turkey: New record.

Diarthrodes ponticus (Kritchagin, 1873)

Material examined: (I). 58: 1♀, 1♂; (II). 57: 1♀; (III). 57: 2♀♀ (1 dissected in 6 slides); 58: 1♀, 1♂.

Distribution in Turkey: Mediterranean Sea (Alper et al., 2010).

Paradactylopusia brevicornis (Claus, 1866)

Material examined: (III). 58: 6♀♀; 60: 1♀; 61: 2♀♀.

Distribution in Turkey: Sea of Marmara (Noodt, 1955), Mediterranean Sea (Pulat et al., 2009).

Family: DARCYTHOMPSONIIDAE Lang, 1936

Leptocaris biscayensis (Noodt, 1955)

Material examined: (I). 61: 1♀.

Distribution in Turkey: New record.

Family: ECTINOSOMATIDAE Sars, 1903

Arenosetella sp.

Material examined: (I). 60: 6♀♀; 61: <40♀♀, <40♂♂.

Ectinosoma reductum Bozic, 1955

Material examined: (I). 60: 2♀♀; (II). 57: 1♀; 59: 1♀; 60: 1♀; (III). 57: 1♀; 58: 1♀; 60: 1♀; Y10: 1♀.

Distribution in Turkey: Mediterranean Sea (Sönmez et al., 2012).

Ectinosoma soyeri Apostolov, 1975

Material examined: (I). Y10: 1♀; (II). 58: 3♀♀; (III). 58: 1♀.

Distribution in Turkey: Mediterranean Sea (Alper et al., 2010; Sönmez et al., 2012).

Glabrotelson bodini (Apostolov, 1974)

Material examined: (III). Y10: 1♂.

Distribution in Turkey: Mediterranean Sea (Alper et al., 2010; Sönmez et al., 2012).

- Microsetella norvegica* (Boeck, 1865)
Material examined: (I). 60: 2♀♀, 2♂♂; (II). 57: 1♀; 58: 1♀; 59: 2♀♀; 60: 1♀; 61: 1♀; (III). 56: 1♀; 58: 1♀; Y10: 1♂.
Distribution in Turkey: Mediterranean Sea (Alper et al., 2010; Sönmez et al., 2012).
- Noodtiella* sp.
Material examined: (II). 59: 1♀.
Family: HARPACTICIDAE Dana, 1846
Harpacticus littoralis Sars G.O., 1910
Material examined: (I). 57: 1♀; 60: 1♀.
Distribution in Turkey: Mediterranean Sea (Alper et al., 2010).
- Harpacticus* aff. *obscurus* T. Scott, 1895
Material examined: (II). 57: 4♀♀ (1 dissected in 6 slides); 58: 4♀♀; 60: 6♀♀; 61: 5♀♀; (III). 57:10 ♀♀; 58: 3♀♀; 60: 4♀♀; 61: 6♀♀.
Distribution in Turkey: New record.
- Harpacticus pacificus* Lang, 1965
Material examined: (II). 57: 1♀ (dissected in 6 slides).
Distribution in Turkey: New record.
- Harpacticus* aff. *tenellus* G. O. Sars, 1920
Material examined: (II). 61: 1♀.
Distribution in Turkey: New record.
Family: LAOPHONTIDAE T. Scott, 1905
Afrolophonte pori Masry, 1970
Material examined: (I). 60: 50♀♀, 30♂♂; (II). 56: 11♀♀, 3♂♂; 59: 11♀♀, 3♂♂; 60: 9♀♀, 9♂♂; 61: 1♂; (III). 57: 11♀♀, 4♂♂; 58: 15♀♀, 2♂♂; 59: 3♀♀, 2♂♂; 60: 9♀♀, 3♂♂.
Distribution in Turkey: Mediterranean Sea (Alper et al., 2010).
- Echinolaophonte hystrix* (Brian, 1928)
Material examined: (II). 61: 1♀; (III). 61: 1♀ (dissected in 9 slides).
Distribution in Turkey: New record.
- Heterolaophonte curvata* (Douwe, 1929)
Material examined: (I). 57: 2♀♀, 1♂; 58: 1♀, 1♂.
Distribution in Turkey: Black Sea (Kaymak et al., 2012), Mediterranean Sea (Kaymak and Karaytuğ, 2014).
- Heterolaophonte stroemi* (Baird, 1934)
Material examined: (II). 61: 4♀♀ (1 dissected in 6 slides), 1♂; (III). 60: 6♀♀ (1 dissected in 6 slides), 3♂♂.
Distribution in Turkey: Mediterranean Sea (Karaytuğ and Sak, 2006).
- Klieonychocamptus ponticus* (Serban and Plesa, 1957)
Material examined: (III). 56: 4♀♀; Y10: 5♀♀.
Distribution in Turkey: Black Sea (Kaymak et al., 2012).
- Laophonte cornuta* Philippi, 1840
Material examined: (III). 61: 2♀♀.
Distribution in Turkey: Mediterranean Sea (Pulat et al., 2009).
- Laophonte lignosa* Hicks, 1988
Material examined: (I). 60: 1♂.
- Distribution in Turkey: New record.
- Laophonte plana* Fiers, 1986
Material examined: (I). 60: 1♀.
Distribution in Turkey: New record.
- Lipomelum adriaticum* (Petkovski, 1955)
Material examined: (II). 59: 1♂; 60: 1♀, 1♂.
Distribution in Turkey: New record.
- Paralaophonte brevirostris* (Claus, 1863)
Material examined: (I). 60: 1♀, 2♂♂.
Distribution in Turkey: Mediterranean Sea (Karaytuğ and Sak, 2006; Pulat et al., 2009), Black Sea (Kaymak et al., 2012).
- Paralaophonte quaterspinata* (Brian, 1917)
Material examined: (III). 61: 1♀.
Distribution in Turkey: Mediterranean Sea (Pulat et al., 2009; Alper et al., 2010).
- Family: LATIREMIDAE Bozic, 1969
Delamarella obscura Huys, Karaytuğ & Cottarelli, 2005
Material examined: (I). 60: 5♀♀.
Distribution in Turkey: Black Sea (Huys et al., 2005), Mediterranean Sea (Karaytuğ and Sak, 2006).
- Family: LOURINIIDAE Monard, 1927
Lourinia armata (Claus, 1866)
Material examined: (II). 61: 1♀ (dissected in 6 slides); (III). 58: 1♀.
Distribution in Turkey: Mediterranean Sea (Alper et al., 2010).
- Family: MIRACIIDAE Dana, 1846
Amonardia phyllopus (G. O. Sars, 1906)
Material examined: (II). 61: 1♀; (III). 60: 1♀; 61: 2♀♀.
Distribution in Turkey: Mediterranean Sea (Sönmez et al., 2014).
- Amonardia* sp.
Material examined: (III). 58: 1♀.
- Amphiascopsis cinctus* (Claus, 1866)
Material examined: (II). 61: 4♀♀; (III). 61: 3♀♀, 4♂♂.
Distribution in Turkey: Mediterranean Sea (Karaytuğ and Sak, 2006; Alper et al., 2010; Sönmez et al., 2014), Black Sea (Sönmez et al., 2014).
- Amphiascopsis thalestroides* (Sars G.O., 1911)
Material examined: (III). 61: 1♀.
Distribution in Turkey: New record.
- Diosaccus tenuicornis* (Claus, 1863)
Material examined: (II). 60: 1♂.
Distribution in Turkey: Mediterranean Sea (Sönmez et al., 2014).
- Diosaccus* sp. 1.
Material examined: (III). 58: 1♀.
- Diosaccus* sp. 2.
Material examined: (II). 61: 1♀ (dissected in 6 slides).
- Metamphiascopsis hirsutus bermudae* (Thompson I.C. & Scott A., 1903)
Material examined: (I). 60: 1♂.

Distribution in Turkey: Mediterranean Sea (Sönmez et al., 2014).

Paramphiascella sp.

Material examined: (II). 57: 1♀.

Psammotopa vulgaris Pennak, 1942

Material examined: (II). 56: 2♀♀; (III). 56: 3♀♀.

Distribution in Turkey: Mediterranean Sea (Sönmez et al., 2014).

Robertgurneya smithi Hamond, 1973

Material examined: (II). 57: 2♂♂.

Distribution in Turkey: Mediterranean Sea (Sönmez et al., 2014).

Sarsamphiascus angustipes (Gurney, 1927)

Material examined: (II). 61: 2♀♀, 4♂♂; (III). 61: 4♀♀, 6♂♂.

Distribution in Turkey: Sea of Marmara (Noodt, 1955), Mediterranean Sea (Sönmez et al., 2014).

Sarsamphiascus kawamurai (Ueda and Nagai, 2005)

Material examined: (I). 57: 3♀♀, 4♂♂; 60: 1♂; (II). 57: 9♀♀, 10♂♂; 58: 1♀; (III). 58: 1♀.

Distribution in Turkey: Mediterranean Sea (Sönmez et al., 2014).

Sarsamphiascus minutus (Claus, 1863)

Material examined: (II). 57: 4♀♀, 2♂♂; 61: 1♀; (III). 61: 3♀♀, 2♂♂.

Distribution in Turkey: Sea of Marmara (Noodt, 1955; Karaytuğ and Sak, 2006), Mediterranean Sea (Alper et al., 2010; Sönmez et al., 2014).

Schizopera brusinae Petkovski, 1954

Material examined: (II). 58: 2♀♀ (juvenile); 59: 1♀, 1♂.

Distribution in Turkey: Mediterranean Sea (Karaytuğ and Sak, 2006; Alper et al., 2010; Sönmez et al., 2014).

Schizopera gligici Petkovski, 1957

Material examined: (III). 61: 1♂.

Distribution in Turkey: Mediterranean Sea (Karaytuğ and Sak, 2006; Sönmez et al., 2014), Black Sea (Sönmez et al., 2014).

Schizopera sp.

Material examined: (I). Y10: 1♀, 1♂.

Family: PARAMESOCHRIDAE Lang, 1944

Emertonia constricta (Nicholls, 1935)

Material examined: (I). 61: 1♀, 1♂; (II). 61: 1♀; (III). 61: 1♀.

Distribution in Turkey: Sea of Marmara (Karaytuğ and Sak, 2006), Mediterranean Sea (Alper et al., 2010).

Emertonia sp.

Material examined: (II). 56: 1♀.

Leptopsyllus punctatus Mielke, 1984

Material examined: (III). 61: 2♂♂.

Distribution in Turkey: Mediterranean Sea (Alper et al., 2010).

Paramesochra helgolandica Kunz, 1936

Material examined: (II). 61: 1♂; (III). 61: 1♀.

Distribution in Turkey: New record.

Family: PARASTENHELIIDAE Lang, 1936

Parastenhelia spinosa (Fischer, 1860)

Material examined: (I). 60: 1♀, 1♂; (II). 57: 4♀♀, 6♂♂; 58: 12♀♀, 7♂♂; 61: 3♀♀, 2♂♂; (III). 57: 11♀♀, 10♂♂; 58: 7♀♀, 2♂♂; 61: 5♀♀, 6♂♂; Y10: 3♀♀, 1♂.

Distribution in Turkey: Mediterranean Sea (Alper et al., 2010).

Family: PELTIDIIDAE Claus, 1860

Alteutha depressa (Baird, 1837)

Material examined: (II). 58: 1♀.

Distribution in Turkey: New record.

Eupelte sp.

Material examined: (III). 61: 1♀.

Distribution in Turkey: New record.

Family: PORCELLIDIIDAE Boeck, 1865

Porcellidium fimbriatum Claus, 1863

Material examined: (III). 60: 2♀♀.

Distribution in Turkey: New record.

Family: TETRAGONICIPITIDAE Lang, 1944

Phyllopodopsyllus bradyi (Scott T., 1892)

Material examined: (I). 60: 1♀.

Distribution in Turkey: New record.

Phyllopodopsyllus gracilipes Wells and Rao, 1987

Material examined: (I). 61: <30♀♀, <30♂♂; (II). 61: 3♀♀; (III). 59: 1♀; 61: 1♀.

Distribution in Turkey: New record.

Family: THALESTRIDAE Sars, 1905

Eudactylopus robustus (Claus, 1863)

Material examined: (I). 57: 1♀.

Distribution in Turkey: New record.

Eudactylopus spectabilis (Brian, 1923)

Material examined: (III). 60: 3♀♀ (1 dissected in 6 slides).

Distribution in Turkey: Mediterranean Sea (Alper et al., 2010).

Eudactylopus sp.

Material examined: (III). 60: 1♀.

Family: TISBIDAE Stebbing, 1910

Scutellidium ligusticum (Brian, 1920)

Material examined: (II). 57: 2♀♀; 58: 1♀ (dissected in 6 slides); 61: 2♀♀ (1 dissected in 6 slides); (III). 58: 2♀♀; 61: 1♀.

Distribution in Turkey: New record.

Scutellidium longicaudum acheloides Itô Tat, 1976

Material examined: (II). 61: 1♀; (III). 60: 1♀ (dissected in 6 slides); 61: 1♀.

Distribution in Turkey: New record.

Tisbe furcata (Baird, 1837)

Material examined: (I). 58: 1♀, 2♂♂; (II). 61: 1♀; (III). 58: 2♀♀; 61: 1♀.

Distribution in Turkey: Sea of Marmara (Noodt, 1955; Karaytuğ and Sak, 2006), Mediterranean Sea (Karaytuğ and Sak, 2006).

Tisbe sp.

Material examined: (III). 60: 1 ♀.

4. Discussion

Anatolia has played an important role in the evolution of many animal and plant species, because of its situation as a natural bridge between Asia, Africa, and Europe as well as its topographical formations and climatic conditions. As Turkey is almost covered by 3 of the world's 34 biodiversity hotspots, the Caucasus, Irano-Anatolian, and Mediterranean regions (Şekercioğlu et al., 2011), many species formed in Anatolia during geological evolution.

Although Turkey has an extensive coastline consisting of many sandy and rocky shores, only limited faunistic information on harpacticoid copepods exists. On the basis of published data, only 140 harpacticoid species have been reported from Turkish seas so far (Sönmez et al., 2014).

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- In this study, a total of 78 taxa belonging to 18 families were identified. All identified taxa are new records for the study area. Three families (Darcythompsoniidae, Peltidiidae, Porcellidiidae), 24 species, and 1 subspecies are recorded for the first time from Turkish coasts; in addition, 8 species and 1 subspecies (*Ameira tenuicornis*, *Psyllocamptus tahuesensis*, *Harpacticus* aff. *obscurus*, *Harpacticus pacificus*, *Laophonte plana*, *Laophonte lignosa*, *Paramesochra helgolandica*, *Phyllopodopsyllus gracilipes*, and *Scutellidium longicaudum acheloides*) are recorded for the first time from the Mediterranean Sea.
- Therefore, the number of marine harpacticoid species that have been recorded so far from Turkey has reached 165 with the results of this study.
- Acknowledgments**
- This work was supported by TÜBİTAK under project number 111T576. We would like to thank Savaş Zengin, Seher Kuru, and Orkan Metin for their help in collecting the material.
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