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Harpacticoida (Crustacea: Copepoda) of the Three Islands on Aegean Sea (Turkey) with Eight New Records

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ABSTRACT

Harpacticoid fauna inhabiting in the mediolittoral zone of the islands of Bodrum (Turkey) called Kara, Çatal and Tavşan was investigated. For this purpose, a total of 23 stations were sampled. In conclusion, 22 species belonging to 11 families within 20 genera have been identified. These species are: *Pseudobradya robusta, Pseudobradya pelobates, Leptocaris biscayensis, Harpacticus* sp., *Parastenhelia spinosa, Sarsamphiascus angustipes, Ameira tenuicornis, Psyllocamptus eridani, Pseudameira breviseta, Leptomesochra infima, Pseudoleptomesochrella marina, Paramesochra helgalondica, Phyllopodopsyllus thiebaudi, Phyllopodopsyllus briani, Orthopsyllus sarsi, Laophonte cornuta, Paralaophonte brevirostris, Echinolaophonte armiger, Klieonychocamptus kliei, Klieonychocamptus kliei adriaticus, Afrolaophonte pori, Lipomelum adriaticum and Neoleptastacus acanthus.* Also, *Pseudobradya robusta, Pseudobradya pelobates, Pseudameira breviseta, Leptomesochra infima, Pseudoleptomesochrella marina, Echinolaophonte armiger* are newly reported from Turkish coasts.

KEYWORDS: Meiofauna, biodiversity, taxonomy, species.

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1. Introduction

Copepods are one of the most vital principal consumers in planktonic communities of marine environment and form the basis of almost all pelagic food web (McIntyre, 1969). The order Harpacticoida is one of the eleven orders of Copepoda and represented by 59 families, 645 genera and over 6000 species (Ahyong et al., 2011; Khodami et al., 2017).

Çatal Island, Kara Island and Tavşan Island are three small islands of Bodrum. The Aegean Sea covers 214.000 km^2 area and islands at the Aegean Sea cover about 23.000 km^2 (Atalay, 1982). During geological periods, crusts and ascent in the Aegean plaque and the changes at the sea level have formed the Aegean Sea (Atalay, 1982).

Turkish harpacticoid research was initiated by Noodt (1955) in the Marmara Sea. Until today, 202 harpacticoid species have been reported from Turkish coasts (Karaytuğ and Koçak, 2017). The main objective of this research was to contribute to the marine interstitial and phytal harpacticoid copepod fauna of Turkey.

2. Material and Methods

Copepod samples were collected from 23 different localities from Kara (7 stations), Çatal (10 stations) and Tavşan Islands (6 stations) (Fig.1, Table 1).Interstitial harpacticoids have been collected by using Karaman and Chappius method (Delamare-Deboutteville, 1964) from the intertidal zone of sandy beaches. Algal specimens were picked up from rocky shores by hand. All samples were stored in 70% ethanol. Harpacticoids have been sorted out from detritus by using Olympus SZX-16 stereo microscope. Examined specimens were initially dissected in lactic acid for identification. Dissected parts of the specimens were mounted on slides in lactophenol. Fracture of coverslip were placed between the coverslip and slide to obstruct compression of the specimen to facilitate rotation and observation of the specimen from desired angles. Identification of the specimens have been carried out with DIC (Differential Interference Contrast) attached to Olympus BX-51 compound microscope. Wells (2007), and other relevant literatures have been used for identification. All materials were deposited at the department of biology in Mersin University. For the terminology, Huys et al. (1996) has been used.

Table 1. Sampling localities

St.	Sampling Dates	Localities	Coordinates
1	17/06/2011	Çatal Island (Phytal)	N 37°0'24.10"; E 27°13'6.88"
2	17/06/2011	Çatal Island	N 37°0'23.56"; E 27°13'5.88"
3	17/06/2011	Çatal Island	N 37°0'24.58"; E 27°13'7.80"
4	17/06/2011	Çatal Island	N 37°0'23.11"; E 27°13'5.17"
5	17/06/2011	Çatal Island	N 37°0'22.29"; E 27°13'4.03"
6	17/06/2011	Çatal Island	N 37°0'20.21"; E 27°13'1.75"
7	17/06/2011	Çatal Island	N 37°0'19.26"; E 27°13'0.75"
8	17/06/2011	Çatal Island (Phytal)	N 37°0'21.16"; E 27°12'58.73"
9	17/06/2011	Çatal Island	N 37°0'22.07"; E 27°12'59.78"
10	17/06/2011	Çatal Island	N 37°0'24.50"; E 27°13'0.21"
11	19/06/2011	Tavşan Island (Phytal)	N 37°3'11.90"; E 27°13'59.90"
12	19/06/2011	Tavşan Island	N 37°3'11.87"; E 27°13'59.17"
13	19/06/2011	Tavşan Island	N 37°3'12.00"; E 27°14'00.44"
14	19/06/2011	Tavşan Island	N 37°3'11.72"; E 27°14'1.74"
15	19/06/2011	Tavşan Island	N 37°3'11.26"; E 27°14'1.59"
16	19/06/2011	Tavşan Island	N 37°3'10.90"; E 27°14'1.29"
17	27/06/2011	Kara Island	N 36°59'8.31"; E 27°27'13.33"
18	27/06/2011	Kara Island	N 36°59'8.57"; E 27°27'14.10"
19	27/06/2011	Kara Island	N 36°59'7.93"; E 27°27'12.20"
20	27/06/2011	Kara Island	N 36°59'77.6"; E 27°27'11.48"
21	27/06/2011	Kara Island	N 36°59'7.35"; E 27°27'10.81"
22	27/06/2011	Kara Island	N 36°59'7.33"; E 27°27'9.92"
23	27/06/2011	Kara Island (Phytal)	N 36°59'9.08"; E 27°27'4.37"

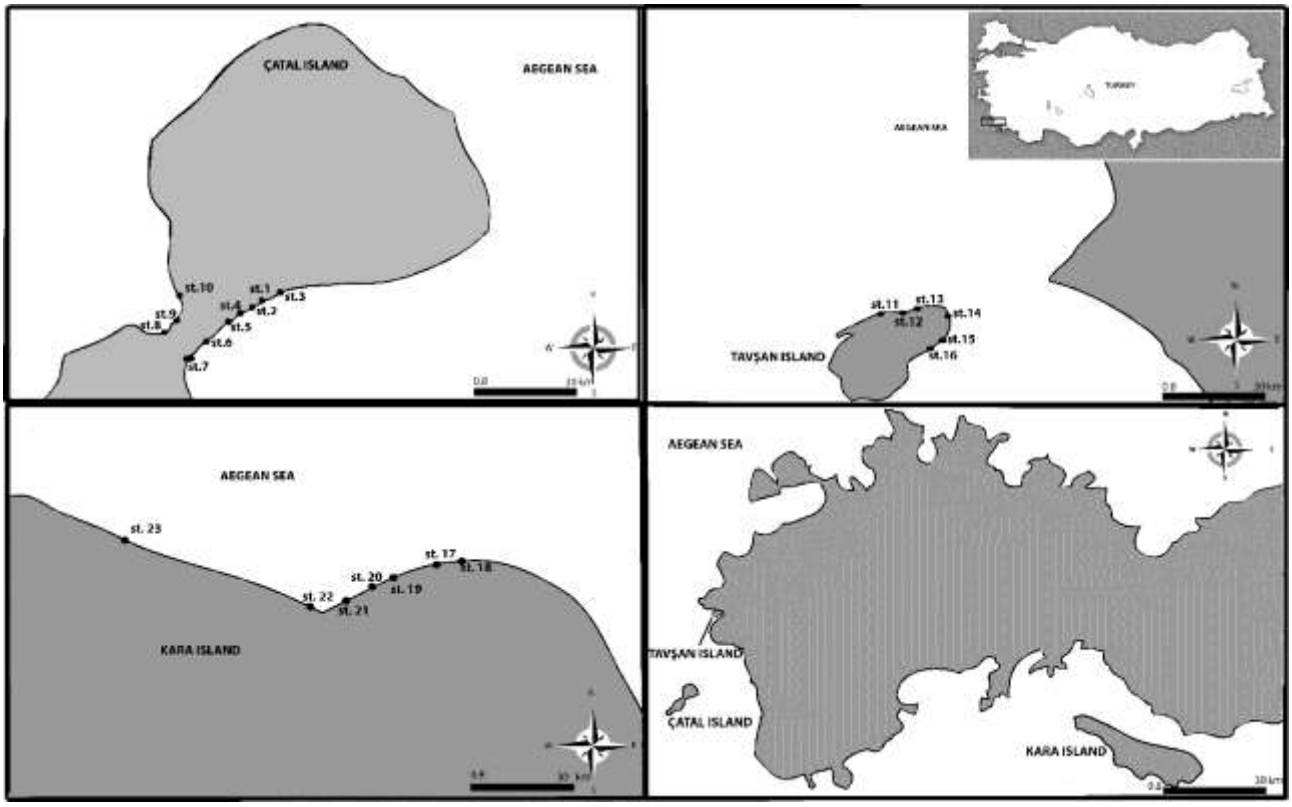

Figure1. Map of the sampling localities.

3. Results

As a conclusion of the examination, 22 species and 1 subspecies belonging to 11 families distributed within 20 genera have been identified (Table 2). According to the number of species; family Laophontidae takes place on the top with 6 species and 1 subspecies. This family was followed by Ameiridae with 5 species and Ectinosomatidae, Tetragonicipitidae with 2 species, Parastenheliidae, Miraciidae, Paramesochridae, Darcythompsoniidae, Orthopsyllidae, Arenopontiidae, with 1 species. Collected algae were identified as *Halopteris* sp. (St.1), *Cystoceria* sp. (St.23), *Corallina* sp. (St. 11).

Table 2. List of Harpacticoids determined and comparison with the previous records **A:** Noodt (1955) **B:** Karaytuğ and Sak (2006) **C:** Alper et al. (2010) **D:** Alper et al. (2015) **E:** Sönmez et al. (2014).

Family	Species	Localities	Distribution in Turkey
Ectinosomatidae	*Pseudobradya robusta* Sars G.O., 1910	11, 16, 21, 23	**New Record**
Ectinosomatidae	*Pseudobradya pelobates* Jakobi, 1954	11	**New Record**
Darcythompsoniidae	*Leptocaris biscayensis* Noodt, 1955	5, 6	A, D
Harpacticidae	*Harpacticus pulex* Humes, 1964	9, 11, 23	**New Record**
Parastentheliidae	*Parastenhelia spinosa* Fischer, 1860	1, 23	C, D
Miraciidae	*Sarsamphiascus angustipes* (Gurney, 1927)	11, 23	A, E
Ameiridae	*Ameira tenuicornis* T. Scott, 1902	20	D
Ameiridae	*Psyllocamptus eridani* Ceccherelli, 1988	18	D
Ameiridae	*Pseudameira breviseta* Klie, 1950	17	**New Record**
Ameiridae	*Leptomesochra infima* Monard, 1928	11	**New Record**
Ameiridae	*Pseudoleptomesochrella marina* Chappius and Rouch, 1961	2	**New Record**
Paramesochridae	*Paramesochra helgolandica* Kunz, 1936	2	D
Tetragonicipitidae	*Phyllopodopsyllus thiebaudi* Petkovski, 1955	9, 1	C
Tetragonicipitidae	*Phyllopodopsyllus briani* Petkovski, 1955	12,13,14,15,16	B, C
Orthopsyllidae	*Orthopsyllus sarsi* Klie, 1941	1	**New Record**
Laophontidae	*Laophonte cornuta* Philippi, 1840	1, 10, 23	C, D
Laophontidae	*Paralaophonte brevirostris* Claus, 1863	2, 1	A, B, C, D
Laophontidae	*Echinolaophonte armiger* Gurney, 1927	1	**New Record**
Laophontidae	*Klieonychocamptus kliei* Monard, 1935	2	B
Laophontidae	*Klieonychocamptus kliei adriaticus*	3, 16	C

	Petkovski, 1954		
Laophontidae	*Afrolaophonte pori* Masry, 1970	2,3,4,5,6,7,12,13,4,15,17,19,20,24	B, C, D
Laophontidae	*Lipomelum adriaticum* Petkovski, 1955	4,9,13,16,17,19,20,22	D
Arenopontiidae	*Neoleptastacus acanthus* Chappius, 1954	2,4,5,24	C, D

Eight of the identified species (*Pseudobradya robusta*, *Pseudobradya pelobates*, *Pseudameira breviseta*, *Leptomesochra infima*, *Pseudoleptomesochrella marina*, *Echinolaophonte armiger*) have been newly reported from the Turkish coasts. Their localities, number of examined species and worldwide distribution are given below:

Family: Ectinosomatidae Sars G. O., 1903
Genus: *Pseudobradya* Sars G. O., 1904
Species: *Pseudobradya robusta* Sars G. O., 1910
Material examined: St. 11 (1 ♀), St. 16 (1 ♀), St. 21 (2 ♀♀), St. 23(2 ♀♀).
Distribution: Norway (Sars, 1910)
Remarks*:* *P. robusta* was originally described from Norway (Sars, 1910) and is reported for the first time since its description. The specimens examined in this study are generally in concordance with Sars's (1910) description. This species is separated by short caudal rami from the other species of this genus.
Species: *P. pelobates* Jakobi, 1954
Material examined: St. 11 (1 ♀).
Remarks: *P. pelobates* was originally described from Brazil (Jakobi, 1954) and then there is no record until this study. **(re)** Although the specimen that was examined in this study was generally very similar to those that were described and illustrated by Jakobi, 1954. It is worth to note that our specimen has relatively shorter inner endopod seta on P5 than the Brazilian population.
Family: Ameiridae Boeck, 1865
Genus: *Pseudameira* Sars G.O., 1911
Species: *Pseudameira breviseta* Klie, 1950
Material examined: St. 17 (9♀♀).
Distribution: Helgoland (Klie, 1950).
Remarks: This species is recorded for the first time outside of its *terra typica* in Helgoland with present study. When compared with the original description (Klie, 1950), no variation was observed between the two populations.
Genus: *Leptomesochra* Sars G.O., 1911
Species: *Leptomesochra infima* Monard, 1928
Material examined: St. 11 (1♀).
Distribution: France (Monard, 1928, Lang, 1948)
Genus: *Pseudoleptomesochrella* Lang, 1965
Species: *Pseudoleptomesochrella marina* Chappius and Rouch 1961
Material examined: St. 2 (1♀).
Distribution: Ghana (Atlantic Ocean) (Lang, 1965)
Remarks: *P. marina* was originally described from Spain, no other record has been given so far. In this study, this species was only found in Kara Island and represented with only 1 female and generally in concordance with the original description (Lang, 1965).
Family: Laophontidae Scott T., 1904
Genus: *Echinolaophonte* Nicholls, 1941
Species: *Echinolaophonte armiger* Gurney, 1927
Material examined: St. 1 (2♀♀, 2♂♂; 1♀ dissected).
Distribution: Suez Canal (Gurney, 1927), Tyrrhenian Sea (Brian 1928; Pesta 1959), Bermuda (Willey 1930), West Australia (Nicholls 1945), the Caroline Islands (Vervoort 1964), Brazil (Carvalho 1952), California (Lang 1965) and Atlantic Ocean (Marinov 1977).
Genus: *Afrolaophonte* Chappius, 1960
Species: *Afrolaophonte pori* Masry, 1970
Material examined: St.2 (23♀♀), St. 3 (9♀♀ 5♂♂), St. 4 (9♀♀ 6♂♂), St. 5 (5♀♀, 12♂♂), St. 6 (1♀), St. 7 (7♀♀ 5♂♂), St. 12 (24♀♀ 1♂) St. 13

(2♀♀), St. 14 (30♀♀ 13♂♂), St. 15 (3♀), St. 17 (6♀♀), St. 19 (9♀♀ 2♂), St. 20 (11♀♀ 1♂), St. 21 (13♀♀, 4♂), St. 22 (4♀♀ 1♂).

Distribution: Israel, Italy (Cottarelli *et al*., 1992), Turkey (Alper *et al*., 2010).

Remarks: Sönmez *et al*. (2018) redescribed *Afrolaophonte pori* by using the material collected from wide range of countries and have revealed variation on the segmentation of the third swimming leg. Some variation was also observed in the material examined in this study: P3 endopod may be 1 or 2-segmented; P3 exopod may be 2- or 3-segmented; P4 endopod 1-segmented, exopod 3-segmented; P5 baseoendopod bears 4 setae and exopod bears 4 setae. This variation is within the range of variation determined by Sönmez *et al*., (2018).

Family: Orthopsyllidae Huys, 1990

Genus: *Orthopsyllus* Brady and Robertson, 1873

Species: *Orthopsyllus sarsi* Klie, 1941

Material examined: St. 11 (1 ♀).

Distribution: Norway (Klie, 1941), Northern Cyprus (Karaytuğ and Koçak, 2017).

Remarks: *O. sarsi* has recently been recorded by Karaytuğ and Koçak (2017) from Mediterranean coast of Northern Cyprus. This species is a new record for Turkish Coast. Lang's population and the populations examined in this study are morphologically similar but all setae of P5 of the specimens in this study are not plumose. Lang (1948) gave the description of all setae on P5 as plumose.

4. Discussion

According to the published data (Alper et al., 2015; Karaytuğ and Koçak, 2017 and references therein), *Pseudobradya robusta*, *Pseudobradya pelobates*, *Pseudameira breviseta*, *Leptomesochra infima*, *Pseudoleptomesochrella marina*, *Echinolaophonte armiger* have been reported for the first time from Turkish seas with the present study. Number of marine harpacticoid copepod from the Turkish coasts has now risen up to 210 with this study.

Pseudobradya robusta, *Pseudobradya pelobates*, *Pseudameira breviseta*, *Leptomesochra infima*, *Pseudoleptomesochrella marina* have been recorded for the first time since their original description. New records of these species by this study makes their distribution highly disjunct which requires plausible explanation. Possible reasons for such disjunct distribution were discussed in detail by Alper et al. (2010).

Copepods are highly sensitive to the pollution especially to the anoxic conditions which are considered as one of the primary reasons for the absence of copepods in their habitat (Huys et al., 1996). It is interesting to remark that station 8 (western coast of Çatal Island) was the only one among 23 sampling localities in which no harpacticoid copepod was determined. This station is intensively used for human activities such as touristic visits, picnics etc. On the other hand, anthropogenic pollution (wastes of detergent, rubbish and others) could even be seen by naked eye (personal observation). Therefore, such pollution may be the reason for the absence of harpacticoid copepod in the area. Unfortunately, due to technical reasons, no chemical measurements in the study area could be taken during the study period, but in the future, it is planned to carry out an ecological study in the area to clarify the problem.

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