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Research on Ephemeroptera (Insecta) fauna of Aydın and Denizli (Türkiye) provinces

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Abstract

Although studies on the order Ephemeroptera are at a sufficient level in many of the provinces in the Aegean region, there is no comprehensive study on the provinces of Aydın and Denizli. Until now, four species from Aydın and two species from Denizli province have been reported from the Ephemeroptera order. The research being done in these provinces, which are the study regions, aims to fill in the gaps in the Aegean Area and provide more precise information about the national Ephemeroptera fauna.

With the aid of sieves and water scoops, nymphs were gathered from the habitats of each locality's various biological characteristics during the field experiments, which were conducted in 25 different locations throughout two provinces. Thirteen species were recognized after examination of the 1177 collected specimens.

In the study, five of the species identified from Aydın province and 12 of the species identified from Denizli province were recorded for the first time from the related provinces within the research area.

Keywords: Ephemeroptera, fauna, Aegean district, Türkiye

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Aydın ve Denizli (Türkiye) illeri Ephemeroptera (Insecta) faunası üzerine araştırmalar

Özet

Ege bölgesinde bulunan illerin birçoğunda Ephemeroptera takımı ile ilgili çalışmalar yeterli sayılabilecek düzeyde olmasına rağmen Aydın ve Denizli illeri ile ilgili yapılmış kapsamlı bir çalışma bulunmamaktadır. Ephemeroptera takımından günümüze kadar Aydın ilinden 4, Denizli ilinden ise 2 tür bildirilmiştir. Araştırma alanı olan bu illerde gerçekleştirilen çalışma ile Ege Bölgesi'ndeki eksikliklerin tamamlanması ve dolayısıyla ülkemizin Ephemeroptera faunası hakkında daha net verilerin ortaya konması amaçlanmıştır.

Arazi çalışmaları, iki ilden 25 farklı lokaliteden gerçekleştirilmiş ve her bir lokalitenin farklı ekolojik özelliklere sahip habitatlarından elek ve su kepçesi yardımıyla larvalar toplanmıştır. Toplanan 1177 örneğin teşhisi yapılmış ve 13 tür tespit edilmiştir.

Çalışmada Aydın ilinden tespit edilen türlerden 5 tanesi; Denizli ilinden tespit edilen türlerin ise 12 tanesi araştırma bölgesi içerisinde kalan ilgili illerden ilk kez tespit edilmişlerdir.

Anahtar kelimeler: Ephemeroptera, fauna, Ege bölgesi, Türkiye

1. Introduction

The Ephemeroptera order, which dates to the late Carboniferous or Permian periods, contains the earliest known primitive flying insects (approx. 290 million years ago) [1, 2].

Since they have a winged, immature stage known as the subimago, they stand apart from other insects. Ephemeroptera spend the most of their life cycles in water, and this period is the nymphal period with the highest morphological diversity as a result of their adaptation to different habitats in the water [3].

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The order Ephemeroptera is one of the significant groups investigated in zoogeographic studies due of the characteristics that limit their distribution, like as their extremely short adult lifespans, poor flying abilities during this time, and the fact that their nymphs are entirely aquatic [4].

Even though mayflies can be found in practically all sorts of freshwater habitats, each species in the order Ephemeroptera has a limited tolerance range and is extremely sensitive to organic contamination, which is why Ephemeroptera species are frequently utilized in water quality assessments. As a result of this, they have an important role in many biotic indices prepared [5]. Although it is recommended to use taxa at the species level in determining the water quality [6]; it is known that the Baetidae and Caenidae were highly tolerant to organic pollution, while the Heptageniidae, Ephemerellidae, and Leptophlebiidae families were considered as intolerant [7, 8, 9]. In addition, they are distributed in almost all fresh waters, can take toxic substances homogeneously with their different feeding habits, and gradual and long-term reactions to environmental changes provide a very important advantage in their usage as a bioindicator [10].

Although the studies on the Ephemeroptera fauna in the Aegean Region are at a level that can be considered sufficient in many provinces, there is no comprehensive study in Aydın and Denizli provinces. With this preliminary study carried out in these provinces, it was aimed to complete these deficiencies in the Aegean Region and to contribute the Ephemeroptera fauna of Türkiye.

2. Materials and methods

This study was carried out in 25 localities determined in Aydın and Denizli provinces between 27-30 June 2022 (Figure 1). In the field studies, sampling was made from areas with different ecological characteristics (stony or sandy ground structure, flow rate, presence of aquatic vegetation, clarity of water, etc.) in each locality. Larval specimens were collected using a sieve with 1mm mesh and water hand net from freshwater habitats and taken into sampling bottles containing 96% ethyl alcohol and values such as date, locality, altitude, and GPS coordinates were recorded (Table 1).

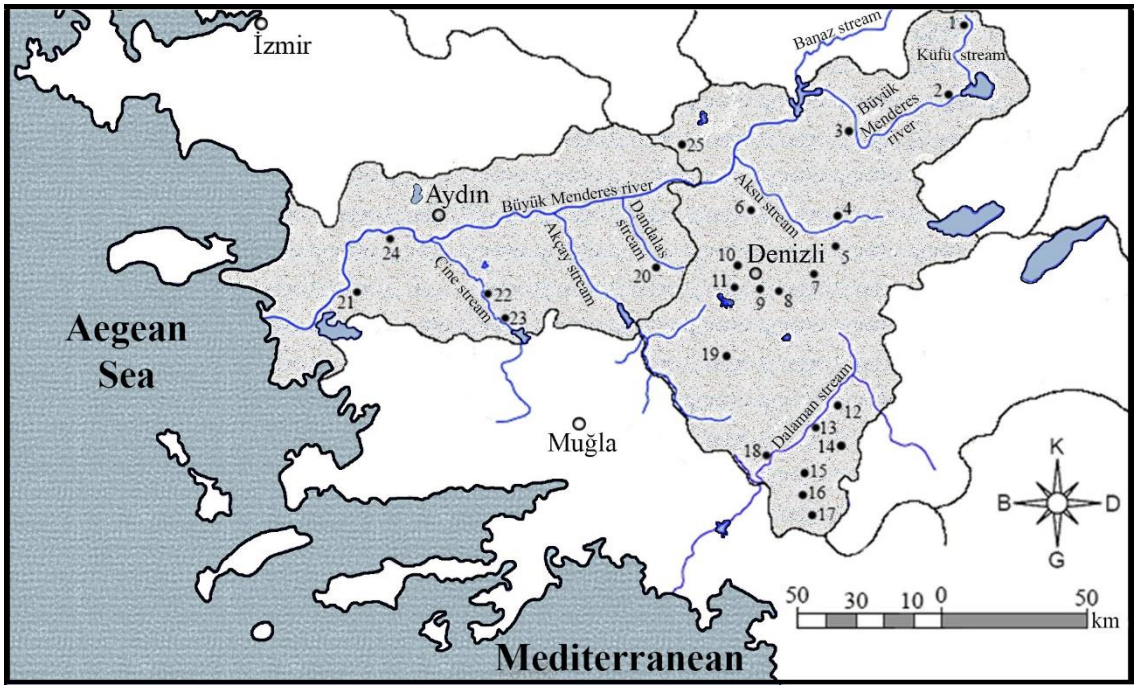

Figure 1. The geographical location of the study area and the sampling stations

All morphological and taxonomic features of the collected larvae were evaluated and microscope slides of taxonomic characters were prepared and identified. They were identified at the species level using references that Grandi (1960), Müller-Liebenau (1969), Belfiore (1983), Malzacher (1984), Elliott et al. (1988), Harker (1989), Hefti et al. (1989), Studemann et al. (1992), Novikova & Kluge (1994), Bauernfeind (1995), Kluge (1997), Eiseler (2005), Gattolliat & Sartori (2008), Bauernfeind & Soldán (2012), and Godunko et al. (2015) [11-25].

Leica MZ12.5 stereomicroscope and Leica DM LS2 microscope were used to examine samples and microscope slides. Examined larvae are labeled and kept as museum specimens in ESTU Zoology Museum, Eskişehir Technical University, Faculty of Science, Department of Biology.

Table 1. General information of sampling stations

Station	Location Name	Geographic Coordinates (N, E)	Elevation a.s.l (m)
1	Çağlayan village	38°20'53.6", 29°50'19.8"	870
2	Seraserli district	38°12'49.1", 29°49'15.2"	817
3	Hançalar bridge	38°07'53.8", 29°26'00.0"	676
4	Başçeşme village	37°49'53.2", 29°33'01.1"	785
5	Çambaşı village	37°46'47.5", 29°31'06.5"	720
6	Kaklık cave	37°51'20.5", 29°23'07.4"	518
7	Pınarbaşı Göz picnic ground	37°45'16.3", 29°14'47.8"	500
8	Gökpınar village	37°44'34.8", 29°09'44.3"	419
9	Gökpınar village	37°44'47.7", 29°09'21.8"	405
10	Karakurt village	37°46'21.0", 29°08'09.0"	347
11	Kayıhan village	37°45'29.3", 29°08'20.2"	364
12	Akşar village	37°12'43.2", 29°16'22.8"	798
13	Gölcük village	37°10'03.8", 29°12'57.2"	743
14	Yaylapınar village	37°08'33.6", 29°14'54.4"	1290
15	Kolak (Kusur) Lake	37°04'56.2", 29°11'40.5"	932
16	Sarıkavak village	37°01'49.8", 29°11'35.9"	710
17	Kirazlıyayla village	36°59'02.2", 29°12'26.1"	818
18	Sandalcık village	37°05'40.7", 29°06'08.0"	607
19	Medet village	37°30'42.2", 29°01'07.2"	900
20	Karacasu village	37°44'31.2", 28°37'33.6"	346
21	Bağarası village	37°43'00.3", 27°33'17.5"	17
22	Çaltı bridge	37°39'01.7", 28°00'00.6"	49
23	Eski Çine district	37°32'32.4", 28°03'45.4"	68
24	Koçarlı district	37°45'24.1", 27°41'28.0"	45
25	Buldan Yayla Lake	37°32'32.4", 28°03'45.4"	1158

3. Results

In this study, 1177 specimens belonging to six families, seven genera, and 13 species were identified from 25 collecting sites. Sampling data and the number of collected individuals per each species are given below:

List of Taxa
Baetidea Leach, 1815
***Baetis* Leach, 1815**
Baetis (Baetis) buceratus Eaton, 1870
Material examined: Loc-1, 28.06.2022, 4 larvae; Loc-3, 28.06.2022, 13 larvae; Loc-5, 28.06.2022, 18 larvae; Loc-6, 28.06.2022, 63 larvae; Loc-7, 28.06.2022, 3 larvae; Loc-8, 28.06.2022, 12 larvae; Loc-12, 29.06.2022, 2 larvae; Loc-13, 29.06.2022, 5 larvae; Loc-16, 29.06.2022, 5 larvae; Loc-18, 29.06.2022, 6 larvae; Loc-20, 29.06.2022, 19 larvae; Loc-22, 30.06.2022, 15 larvae; Loc-23, 30.06.2022, 1 larva.

Baetis (Baetis) fuscatus (Linnaeus, 1761)
Material examined: Loc-16, 29.06.2022, 5 larvae; Loc-18, 29.06.2022, 22 larvae; Loc-22, 30.06.2022, 2 larvae.

Baetis (*Baetis*) *lutheri* Müller-Liebenau, 1967
Material examined: Loc-5, 28.06.2022, 6 larvae; Loc-7, 28.06.2022, 3 larvae; Loc-12, 28.06.2022, 1 larva; Loc-13, 29.06.2022, 1 larva; Loc-17, 29.06.2022, 24 larvae.

Baetis (Baetis) nexus Navás, 1918
Material examined: Loc-1, 28.06.2022, 14 larvae; Loc-2, 28.06.2022, 15 larvae; Loc-3, 28.06.2022, 41 larva; Loc-5, 28.06.2022, 6 larvae.

Baetis (Baetis) vernus Curtis, 1834

Material examined: Loc-1, 28.06.2022, 40 larvae; Loc-3, 28.06.2022, 4 larvae; Loc-5, 28.06.2022, 19 larvae; Loc-6, 28.06.2022, 6 larvae; Loc-8, 28.06.2022, 2 larvae; Loc-12, 29.06.2022, 60 larvae; Loc-17, 29.06.2022, 3 larvae; Loc-20, 29.06.2022, 36 larvae; Loc-22, 30.06.2022, 25 larvae.

Baetis (*Rhodobaetis*) *rhodani* (Pictet, 1843)
Material examined: Loc-5, 28.06.2022, 27 larvae; Loc-7, 28.06.2022, 18 larvae; Loc-8, 28.06.2022, 2 larvae; Loc-12, 29.06.2022, 13 larvae; Loc-14, 29.06.2022, 50 larvae; Loc-16, 29.06.2022, 92 larvae; Loc-17, 29.06.2022, 99 larvae; Loc-18, 29.06.2022, 10 larvae; Loc-22, 30.06.2022, 2 larvae.

Baetis (Nigrobaetis) muticus (Linnaeus, 1758)
Material examined: Loc-18, 29.06.2022, 6 larvae.

***Cloeon* Leach, 1815**
Cloeon dipterum (Linnaeus, 1761)
Material examined: Loc-1, 28.06.2022, 5 larvae; Loc-6, 28.06.2022, 2 larvae; Loc-15, 29.06.2022, 15 larvae; Loc-19, 29.06.2022, 76 larvae; Loc-21, 30.06.2022, 59 larvae; Loc-22, 30.06.2022, 1 larva; Loc-23, 30.06.2022, 4 larvae; Loc-25, 30.06.2022, 21 larva.

Heptageniidae Needham in Needham & Betten, 1901
***Epeorus* Eaton, 1881**
Epeorus (Epeorus) zaitzevi Tshernova 1981
Material examined: Loc-18, 29.06.2022, 9 larvae.

***Ecdyonurus* Eaton, 1865**
Ecdyonurus (Ecdyonurus) russevi Braasch & Soldán, 1985
Material examined: Loc-16, 29.06.2022, 4 larvae.

Potamanthidae Albarda in Selys-Longchamps, 1888
***Potamanthus* Pictet, 1843**
Potamanthus luteus (Linnaeus, 1767)
Material examined: Loc-16, 29.06.2022, 3 larvae.

Ephemerellidae Klapálek, 1909
***Ephemerella* Walsh, 1863**
Ephemerella ignita (Poda, 1761)
Material examined: Loc-16, 29.06.2022, 58 larvae; Loc-17, 29.06.2022, 15 larvae; Loc-18, 29.06.2022, 3 larvae.

Caenidae Newman, 1853
***Caenis* Stephens, 1835**
Caenis macrura Stephens, 1836
Material examined: Loc-5, 28.06.2022, 2 larvae; Loc-15, 29.06.2022, 15 larvae; Loc-16, 29.06.2022, 5 larvae; Loc-21, 30.06.2022, 29 larvae.

4. Conclusions and discussion

According to the most recent studies, despite the fact that the order Ephemeroptera is represented by 166 species in Türkiye, there are still unexplored territories [26, 27]. Among previous studies on the Turkish Ephemeroptera order, there are no detailed studies on the Aydın and Denizli provinces, which are the research areas. However, four species (*Siphlonurus lacustris* Eaton, 1870; *Dacnogenia coerulans coerulans* Rostock, 1878; *C. macrura* Stephens, 1836 and *P. luteus* (Linnaeus, 1767)) from the Aydın province and two species (*Ephemera vulgata* Linnaeus, 1758 and *P. luteus*) from the Denizli province were reported from the Ephemeroptera order [28].

In the study, five of the identified species from Aydın province (*B. (B.) buceratus*, *B. (B.) fuscatus*, *B. (B.) vernus*, *B.* (*R.*) *rhodani*, and *C. dipterum*) and 12 of the identified species from Denizli province (*B. (B.) buceratus*, *B. (B.) fuscatus*, *B.* (*B.*) *lutheri*, *B. (B.) nexus*, *B. (B.) vernus*, *B.* (*R.*) *rhodani*, *B. (N.) muticus*, *C. dipterum*, *E. (E.) zaitzevi*, *E. (E.) russevi*, *E. ignita*, *C. macrura*) were recorded for the first time from which related provinces within the studying area.

The distribution of *E. russevi* on the same vertical line only in the eastern part of Bulgaria [29] and in the west of Türkiye (Balıkesir [28] and Denizli [in this article]), reveals that this species spreads over the Macedonia-Thrace line and is distributed only in limited regions.

Similarly, *E. zaitzevi* has a limited distribution around the world including Armenia, Türkiye, Syria, Iran, Iraq and Israel [30- 33]. It has been reported from the northeastern (Ardahan, Erzurum, Bayburt, Giresun, Gümüşhane, Kars, Tunceli) and southeastern (Hakkari, Şanlıurfa, Şırnak) regions of Anatolia [34]. When the distribution in our country is examined, it is seen that this species shows a linear distribution in the horizontal plane (independently of each other) including the Caucasian line in the north (except Tunceli) and the Eremial line in the south. Considering the entranceways of the aquatic fauna elements to Anatolia [35] and the distribution of this species in the Anatolia; the existence of this species in the Aegean Region (in Denizli province), where boreal fauna elements are dominant, indicates that this species originated from the south Caspian basin and spread into Anatolia through the Iran-Caucasus entranceways. It is possible that this species may have reached Western Anatolia through the inland water system in Central Anatolia and remained in a limited area in Denizli province.

Considering the geographical and ecological characteristics of the study area, it was concluded that the number of identified species was less than expected. Water pollution comes first among the main reasons for this situation: It has been reported that untreated domestic wastewater; livestock and mining wastes; discharge of textile and leather industry (especially concentrated in Denizli and Uşak provinces) waste to surface waters without treatment; uncontrolled use of chemical fertilizers and pesticides in agricultural areas; high boron concentration originating from geothermal power plants, and olive mill wastewater in Aydın province cause significant pollution in the water resources in the study area [36, 37]. In addition to all these, the dominance of *Baetis* species with high pollution tolerance among the species identified in the study also indicates the presence of organic pollution in the waters in the study area. However, the intensive use of surface waters for agricultural activities rapidly depletes natural reserves or causes deterioration of aquatic ecosystems, destroying the habitats and biodiversity of aquatic organisms. In addition, it was observed that many aquatic habitats dried up due to the decrease in precipitation and the increase in temperature during the study period.

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