Kafkas Univ Vet Fak Derg
16 (Suppl-B): S329-S333, 2010
DOI:10.9775/kvfd.2010.2527

RESEARCH ARTICLE

A Field Study on Bio-Ecology of *Hygrotus ahmeti* (Coleoptera: Dytiscidae) in the Eastern Anatolia Region of Turkey

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Makale Kodu (Article Code): KVFD-2010-2527

Summary

Hygrotus (Coelambus) ahmeti Hájek, Fery and Erman, 2005 is endemic for Turkey and it has limited distribution. Aquatic insects were collected once a month from eight different habitats around Erzurum (Çat district) during March-September 2009 period. *H. ahmeti* could be only sampled from one habitat. A total 546 insect specimens belonging to 27 species were sampled in this mountain meadow pond. *H. ahmeti* was a rare species in the study area (Distribution=12.5%). While the species were sampled with very low number during June-August period (one each specimen), it reached its peak (n=10) during September period. Habitat waters were determined as class I waters with regard to various parameters (Na, K, Mg, Ca, Cl, F, NH_4, NO_2, NO_3, SO_4, PO_4, water temperature, dissolved oxygen, pH and conductivity). We believe that these findings will contribute to both determining the diversity of aquatic insects in mountain meadow ponds and bio-ecology of *H. ahmeti*.

Keywords: *Hygrotus ahmeti, Dytiscidae, Ecology, Aquatic insects, Diversity, Turkey*

Doğu Anadolu Bölgesi'nde (Türkiye) *Hygrotus ahmeti* (Coleoptera: Dytiscidae)'nin Biyo-Ekolojisi Üzerine Bir Alan Çalışması

Özet

Hygrotus (Coelambus) ahmeti Hájek, Fery and Erman, 2005 Türkiye için endemik ve sınırlı yayılışa sahiptir. Mart-Eylül 2009 süresince Erzurum (Çat) civarında sekiz farklı habitattan ayda bir sucul böcekler toplandı. *H. ahmeti* yalnızca bir habitattan örneklenebildi. Dağ çayırı tipi bu habitatta 27 türe ait toplam 546 böcek toplandı. *H. ahmeti*, çalışma alanında nadir bir türdü (Yayılım=%12.5). Haziran-Ağustos süresince oldukça düşük sayıda (1'er birey) örneklenen tür, Eylül periyodunda en yüksek populasyon yoğunluğuna (n=10) ulaştı. Habitat sularının birçok parametre (Na, K, Mg, Ca, Cl, F, NH_4, NO_2, NO_3, SO_4, PO_4, su sıcaklığı, çözünmüş oksijen, pH ve iletkenlik) açısından I. sınıf su kalitesinde olduğu belirlendi. Bu bulguların, hem *H. ahmeti*'nin biyo-ekolojisine hem de dağ çayırı su birikintilerinde sucul böcek çeşitliliğinin belirlenmesine katkı sağlayacağını düşünüyoruz.

Anahtar sözcükler: *Hygrotus ahmeti, Dytiscidae, Ekoloji, Sucul böcekler, Çeşitlilik, Türkiye*

INTRODUCTION

Most dytiscids are excellent swimmers with compact, flattened, streamlined bodies. The flattened oar-like mid and hind legs often bear fringes of long swimming hairs. Adults and larvae of dytiscids occur together and have adapted to almost all aquatic habitats imaginable. Most dytiscids occur in lentic habitats such as shallow, weedy lakes, ponds, ditches, stock ponds, and springs while some occur in more specialized habitats [1]. Both adults and larvae are aquatic and predaceous, feeding not only on a wide range of invertebrates such as molluscs, annelids, and insect larvae, but also on vertebrates such as fish fry and small amphibians [2]. Generally, densely vegetated waters have a more diverse dytiscid fauna than barren ones [3].

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The Dytiscidae includes about 4000 species and 177 genera. About 1000 species have been recorded from the Palaearctic region. The number of Palaearctic genera is currently 66 [4,5]. The presence of about 149 species belonging to 29 genera in 6 subfamilies in Turkey is largely based on recent studies. The type localities of 24 of these 149 species are themselves located in Turkey [4-8]. According to Fery (2003), 30 species of *Hygrotus* were known to occur in the Palearctic region, 25 of these belonging to the subgenus *Coelambus* [9]. Eleven *Hygrotus* species have been recorded from Turkey so far [4-6]. *Hygrotus (Coelambus) ahmeti* Hájek, Fery and Erman, 2005 is endemic for Turkey [6].

In this study, our objectives were to determine some bio-ecological characteristics of *H. ahmeti*. Besides, we believe that our study will contribute to the determination of aquatic insect species diversity in highland ponds. Determining biological diversity in these habitats is important for natural conservation.

MATERIAL and METHODS

Study Area and Sampling Method

Aquatic insects were collected once a month from eight different type habitats (overflow of stream, stream bank, swamp, snow pool, and mountain meadow pond) around Erzurum (Çat district) during March-September 2009 period. The insects were collected in the habitat by means of a sieve, ladle and net having a mesh diameter of 0.5 mm. The samples were killed with ethyl acetate or in 70% alcohol solution and then the clayey and muddy substance on their surfaces was brushed off with a small paint brush in the laboratory. The samples were examined using a Nikon type SMZ-U stereo microscope. The species of Dytiscidae and Haliplidae were identified using the keys by Zaitzev [10] and Hájek et al.[6]. Hydrophilidae species were identified by Dr. Abdullah MART (Atatürk University, Turkey) and Hemiptera species were identified by Dr. Ali SALUR (Hitit University, Turkey).

Determining the Distribution of Hygrotus ahmeti

Distribution was determined as the percent of sampling sites in which a species was noted, according to the formula [11]:

C= n/N.100%

Where: C- distribution, n- number of sites of the species, N- number of all sites.

C1- sporadic appearance (constancy 0 - 20%)
C2- infrequent (20.1 - 40%)
C3- moderate (40.1 - 60%)
C4- frequent (60.1 - 80%)
C5- constant (80.1 - 100%)

Analysis of Water Quality in Habitats

Physico-chemical parameters of the habitats were measured in each month during insect collect procedures. Anions (NO_2, NO_3, SO_4, PO_4, F, Cl) and cations (Na, K, Mg, Ca, NH_4) of the water were analyzed by using Dionex ICS 3000 and Dionex ICS 1000 model devices (Ion Chromatography System), respectively. Physical parameters (water temperature, dissolved oxygen, pH and conductivity) were measured on site using portable devices. The results of water analysis were evaluated according to water quality criteria of Turkey Ministry of Environment [12]. Besides, some basic characteristics of aquatic habitats (appearance, water dept etc.) were recorded.

RESULTS

H. ahmeti could be only sampled from one habitat out of eight different type habitats. This habitat was a mountain meadow pond (39°37′N, 40°59′E; altitude of 1960 m). In this paper, the findings in this habitat where *H. ahmeti* could be only sampled are given. On the other hand, *H. ahmeti* had sporadic appearance (C=12.5%) in the study area.

Aquatic Insects Species and Their Population Fluctuations in the Habitat

The population fluctuations of aquatic insects during the study are shown in *Table 1*. A total of 546 aquatic insects of the 27 species present were collected during the study in the habitat. Aquatic insects could be sampled continuously during March-September period. During October period habitat water was dried up completely. The number of aquatic insects was very low in March (n=10). The number of the insects was peaked in May (n=172) and June (n=165).

H. ahmeti could not be sampled during March-May period in the habitat. The species could be sampled very low during June-August period (one each specimen), and it reached its peak in September (n=10) *(Table 1)*.

Familia Dytiscidae (11 species), Hydrophilidae (7 species) and Notonectidae (3 species) had high species diversity in the habitat. *H. ahmeti* could be sampled densely with three species from its own family *(Hygrotus inaequalis, Hyphydrus ovatus, Laccophilus minutus)*, *Haliplus* sp., *Notonecta* sp. and *Plea minutissima*.

Table 1. *Monthly population fluctuations of 27 aquatic insect species in the study area*
Tablo 1. *Çalışma alanındaki 27 sucul böcek türünün aylık populasyon dalgalanması*

	Family	Species	March	April	May	June	July	August	September	Total
Coleoptera	Dytiscidae	*Hygrotus ahmeti*	-	-	-	1	1	1	10	13
		Hygrotus inaequalis	-	-	-	-	7	3	4	14
		Hygrotus parallellogrammus	6	3	5	7	6	-	-	27
		Hydroglyphus geminus	-	-	4	2	13	-	-	19
		Hydroporus marginatus	-	-	1	1	1	-	-	3
		Hydroporus palustris	-	-	-	7	3	-	-	10
		Hydroporus thracicus	-	-	-	2	1	-	-	3
		Hyphydrus ovatus	-	-	23	4	1	1	7	36
		Laccophilus hyalinus	-	-	-	2	10	-	-	12
		Laccophilus minutus	-	-	11	27	-	6	20	64
		Scarodytes halensis	3	2	5	3	-	-	-	13
		Total	-	-	-	-	-	-	-	**214**
	Gyrinidae	*Gyrinus* sp.	-	-	1	-	-	-	-	1
		Total	-	-	-	-	-	-	-	**1**
	Haliplidae	*Haliplus* sp.	-	1	95	60	2	2	14	174
		Total	-	-	-	-	-	-	-	**174**
	Hydrophilidae	*Berosus luridus*	1	9	15	18	-	3	1	47
		Helophorus discrepans	-	-	-	-	3	4	-	7
		Helophorus longitarsis	-	-	-	-	2	-	-	2
		Laccobius sulcatulus	-	-	-	-	7	-	-	7
		Berosus signaticollis	-	-	-	16	-	-	-	16
		Helophorus sp.	-	3	2	-	-	-	-	5
		Helochares sp.	-	-	2	-	-	-	-	2
		Total	-	-	-	-	-	-	-	**86**
Hemiptera	Corixidae	*Corixa* sp.	-	1	-	-	-	1	1	3
		Sigara nigrolineata	-	1	-	2	-	1	1	5
		Total	-	-	-	-	-	-	-	**8**
	Naucoridae	*Ilyocoris cimicoides*	-	1	2	5	9	1	2	20
		Total	-	-	-	-	-	-	-	**20**
	Notonectidae	*Notonecta glauca*	-	1	1	-	-	-	-	2
		Notonecta viridis	-	-	-	1	-	-	-	1
		Notonecta sp.	-	-	-	5	2	-	7	14
		Total	-	-	-	-	-	-	-	**17**
	Pleidae	*Plea minutissima*	-	-	5	2	-	-	19	26
		Total	-	-	-	-	-	-	-	26
General Total			**10**	**22**	**172**	**165**	**68**	**23**	**86**	**546**

The Valeus of Physico-chemical Parameters in the Habitat of H. ahmeti

Monthly values of physico-chemical parameters in the breeding habitat of *H. ahmeti* are shown in *Table 2*. Sodium, Magnesium and Calcium were the highest in September period (31.65, 40.86 and 151.7, respectively). The highest values of ammonium, nitrite and nitrate were 0.42, 0.12 and 2.62, respectively during the study. Phosphate values were too low to be measured, except September period. Values of chlorine, flour and sulphate were very low. The highest water temperature was 24.6°C, and the lowest dissolved oxygen was 2 mg/l in the habitat during the study. pH was between 7 and 9.27, and while conductivity was the lowest in August (177 µS/cm), it was 442 µS/cm in September.

Habitat waters were determined as class I waters with regard to the parameters, except nitrite in March-April period and dissolved oxygen in September.

Some Basic Characteristics of Aquatic Habitat of H. ahmeti

The habitat was mountain meadow type pond which was natural, clear water, without current, generally permanent, exposed to direct sunlight, vegetation with *Potamogeton* sp. It continues to exist through some leakage throughout season. The water depth was between 5 and 60 cm in the area whose size was about 1.000 m^2.

Table 2. *Monthly fluctuations of physico-chemical parameters in the breeding habitat*
Tablo 2. *Üreme habitatındaki fiziko-kimyasal parametrelerin aylık dalgalanması*

Parameter	March	April	May	June	July	August	September
Sodium (mg Na^+/l)	12.31	5.54	13.4487	6.97	9.75	8.94	31.65
Potassium (mg K^+/l)	12.02	8.1	12.9507	5.84	6.60	5.75	11.63
Magnesium (mg Mg^+/l)	9.89	9.47	24.291	8.81	6.95	7.29	40.86
Calcium (mg Ca^+/l)	37.23	30.04	51.7122	34.44	20.59	18.53	151.7
Ammonium (mg NH_4^+/l)	0.31	0.4196	0.3397	<0.01	-	-	<0.001
Nitrite (mg NO_2^-/l)	0.12	0.02	-	0.0036	-	-	<0.002
Nitrate (mg NO_3^-/l)	2.62	0.85	-	0.52	-	0.097	0.1
Sulphate (mg $SO_4^=$/l)	46.33	37.02	33.4842	32.02	28.14	17.85	8.97
Phosphate (mg PO_4^{-3}/ l)	-	-	-	-	-	-	<0.0173
Flour (mg F^-/l)	0.18	0.33	0.2641	0.41	0.45	0.37	0.40
Chlorine (mg Cl^-/l)	7.56	5.79	4.3931	6.78	7.73	7.86	11.31
Water temperature (°C)	14.8	12.7	22.8	19.5	24.6	21.2	8
Dissolved oxygen (mg O_2 /l)	9.5	8.8	8.6	6.4	5.73	8.76	2
pH	8.52	8.57	8.68	8.42	8.9	9.27	7
Conductivity (µmhos/cm)	290	273	289	248	190	177	442

DISCUSSION

Low population density (2.38%) in the habitat and limited distribution (12.5%) in the study area of *H. ahmeti* can be caused by its low ecological tolerance. In a previous study, this species could be only sampled from four temporary habitats (Erzincan and Erzurum province of Turkey) and it was given as a new record for the world [6]. Since water was dried up in October in our study, this habitat can be evaluated as temporary/ generally permanent. While the number of aquatic insects decreased in the habitat in September, the number of *H. ahmeti* increased. This phenomenon might be caused by biology of *H. ahmeti*. According to our findings, *H. ahmeti* needs more time than most aquatic insects to be mature in the same habitat.

Since there were no polluting sources around the habitat and it was away from residential areas, low water parameters are normal. The reason why some parameters, especially nitrite, nitrate and sulphate, were high in March in the habitat could be related to the materials, carried into the habitat by snow melting. Basic reason of an increase of most physico-chemical parameters in September can be a decrease of water in the habitat because of evaporation. Environmental factors such as water chemistry, size of water, or habitat homogenity are assumed to be imported in determining assemblage structure of diving beetles [13-15]. On the other hand, Nilsson and Söderberg (1996) studied boreal lakes and did not detect a clear relationship between dytiscid faunas and water chemistry [16]. Since *H. ahmeti* could be only sampled from one habitat in our study, we cannot explain accurately the effect of water parameters on the population density of the species.

In this study, sampling 27 species belonging to two Ordo (Coleoptera and Hemiptera) in only one habitat shows the importance of ponds in highland areas for biological diversity. Ponds are valuable resource for the conservation of freshwater biodiversity and indicator taxa for the conservation of pond can be different in various geographical areas [17]. The 55% of Turkey's territory is above 1.000 m. This geographical position is important with regard to variety of ponds in plateau and mountains. The Eastern Anatolian Region has high endemism on account of freshwater invertebrates because of its geographical structure [18]. On the other hand, scientific data in Turkey is restricted for the ecology and protection of ponds. At a regional level, ponds can contribute highly to freshwater biodiversity, with recent evidence showing that they often support considerably more species, more unique species and more scarce species than other water-body types [19]. Although temporary ponds have recently been recognized as a wetland type of international importance by the Ramsar Convention, political recognition of ponds as an entity and as an important part of the water environment remains insignificant throughout Europe [20].

With this study both some data about bio-ecology of *H. ahmeti* and the species diversity of the ponds in highland area are obtained. We recommend multi-disciplinary studies of the biological diversity in ponds. Multidisciplinary studies will provide us valuable data related to rare and endemic species, and these data are important for natural conservation.

Acknowledgments

We thank Dr. Ergün YILDIZ (Atatürk University, Turkey) for analysis of chemical parameters, and Dr. Abdullah Mart (Atatürk University, Turkey) for the identification of Hydrophilidae species and Dr. Ali Salur (Hitit University, Turkey) for the identification of Hemiptera species.

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