AN INVESTIGATION OF SOME PHYSICOCHEMICAL PARAMETERS OF WATER QUALITY AND AQUATIC COLEOPTERA DIVERSITY AT EBER, EMRE, KARAMIK AND PINARBAŞI LAKES (AFYON, TURKEY)

Hakan Özdamar* and Suat Kıyak*

* Gazi University, Science Faculty, Department of Biology, Ankara, TURKEY. E-mail: hakanozdamar@gazi.edu.tr

[Özdamar, H. & Kıyak, S. 2017. An investigation of some physicochemical parameters of water quality and aquatic Coleoptera diversity at Eber, Emre, Karamık and Pınarbaşı Lakes (Afyon, Turkey). Munis Entomology & Zoology, 12 (2): 583-597**]**

ABSTRACT: This study was conducted to determine the physicochemical parameters (pH, temperature, electrical conductivity, salinity and dissolved oxygen) of water quality at Eber Lake, Emre Lake, Karamık Lake and Pınarbaşı Lake in Afyon province. Additionally we determined the effects of these parameters on aquatic Coleoptera diversity by taking water and insect samples every month from these lakes between May 2009 - September 2009 and April 2010 - September 2010 As a result of the study 69 aquatic Coleoptera species were identified in these lakes. It has been determined that the lakes have I-II water quality according to WPCR (in terms of pH, temperature, dissolved oxygen). It is thought that the monthly fluctuations in the physicochemical parameters and the differences in the mean values are considered to be effective in the distribution of the aquatic Coleoptera according to the ponds.

KEY WORDS: Aquatic Coleoptera, Turkey

Many organisms are sensitive to changes in the environment they live in, whether man-made or natural orginated. Different organisms respond to these changes in different ways, some of them completely disappear while others change the environment they live in and some of them are getting out of reproductive conditions. When the responses of aquatic organisms in the face of changes are determined, the quality of the existing water environment is determined. Therefore, when planning the quality monitoring work in a lake or stream, biological parameters as well as chemical parameters should be included (Serdar, 2012). Because of their limited mobility, benthic invertebrates are among the best-responding organism groups in all kinds of changes that occur in the environment (Özbek et al., 2016). Aquatic insect fauna is easily affected by deteriorating water quality, therefore many species migrate to other suitable habitats due to high pollution. In light of this, adults of aquatic insects can be used as a freshwater monitor (İncekara, 2009). Aquatic insect variety can be affected by various environmental factors such as pH and electrical conductivity (Bloechl et al., 2010). Therefore, the determination of the physicochemical properties of lake water is important in terms of evaluating the parameter preferences of the species while determining the lake fauna.

This work aims to determine the some physicochemical parameters (pH, temperature, dissolved oxygen, electrical conductivity and salinity) in Eber Lake, Emre Lake, Karamık Lake and Pınarbaşı Lake in Afyon province and their effects to aquatic Coleoptera fauna.

MATERIALS AND METHODS

1. Procedure and Physicochemical Analyses

In the present study, we determined the effects of some physicochemical parameters on aquatic Coleoptera diversity by taking water and insect samples every month from these lakes between May 2009 - September 2009 and April 2010 - September 2010. Water samples of lakes were taken in pots with 120 ml. At the same time samples were measured with the Hagh Lange HQ40d multiparameter device. Then, pH, temperature, electrical conductivity, salinity and dissolved oxygen values were obtained from the lakes were recorded together and transferred to the pc. Insect samples were catched by diggers and fishnets from the lakes, and placed in glass bottles containing 70% ethyl alcohol then determined in the laboratory and formed to museum material.

2. Research Area

The Eber Lake is a fresh water lake, located in the inner west of the Turkey. The area of the lake is 156 km^2. The lake is located on the border of Bolvadin, Çay and Sultan Mountain.The water level changes with season and years, and the flood water is discharged to the Aksehir Lake.

Emre Lake is located in the boundaries of the Ihsaniye district, at an elevation of 1150 m, with a surface area of approximately 4.5 km^2 and fed by the Emre river and other small rivers.

Karamık Lake which is located at a height of 1015 meters in the Çay district, 38 km^2 in area. This lake is fed with a few small water sources and the waters flow to Hoyran Lake. It is generally reed.

The Pınarbaşı lake is a small lake with an area of 833 meters in height and a surface area of about 1.5 km^2 in the boundaries of the Emirdag district. It is generally reeds.

3. Statistics

Statistical significance was performed by ANOVA using SPSS 16.0. Means for physicochemical parameters were separated using by Fisher's least significant difference (LSD) at $p<0.05$ level. Relationships between parameters and distribution were analyzed by correlation and regression tests. Cluster analyses were performed by Biodiversity Pro ver. 2 programme.

RESULTS

1. Physicochemical Results

pH, temperature, dissolved oxygen, electrical conductivity and salinity values of the physicochemical water quality parameters obtained from Eber Lake, Emre Lake, Karamık Lake and Pınarbaşı Lake are given in the table below (Table 1).

In Figure 2-6, various physicochemical parameters of the surveyed Eber Lake, Emre Lake, Karamık Lake and Pınarbaşı Lake are shown in terms of months during the research period. Projections and interpretations related to these pictures are discussed in the results section.

2. Biological Results

In the present study, total of 69 aquatic beetle species have been identified and listed on the table below (Table 2). There were 45 species in Eber Lake, 35 species in Emre Lake, 27 species in Karamık Lake and 23 species of aquatic Coleoptera in Pınarbaşı Lake.

DISCUSSION

1. Physicochemical Results

As a result of this 11-month study, when the physicochemical parameter values of these lakes were statistically examined ($p<0.05$); the highest pH value (9.02), average temperature value (25,4 °C), average dissloved oxygen value (9,18 mg/l) was found in Emre Lake, the highest electrical conductivity value (2312 µs/cm) and average salinity value (1,24 ‰) was recorded in Karamık Lake (Table 1).

High pH and low oxygen have lethal effect on organisms (Tanyolaç, 2006). pH and electrical conductivity are the most important factors affecting the distribution of the Dytiscidae family (Eyre et al., 1986). Each organism has tolerate a certain pH range. There is a negative relationship between pH and oxygen value (Ünlü and Uslu, 1999). The negative relationship between pH and oxygen was found in Eber Lake ($r=0.767$), positive relationship was found in Emre Lake ($r=0.810$), this relationship was not fully seen in Karamık and Pınarbaşı Lake ($p<0.05$). During the study, the lowest pH value was measured as 6.38 at Karamık Lake in June 2009. The highest pH value was measured as 9.6 at Emre Lake in September 2009 (Fig. 2).

Dissolved oxygen which is inversely correlated to temperature, decreases with increasing temperature, increases with decreasing temperature (Sarıhan, 1985). In this case, the dissolved oxygen values are expected to be high in the winter months. This known relationship was not seen in the lakes of our study, but a positive relationship was observed in Emre Lake. It is thought that the fresh water, especially from the Sultan Mountains in Eber Lake and Karamik Lake, influences the dissolved oxygen value in lakes even if the temperature increases. The lowest temperature value was measured as 14.4 °C in Eber Lake in April 2010 and the highest temperature value was measured as 31.3 °C in Karamık Lake in September 2009 (Fig. 3).

Electrical conductivity is an environmental factor affecting aquatic insects (Eyre et al., 1986). Salinity increases in the summer, when evaporation is very common (Tepe, 2009). The relationship between temperature and salinity was not observed in Emre Lake and Pınarbaşı Lake while it was seen in Eber Lake ($r = 0,708$) and Karamık Lake ($r = 0,614$). Electrical conductivity increases in parallel with salinity and temperature increase (Barlas et al., 1995). The relation between conductivity and salinity was found to be strong in Eber Lake ($r = 0,990$), Emre Lake ($r = 0,793$), Karamık Lake ($0 = 0,867$) and Pınarbaşı Lake ($r =0,790$).

According to the US Salinity Laboratories System, waters are separated into four groups according to their electrical conductivity. These are 0-250 µS / cm (low saline), 250-750 µS / cm (medium saline), 750-2250 µS / cm (high saline) and more than 2250 µS / cm (very high saline) (Tanyol & Uslu, 2013). When the average electrical conductivity values are taken into consideration, it is seen that Emre Lake is low salinity, Eber Lake and Pınarbaşı Lake are high saline and Karamık Lake is in very high salinity class. The lowest electrical conductivity value was measured as 210 µS / cm at Emre Lake in August 2009 and 2831 µS / cm, the highest electrical conductivity value was measured as 2831 µs/cm at Karamık Lake in September 2009 (Picture 4). Accordingly, it is seen that there are aquatic Coleoptera in high saline water in terms of electrical conductivity.

Salinity affects directly on osmoregulation of the living organisms the or indirectly the amount of dissolved gas, density and viscosity (Tanyolaç, 2006). In order to comment on salinity values and the relationship with other parameters, it is considered that other anions, cations and compounds dissolved in water should be examined and evaluated in detail. The lowest salinity values were measured as

0.1 ‰ at Emre Lake in July 2009-April 2010 and the highest salinity value was measued as 0.71 ‰ at Eber Lake in July 2009 and September 2009 (Fig. 5).

Oxygen is directly influence on the distribution, behavior and association of specimens with other organisms (Tanyolaç, 2006). The ability of aquatic beetles to absorb and store oxygen from the water surface under water reduces their direct dissolved oxygen dependence. Furthermore, it should not be overlooked that the dissolved oxygen in the water can be displaced due to active swimming properties. Studies conducted during larval stages, where the samples are more stable, would better demonstrate their dissolved oxygen response.

The lowest dissolved oxygen value was measured as 5.02 mg/l at Karamık Lake in May 2009 and the highest dissolved oxygen value was measured as 9.65 mg/l at Emre Lake in August 2009.

The classes of inland water resources according the Ministry of Environment (2004); pH value of water between 6.5-8.5 named as I and II. Class, between 6-9 named as III. Class and above to 9, named as IV. Class. When the measured values are taken into account, the mean pH values of the lakes in our study has I. and II. Class water quality (Table 1). Only with a small nuance of Emre has the III. Class water quality. However, the average pH values found in both lakes were found to be in line with the freshwater pH values reported by the EPA (EPA, 2002).

According to the classes of inland water resources given by the Ministry of Environment (2004); when temperature value of lake is 25 °C, named as I and II. Class, 30 °C, named as III. Class, above 30 °C, named as IV. Class water quality. When the measured values are taken into consideration, the average temperature values of the lakes of our study, lakes have I and II. Class water quality (Table 1).

According to the classes of inland water resources given by the Ministry of Environment (2004); dissolved oxygen values of less than 8 mg/ l for the clean water class, 6 mg/l for the less polluted water class, 3 mg/l for the polluted water class and 3 mg/l for the very polluted water class. When the measured values are taken into consideration, the average temperature values of the lakes of our study, lakes have I and II. Class water quality (Table 1).

2. Biological Results

As a result of this work, 69 aquatic beetle species belong to 7 families including Gyrinidae, Haliplidae, Noteridae, Dytiscidae, Helophoridae, Hydrochidae and Hydrophilidae were identified. The most abundant species were Hydrophilidae (Table 2).

Margaleff index which expresses richness of species by evaluating different samples living in different habitats is a measure of the number of species found for the number of individuals obtained (Margalef, 1958). According to the Margaleff diversity index the highest diversity in terms of the number of months during our research was identified in the Eber Lake in July 2009. The lowest diversity value was found in Eber Lake and Emre Lake in September 2009. The diversity values by sampling points are given in Table 3 on a monthly basis.

As a result of the dominance analysis (Kocataş, 2006) on the samples collected in the lakes during the study, *Hygrotus inequalis* in Eber Lake, *Helochares punctatus* in Emre Lake, *Hydrophilus piceus* in Karamık Lake and *Noterus clavicornis* species in Lake Pınarbaşı were predominant. Families with the highest number of species were identified as Hydrophilidae and Dytiscidae families.

The Bray-Curtis Cluster similarity index is used to examine the degree of similarity between different communities (Bayram and Aslan, 2015). Accordingly, Eber Lake is evaluated as with Emre Lake is 60% and Karamik Lake is 47% of the most similar aquatic beetle fauna to each other. (Fig. 7).

Although there is no significant relationship between the pH values and diversity of species determined in our studied lakes ($p>0.05$), the aquatic beetles were identified generally found between pH values of 6.5-8.5 (Kara & Çömlekçioğlu, 2004), which are suitable for aquatic life (Table 1). The highest diversity value was seen at 8.22 in Eber Lake in July 2009 when the pH was 8.22 (Fig. 2).

Although statistically significant values did not appear ($p>0.05$), the aquatic Coleoptera identified in our study varied in temperature (25 °C) and lower values in clean water criteria. (WPCR, 2004), (Fig. 9). It is thought that higher temperatures adversely affect aquatic Coleoptera. The highest diversity value was seen at 25.2 °C on Eber Lake in July 2009 (Fig. 3).

It is known that electrical conductivity increases in parallel with salinity and temperature increase (Barlas et al., 1995). Salinity values and electrical conductivity values of our studied lakes were also parallel. Statistically, there is no direct relationship between electrical conductivity and species diversity. Aquatic Coleoptera varied in different ranges of electrical conductivity values in different lakes (Fig. 10). The highest diversity value was seen as 1338 µs / cm in Eber Lake in July 2009 (Fig. 4).

Salinity directly affects on osmoregulation of the living organisms the or indirectly the amount of dissolved gas, density and viscosity (Tanyolaç, 2006). The significant differences were not found between salinity values and diversity of species ($p> 0.05$). However, it is considered more appropriate to separately evaluate the salts in water. It should not be overlooked that whether or not the location of the lake, it is fed with spring water or other streams, directly affects the salinity rate. The highest diversity value was seen as 0.71 ‰ in Eber Lake in July 2009 (Fig. 5).

The oxygen-free formation of aquatic beetles in water makes it possible to store air on the water surface and use it in water, making them independent of dissolved oxygen values directly. There was no significant relationship between changes in dissolved oxygen values and diversity of species in our study lakes ($p>0.05$) but according to correlation test, positive relationship was found ($r=0.641$). In other lakes, this relationship was not observed ($p>0.05$). The aquatic Coleoptera fauna generally vary in the low dissolved oxygen values and prefer I. and II. class water quality (WPCR, 2004, Fig. 12). The highest diversity value was seen at 7.7 mg/l on Eber Lake in July 2009 (Fig. 6). Considering the temperature, pH and dissolved oxygen parameters used in the classification of in-continental water resources, all studied lakes has I and II class of water quality (Table 1). The largest species of aquatic Coleptera and the most diversity value were also identified on Eber Lake.

It is seen that the diversity of species in the spring and summer season generally decreases in the lakes of the study area and the diversity decreases in summer and late autumn (Table 3). It has been considered that the increasing values of pH, temperature, salinity and conductivity were negatively affect the diversity since June. Many aquatic Coleoptera need aquatic plants for spawning and hiding (Bloechl et al., 2010). Due to the increased evaporation caused by the heat in August and September, the lake that is drawn in leads to the drying of the coastal plants and the habitat is getting out of the way. It is known that many aquatic beetles are active flyer and migrate to other habitats due to negative changes in the environment (İncekara, 2009). These lakes are used as a recreation area and preferred as handline fishing in summer, areas are also used by the villagers and exposes pollutants the coastal areas. These activities resulted in destroying habitat of the aquatic Coleoptera species and caused to migrating other habitats.

Because of their higher tolerance physicochemical parameter changes in the water, *Noterus clavicornis, Hydroglyphus geminus and Limnoxenus niger* species were found in four lakes (Table 1). In addition, *Noterus clavicornis* has the highest number of samples in the lakes, its ecological tolerance is the broader and named as cosmopolitan species.

Compared to other Lakes, the high salinity electrical conductivity in Karamık Lake and Pınarbaşı Lake draws attention (Figs. 4, 5). It is thought that long term and different points should be studied in order to follow that this is seasonal or continuous. When assessing the aquatic beetle fauna in different lakes, the consideration of more physicochemical parameters, the determination of the soil structure of the lake, the vegetation composition and the predator species will ensure that we obtain clearer results.

This study will contribute more detailed basal grand invertebrata and water quality studies in the future.

ACKNOWLEDGEMENTS

The study was supported by Department of Scientific Research Project Management of Gazi University with the Project number 05/2009-14.

LITERATURE CITED

Barlas, M., İkiel, C. & Özdemir, N. 1995. Gökova Körfezi' ne Akan Tatlı Su Kaynaklarının Fiziksel ve Kimyasal Açıdan İncelenmesi. In: Doğu Anadolu Bölgesi I. ve II. Su Ürünleri Sempozyumu Bildirileri, 14–16 Haziran 1995, Erzurum, 704-712.

Bayram, F. & Aslan, E. G. 2015. Comparation of Alticini (Coleoptera: Chrysomelidae: Galerucinae) diversity of species in different habitats selected from Bafa Lake Natural Park (Aydın) basin with a new record for Turkish fauna. Turkish Journal of Entomology, 39 (2): 147-157.

Bloechl, A., Koenemann, S., Philippi, B. & Melber, A. 2010. Abundance, diversity and succession of aquatic Coleoptera and Heteroptera in a cluster of artificial ponds in the North German Lowlands. Limnologica, 40: 215-225.

Bulut, İ. & Kantürk, G. 2010. Denizli- Honaz-Yukarı Dağdere Köyü Saklı Lake Yüzen Adası. TSE Standart Ekonomik ve Teknik Dergi, 49 (573): 524-528.

EPA 2002. Ground water and drinking water. Environmental Protection Agency, U.S.

Eyre, M. D., Ball, S. G. & Foster, G. N. 1986. An initial classification of the habitats of aquatic Coleoptera in north-east England. Journal of Applied Ecology, 23: 841-852.

George, A. D. I., Abowei, J. F. N. & Daka, E. R. 2009. Benthic macroinvertebrate fauna andphysico-chemical parameters in Okpoka Creek sediments, Niger Delta, Nigeria. International Journal of Animal and Veterinary Advances, 1: 59-65.

İncekara, Ü. 2009. Records of Aquatic Beetles Helophoridae Hydrophilidae Hydrochidae Dytiscidae and Physico Chemical Parameters in a Natural Lake Artvin Turkey. Turkish Journal of Zoology, 33: 89-92.

Kara, C. & Çömlekçioğlu, U. 2004. Karaçay (Kahramanmaraş)'ın Kirliliğinin Biyolojik ve Fizikokimyasal parametrelerle İncelenmesi. Kahramanmaraş Sütçü İmam Üniversitesi Fen ve Mühendislik Dergisi, 7 (1): 1-7.

Kocataş, A. 2006. Ekoloji ve Çevre Biyolojisi. Ege Üniversitesi Matbaası, İzmir, 274-275.

Margaleff, D. R. 1958. Information Theory in Ecology. Yearbook of the Society for General Systems Research, 3: 36-71.

Özbek, M., Taşdemir, A. & Yıldız, S. 2016. Adıgüzel Baraj Lake (Denizli-Türkiye)'nün bentik makroomurgasızları. Ege Journal of Fisheries and Aquatic Sciences, 33 (3): 259-263.

Sarıhan, E. 1985. Limnoloji. Çukurova Üniversitesi Ziraat Fakültesi Yayını, Adana, 70.

Serdar, O. 2012. İyidere ve Çiftekavak Derelerinin Su Kalitesinin Fiziko-Kimyasal Parametreler ve Saprobik Sistem Kullanılarak Belirlenmesi, Yüksek Lisans Tezi, Recep Tayyip Erdoğan Üniversitesi, Fen Bilimleri Enstitüsü, Su Ürünleri Anabilim Dalı, Rize, 104, 3.

Tanyol, M. & Uslu, G. 2013. Tunceli Evsel Atıksu Arıtma Tesisinin Arıtma Etkinliğinin Değerlendirilmesi. Mehmet Akif Ersoy Üniversitesi Fen Bilimleri Enstitüsü Dergisi, 4 (2): 24-29.

Tanyolaç, J. 2006. Limnoloji. Hatipoğlu Basım ve Yayım Sanayi, 4. Baskı, Ankara, 237.

Tepe, Y. 2009. Reyhanlı Yenişehir Gölü (Hatay) su kalitesinin belirlenmesi. Ekoloji, 18 (70): 38-46.

Ünlü, A. & Uslu, G. 1999. Hazar Gölü'nde Su Kalitesinin Değerlendirilmesi. Ekoloji Dergisi, 32: 7-13.

WPCR (Water Pollution Control Legislation) 2004. Landbased Water Quality Classification. Official journal, 25687, Turkey.

Yılmaz, F. 2004. Mumcular Barajı (Muğla-Bodrum)'nın Fiziko-Kimyasal Özellikleri. Ekoloji, 13 (50): 10-17.

Yılmaz, A. & Aslan, E. G. 2017. Aquatic Coleoptera (Coleoptera: Hydrophilidae, Helophoridae) of İzmir, Manisa and Aydın provinces (Turkey) with new locality records for Aegean Region. Turkish Journal of Fisheries and Aquatic Sciences, DOI: 10.4194/1303-2712-v17_4_13

Table 1. Water quality according to the average of physicochemical parameters is classified according to WPCR (Water Pollution Control Regulation), 2004. I: High quality water, II: Lightly polluted water.

Parametre	**Göller**				**WPCR'ye Göre Sınıfı**
	Eber Lake	Emre Lake	Karamık Lake	Pınarbaşı Lake	
pH	8,56	9,02*	8,05	7,46	I. and II
Sıcaklık (°C)	22,6	25,4	22,8	25,3	I. and II
İletkenlik (µs/cm)	802	290	2312	1530	-
Tuzluluk (‰)	0,43	0,12	1,24	0,72	-
Çözünmüş Oksijen (mg/l)	8,22	9,18	7,54	7,24	I. and II

*Emre Lake is also found to close to III. Class water quality.

Table 2. Aquatic Coleoptera species and their distribution.

Family	**Species**	**Eber Lake**	**Emre Lake**	**Karamık Lake**	**Pınarbaşı Lake**
Gyrinidae Latreille, 1810	*Gyrinus paykulli* G. Ochs, 1927			*	
Haliplidae Kirby, 1837	*Haliplus fulvus* (Fabricius, 1801)			*	
	Haliplus heydeni Wehncke, 1875				*
	Peltodytes caesus (Duftschmid, 1805)	*	*		*
Noteridae C.G. Thomson, 1860	*Noterus clavicornis* (De Geer, 1774)	*	*	*	*
Dytiscidae Leach, 1815	*Agabus labiatus* (Brahm, 1790)	*			
	Agabus bipustulatus (Linnaeus, 1767)	*			
	Agabus conspersus (Marsham, 1802)	*			
	Agabus nebulosus (Forster, 1771)	*	*		
	Ilybius ater (De Geer, 1774)	*		*	
	Colymbetes fuscus (Linnaeus, 1758)	*	*		*
	Liopterus haemorrhoidalis (Fabricius, 1787)	*			
	Cybister lateralimarginalis torquatus (Fischer von Waldheim, 1829)	*		*	
	Hydaticus transversalis laevisculptus Zaitzev, 1910		*		
	Bidessus nasutus Sharp, 1887	*		*	
	Hydroglyphus geminus (Fabricius, 1792)	*	*	*	*

	Graptodytes sedilloti phrygius Guignot, 1942	*			*
	Graptodytes veterator behningi Zaitzev, 1927			*	*
	Hydroporus angustatus Sturm, 1835	*	*		
	Hydroporus planus (Fabricius, 1782)	*	*		
	Hydroporus palustris (Linnaeus, 1761)		*		
	Porhydrus lineatus (Fabricius, 1775)	*			
	Scarodytes halensis (Fabricius, 1787)		*		
	Hydrovatus cuspidatus (Kunze, 1818)	*		*	*
	Hygrotus impressopunctatus (Schaller, 1783)	*			*
	Hygrotus lernaeus (Schaum, 1857)	*			*
	Hygrotus saginatus (Schaum, 1857)	*			
	Hygrotus inaequalis (Fabricius, 1777)	*	*	*	
	Laccophilus hyalinus (DeGeer, 1774)	*			
	Laccophilus poecilus Klug, 1834	*		*	*
	Laccophilus minutus (Linnaeus, 1758)		*	*	*
Helophoridae Leach, 1815	*Helophorus nubilus* Fabricius, 1777	*	*		
	Helophorus micans Faldermann, 1835	*	*		*
	Helophorus syriacus Kuwert, 1885	*	*		*
	Helophorus brevipalpis Bedel, 1881	*	*		
	Helophorus aquaticus (Linnaeus, 1758)		*		
	Helophorus discrepans Rey, 1885		*		
	Helophorus longitarsis Wollaston, 1864		*	*	
	Helophorus nanus Sturm, 1836		*		
	Helophorus obscurus Mulsant, 1844		*	*	
Hydrochidae Thomson, 1859	*Hydrochus elongatus* (Schaller, 1783)	*	*		
	Hydrochus flavipennis Kuster, 1852	*			

Hydrophilidae Latreille, 1802	*Anacaena limbata* (Fabricius, 1792)	*	*		*
	Paracymus aeneus (Germar, 1824)	*		*	
	Berosus affinis Brullé, 1835			*	
	Berosus luridus (Linnaeus, 1760)	*	*	*	
	Berosus signaticollis (Charpentier, 1825)		*		
	Berosus frontifoveatus Kuwert, 1888		*		
	Berosus spinosus (Steven, 1808)	*			
	Chasmogenus livornicus (Kuwert, 1890)			*	
	Cymbiodyta marginella (Fabricius, 1792)	*	*	*	
	Enochrus melanocephalus (Olivier, 1792)				*
	Enochrus ater (Kuwert, 1888)				*
	Enochrus bicolor (Fabricius, 1792)	*	*		
	Enochrus fuscipennis (Thomson, 1884)				*
	Enochrus testaceus (Fabricius, 1801)			*	*
	Enochrus coarctatus (Gredler, 1863)	*			
	Enochrus nigritus (Sharp, 1872)	*		*	
	Helochares lividus (Forster, 1771)				*
	Helochares obscurus (O. F. Müller, 1776)	*	*	*	
	Helochares punctatus Sharp, 1869	*	*	*	
	Hydrobius fuscipes (Linnaeus, 1758)	*	*		
	Limnoxenus niger (Gmelin, 1790)	*	*	*	*
	Hydrochara dichroma (Fairmaire, 1892)	*	*		
	Hydrophilus piceus (Linnaeus, 1758)	*		*	
	Laccobius syriacus Guillebeau, 1896	*	*		*
	Laccobius gracilis Motschulsky, 1855				*
	Coelostoma orbiculare (Fabricius, 1775)				*
	Cercyon circumcinctus Reitter, 1889	*	*	*	

Table 3. Monthly diversity values of sampling points according to Margaleff Diversity Index.

		LAKES			
2009	**MONTHS**	**Eber Lake**	**Emre Lake**	**Karamık Lake**	**Pınarbaşı Lake**
	May	3,11	2,79	2,04	1,86
	June	3,16	3,92	1,82	2,73
	July	4,21	2,48	2,27	1,91
	August	2,04	2,25	2,12	2,43
	September	1,20	1,20	1,36	1,82
2010	April	2,28	2,18	2,44	1,86
	May	3,71	3,78	2,33	1,76
	June	3,17	1,97	1,71	2,67
	July	3,68	2,62	2,35	1,82
	August	2,45	2,04	1,91	1,83
	September	2,41	1,73	1,48	2,06

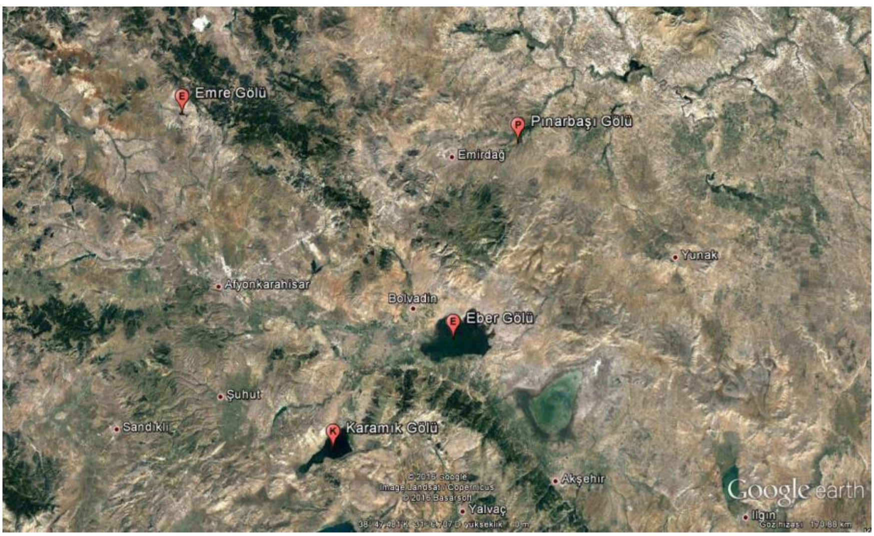


Figure 1. Lakes in the research area.

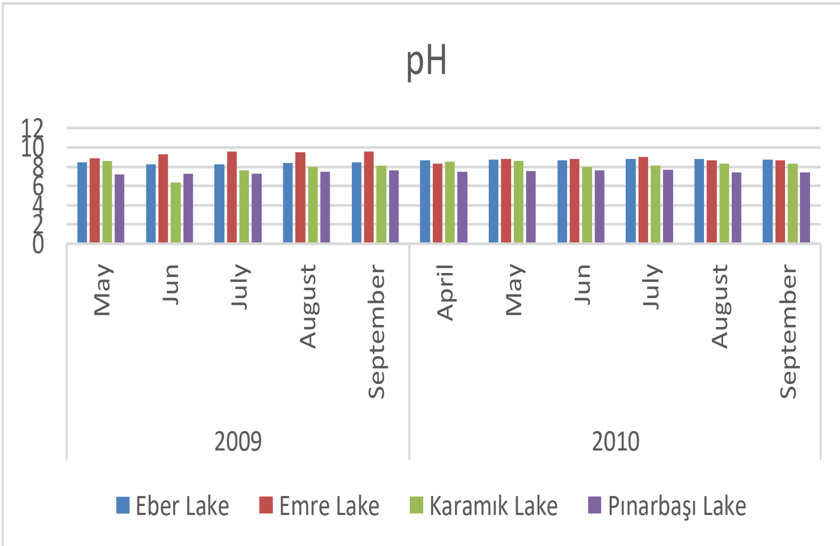


Figure 2. Monthly alterations of pH values.

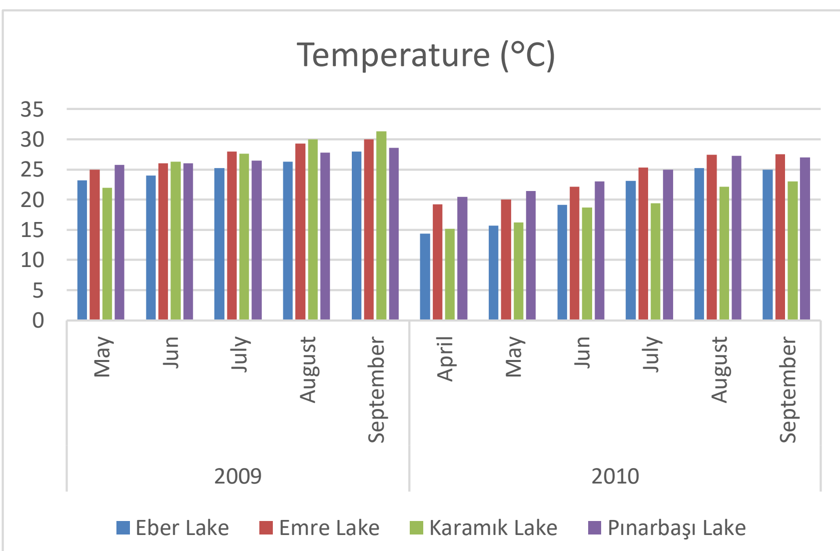


Figure 3. Monthly alterations of temperature values.

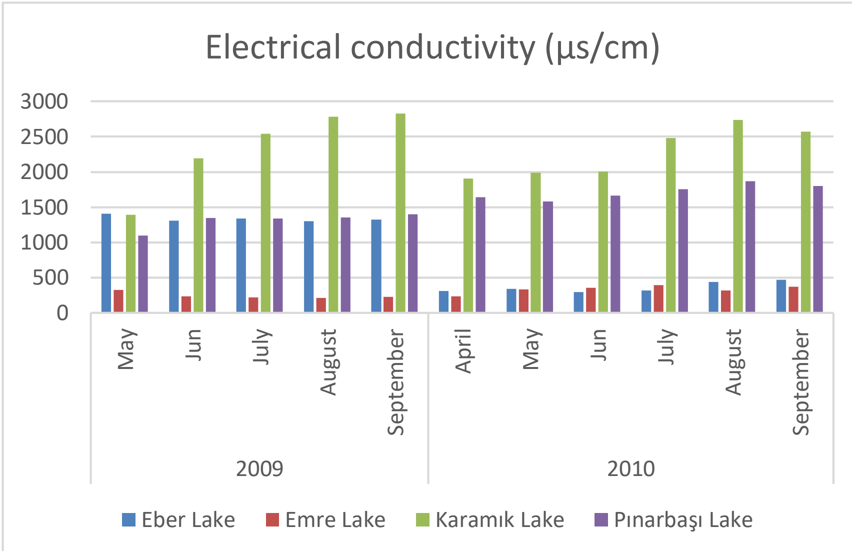


Figure 4. Monthly alterations of electrical conductivity values.

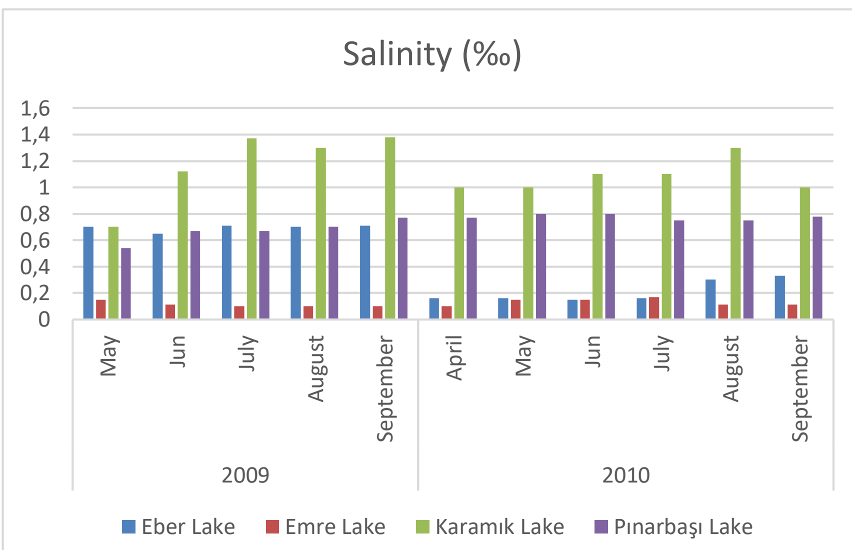


Figure 5. Monthly alterations of salinity values.

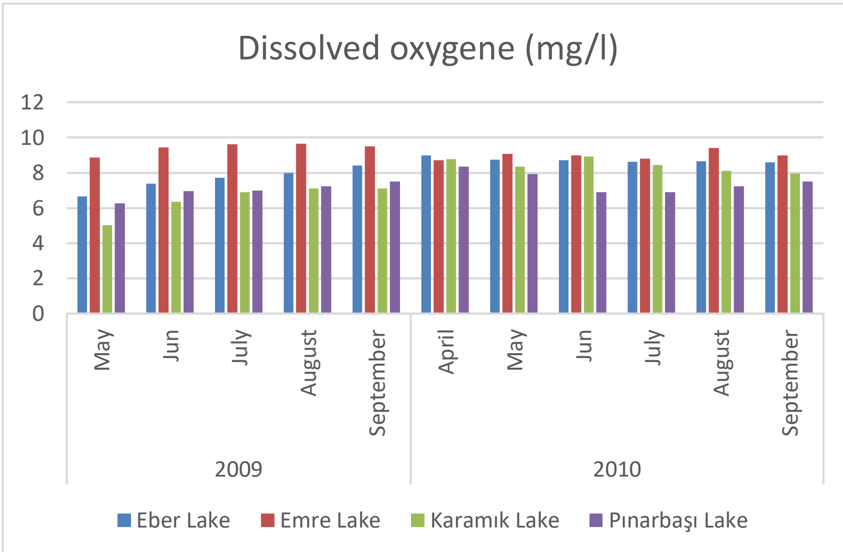


Figure 6. Monthly alterations of dissolved oxygen values.

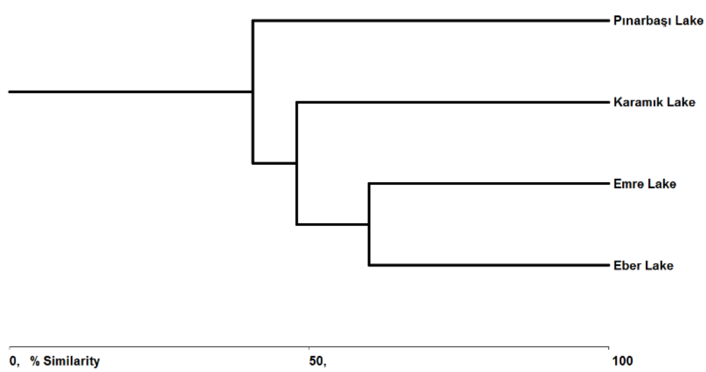
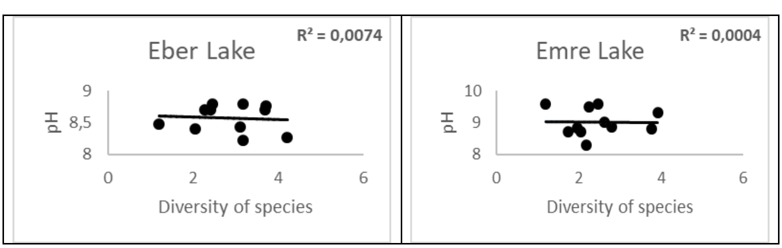


Figure 7. Similarity relationship between lakes according to cluster index



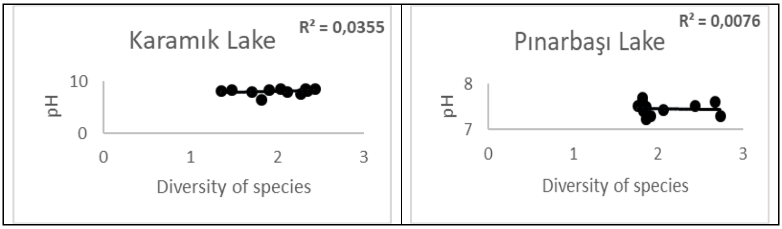


Figure 8. The relationship between aquatic Coleoptera diversity and pH in studied lakes.

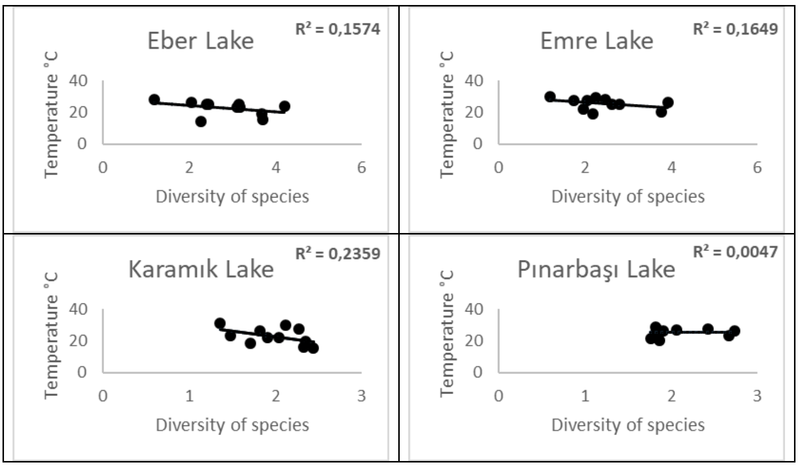


Figure 9. The relationship between aquatic Coleoptera diversity and temperature in studied lakes.

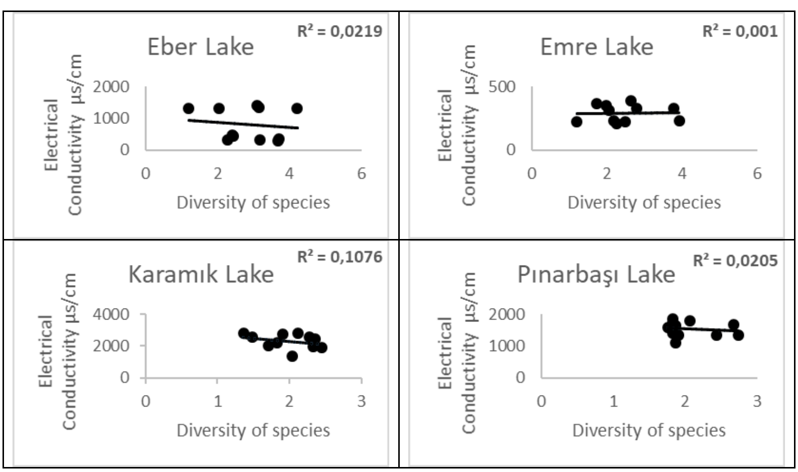


Figure 10. The relationship between aquatic Coleoptera diversity and electrical conducivity in studied lakes.

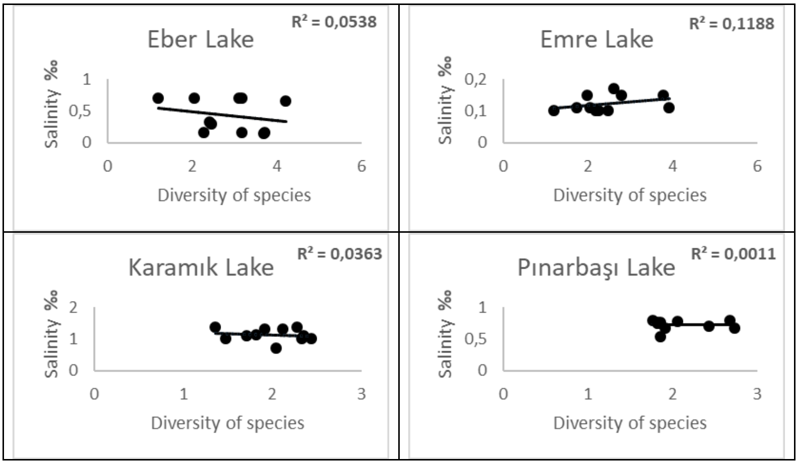


Figure 11. The relationship between aquatic Coleoptera diversity and salinity in studied lakes.

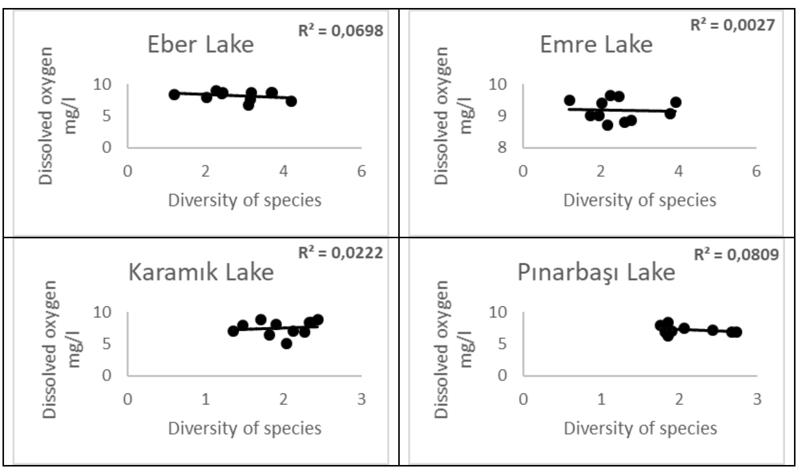


Figure 12. The relationship between aquatic Coleoptera diversity and dissolved oxygen in studied Lakes.