AN INVESTIGATION OF SOME PHYSICOCHEMICAL PARAMETERS OF WATER QUALITY AND AQUATIC COLEOPTERA DIVERSITY AT GÖLCÜK YAYLA LAKE AND ÖRENLİ LAKE (KÜTAHYA, TURKEY)

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ABSTRACT: This study was conducted to determine the physicochemical parameters (pH, temperature, electrical conductivity, salinity and dissolved oxygen) of water quality at Gölcük Yayla and Örenli Lake in Kütahya province. Additionally we determined the effects of these parameters on aquatic Coleoptera diversity by taking water and insect samples every month from these two lakes between May 2009 - September 2009 and April 2010 - September 2010. As a result of the study 40 aquatic Coleoptera species were identified in both lakes. The study also showed that the monthly fluctuations in the physicochemical parameters and the differences in the mean values are considered to be effective in the distributions of aquatic Coleoptera.

KEY WORDS: Aquatic Coleoptera, Turkey

Lakes are constitute 98% of freshwater resources so it is important to know their physicochemical properties (Gökmen, 2007). Water quality includes all physicochemical, chemical and biological factors that enable water to be used beneficially. For this reason, water quality identification is essential for the determination of the physicochemical, chemical and biological parameters affecting the water quality (Zeybek, 2007). As the aquatic Coleoptera species directly associated with the water, they are directly affected by these physicochemical parameters (Kazancı et al., 1997). Aquatic insect variety can be affected by various environmental factors such as pH and electrical conductivity (Bloechl et al., 2010). Lakes show continuous receiving environment characteristics in the all aquatic ecosystems, for this reason they are affected firstly by environmental pollution (Yılmaz, 2004). Lakes are dead and inactive environments compared to other aquatic environments. The harmful factors that occur in the system directly or indirectly affect the water, the living organisms in the environment sometimes make this effect harmless or harmful (Tanyolaç, 2006). In this study, we initially characterized the impact of lake water's physicochemical properties on the distribution of species. The findings assist in understanding better the importance of evaluating the parameter preferences of species. In the present study, we aimed to investigate some physicochemical parameters of Gölcük Yayla and Örenli Lake water in Kütahya province, and was to determine the effect of these parameters on aquatic Coleoptera diversity.

MATERIALS AND METHODS

1. Procedure and Physicochemical Analyses

This study was carried out in Gölcük Yayla and Örenli Lakes located in Simav district of Kütahya province. In the study, we determined the effects of some physicochemical parameters on aquatic Coleoptera diversity by taking water and insect samples every month from these two 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 every month. Than, pH, temperature, electrical conductivity, salinity and dissolved oxygen values were obtained from the stations with the station code were recorded together and transferred to the electronic center in the laboratory.

Different types of aquatic equipments were used to collect the aquatic insect specimens. The net trap with a pore diameter of 1 mm was used in environments where water depth was high and aquatic plants were low. Metal sieves with a pore diameter of 0.5-1 mm were used in the shoreline where vegetation is thick and surface depth is less. All collected samples were placed in glass bottles containing 70% ethyl alcohol.

2. Research Area

Gölcük Yayla Lake which is 17 km away from the Simav district of Kütahya province, and 1309 meters high. This crater lake which is adjacent to the Katran Mountain, is fed to the Cattle River and other small rivers. The lake and almost all its surroundings are used as picnic areas, surrounded by reeds, aquatic plants and in many places the formation of algae is intense. Research area is used by animals as pasture therefore directly exposed to human and animal wastes. Örenli Lake, located in Örenli Village, Simav district of Kütahya and 819 meters high. The lake is fed to the Cepmi River which is very close to the Örenli village, 3 km away from the town of Simav. The research area is very close to village and villagers use as fishing and picnic area. Due to intensive herbaceous vegetation, villagers are used for grazing of bovine animals as rangeland (Fig. 1).

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 Gölcük Yayla and Örenli Lake are given in the table 1.

In figures 2-6, various physicochemical parameters of the surveyed Gölcük Yayla and Örenli Lakes 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

A total of 40 aquatic Coleoptera species were identified in this study and listed on the table 2. There are 33 species in Gölcük Yayla Lake and 14 species in Örenli Lake, 7 of them are mutual, 26 species are found only in Gölcük Yayla Lake and 7 species are only in Örenli Lake.

DISCUSSION

1. Physicochemical Results

As a result of this 11-month study, when the physicochemical parameter values of both lakes were statistically examined ($p<0.05$); the average pH (7.80 ± 0.36), temperature (25.5 ± 4.9 ° C), electrical conductivity (581.64 ± 195.44 µs / cm) and salinity values (0.30 ± 0.11 ‰) were higher in Örenli Lake. The dissolved oxygen level (5.33 ± 0.94 mg / l) was higher in Gölcük Yayla Lake (Table 1). It is thought that especially after the winter months, the snow water is taken from the mountain on Gölcük Yayla Lake is effective on the high dissolved oxygen level.

High pH and low oxygen have a 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 (Ünlü & Uslu, 1999). The negative relationship between pH and oxygen is not fully visible on the Gölcük Yayla Lake ($r=0.608$), which is thought to be due to the snow waters that were added to the lake.

There is no correlation between pH and oxygen parameters in Örenli Lake ($r=0.001$). During the study, the lowest pH value was measured in Gölcük Yayla Lake as 6.1 in April 2010 and 8.23 in August 2010 as the highest pH value in Örenli Lake (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. The relationship was clearly seen in Örenli Lake ($r = -0.826$), but it was not clearly seen in Gölcük Yayla Lake ($r=0.763$). Because of the snow waters joined from the higher sections of the Gölcük Yayla Lake. While the lowest temperature value was measured in Gölcük Yayla Lake as 14.3 °C in April 2010 and the highest temperature value was measured in Örenli Lake as 30.9°C 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). Although it is not strong in Gölcük Yayla Lake, salinity increases with the temperature ($r=0.938$) with stronger in Örenli Lake. Electrical conductivity increases in parallel with salinity and temperature increase (Barlas et al., 1995). The increase in electrical conductivity in parallel with the increase in salinity in Örenli Lake also supports this knowledge ($r=0.969$). 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 and Uslu, 2013). When the average electrical conductivity values are taken into account, it is seen that the Gölcük Yayla Lake is low saline and the Örenli Lake is medium saline water group. Wheras the lowest electrical conductivity value was measured in Gölcük Yayla Lake as 164 µS / cm in June 2009, the highest electrical conductivity value was measured in Örenli Lake as 801 µS / cm in June 2009. According to these data, Gölcük Yayla Lake is more suitable for aquatic Coleoptera species prefer low and medium salty waters (Fig. 4).

According to electrical conductivity, Gölcük Yayla Lake is more suitable for aquatic Colepotera species. Therefore, it can be said that these species prefer low or medium saline waters. Salinity affects directly on osmoregulation of the living organisms the or indirectly the amount of dissolved gas, density and viscosity

(Tanyolaç, 2006). It is thought that only 0.2 ‰ of salinity ratio difference between these two lakes can not directly be effective on distribution of species, for this reason, other dissolved anions, cations and compounds of water should be examined and evaluated in detail. The lowest salinity value was measured in Gölcük Yayla Lake as 0.08 ‰ in September 2009 and the highest salinity value was measued in Örenli Lake as 0.42 ‰ in September 2009 (Fig. 5).

Oxygen is directly influence on the distribution, behavior and association of species with other organisms (Tanyolaç, 2006). Aquatic beetles can absorb and store oxygen from the water surface and use underwater. This ability can reduces their dependency of direct dissolved oxygen. Furthermore, it should not be overlooked that due to their active swimming ability in the water, they can displaced through dissolved oxygen. Instead of this, studies can be conducted during larval stage where the samples are more stable, would better demonstrate their response to dissolved oxygen. The lowest dissolved oxygen value was measured in Örenli Lake as 2.67 mg / l in June 2009 and the highest dissolved oxygen value was measured in Örenli Lake as 8,26 mg / l in May 2009 (Fig. 6).

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. From our results, we found that, in the Gölcük Yayla Lake, the lowest pH value was measured as 6.1 in April 2010 and the highest value was measured as 7.85 in August 2009 (Fig. 2). The average pH value of Gölcük Yayla Lake was determined as 7.3 and lake water has Class I. and II. water quality (Table 1). The lowest value on Örenli Lake was measured as 7 in April 2010 and the highest value was measured as 8.23 in August 2010 (Fig. 2). According to monthly values and average pH value determined as 7.8, it was found that lake water has Class I water quality (Table 1). Additionally, the average pH values determined in both lakes were found to be in accordance with the fresh water pH values reported in 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 lowest temperature value at Gölcük Yayla Lake was measured as 14.3 ° C and the highest value in April 2010 was measured as 24.8 ° C in August 2010 (Fig. 3). The average temperature values of the lake water was 20,3 ° C, so, lake water has I and II. Class water quality (Table 1).

The lowest temperature in Örenli Lake was measured as 17.2 ° C in April 2010 and the highest value was measured as 30.9 ° C in September 2009 (Fig. 3). Although monthly fluctuations indicate the III. class water quality, the average temperature value determined as 25.5° C and lake water has 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 lowest value at Gölcük Yayla Lake was measured as 3.17 mg / l in May 2009 and the highest value was measured as 6.3 mg / l in September 2010 (Fig. 6). Although the monthly fluctuations occasionally approach the polluted (Class III) water values, it is seen that the average dissolved oxygen value, which is determined as 5.33 mg / l, brings the lake water into the less polluted water (Class II) (Table 1). The lowest value at Örenli Lake was measured at 2.67 mg / l in June 2009 and the highest value was measured at 8.26

mg / l in May 2009 (Fig. 6). Although the monthly fluctuations occasionally approach the polluted (Class III) water values, according to the average dissolved oxygen value determined as 5.11 mg / l, makes the lake water into the less polluted water (Class II) (Table 1).

2.Biological Results

From our results, total of 40 species were identified, 33 of them were on the Gölcük Yayla Lake and 14 of them were Örenli Lake. All these species were belonging to Gyrinidae, Haliplidae, Noteridae, Dytiscidae, Helophoridae and Hydrophilidae families. The family with the most species is Hydrophilidae (Table 2).

The Margaleff index which expresses species richness 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 value between the two lakes in terms of the month was found in Gölcük Yayla Lake in May 2010 and the lowest diversity value was found in Örenli Lake in July 2010 and in Gölcük Yayla Lake in September 2010. According to sampling points, the monthly diversity values were given at the Table 3.

According to the results of dominance analysis on the collected samples during the study period (Kocataş, 2006), dominant species of the Gölcük Yayla Lake is *Helophorus obscurus* and Örenli Lake is *Noterus clavicornis*.

There are several statistical methods have been developed to determine the degree of similarity between sampling points, one of them is the Sorensen similarity index (İpek & Saler, 2008). Accordingly, as the number of common species in the area increases, the similarity rate also increases. The Sorensen similarity index was applied to the total number of species in both areas and both lake fauna were found to be 30% similar to each other.

The Bray-Curtis Cluster similarity index is used to examine the degree of similarity between different communities (Bayram and Aslan, 2015). According to this, both lake faunas were found to be 29.78% similar (Fig. 7).

The pH value in the Gölcük Yayla Lake was found between 6.5-8.5 (Kara & Çömlekçioğlu, 2004), this value is suitable for aquatic life (Fig. 8). There was a strong negative relationship between pH values and diversity of species (r=-0.748). Hovewer the diversity value has increased as the pH values approach the lower boundary, decreased as the pH values approach the upper boundary (Fig. 8). This result showed us that these sub-values are more appropriate for aquatic beetles, with the highest diversity value seen in May 2010 when pH was 6.9 (Fig. 2).

The temperature of the Gölcük Yayla Lake has increased in diversity value as the temperature of the clean water criterion is lower than the upper values (WPCR, 2004; Fig. 9).

There was a strong negative relationship between temperature values and diversity of species (r=-0.876). This data show us that high temperatures are not suitable for aquatic Coleoptera and as the temperature approaches the upper limit, the diversity of species was decreased. The highest diversity value was seen at 15.5 ° C in May 2010 (Fig. 3).

It is known that electrical conductivity increases in parallel with salinity and temperature increasing (Barlas et al., 1995). The electrical conductivity values are in parallel with the salinity values on the Gölcük Yayla Lake. There was no significant relationship between electrical conductivity and diversity of species (r=-0.393). However, this relationship is thought to be influenced by streams and snow water in the lake. The highest diversity value was observed in May 2010 at 228 µS / cm (Fig. 4). This data suggests that aquatic Coleoptera species prefer relatively low electrical conductivity values.

Salinity affects directly on osmoregulation of the living organisms the or indirectly the amount of dissolved gas, density and viscosity (Tanyolaç, 2006). There was no significant relationship between salinity and diversity of species (r=-0.491) However, this relationship is thought to be influenced by streams and snow water in the lake. The highest diversity was observed in May 2010 at 0.1 ‰ (Fig. 5). Aquatic Coleptera have been found to prefer lower salinity values, which are affected by high salinity.

When the dissolved oxygen values in the Gölcük Yayla Lake are examined, it is seen that the aquatic beetles prefer the values according to clean water criteria in general but they also show diversity in lower dissolved oxygen values (r=-0.746) (WPCR, 2004; Fig. 12). It is believed that the aquatic Coleptera have the ability of store air at the water surface and use it in the water is effective in this case, and this property is thought to make them independent of dissolved oxygen values directly. The highest diversity value was seen at 4.05 mg / l in May 2010 (Fig. 6).

The pH value in the Örenli Lake was found between 6.5-8.5 (Kara & Çömlekçioğlu, 2004), this value is suitable for aquatic life. However the obtained data is not statistically significant values (r=-0.566), it has been shown that suitable values for aquatic life are preferred by aquatic beetles (Fig. 13). The highest diversity value was seen at pH 7 in April 2010 (Fig. 2).

The temperature on the Örenli Lake has increased in diversity value as the temperature of the clear water criterion is lower than the upper values (WPCR, 2004, Fig. 14). There was a negative relationship between temperature values and diversity of species (r=-0.683). This data shows us that high temperatures are not suitable for aquatic Coleoptera and as the temperature approaches the upper limit, the diversity of species was decreased. The highest diversity value was seen at 17.2 ° C in April 2010 (Fig. 3).

It is known that electrical conductivity increases in parallel with salinity and temperature increasing (Barlas et al., 1995). The electrical conductivity values are in parallel with the salinity values on the Örenli Lake. When EC value was decreased, diversity was increased. When the EC value was at the upper limits, diversity was decreased (Fig. 15). There was a negative relationship between electrical conductivity and diversity of species (r=-0.634). This data suggests that aquatic Coleoptera species prefer relatively low electrical conductivity values. The highest diversity value was observed in April 2010 at 265 µs / cm (Fig. 4).

Salinity affects directly on osmoregulation of the living organisms the or indirectly the amount of dissolved gas, density and viscosity (Tanyolaç, 2006). In the Örenli Lake, when the salinity value was too high, the diversity value was decreased (Fig. 16).

There was a strong negative relationship between electrical conductivity and diversity of species (r=-0.745). Aquatic Coleptera have been found to prefer lower salinity values, which are affected by high salinity. The highest diversity value was observed in April 2010 at 0.1 ‰ (Fig. 5).

When the dissolved oxygen values in the Örenli Lake are examined, it is seen that the aquatic beetles prefer the values according to clean water criteria in general but they also show diversity in lower dissolved oxygen values (WPCR, 2004; Fig. 17). There was a positive relationship between temperature values and diversity of species (r=0.603). It is believed that the aquatic Coleptera have the ability of store air at the water surface and use it in the water is effective in this case, and this property is thought to make them independent of dissolved oxygen values directly. The highest diversity value was seen at 6.9 mg / l in April 2010 (Fig. 6).

From the result of this work it can be concluded that, according to temperature, pH and dissolved oxygen parameters used in the classification of inland water resources, both lakes were classified as I. and II. water quality, each other has the different species and aquatic Coleoptera specimens can not survive at higher pH levels. As a matter of fact, the average pH value in the Örenli lake has been determined more than Gölcük Yayla Lake (Table 1).

When both lakes were examined, diversity values were observed to increase in April and May. The lowest diversity value was seen in August and September (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). In August and September, due to increased evaporation resulted warming, the lake is drawn in leads to the drying of the coastal plants and the habitat is removed. It is known that many aquatic beetles are active flyer and migrate to other habitats due to negative changes in the environment (İncekara, 2009).

Gölcük Yayla Lake is used as a recreation area and preferred as handline fishing in summer, Örenli Lake is used by the villagers and exposes pollutants the coastal areas. These activities resulted in destroying habitat of the aquatic Coleoptera and caused to migrating other habitats.

The mutual species between two lakes are *Noterus clavicornis, Agabus bipustulatus, Hydroglyphus geminus, Hygrotus lernaeus, Laccophilus minutus, Helophorus micans* and *Hydrobius fuscipes*. As a result of this, these species which have wider tolerance values are cosmopolitan species in both lakes.

Notreus clavicornis which was found in both lakes (Table 1) was predominant species on Örenli Lake. Thus it can be suggested that it was more tolerant to changes in some physicochemical properties of water and its ecological tolerance is wider than other species.

Yılmaz & Aslan (2017) indicated that Helophorus group was the largest group in terms of abundance in the study on Hydrophilidae and Helophoridae. In this study, Helophorus genus was identified as one of the most abundant groups (Bloechl et al., 2010). In the study conducted in Northern Germany, two species belonging to the genus Noterus and Helophorus were detected with the highest abundance. From our results we found that, the most dominant species of Gölcük Yayla Lake is *Helophorus obscurus*, Örenli Lake is *Noterus clavicornis*.

Although the genus, species and area are different from our study, this result shows that these two genus are more tolerant to physicochemical parameter changes of water.

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

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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.

Parameter	**Mean Value**		**WPCR Class**
	Gölcük Yayla Lake	**Örenli Lake**	
pH	7,31 ± 0,56	7,80 ± 0,36	I. and II
Temperature (°C)	20,3 ± 3,9	25,5 ± 4,9	I. and II
Electrical conductivity (µs/cm)	224,4 ± 42,6	581,6 ± 195,4	-
Salinity (‰)	0,1 ± 0,01	0,30 ± 0,11	-
Dissolved oxygen (mg/l)	5,33 ± 0,94	5,11 ± 1,51	I.

Table 2. Aquatic Coleoptera species and their distribution.

FAMILY	SPECIES	LAKES	
		Gölcük	Örenli
GYRINIDAE Latreille, 1810	*Gyrinus caspius* Ménétriés 1832	+	
HALIPLIDAE Kirby, 1837	*Haliplus mucronatus Stephens, 1828*	+	
NOTERIDAE C.G. Thomson, 1860	**Noterus clavicornis* (De Geer, 1774)	+	+
DYTISCIDAE Leach, 1815	**Agabus bipustulatus* (Linnaeus, 1767)	+	+
	Agabus conspersus (Marsham, 1802)	+	
	Agabus didymus (Olivier, 1795)	+	
	Agabus nebulosus (Forster, 1771)		+
	Colymbetes fuscus (Linnaeus, 1758)		+
	Graphoderus cinereus (Linnaeus, 1758)		+
	Cybister lateralimarginalis torquatus (Fischer von Waldheim, 1829)		+
	**Hydroglyphus geminus* (Fabricius, 1792)	+	+
	Hydrovatus cuspidatus (Kunze, 1818)	+	
	Herophydrus musicus (Klug, 1834)	+	
	**Hygrotus lernaeus* (Schaum, 1857)	+	+
	Hygrotus parallellogrammus (Ahrens, 1812)	+	
	Hygrotus saginatus (Schaum, 1857)	+	
	Hygrotus inaequalis (Fabricius, 1777)	+	
	Laccophilus hyalinus (DeGeer, 1774)	+	
	* *Laccophilus minitus* (DeGeer, 1774)	+	+
	Laccophilus poecilus Klug, 1834		+
HELOPHORIDAE Leach, 1815	**Helophorus micans* Faldermann, 1835	+	+
	Helophorus aquaticus (Linnaeus, 1758)	+	
	Helophorus brevipalpis Bedel, 1881	+	
	Helophorus longitarsis Wollaston, 1864		+
	Helophorus obscurus Mulsant, 1844	+	
	Hydrochus flavipennis Kuster, 1852	+	
	Anacaena limbata (Fabricius, 1792)	+	
	Paracymus aeneus (Germar, 1824)	+	
HYDROPHILIDAE Latreille, 1802	*Berosus affinis* Brullé, 1835	+	
	Berosus spinosus (Steven, 1808)	+	
	Cymbiodyta marginella (Fabricius, 1792)	+	
	Enochrus melanocephalus (Olivier, 1792)	+	
	Enochrus bicolor (Fabricius, 1792)	+	
	Enochrus testaceus (Fabricius, 1801)	+	
	Helochares lividus (Forster, 1771)		+
	Helochares obscurus (O. F. Müller, 1776)	+	
	Helochares punctatus Sharp, 1869	+	
	**Hydrobius fuscipes* (Linnaeus, 1758)	+	+
	Hydrochara flavipes (Steven, 1808)	+	
	Coelostoma orbiculare (Fabricius, 1775)	+	

* It refers to common species.

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

2009	**MONTHS**	**LAKES**	
		Gölcük Yayla Lake	**Örenli Lake**
	May	1,63	1,06
	June	1,24	0,74
	July	1,34	0,43
	August	0,98	0,51
	September	0,70	0,89
2010	April	1,65	1,60
	May	1,91	0,89
	June	1,10	0,69
	July	1,14	0,41
	August	0,88	0,48
	September	0,41	0,51

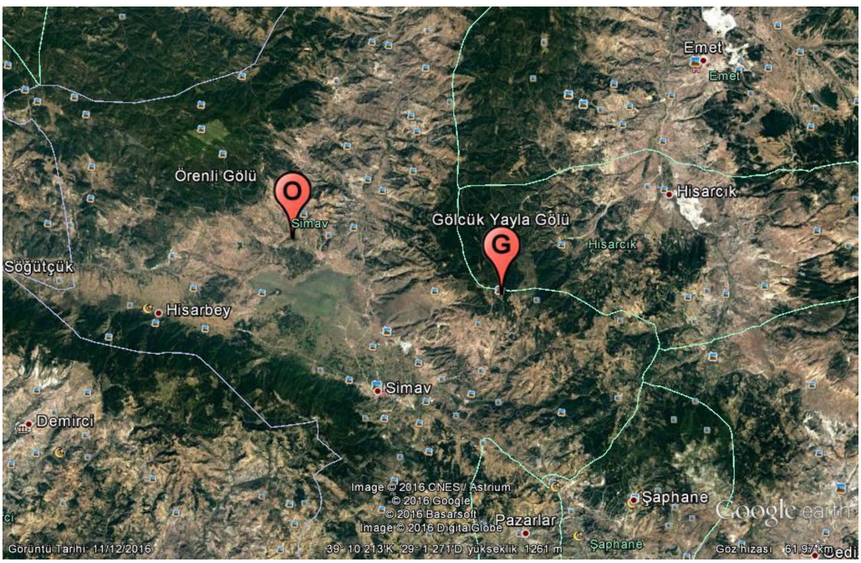

Figure 1. Lakes in the research area.

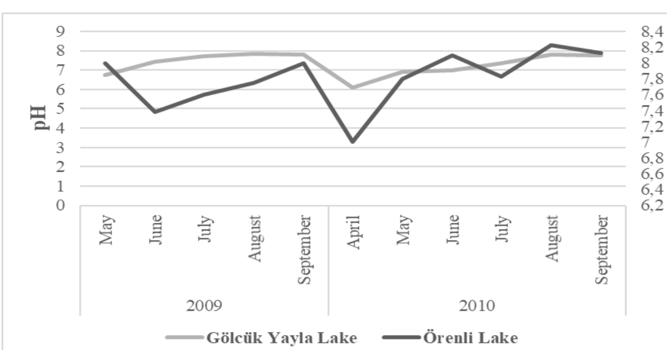

Figure 2. Monthly alterations of pH values.

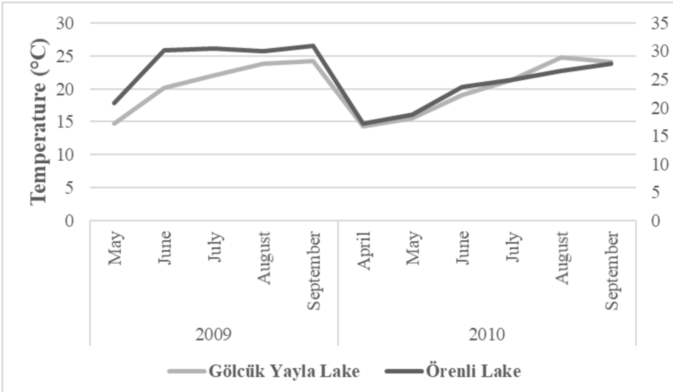

Figure 3. Monthly alterations of temperature values.

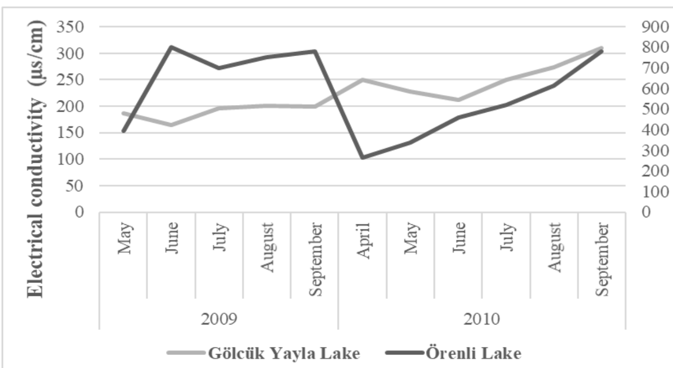

Figure 4. Monthly alterations of electrical conductivity values.

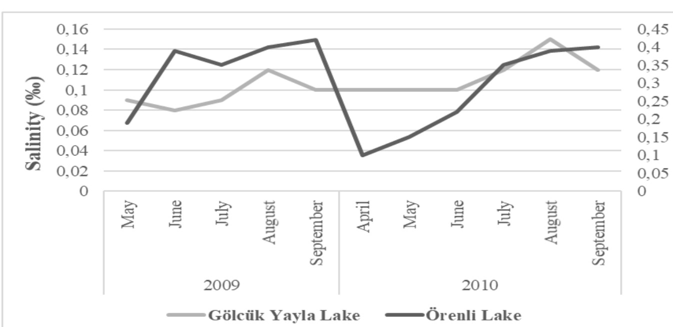

Figure 5. Monthly alterations of salinity values.

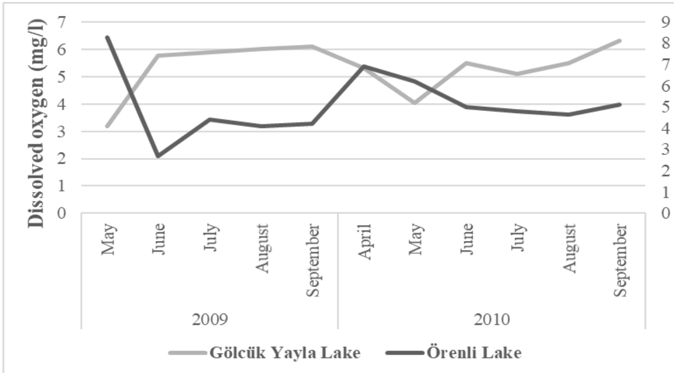

Figure 6. Monthly alterations of dissolved oxygen values.

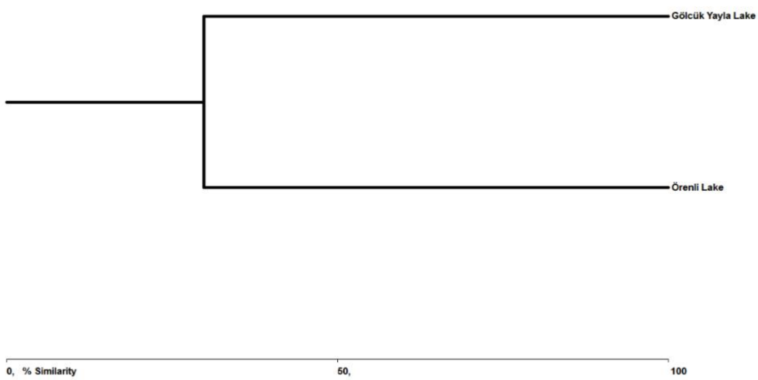

Figure 7. Similarity relationship between lakes according to cluster index.

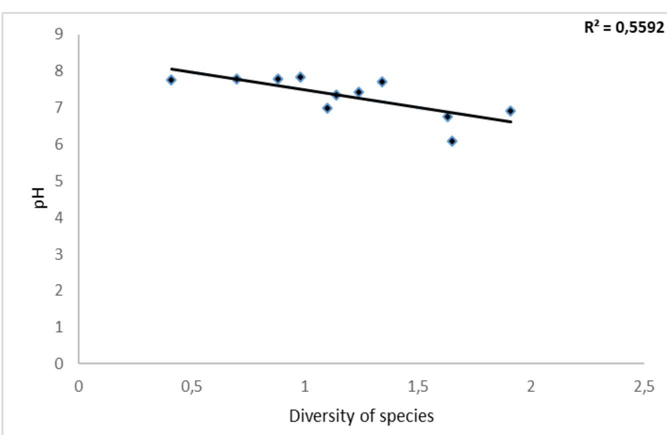

Figure 8. The relationship between aquatic Coleoptera diversity and pH in Gölcük Yayla Lake.

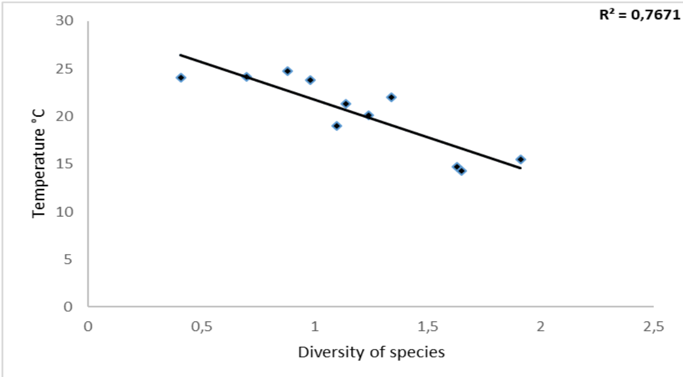

Figure 9. The relationship between aquatic Coleoptera diversity and temperature in Gölcük Yayla Lake.

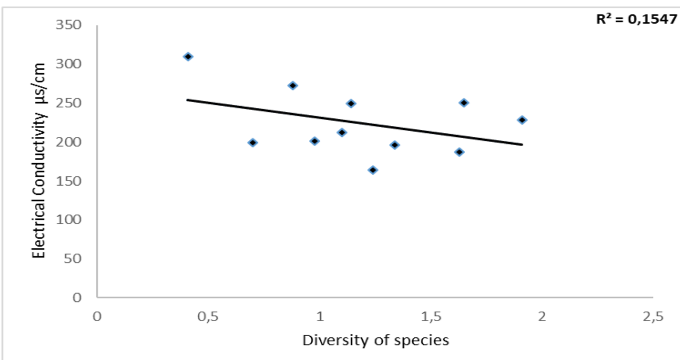

Figure 10. The relationship between aquatic Coleoptera diversity and electrical conducivity in Gölcük Yayla Lake.

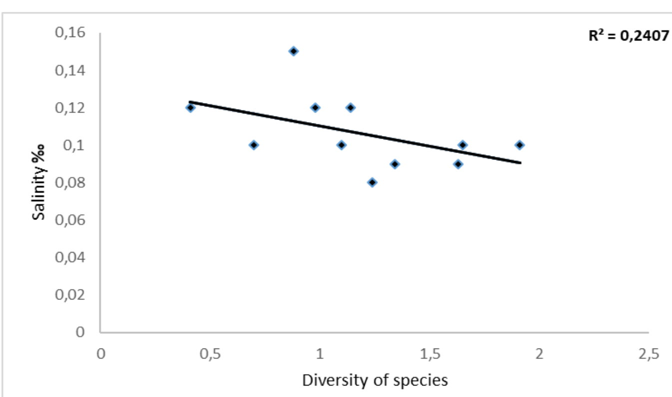

Figure 11. The relationship between aquatic Coleoptera diversity and salinity in Gölcük Yayla Lake.

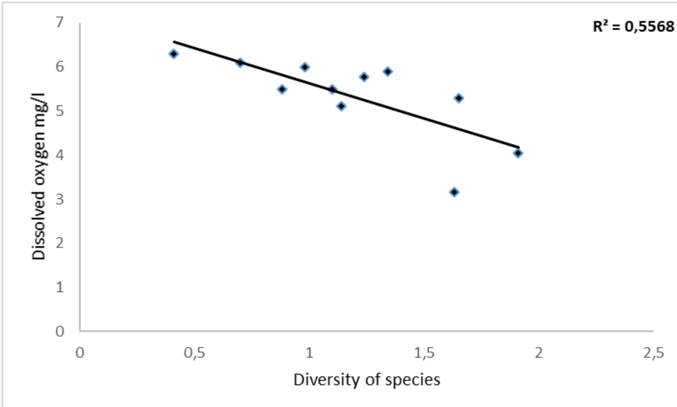

Figure 12. The relationship between aquatic Coleoptera diversity and dissolved oxygen in Gölcük Yayla Lake.

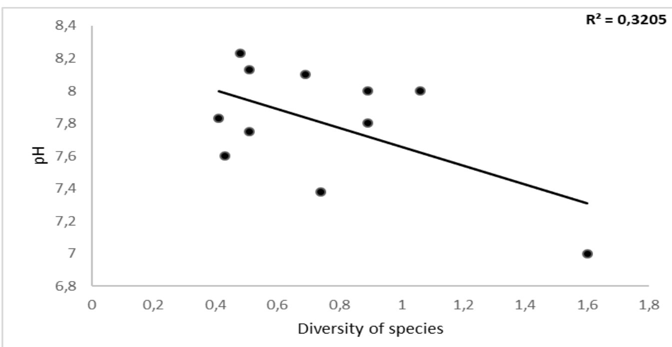

Figure 13. The relationship between aquatic Coleoptera diversity and pH in Örenli Lake.

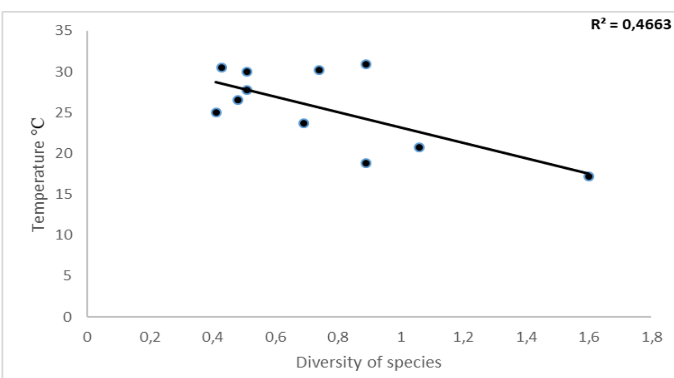

Figure 14. The relationship between aquatic Coleoptera diversity and temperature in Örenli Lake.

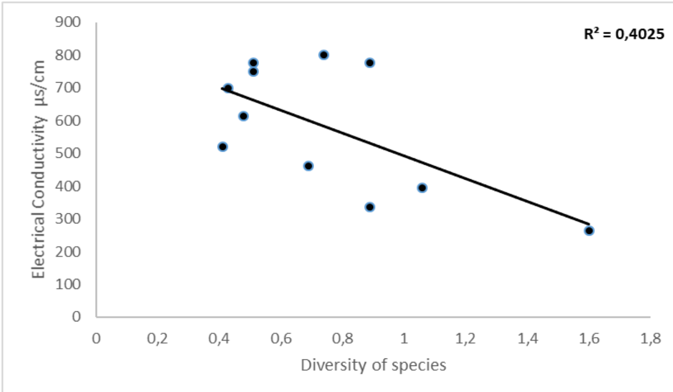

Figure 15. The relationship between aquatic Coleoptera diversity and electrical conductivity in Örenli Lake.

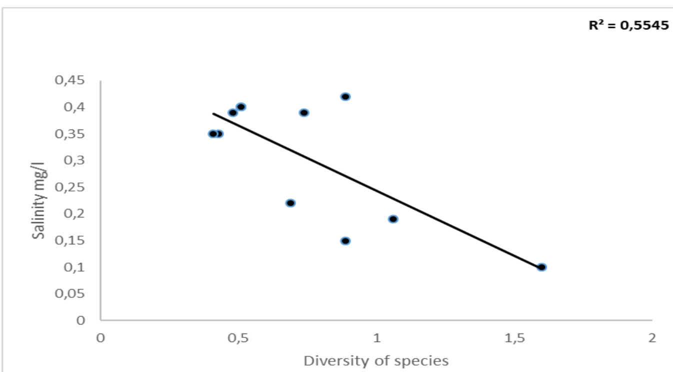

Figure 16. The relationship between aquatic Coleoptera diversity and salinity in Örenli Lake.

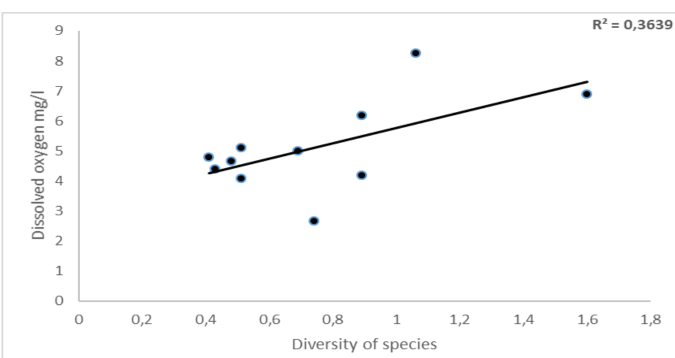

Figure 17. The relationship between aquatic Coleoptera diversity and dissolved oxygen in Örenli Lake.