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Research Article

Distribution of Aquatic Insects in Freshwater Areas in Antalya and Mersin Provinces (Türkiye)

Mehmet Bektaş [1,*], Yahya Tepe [2]

[1] Ataturk University, Hınıs Vocational Collage, Erzurum, Türkiye; https://orcid.org/0000-0002-7420-6883

[2] Ataturk University, Science Facult, Department of Biology, Erzurum, Türkiye; https://orcid.org/0000-0002-4589-9860

*** Corresponding author:** mehmet.bektas@atauni.edu.tr

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Abstract: Researchers have recently conducted faunistic research on aquatic insect families. But, we must find and track the animals in these waters. They are shrinking due to global warming. Also, from the expansion of farms and pesticides used in these areas. In this framework, we evaluated aquatic Coleoptera and Hemiptera species. We collected them in the Mediterranean coastal regions. We collected them from the freshwater areas of Antalya and Mersin provinces. We collected them in October, May, and July between 2022 and 2023. Researchers collected 2784 insects in the study area. 99 were Hemiptera (Corixiidae, Hydrometridae, Pleidae, Gerridae and Notonectidae). 2685 were Coleoptera. They were from the Dryopidae, Dytiscidae, Helophoridae, Heteroceridae, Hydranidae, Hydrophilidae, Hydrochidae, Haliplidae, Noteridae, and Spercheidae families. So far, we have only identified the collected specimens at the family level. We caught many Hydrophiliade and Corixiidae beetles and bugs. We caught them in large numbers, one family at a time. But, we caught very few Spercheidae and Pleidae. We caught almost none compared to previous places. Also, the maps show insect distributions. Greenhouse farming, which uses pesticides, is near rivers, streams, and so on. Researchers find few insect samples near the coast and in the lower parts of greenhouses. This is due to the use of water for farming. This study mapped aquatic insects in the research area for the first time. In conclusion, Türkiye's aquatic insects need more studies. These studies should cover all provinces. This is necessary for the insects to detect their existence. Moreover, it must continue.

Keywords: Aquatic insects; Biodiversity; Mediterranean region; Türkiye.

1. Introduction

The threat to biodiversity is one of the main concerns in the increase of environmental problems caused by agricultural purposes and more broadly by anthropogenic activities (Williams, 2001). The causes and spread of these activities affect freshwater lakes, rivers and streams. In fact, the negative circumstances affect aquatic insects, the most common macroinvertebrates that use these aquatic bodies as habitat, and also limit their habitat. In addition to the negative effects of agricultural measures, the use of pesticides should not be overlooked. Even though the use of pesticides is an agricultural control method, increased use of pesticides can increase yield but causes some problems in terms of environmental sustainability (Akdoğan et al., 2012; Kraus et al., 2021).

Pesticides travel through the air, water, and soil. They pose a big risk to invertebrates. These include aquatic insects (Prakash and Verma, 2022). Aquatic insects support ecosystem function and provide resources for high-level consumers. We need to find how much harm pesticides cause to freshwater (Özercan and Taşci, 2022).

Türkiye's economic performance is expected to be among the best in the Mediterranean in the near future. The provinces of Antalya and Mersin cover the largest area in the Mediterranean. In addition, Antalya with the best level of development in tourism (Kervankiran and Eteman, 2020) and Mersin province are areas where many economic sectors, especially the agricultural sector, can be sustained together due to their geographical features. It is necessary to compare the wetlands of Antalya and Mersin, the provinces where most pesticides are used in Türkiye, at least at the family level, to find out to what extent the pesticides affect the freshwater areas from different points of view (Eroğlu, 2012; Sargın, 1998; Zaman et al., 2011).

The main objective of this study is to assess the current state of freshwater resources in two significant provinces in the Mediterranean region (Antalya and Mersin, Turkey), which are important for tourism, agriculture, and industry. Greenhouses play a vital role in the local economy by providing a source of livelihood for residents (Sargın, 1998; Sandal and Gürbüz, 2003; Eroğlu, 2012; Zaman et al., 2011; Karakuş, 2014; Tiryaki, 2016). However, the depletion of freshwater sources due to greenhouse use and the impact of pesticides on macroinvertebrate distribution in freshwater ecosystems, particularly aquatic insects (Saler, 2006; Akdoğan et al., 2012), will be analyzed through mapping and numerical comparisons. This research aims to identify potential alternative solutions for addressing these challenges.

2. Materials and Methods

2.1. Study area and collecting-identification of insects

The study was conducted in fresh waters (Table 1) in the provinces of Antalya and Mersin (lakes, rivers, ponds, streams and branches of rivers). Insects were collected once in 3 seasons using a sieve: October (2022), May (2023) and July (2023) with the exception of the winter season (due to unavailability in the winter season). In research area, 2784 individual were collected. Samples killed with 70% ethyl acetate were stored in tubes containing 96% ethanol. After sorting the specimens by body structures and sexual organs, the researchers cleaned them with a brush. Then, they identified them. In the laboratory, we dissected the insects' aedeagi (sexual organs) under a stereomicroscope. The collected samples were identified using identification keys published by Bektaş et al. (2014), Bektaş (2015), Bektaş (2018), Bektaş et al. (2019), Darılmaz and Kıyak (2009), Daşbaşı (2017), Taşar (2017), Martins-Silva (2022), Mitra et al. (2016), Önder and Lodos (1986), Smetana (1985) and Yalçın (2010). Identification was done at the family, genus and species level. Unidentified specimens were recorded at the genus level.

The workers in the greenhouse gardens located near the areas where the insect samples were collected were asked if they used pesticides and it was stated that pesticides were generally used.

2.2. Statistical analyses

Since the biotic index rating system (BMWP) was used to consider the sensitivity of invertebrates to pesticide effects, the Shannon diversity index, which uses the number of individuals to calculate the abundance and dominance of aquatic insects in the study region (Antalya and Mersin provinces, Türkiye), was evaluated (Table 3).

At one point in this system, administrators assigned each family scores ranging from 1 to 10. They based the scores on their sensitivity to pesticides. Each type of organism added one point. Dividing the BMWP score by the number of taxa in the sample found the average score per taxon (ASPT). A high score means that the area is clean and contains many high-scoring taxa. Researchers calculate the average score per taxon (ASPT) using this formula. They found it in these sources: (Magurran, 1988; Mustow, 2002; Paisley et al., 2014):

ASPT = BMWP score / total number of insect families.

3. Results

In this study, 2784 insects were collected, 99 individuals from the order Hemiptera and 2685 individuals from the order Coleoptera. The captured individuals were identified only at the family level. According to a series of counts, the families Hydrophiliade (Coleoptera) and Corixiidae (Hemiptera) are more common than others; the families Spercheidae (Coleoptera) and Pleidae (Hemiptera) were almost not caught at all compared to previous sites (Table 1 and 2).

Insects are the most species-rich group. They have the most diverse diet, habitat, and adapt to different areas. (Bektaş, 2015; Bertola and Mutinelli, 2021). There are an estimated 5.5 million different species of these insects. Members of order Coleoptera are the group with the most species. This order includes 40% of insects (Bektaş, 2015; Bektaş et al., 2022).

The study bases its results on the average score per taxon (ASPT) of the collected insect numbers. The map of the study area displays the results in a color scale (Figure 1). It categorizes the results as Perfect, Good, Moderate, Poor, or Little to None (Figure 1 and Table 3). This classification reflects the pesticide effect and scarcity/absence of water resources. Also, we show the insects caught from the families Coleoptera and Hemiptera. We show their numbers in Table 2 and 3.

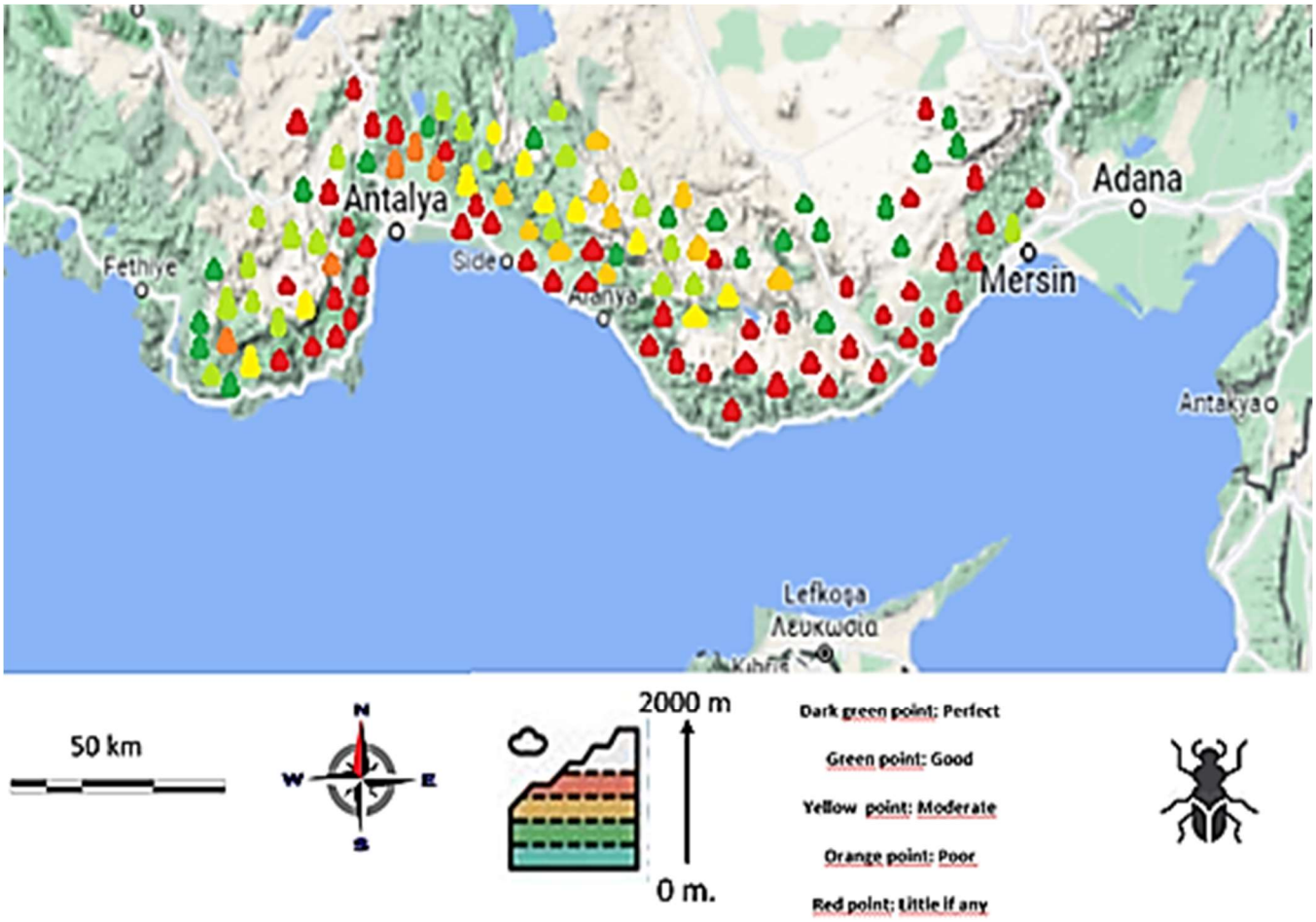

Figure 1. Capture points of aquatic insects on the map (expressed in colors).

Table 1. Locality information of sampling points.

Location (Türkiye)	Long-Latitude	Altitude (m)	Description of sampling point
Kargıcak / Alanya / Antalya	36◦ 28ˈ 13ˈˈ N / 33◦ 38ˈ 39ˈˈ E	63	There is very little human activity.
Söğüt deresi / Alanya / Antalya	36⁰11ˈ 48ˈˈ N / 33⁰ 13ˈ 16ˈˈ E	99	Livestock effects available. Vegetation is good.
Ormancık / Anamur / Mersin	36⁰ 04ˈ 15ˈˈ N / 32⁰ 47ˈ 19ˈˈ E	20	Occasional puddle of water
Anamur çayı / Alaköprü / Anamur / Mersin	36⁰10ˈ 28ˈˈ N / 32⁰ 52ˈ 42ˈˈ E	44	Puddles with vegetation left over from floods
Kırgı çayı / Alara / Gündoğmuş / Antalya	36⁰ 28ˈ 13ˈˈ N / 33⁰ 38ˈ 39ˈˈ E	17	Stream without vegetation
Oymapınar / Manavgat / Antalya	36⁰ 44ˈ 20ˈˈ N / 31⁰ 37ˈ 22ˈˈ E	23	Occasional puddle of water
Çandır çayı/ Çakırlar / Konyaaltı / Antalya	36◦ 51ˈ 55ˈˈ N / 30◦ 35ˈ 25ˈˈ E	26	Vegetated stream
Demre Kuş Cenneti / Demre / Antalya	36◦ 13ˈ 57ˈˈ N/ 30◦ 00ˈ 37ˈˈ E	0	Natural park with vegetation
Yaylakılınçlı Kaş / Antalya	36◦ 20ˈ 11ˈˈ N / 29◦ 28ˈ 18ˈˈ E	1107	Occasional puddle of water
Kargalık / Korkuteli / Antalya	37◦ 05ˈ 04ˈˈ N / 30◦ 09ˈ 56ˈˈ E	1050	There is very little human activity.
Akgöl / Silifke / Mersin	36◦ 30ˈ 19ˈˈ N / 34◦ 36ˈ 31ˈˈ E	5	Puddles with vegetation left over from floods
Bolatlı / Tarsus / Mersin	37◦ 36ˈ 21ˈˈ N / 35◦ 29ˈ 36ˈˈ E	50	Berdan Dam floods
Sipahili deresi / Bozağaç Gülnar / Mersin	36◦ 28ˈ 24ˈˈ N / 33◦ 37ˈ 32ˈˈ E	1002	Occasional puddle of water

Table 2. Collected insect families and numbers.

Order	Families	Collected numbers
Coleoptera	Hydrophilidae	1181
	Helophoridae	956
	Noteridae	452
	Hydranidae	42
	Dytiscidae	38
	Dryopidae	9
	Heteroceridae	4
	Hydrochidae	2
	Spercidae	1
Hemiptera	Corixidae	82
	Notonectidae	38
	Gerridae	6
	Hydrometridae	5
	Pleidae	1

Table 3. Assessment interpretation of collected insects from research area.

BMWP score	ASPT score	Remark of insects diversity and color	Remark of diversities colores on the reseach map
> 100	> 5	Perfect (Dark green)	
75–100	= 5	Good (Green)	
50–75	> 4	Moderate (Yellow)	
25–50	< 4	Poor (Orange)	
0–25		Little if any (Red)	

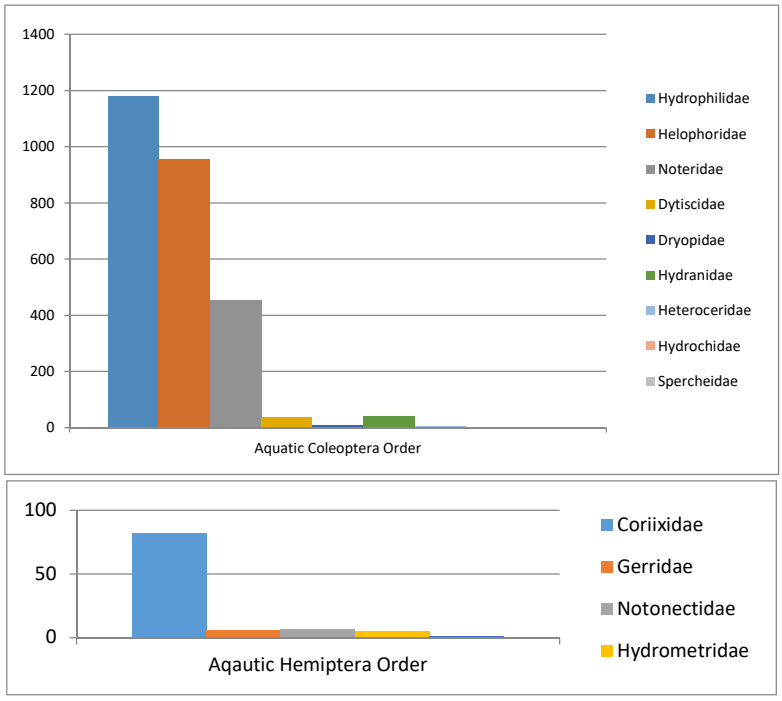

Figure 2. Diversity of collected insect family (families of aquatic coleptera and hemiptera).

4. Discussion

Freshwaters are one of the most important water resources for aquatic ecosystems and water supply, which are affected by global warming. In addition to global warming, pesticide residues also have a negative impact on freshwaters and restrict the reproduction and life of aquatic organisms. Many species of freshwater organisms (rotifers, copepods, insects, fish, etc.) reach their limits at or above 200C degrees (Paisley et al., 2014; Brkić, 2023). This critical temperature can be exceeded by global warming for long periods of time and thus potentially have various impacts on ecosystems (Bektaş, 2023).

Species richness ranged from 1 to 25 and is not the same for all families. The family Hydrophilidae was found to be the most abundant individuals due to its large number of genera. The insect individuals captured on the survey map are shown in different colors, from very dense to less dense (Figure 2). Red and orange colored areas can be seen near the coast and in areas below agricultural land, especially in banana greenhouses, which is due to both lack of water and the effect of pesticides. Despite the fact that the expected number of insects was not caught near water sources, it was found that the numerical results were positive compared to the lower-lying regions.

The maps (Figure 1) show the insect distribution. Researchers have observed that greenhouses use pesticides. Also, rivers, streams, and creeks have few insect samples. Collect them near the coast and in the lower areas of greenhouses. In conversations with greenhouse owners, it became clear. The number of water insects has dropped (Figure 2). They have even disappeared due to pesticides. When we went to the high-altitude regions of Antalya and Mersin provinces, we found that the sources of streams and rivers were diverted to the greenhouse gardens, resulting in completely dried-up riverbeds.

5. Conclusions

This research data was performed to determine the abundance of captured individuals of the families of the order Aquatic Hemiptera and Coleoptera. It was found that the number of insects is very low due to the use of freshwater in Antalya and Mersin provinces as a resource for agricultural purposes and the effect of pesticides. Biomonitoring programs have been proposed and it is pioneer research to develop ideas about the chemicals used in agricultural activities in the inland waters of the research region and the protection of the waters. In addition to insects, other macroinvertebrates should also be studied in the research area.

Conflicts of Interests

This work has been previously published as an abstract only in the 6th International Eurasian Conference on Biological and Chemical Sciences (EurasianBioChem 2023, Ankara, Turkey, October 11 - 13, 2023, vol.1, pp.214).

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Statement contribution of the authors

This study's experimentation, analysis and writing, etc. all steps were made by the Mehmet Bektaş, Yahya Tepe helped to collect the samples.

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