Entomology

Results of the Study of Honeybee (*Apis mellifera*) Populations in Various Habitats of Borjomi Gorge

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(Presented by Academy Member Tinatin Sadunishvili)

Pollination is one of the major ecosystem processes and pollinator insects play a crucial role in maintaining terrestrial (wild and agricultural) ecosystems. Among insects the major pollinators are wild and honeybees (Hymenoptera; Apoidea) and among bee species, the most important should be regarded the honeybee. Caucasian honeybee – *Apis melliefera* individuals were collected from different habitats and locations of Borjomi – 801 individuals in total. Their abundance differed between the studied habitats. The highest percentage of honeybees was recorded in grasslands, and the lowest – in coniferous forests. The abundance of the honeybee populations does not decrease with the increase in altitude and completely depends on the vegetation type. As long as the conditions are favorable for the existence of flowering plants, bees represent the dominant pollinators. Even at higher altitudes (853-1674 m a.s.l.), reduction of vegetation cover is not associated with a decline of pollinator honeybees. *© 2024 Bull. Georg. Natl. Acad. Sci.*

honeybee, ecology, pollination, Borjomi gorge

According to morphometric, genetic, ecophysiological and other features, there are several evolutionary lineages in the *Apis mellifera* species [1]. Despite considerable research into the number of honeybee subspecies or races, no scientific classification exists. The species is split into four evolutionary branches that is represented by the diversity of 31 subspecies (also called geographic races) [1-4].

The studies of the bees in Georgia were intensively conducted in the 1980^{th} [5-8]. Nevertheless, no thorough taxonomy research on the apidofauna of Georgia has been produced since. According to the latest data, 389 species of apidofauna are recorded from different regions of Georgia, which are united into 46 genera and 6 families [9,10].

Honeybees pollinate different wild and domestic plants and play important role of maintain the balance in the ecosystems. As it is widely known, nearly one-third of crops comes from plants that are pollinated by insects, and especially by honeybees [11,12]. The Food and Agriculture Organisation of the United Nations (FAO) estimates that out of some 100 crop species which provide 90% of food worldwide, 71% are bee-pollinated (http://www.fao.org/ag/magazine/0512sp1.htm).

The European honeybee (*Apis mellifera* L.) is an important species of bees that pollinates a number of agricultural crops worldwide [13] and also honeybees play an important role as pollinators to maintain biodiversity because there is a coevolution between flowering plant species and pollinator diversity [14]. Therefore, protection and preservation of honeybees should be considered a priority scientific and practical problem.

It should be noted that among other honeybees, the Caucasian Gray Mountain bee (*Apis mellifera mellifera*) plays an important role in maintaining biodiversity. This group of bees has many unique characteristics, the most important of which is the length of the proboscis (7.23 mm). The long proboscis allows to penetrate the generative organs located at any depth of the flower and carry out an effective pollination process [15,16]. The long proboscis allows the Georgian bee to suck nectar even from flowers with deep nectar; collect more honey and play a major role in pollination of entomophilous crops. The named characteristic is hardly found in other subspecies of honeybees [15-17].

Depending on the geographical location, climatic conditions, and distribution of flowering plants, different groups or populations of Georgian bees have emerged in different areas of Georgia. Scientifically, Georgian bees have been studied in: Samegrelo, Abkhazia, Zemo Svaneti, Imereti-Racha, Kartli and Kakheti. According to the location, six populations of Georgian bees are known: Megrelian, Abkhazian, Imeretian-Rachian, Zemo Svanetian, Kartlian and Kakhetian [15,16].

The native gray bee of Georgia mostly inhabited in the mountainous area, although it was also widespread in the lowlands. This is confirmed by the fact that honeybees which distributed in the lowlands of Georgia, were very similar to Caucasian Gray Mountain bees. Over the time, the common bee in the lowland areas of Georgia was hybridized with the yellow bee common in the neighboring areas. As a result, bees in lowland areas are characterized by a partial yellowish color on abdominal segments and relatively short proboscis. The lowland bees could not interbreed with bees of high mountains because they were separated by physical barriers and thus, mountainous populations remained isolated [17].

Honeybee populations differ between the western and eastern parts of the country too. The statistically significant differences between the morphological characteristics of the Caucasian Gray Mountain bee (Gurian, Megrelian, Svanetian, Imeretian-Rachian and Ajarian) populations in Western Georgia is low. In a similar manner, there are no significant differences between the populations of Kartli and Kakheti regions of eastern Georgia. As for the bee populations are distributed through the whole country, the difference between western and eastern populations is large and visually noticeable [15].

Unlike other regions of Georgia, the distribution of the populations of honeybee in Borjomi valley is scarcely studied. This area is distinguished by significant landscape diversity. Geomorphological features contribute to the abundance of mosaic landscapes and a high level of endemism [18,19]. The main phytocenological formations of this area are mesophilic mixed deciduous and coniferous forests [18-20]. Along with the increase in altitude, the air temperature gradually decreases and, accordingly, the forest formations change, first near the subalpine and alpine meadows and finally at the subnival zone [20,21]. An important part of the Borjomi valley belongs to the Borjomi-Kharagauli National Park, and this gives special importance to biodiversity research (https://apa.gov.ge).

Based on the above, the main goal of our research was 1) study of the population size of *Apis mellifera* in different landscape units and key habitats of Borjomi gorge; 2) determination of the high-altitude zonation spectrum of honeybee distribution; 3) study of population density and distribution in individual habitats; 4) revealing the role of European honeybee as pollinators in maintaining the sustainability of an ecosystem in a particular landscape.

Materials and Methods

The specimens of honeybee were collected during the summer season (8-12 June; 2023). We explored six locations in the Borjomi valley: Kvabiskhevi, Likani, Riv. Borjomula valley, Timothesubani, the villages of Mitarbi and Mzetamze. Materials were collected from seven habitats: deciduous forest, coniferous forest, meadows, riparian forest, grass-

Table 1. The number of bee individuals according to each location

Name of the research area	Habitat type	Geographical coordinates	No. of individuals *Apis mellifera*
Kvabiskhevi	1. Deciduous forest	950m a.s.l.; 41°46′31″N 43°14′35″E	11
	2. Coniferous forest	1.088m a.s.l.; 41°46′36″N 43°14′08″E	5
	3. Meadows	1.027m a.s.l.; 41°46′19″N 43°13′49″E	22
	4. Riparian forest	1.087m a.s.l.; 41°48′07″N 43°14′22″E	18
	5. Grassland	990m a.s.l.; 41°47′12″N 43°14′12″E	36
	6. Forest-steppe	927m a.s.l.; 41°46′38″N 43°14′36″E	12
	7. Mix (deciduous/coniferous) forest	1.288m a.s.l.; 41°47′36″N 43°14′48″E	11
Likani	1. Deciduous forest	853m a.s.l.; 41°49′48″N 43°21′08″E	9
	2. Coniferous forest	1.018m a.s.l.; 41°49′48″N 43°20′25″E	3
	3. Meadows	1.180m a.s.l. 41°50′46″N 43°20′38″E	21
	4. Riparian forest	1.313m a.s.l.; 41°50′15″N 43°19′14″E	7
	5. Grassland	1.056m a.s.l.; 41°50′13″N 43°20′39″E	17
	6. Forest-steppe	1.162m a.s.l.; 41°50′19″N 43°20′53″E	22
	7. Mix (deciduous/coniferous) forest	959m a.s.l.; 41°50′08″N 43°20′13″E	8
Borjomula riv. gorge	1. Deciduous forest	1.055m a.s.l.; 41°50′30″N 43°19′59″E	16
	2. Coniferous forest	1.272m a.s.l.; 41°48′24″N 43°23′43″E	8
	3. Meadows	1.004m a.s.l.; 41°50′05″N 43°19′50″E	19
	4. Riparian forest	871m a.s.l.; 41°48′04″N 43°19′14″E	40
	5. Grassland	1.158m a.s.l.; 41°51′56″N 43°23′50″E	26
	6. Forest-steppe	1.295m a.s.l.; 41°47′18″N 43°26′10″E	21
	7. Mix (deciduous/coniferous) forest	1.341m a.s.l.; 41°47′32″N 43°27′11″E	11
Timotesubani	1. Deciduous forest	1.122m a.s.l.; 41°48′08″N 43°30′51″E	18
	2. Coniferous forest	1.307m a.s.l.; 41°48′56″N 43°31′06″E	3
	3. Meadows	1.212m a.s.l.; 41°48′35″N 43°31′12″E	42
	4. Riparian forest	1.077m a.s.l.; 41°48′16″N 43°29′57″E	25
	5. Grassland	1.218m a.s.l.; 41°48′20″N 43°31′14″E	36
	6. Forest-steppe	1.303m a.s.l.; 41°48′45″N 43°30′25″E	12
	7. Mix (deciduous/coniferous) forest	1.394m a.s.l.; 41°48′42″N 43°31′34″E	28
vil. Mitarbi	1. Deciduous forest	1.432m a.s.l.; 41°46′36″N 43°33′31″E	21
	2. Coniferous forest	1.293m a.s.l.; 41°47′18″N 43°34′01″E	6
	3. Meadows	1.564m a.s.l.; 41°44′31″N 43°34′45″E	12
	4. Riparian forest	1.426m a.s.l.; 41°45′35″N 43°34′45″E	14
	5. Grassland	1.674m a.s.l.; 41°44′42″N 43°33′55″E	29
	6. Forest-steppe	1.193m a.s.l.; 41°47′26″N 43°33′55″E	9
	7. Mix (deciduous/coniferous) forest	1.273m a.s.l.; 41°47′25″N 43°32′40″E	21
vil. Mzetamze	1. Deciduous forest	1.122m a.s.l.; 41°47′42″N 43°29′20″E	32
	2. Coniferous forest	1.328m a.s.l.; 41°47′25″N 43°31′11″E	19
	3. Meadows	1.203m a.s.l.; 41°47′44″N 43°30′09″E	37
	4. Riparian forest	1.420m a.s.l.; 41°47′02″N 43°31′54″E	22
	5. Grassland	1.150m a.s.l.; 41°47′53″N 43°31′54″E	34
	6. Forest-steppe	1.321m a.s.l.; 41°47′10″N 43°29′50″E	11
	7. Mix (deciduous/coniferous) forest	1.419m a.s.l.; 41°47′22″N 43°30′38″E	27

land, forest-steppe, and mixed (deciduous/coniferous) forest). Honeybees were gathered in natural habitats, away from the settlements about seven kilometers to avoid interference with honeybees from beehives of local farmers. At each location the study was performed along the transects covering an altitude range from 800 m to 1.674 m a.s.l. In each habitat, apidofauna was collected during one hour using insect nets; and the mostly in the middle of the day. We placed the collected material in labeled containers filled with 96% ethyl alcohol solution. These materials stored at the laboratory of the Department of Biodiversity of Tbilisi State University. In the next stage, during the laboratory research, mounting and species identification are done. Identification provided after field-specific keys [22-24].

The significance of the differences in abundance of *A. milifera* was provided using "linear mixed effects model", the function "lmer" of the lme4 package [25]. The analyse was carried out using R version 4.3.2 [26].

Results

The total of 801 individuals of *A. millifera* were collected in all studied habitats. The number of individuals of *A. millifera* differed between the studied locations. The highest proportion of honeybees was revealed in Mzetamze territory (182 indi-

Table 2. Distribution of the number of honeybee (*Apis mellifera*) individuals according to each habitat

Name of habitat	No. of individuals *Apis mellifera*
1. Deciduous forest	107
2. Coniferous forest	44
3. Meadows	153
4. Riparian forest	126
5. Grassland	178
6. Forest-steppe	87
7. Mix (deciduous/coniferous) forest	106

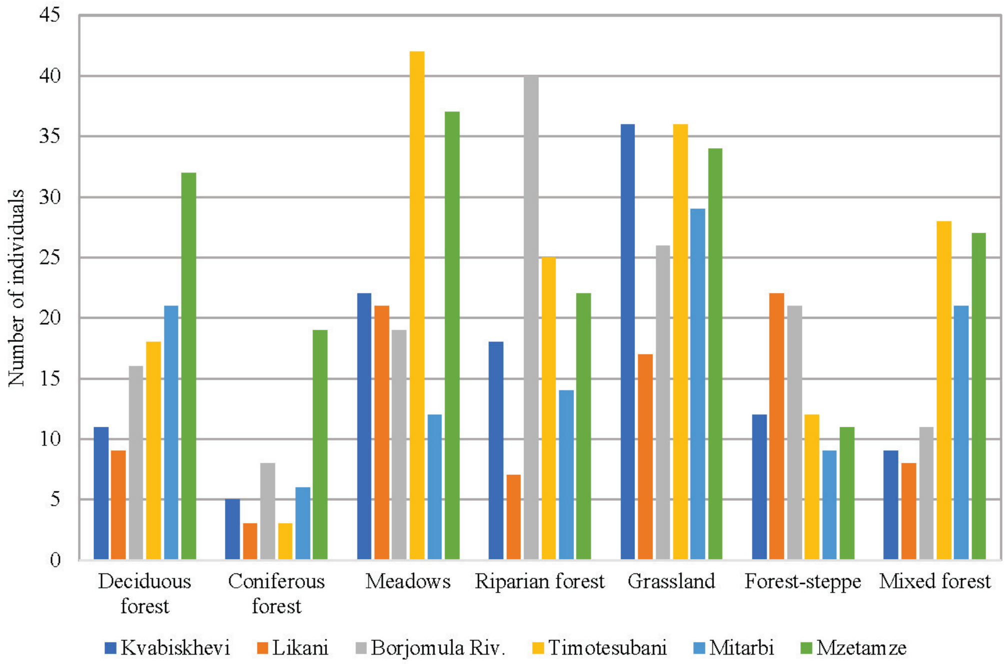

Fig. Number of honeybee individuals in different habitats.

viduals), while the least number of individuals was recorded in Likani (87 individuals) (Table 1).

The abundance of honeybees differed between the studied habitats, but the difference is not significant (df = 6, $p>0.05$). The highest number of individuals was recorded in grasslands (178 individuals), and the lowest – in coniferous forest (44 individuals) (Table 2).

In three out of the six locations of the study area (Kvabiskhevi, Timothesubani, Mitarbi), the number of honeybee individuals was highest in grassland. The lowest number of honeybee individuals was collected in a coniferous forests. Mitarbi location was an exception, where the lowest number of honeybees was recorded in the forest-steppe habitat (Figure).

Discussion

The reason for such high abundance is that the territory of the Borjomi valley is characterized by the optimal amount of moisture and temperature and great diversity of nutritious flowering plants. The presence of a large number of key pollinators is a sign that studied ecosystems are not threatened by a lack of pollinators. The difference in numbers in different locations, could be caused by complex environmental conditions in the Borjomi valley and climatic and phytocenological differences between the studied areas (Kvabiskhevi, Likani, Borjomula river, Timothesubani, Mitarbi village, Mzetamze village).

The abundance of honeybees differed between the studied habitats. The highest number of individuals was recorded in grasslands, and the lowest - in coniferous forests. The obtained results are in correlation with the host plants of honeybee. In habitats covered with diverse flowering plants, the number of bees is high, while in habitats populated by dark coniferous trees is much less. In dark coniferous forests, herbaceous and other flowering plants are less developed due to the lack of sunlight, therefore pollinating insects, including honeybees, are collected in small numbers. An exception was the study area of Mitarbi, where a large number of honeybees were collected in the coniferous light forest. This should be explained by the fact that here was the light coniferous forest and the grass cover was well developed.

The abundance of the honeybee populations does not decrease with the increase in altitude and completely depends on the type of vegetation. This should be explained by the fact that honeybee has the unique ability to adapt to the fluctuations of the temperature regime along the change of the altitude. As long as the conditions are favorable for the existence of flowering plants, bees represent the dominant pollinators. Even at higher altitudes, reduction of vegetation cover is not associated with a decline of pollinator honeybee (Table 1). Accordingly, maintaining the populations of honeybees as the main pollinators is a significant factor in pollinating plants in mountainous ecosystems.

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ენტომოლოგია

მეთაფლია ფუტკრის (*Apis mellifera*) პოპულაციების შესწავლა ბორჯომის ხეობაში

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მეთაფლია ფუტკარი (*Apis mellifera*) წარმოადგენს ყვავილოვანი მცენარეების ერთ-ერთ უმნიშვნელოვანეს დამმტვერავს. შესაბამისად, მისი პოპულაციების სიდიდის დადგენას დიდი მნიშვნელობა აქვს უნიკალური ეკოსისტემის შენარჩუნებისათვის. მეთაფლია ფუტკრის პოპულაციების რაოდენობის შესწავლა განხორციელდა ბორჯომის ხეობის საკვანძო ჰაბიტატებში. შევისწავლეთ ექვსი ლოკაციის შვიდი განსხვავებული ჰაბიტატი. სხვადასხვა ჰაბიტატში გამოვლინდა მეთაფლია ფუტკრის პოპულაციის განსხვავებული სიდიდე. ინდივიდთა ყველაზე მეტი რაოდენობა გამოვლინდა მზეთამზის ტერიტორიაზე, ხოლო ყველაზე ნაკლები ლიკანში.ბალახოვანი მცენარეებით დაფარულ ჰაბიტატში აღირიცხა ინდივიდების ყველაზე მაღალი მაჩვენებელი, ხოლო ყველაზე მცირეწიწვოვანი მცენარეებით დაფარულ ტყეში. დადგინდა, რომ მეთაფლია ფუტკრის პოპულაციების მნიშვნელოვანი რაოდენობა არ მცირდება ზღვის დონიდან სიმაღლის მატების პარალელურად.

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