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Entomology

Diversity and Abundance of Chalcidoids in the Borjomi-Kharagauli National Park, Georgia

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(Presented by Academy Member I. Eliava)

ABSTRACT. Chalcid diversity was investigated in the Borjomi-Kharagauli National Park, Georgia. 13 subfamilies of chalcids were recorded during the survey. Chalcids were most abundant at the site of Bairagebis Seri where 37.7% of all sampled individuals were found. Chalcid subfamilies were found to be unequally partitioned in all five microhabitats. The similarity indices between the sampling sites were low, but the highest similarity index (0.115) was found between the sites Lomis Mta and Datvis Tsumpe. The study revealed that the site close to old fired forest provide special, poor microhabitats for chalcid fauna. *© 2010 Bull. Georg. Natl. Acad. Sci.*

Key words: *chalcids, Borjomi-Kharagauli, Georgia, diversity.*

Introduction

The Chalcidoidea constitutes one of the most abundant and diverse group of insects. Equating this to well-studied insect groups such as beetles, moths and butterflies would suggest that had the Chalcidoidea been as popular with collectors and taxonomists of these groups in the past, the current number could well be in excess of 100,000 species. Recent estimates suggest that there may be more than 500,000 species in existence. Chalcidoids probably have a greater range of biological diversity than species of any other parasitic superfamily and, to a much greater extent than in other groups, considerable diversity often occurs within genera. Most species are parasitoids, but groups of species in several families are phytophagous. The Chalcidoidea is the most important successful group used in applied biological control. Over 800 different species of chalcids have been associated with biocontrol programmes in one way or another [1].

There is a large body of research suggesting that natural ecosystem properties greatly depend on biodiversity and that the functioning of ecosystems is associated with biodiversity [2]. Biodiversity is also infiltrating administrative language, particularly after the UN global Conference on the Environment and Development held in 1992 [3,4]. The conference declared preservation of biodiversity as one of the major elements of sustainable development [5]. Insects are a suitable subject for assessing the impact of disturbance on ecosystem composition and dynamics. Furthermore, insects may serve as "test organisms" for comparing disturbed and undisturbed Sampling Sites, because of the functional relationships among species and the high abundance in many taxa [5].

Studies on chalcids in nature of Georgia are of a faunistic character and provide no detailed quantitive data [6-11]. This kind of study can serve as a basis for future long-term observations on the biodiversity recovery processes in the Borjomi-Kharagauli National Park (BKhNP) and can be used as a reference case study in similar faunistic studies in future.

Materials and methods

Borjomi-Karagauli National park is a most beautiful place in Georgia and rich in mineral waters. It was founded in 1995 on the basis of the Borjomi reserve. The park covers more than 75,928 hectares [12], which amounts to nearly 1% of the territory of Georgia. The Caucasus region is one of the most interesting regions from the point of view of the origin of life and at the same time it is in the list of 34 hot spots of wild life in the world [13]. The Caucasus region is characterized by high biodiversity and high degree of endemism. The quantity of plant and animal species per unit of land exceeds the average world index by 100 times and this is a result when the fauna of invertebrate animals (especially insects) is far from investigated well.

Typical Kolkheti landscapes combine foothill and lowland subtropical forests with high content of evergreen plants in the understory. High mountains in the park are presented by mountain and subalpine forests, subalpine and alpine meadows, and subnival landscapes. Characteristic of the park are: Imeretian buckthorn (*Rhamnus imeretina*), the yew (*Taxus baccata*), Pontic and Caucasian rhododendron (*Rhododendron ponticum* and *Rh. Caucasicum*), cherry laurel (*Laurocerasus officinalis*), holly (*Ilex colchica*), Colchian ivy (*Hedera colchica*), sweet chestnut (*Castanea sativa*), beech (*Fagus orientalis*), hornbeam (*Carpinus caucasica*), linden (*Tilia caucasica*), Colchian oak (*Quercus hartwissiana*) and some others. As far as insects are connected with plants and they are often narrow oligophagous and even sometimes monophagous, it serves guarantee for high biodiversity and endemism.

The study area was divided into five sampling areas with different plant associations: 1. Banis Khevi – entrance from Banis Khevi side, near the village. This place is semi-natural, used by local people both for agricultural purposes and for grazing. The collecting was carried out in a place enclosed for grass by a local inhabitant. The altitude of this site was 848 m, coodrinates in decimal degrees are N41.873672, E43.40047 2. Bairagebis Seri – near the tourist base with very high plant diversity grassland, altitude 1803 m, coordinates N41.84043, E43.27454; 3. Datvis Tsumpe – this is a microhabitat close to which a forest fire happened 20 years ago and reforestation is under way, altitude 1770 m, coordinates N41.8598, E43.24987; 4. Likani – site with grassland next to mixed forest, dominant tree species Quercus and Picea, altitude 975, coordinates N41.83222, E43.3236; 5. Lomis Mta – subalpine field affected by grazing, altitude 1921 m, coordinates N41.86446, E43.24217. Coodrinates are given in decimal degrees.

Sampling was performed every three weeks (one day interval between the sampling localities). Areas of similar characteristics (generally grasslands) were chosen from each locality. Chalcids were collected with a sweeping net. During daytime 100 sweepings were conducted at each sampling site. Data were collected from April 15 to September 15, 2008. After the material was collected, it was preserved in 75% alcohol, and material was dried once in the laboratory by using hexamethyldisilazene (HMDS) and mounted according to Noyes [1] methodology. We used different keys and web sources to determine the families and species [1,14-15].

Diversity indices and family evenness models were calculated by Shannon-Wiener and Shannon equations respectively:

$$H' = -\sum pi \ln(pi) \quad J = H'/\ln S$$

Fig. 1. Map of sampling sites

where *pi* is the proportion of individuals found in the *i*-th family and *S* is the number of families.

Species richness indices were calculated by Margalef's diversity index equation:

$$D_{mg} = \frac{(S-1)}{\ln N}.$$

Where *S* is the number of recorded species and *N* is the total number of individuals in the sample.

Dominance measures were calculated by the Simpson index equation:

$$l = \sum ni(ni-1) / N(N-1),$$

where *l* is Simpson index, *ni* – number of individuals in each of the families and *N* – the total number of individuals [16].

To estimate the total species richness of each site from the abundance data, we used the Chao 1.

$$S_{Chao1} = S_{obs} + \frac{F_1^2}{2F_2},$$

where S_{obs} is the number of species in the sample; F_1– the number of observed species represented by a single individual (singletons); F_2 – the number of observed species represented by two individuals (doubletons) [16].

To estimate the absolute number of species at all sites, we used the Chao 2 equation

$$S_{Chao2} = S_{obs} + \frac{Q_1^2}{2Q_2},$$

where Q_1 is the number of species that occur in one sample only (unique species) and Q_2 – the number of species that occur in two samples [16].

The similarity coefficient was calculated by the Jaccard equation:

$$Cj = j / (a + b - j),$$

where *a* is the number of species at the site A, *b* – the number of species at site B, *j* – the number of species found at both sites.

Biodiversity Professional program was used for cluster analyses, as well as for calculation of Mean Individuals, Variance, Standard Deviation, Standard error, Total Individuals and Mean Confidence Interval [17].

Results

Collections at five sites resulted in 247 database specimens. Specimens were identified to subfamily level, but also to species and morphospecies with sufficient confidence. All species were sorted into 94 distinct morphospecies, belonging to 13 subfamilies. The chalcid communities of 6 micro-habitats at BKhNP are shown in Fig.1.

The greatest diversity was found at site Bairagebis Seri (44 species) (Table 1).

The estimated absolute number of species at all sites was 563, which means that 83.3% of chalcid fauna is still undiscovered at the BKhNP.

The site Bairagebis Seri harbored the highest abundance of chalcids, where 37.7% of all sampled chalcids were collected (site Banis Khevi – 26.7%, site Lomis Mta – 18.7 %, site Likani – 9.7% and site Datvis Tsumpe only 7.3%). 61.5 – 61.5 % of the recorded families were represented at the sites Bairagebis Seri and Lomis Mta. The number of families found at sites Bairagebis Seri and Lomis Mta were 8 in each (Table 2). The lowest number of samples was recorded from site Datvis Tsumpe (7 %), which also had the lowest number of families as well (38%).

The highest species richness was observed at site Bairaghebis Seri (9.49). The lowest species richness was recorded at site Datvis Tsumpe (2.08), which site was next to the place where forest fire took place 20 years ago. The highest diversity index (1.8) at the family level was observed at site Lomis Mta. The lowest Shannon-

Table 1.

Basic site-by-site diversity statistics for chalcids

Site	Total specimen	Species observed	Estimated species	Estimated completeness (%)	Singletons	Doubletons	Unique species
Banis Khevi	66	22	32	68.75%	10	5	18(22.22%)
Bairagebis Seri	93	44	164	26.8%	31	4	34(42%)
Likani	24	16	30	53.33%	9	3	10(12.35%)
Lomis Mta	46	22	42	52.38%	14	5	15(18.52%)
Datvis Tsumpe	18	7	11	63.64%	4	2	4(4.94%)

Table 2.

Relative abundance of coleopteran families recorded at four sites at Golcuk Natural Park, Isparta, Turkey

Family and Subfamily	Banis Khevi	Bairagebis Seri	Likani	Lomis Mta	Datvis Tsumpe
Euritominae	0.303	0.054	0.167	0.065	0.167
Pteromalinae	0.318	0.183	0.25	0.13	0.333
Miscogasterinae	0	0	0	0.022	0
Ormocerinae	0.03	0	0	0	0
Pireninae	0	0	0	0.043	0
Perilampinae	0	0.032	0	0	0
Chrysolampinae	0	0	0	0	0.056
Tetrastichinae	0.242	0.474	0.5	0.196	0
Entedoninae	0.061	0.065	0	0.26	0.111
Euderinae	0.015	0.011	0	0	0
Eulophinae	0	0.032	0.042	0.043	0.222
Encyrtinae	0.03	0.128	0	0.239	0.111
Coccophaginae	0	0	0.042	0	0
Total	66	47	24	46	18
H'	1.515	1.6158	1.2566	1.8115	1.6479
E	0.7786	0.7354	0.7808	0.8711	0.9197
D_{mg}	5.01	9.49	4.72	5.48	2.08
l	0.2576	0.2836	0.3438	0.189	0.216

Wiener diversity index was found at site Likani (1.2566).

Mean Individuals, Variance, Standard Deviation, Standard Error, Total Individuals and Mean Confidence Interval were also calculated (Table 3).

The site Likani does not cluster with any of the other sites in the cluster analysis (Fig. 2).

The subfamily Tetrastichinae was the most abundant group at all sites, followed by the family Pteromalinae. The Euritominae was also a common subfamily at all sites.

Table 3

Descriptive statistics of chalcids at different sites

Sample	Mean Individuals	Variance	Standard Deviation	Standard Error	Total Individuals	Total Species	Mean Confidence Interval
Banis Khevi	5.077	65.577	8.098	2.246	66	7	35.648
Bairagebis Seri	7.154	148.974	12.206	3.385	93	9	80.983
Likani	1.846	12.808	3.579	0.993	24	5	6.963
Lomis Mta	3.538	19.769	4.446	1.233	46	8	10.747
Datvis Tsumpe	1.385	3.756	1.938	0.538	18	6	2.042

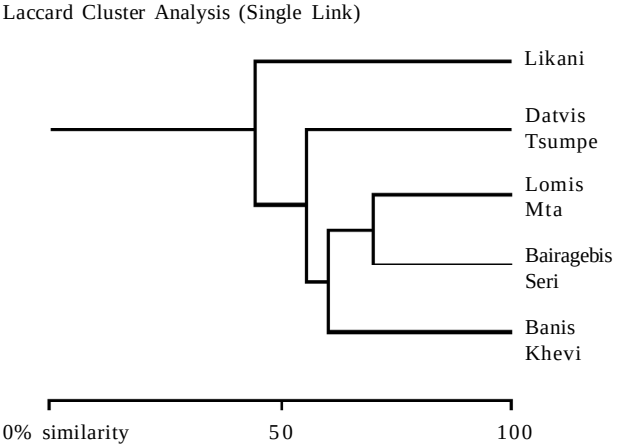

Fig. 2. Chalcid fauna similarity between sampling sites based on subfamily level

The similarity indices between sites was very low; however, the highest percentage similarity index at species level (0.115) was found between Lomis Mta and Datvis Tsumpe, which can be explained by the distance between these two sites (Banis Khevi/Bairagebis Seri = 0.0127; Banis Khevi/Likani = 0.056; Banis Khevi/Lomis Mta = 0.048; Banis Khevi/Datvis Tsumpe = 0.074; Bairagebis Seri/Likani = 0.035; Bairagebis Seri/Lomis Mta = 0.045; Bairagebis Seri/Datvis Tsumpe = 0.028; Likani/Lomis Mta = 0.056; Likani/Datvis Tsumpe = 0.031; Lomis Mta/Datvis Tsumpe = 0.115). The lowest similarity index was found between Banis Khevi and Bairagebis Seri (0.0127). Distributions of abundance of chalcid families were different between all studied sampling sites.

The subfamily Pireninae was recorded only from site Lomis Mta, Ormocerinae only from site Banis Khevi, Perilampinae only from site Bairagebis Seri, Chrysolampinae only from Datvis Tsumpe site and Coccophaginae from Likani. From the results of this study, we consider that the between-site diversity (β diversity) in the Borjomi-Kharagauli National park is high.

Discussion

The present study revealed that the site Bairagebis Seri provides a special sampling site for chalcids. This could be attributed to the influence of the high plant, especially grass diversity forming of microhabitats suitable for chalcids – has played an important role in structuring the chalcid fauna of this site. The lowest percent was found at the site Datvis Tsumpe, which we explain by the high erosion level and poor flora, because of forest fire taken place 20 years ago and restoration of the habitat goes on naturally. Tilman et al. [18] observed that destroying an additional 1% of the habitat caused eight times more extinction than similar sized disturbed habitats. It is a fact that species with small population sizes will suffer most. We recommend further long-term surveys in the BKhNP using some chalcid groups as taxonomic indicators for assessing the natural processes underway in the park, especially sites of fire places. Conservation measures will help to conserve and monitor rare and endangered species and populations. In any conservation effort one should bear in mind that each recovery measure taken should consider the improvement of the habitat conditions and increase biodiversity. We suggest that conservation efforts and monitoring in the study area should use selected insect groups as taxonomic indicators in order to help adjust mitigation measures. It should be considered also that BKhNP is in good condition and if the park administration continues this policy it will be an attractive place for tourists.

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ენტომოლოგია

ბორჯომ-ხარაგაულის ეროვნული პარკის ქალციდების მრავალფეროვნება და სიმდიდრე

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ნაშრომში შესწავლილია ბორჯომ-ხარაგაულის ეროვნული პარკის ქალციდების მრავალფეროვნება. კვლევების დროს 13 ქვეოჯახი იქნა რეგისტრირებული. ქალციდებით ყველაზე მდიდარი აღმოჩნდა ბაირაღების სერი, სადაც მოპოვებული ინდივიდების 37.7% იქნა შეგროვებული. ქალციდების ქვეოჯახები წერტილებს შორის არათანაბრად იყო გადანაწილებული. მსგავსების ინდექსი წერტილებს შორის იყო მცირე, ყველაზე მაღალი მსგავსების ინდექსი ლომის მთასა და დათვის წუმპეს შორის დაფიქსირდა. კვლევის შედეგებმა აჩვენა რომ ძველი ნახანძრალი ტყის მახლობლად ჩამოყალიბებულია განსაკუთრებული მიკროჰაბიტატი ქალციდების ფაუნისათვის.

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