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Gelechiid Moths from the Islands of Peter the Great Gulf (Lepidoptera: Gelechiidae): Preliminary Faunistic Analysis

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Abstract

The comparative faunistic analysis of species diversity of family Gelechiidae in Islands of Peter the Great Gulf and in neighboring continental territories is made. The island fauna turned out depleted because of small size of islands, limited landscape diversity and impossibility of active moth migration due to their weak flying abilities. However the concentration of species diversity in islands is almost two orders of magnitude larger than that in continental part. The proportion of Gelechiid groups with certain type of geographic range in islands is similar to that in continental part, that is treated by recent their isolation. The fauna of every examined island is disharmonic, representing by some species from every genus and includes small number of common species that is interpreted by continual species extinction and an insignificant random drift from mainland.

Keywords: Biodiversity; Gelechiidae; Russian Far East; Islands; Comparative faunistic analysis

Introduction

The island's fauna, being the result of natural experiment, has long attracted the attention of researchers. It was made many discoveries on a research of island faunas, assumed as basis of significant generalizations, among which the largest is an evolutionary theory of Charles Darwin [1]. Now the island biogeography is separate field in Biogeography, the base of which was put by R.H. MacArthur and E.O. Wilson [2]. During long-term studies of island biota it was identified factors more or less influencing on its features. Despite the general manifestations each of the islands and its biota are unique and have their own specific features. Precisely these original features attract researchers and an extensive literature is devoted to island fauna of invertebrates and vertebrates. The character of publications and circle of discussed questions are depending on the degree of scrutiny of the island biota. The initial studies are usually limited to the lists of species, but as result of continued study the most deep faunal and arealogical analyze demonstrating zoogeographic relationships, and discussion of theoretical problems concerning the regularity of fauna formation in the islands and its peculiarities, that finds a place in the recently published work on the islands of the Baltic Sea [3]. The object of present work, islands of the Peter the Great Gulf, are poor studied, especially from the viewpoint of taxonomic diversity of the microlepidoptera. Until recently there were only separate descriptions of 10 species of tortricids and 1 species of carposinid moths from Askold Island [4-8] and 1 species of Gelechiid moths from Rikord Islands [9]. Current year the first list of Gelechiid moths found on the three islands of the Peter the Great Gulf was published [10]. The goal of present work is faunistic and arealogical analyses of the Gelechiid moths found in the islands, specifically the comparison of their species diversity with data on this group from neighboring continental territories located in temperate zone to understand the zoogeographic relationships and estimate origin and peculiarities of island Gelechiid fauna. All materials collected in Islands of Peter the Great Gulf is kept in collection of Institute of Biology and Soil Science (Russia, Vladivostok).

Materials and Methods

The subject of investigation is species diversity of Gelechiid moths on the Islands, Rikord, Bolshoy Pelis and Furugelm, placed in Peter the Great Gulf of Japanese Sea (Figures 1 and 2). The moths from family Gelechiidae are small with wingspan from 7 to 28 mm. They are not belonging to migratory groups and even narrow sea channel of 5 km width is serious barrier, which cannot be actively overcamed by them.

Figure 1: Sea of Japan with continental and island territories. The locality of Islands of the Peter the Great Gulf is shown by dotted line.

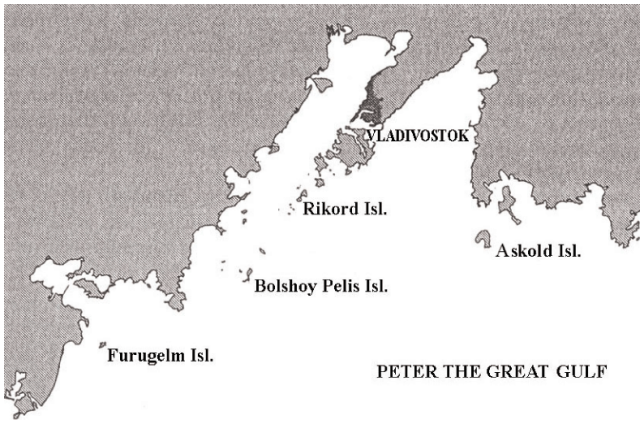

Figure 2: Peter the Great Gulf with examined islands.

The three studied islands are shelf and short-distance islands. The time of their isolation from continental part is about 11–8.5 thousand years ago [11], and all of them were part of mainland at the end of Pleistocene. The characteristics on each island are taken from Wikipedia [12] and combined in Table 1.

Island	Area, km^2	Minimal distance from mainland, km	Highest elevation above sea level, m	Coordinates
Rikord	5	14	178	42°52′N 131°39′E
Bolshoy Pelis	3,6	14	193	42°39′N 131°27′E
Furugelm	1,9	5	120	42°27′55″N 130°55′10″E

Table 1: Area and remoteness of islands from mainland.

All data on faunistic diversity of Gelechiid moths in the Islands are original and based on material collected by author in 2012 and 2013. In comparative faunistic analysis the available literary data on the fauna of Gelechiidae from following neighboring territories placed in same zonality are involved: Russia: south part of Primorsk Territory (Khasansk, Nadezhdinsk, Shkotovsk and Partizansk districts) [13], China: North-East Jilin prov. [14-16], Korean Peninsula: North and Central part [17] and Japan: Hokkaido and Honshu [18].

The local faunistic lists were combined in matrix (Supplementary Table), which was processed with program package PAST (PAleontological STatistics) [19]. The genera in the List are arranged according to system proposed by author [20,21], the species names within genus are given in the alphabetic order.

Results

Totally 49 species of 29 genera Gelechiid moths were collected in the Rikord Isl., Bolshoy Pelis Isl. and Furugelm Isl. (Supplementary Table). Species diversity of Gelechiidae in islands turned out almost three times lower than in continental part of south of Primorsk Territory. The material collected in the Rikord and Bolshoy Pelis Islands are slightly more diverse on the genera, 15 and 16, respectively. The species diversity of Gelechiids is more in Furugelm Isl., which placed more south, where 23 species were collected.

The grouping of collected species according to type geographic range showed unexpected result: proportion of island species-group with same range was similar to that of continental Gelechiid moths recorded from south Primorsk Territory (Figure 3). The species group with East Asian distribution was a dominant in each island's fauna, numbering from 60.9% to 83.3% and in continental part of Primorsk Territory amounted 75.2% of list of collected species. Thus, the group with East-Asian species includes 16 of 20 species collected in Bolshoy Pelis Isl., 15 of 18 species found in Rikord Isl., and 14 of 23 species from Furugelm Isl. The species-group with transpalaearctic range ranks is second, numbering from 6% to 39% of total collected species. The other types of ranges are characteristic to single island species and their part is not exceeding several percentages of total list of collected species.

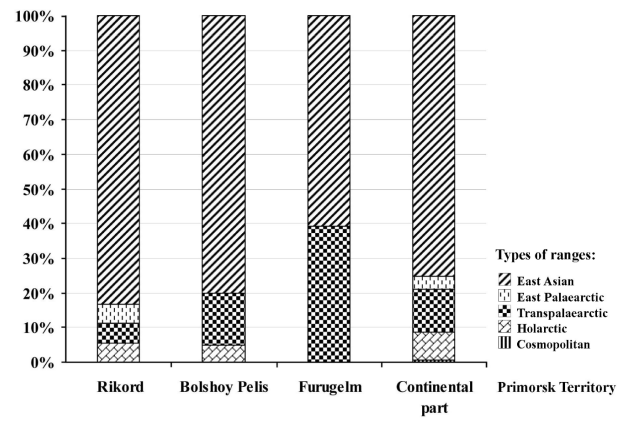

Figure 3: Grouping of the Gelechiid species according to type of geographic range.

To establish the faunistic relations of island Gelechiids the species lists from neighboring continental regions placed in temperate zone were involved into comparative analysis. The results of manual comparison and processing of the species lists in the program package PAST are shown in the Table 2.

	Rikord Isl.	Bolshoy Pelis Isl.	Furugelm Isl.	Continental part of Primorsk Territory	North of Korean Peninsula	Central part of Korean Peninsula	China: NE Jilin	Japan: Hokkaido	Japan: Honshu
Rikord Isl.	**18**	0,22581	0,078947	0,091463	0,086957	0,081761	0	0,076923	0,085561
Bolshoy Pelis Isl.	7	**20**	0,13158	0,09697	0,019608	0,09434	0	0,090909	0,067708
Furugelm Isl.	3	5	**23**	0,088757	0,018519	0,092593	0,044444	0,081633	0,066667

Continental part of Primorsk Territory	15	16	15	**161**	0,1092	0,41256	0,12805	0,39437	0,38956
North of Korean Peninsula	4	1	1	19	**32**	0,12048	0,098039	0,13514	0,09596
Central part of Korean Peninsula	13	15	14	92	20	**154**	0,047059	0,33641	0,44255
China: NE Jilin	0	0	2	22	5	8	**24**	0,081081	0,055556
Japan: Hokkaido	11	13	12	84	20	73	13	**136**	0,4141
Japan: Honshu	16	13	13	97	20	106	11	90	**185**

Table 2: Intersection matrix of Gelechiid species diversity in Islands of Peter the Great Gulf and continental localities.

Despite of relative proximity each island has own Gelechiid fauna and a few common species with other. Only 3 species (*Scrobipalpa pauperella, Teleiodes orientalis, Faristenia furtumella*) are common for all three islands. The neighboring Rikord and Bolshoy Pelis Islands are closer faunistically with 7 common species, 4 of which were found in them only (*Angustialata gemmellaformis, Parachronistis fumea, Carpatolechia deogyusanae, Faristenia geminisignella*). 2 species (*Chorivalva bisaccula, Empalactis neotaphronoma*) are found in Bolshoy Pelis and Furugelm Islands only. Most original Gelechiid fauna is from Furugelm Isl., owing to 5 species, 4 of which are unknown from other considered East Asian regions, and 1 species is probable new to science.

As result of comparison with continental localities, the maximal faunistic similarity observed for followings territories: Rikord and Bolshoy Pelis Islands and continental part of Primorsk Territory (Russia), Jaccard coefficient (JC) -0.091463 and 0.09697, respectively; Bolshoy Pelis and Furugelm Islands and Central part of Korean Peninsula, JC -0.09434 and 0.092593, respectively; Bolshoy Pelis Isl. and Hokkaido (Japan), JC –0.090909.

The two clusters with island and continental faunas are clearly distinguished in the dendrogram constructed using Jaccard coefficient and showing similarity of local species lists of Gelechiidae (Figure 4). That is appropriately proceeding from quantitative differences in the analyzed lists. The largest similarity (coefficient more than 0.6) stated for Gelehiid faunas of Central part of Korean Peninsula and Honshu (Japan). Gelechiid faunas from south of Primorsk Territory and Hokkaido (Japan) are close resemblance to this parameter reaching coefficient of similarity 0.57 and 0.54, respectively. The North of Korean Peninsula and Northeast Jilin (China), both poor studied regions with depleted lists of Gelehiidae, located in dendrogram between faunistically richer above mentioned localities and studied islands. However, despite the very low similarity (0.12 and 0.2), both North Korean Peninsula and Northeast Jilin (China) are included in the common cluster with other continental localities. As to the islands, that is expected, they were combined into a separate cluster on the base of faunistic poorness with similarity indices 0.36 for Bolshoy Pelis and Rikord Islands and 0.18 for Furugelm Island attached to them.

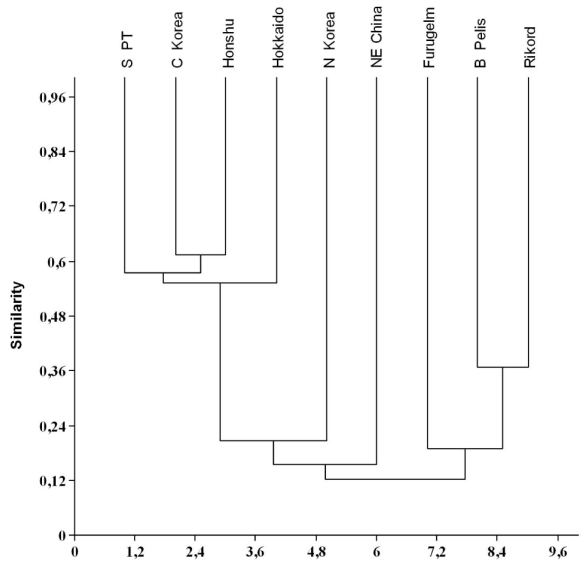

Figure 4: Dendrogram showing similarity of Gelechiid species diversity in islands and mainland localities constructed using the Jaccard coefficient.Legend: B Pelis – Bolshoy Pelis Isl., C Korea – Central part of Korean Peninsula, N Korea – North part of Korean Peninsula, NE China – North East part of Jilin prov., China, S PT – south of Primork Territory, Russia.

Discussion

Alleged that two indicators, the distance from the mainland and the size of the island, are usually effect on feature of its biota. In the course of present investigation the dependence of species diversity from island size has not been established. The Furugelm Isl., smallest in area, appeared with slightly more Gelechiid diversity. It seemed both the climatic conditions and the shape of the island are rather more significant. The weather in the examined islands is determined by their position in the Peter the Great Gulf. According to long-term observations the average January temperature in high sea is about -4°C. It is much higher than temperature of same month in

continental part of Primorsk Territory and even in its inshore parts. Thus, the Furugelm Isl. same as other examined islands have softer conditions in the winter, determined by temperature in the Gulf. However, all three islands having a small width and being blown through with sea wind, bearing drops of saturated salt solution are characterized by hard conditions of insect existence. The confirmation of that is special ethological reaction in flying insects plummeting down at the slightest vibration of support, as well as the almost complete absence of blood-sucking Diptera. Therefore the number of found species in islands is small. Also limited landscape diversity could have an impact on species extinction since the isolation of the islands. Endemics were not found in the Islands, that is quite natural taking into account a small distance to the mainland and their recent isolation. Despite strait narrowest width of 5 km, probability of active Gelechiid migration to the Islands could not be allowed, considering their weak flying abilities. Therefore the similarity in grouping of Gelechiid species in continental and island parts by types of geographic ranges is rather caused by relatively short duration of isolation and periodic random passive drift of species.

What is remarkable in the island fauna? That is the high concentration of species diversity, much more than that in any above considered continental localities. Thus, 49 species of Gelechiid moths were found on 10.5 km^2, which is total area of three islands, otherwise more than 4 species are on area of 1 km^2. For comparison the concentration of species diversity in continental part of south Primorsk Territory is about 1 species on 79 km^2 (total area of considered in present work districts is 12730.2 km^2 [12]). Similar effect of high concentration of species diversity was recorded in Kunashir Isl., where it was recorded 37% of total species list known from neighboring Hokkaido, whereas the area of Kunashir Isl. makes up 2% of Hokkaido area [22].

Conclusion

In general the peculiarities of Island faunas (Rikord Isl., Bolshoy Pelis Isl. and Furugelm Isl.) turned out expected. As it is typical for many islands of the World the generic and species diversity in all three islands are appeared depleted in comparison with mainland, even with poorly examined localities. That is due to the small size of the islands and limited landscape diversity on them. Being derivative from continental part in the recent past the island faunas kept similar structure of species diversity, the dominant groups are represented by species with East Asian and transpalaearctic ranges. Despite of this similarity the species composition of island faunas is disharmonic; every recorded genus is represented by some species, mainly trophically associated with dendroflora in islands. Attention is drawn to the small number of common species in island faunas. Both phenomena could be interpreted by continual species extinction and an insignificant random drift from mainland.

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