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BIODIVERSITY OF INSECTS OF ARID AND SEMIARID LANDS OF EURASIA

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Introduction

Arid and semiarid lands are a very complicated and interesting part of Eurasia. This area should be mainly included in the Palaearctic Region as the Saharan-Gobian Subregion (see Kryzhanovskij, 1965; Sergeev, 1992 *et al.*). The southern belt of this area is evidently associated with the Ethiopian Region (see Kryzhanovskij, 1980; Larsen, 1984 *et al.*).

In general, arid and subarid territories are inhabited by a lot of animal species, both plain and montane. Their origination may be very different. Some taxa are evidently associated with the boreal parts of Eurasia, another groups are the members of the Mediterranean fauna. Many taxa are the representatives of the tropical faunas, both Ethiopian and Oriental. Very complicated relief, aridity factor and landscape variability are favorable for co-existence of such taxa inside the Saharan-Gobian Subregion. Importance of this area is also determined by usual pests' outbreaks (Fortescue-Foulkes, 1953; Shumakov, 1963, *et al.*).

The main aim of this article is to describe general patterns of biodiversity of insects in the arid and semiarid areas of Eurasia. Some insect group (Entognatha, amphibian and parasitic insects) should be excluded, because the patterns of such groups are usually too different (e.g. Belyshev, Haritonov, 1981). As a result, I use data concerning the terrestrial insects properly. Moreover, it should be noted that the orthopteran biodiversity will be mainly discussed, because the orthopteran insects are more or less the typical and well studied group of insects inhabiting arid and semiarid lands.

Some parts of this area are more or less well investigated. But it should be noted that other parts of this area are very poorly investigated. Now some old works (e.g., Semenov-Tien-Shanskij, 1935; Chang K., 1937; Uvarov, 1943 *et al.*) and especially new data of entomologists (Shumakov, 1974; Cheng, Hang, 1981; Kiefer *et al.*, 1982; Huang *et al.*, 1981; Cowie, 1989; Kang *et al.*, 1990; Li *et al.*, 1990; Ma *et al.*, 1991; Yin, 1984, *et al.*) allow us to describe tentatively a pattern of the insect distribution, to evaluate the regionalization scheme, and to discuss some biogeographical problems linked with this region and its neighbors.

Boundaries of Arid and Subarid Lands of Eurasia

The position of north, north-eastern and eastern boundaries of this Subregion have been described early (Sergeev, 1986, 1988a, 1992, 1993a, b). In general, these boundaries are associated with the steppe life zone. The position of the north-western boundary is problematic (see Sergeev, 1988a).

The southern boundary of the Saharan-Gobian Subregion is mainly associated with barriers between the tropical and subtropical belts (Kryzhanovskij, 1980; Larsen, 1984; Cowie, 1989). Therefore, the extremely southern parts of Iran and Pakistan and the southern half of the Arabian Peninsula should be included in the Ethiopian (Afrotropical) Region. The boundary between the Palaearctic and Oriental regions may be altitudinal (Avinov, 1913; see also Sergeev, 1988b). In the northern parts of the studied territory, the boundaries between plain and mountain faunistic regions usually coincide with the geomorphological junction of local piedmont plains and mountain slopes (Sergeev, 1988b, 1992). In the southern parts, the situation is supposed to be more complicated. Really this junction seems to limit some plain tropical species. The typical Palaearctic forms inhabit the upper altitudinal belts, which are connected with high arid and semiarid plateaus of Tibet, Ladakh and the Pamirs (Avinov, 1913; Huang *et al.*, 1981; Yin, 1984). The middle belts of the Central and West Himalaya are usually settled by the specific conglomeration of the Middle Asian (including the montane ones), subtropical and tropical insects. The same belts in the East Himalaya are mainly occupied by some so-called Sino-Himalayan (Orthrian) forms. So I tentatively propose to determine the lower boundary of the Saharan-Gobian Subregion in the southern parts of the Himalaya, Tibet and Hengduanshan on the altitude +2000 m. The frontier between the Palaearctic and Oriental Regions seems to be situated near +1000 m. Therefore, in the West Himalaya, all altitudinal belts perhaps belong to the Palaearctic (the Saharan-Gobian Subregion proper). On the contrary, in the East Himalaya, South Tibet and Hengduanshan, the low belts should be included in the Oriental Region, the middle ones - in the Orthrian Subregion of the Palaearctic, and the upper ones -in the Saharan-Gobian Subregion. Certainly, the study of species settlement distribution along altitudinal transects is needed for solution of this problem.

General Estimation of Biological Diversity

It is well known biological diversity can be estimated by various methods and on different levels of organization of living matter (population, species, biogeocenosis). Clearly, these approaches do not rule out, but are the complement of one another. At the same time, success in realization of any of them, and, as a result, elucidation of the most general patterns of biological diversity, is evidently determined by many reasons. There are a lot of problems arising from attempts to estimate the biological diversity on the population and biocenotic levels. Importantly, as a rule, one limits oneself to analyze some parameters within a local population when estimating the biodiversity on the population level. Beyond doubt not only distant colonies of each species may be distinguished from each other very strongly, but the neighboring ones may so be too. As a result, that may be reason of essential difference in the character of neighboring biogeocenoses. This is just why we should importantly to estimate the diversity of proper

population groups of different ranks, especially in connection with spatial organization of the population system of every species.

Usually every insect order include some taxa or populations with adaptations to arid and semiarid conditions. Rare the majority of species are typical arid forms. Many Orthoptera, Hemiptera, Homoptera, Thysanoptera, Coleoptera, Lepidoptera, Neuroptera, Diptera and Hymenoptera inhabit the arid and semiarid lands. Other orders (Blattariae s.l., Phasmoptera, Dermaptera *et al.*) include usually some arid subfamilies or genera. Really a few orders (e.g. Notoptera) do not include modern arid taxa.

The general trends of insect distribution in the arid and semiarid areas of Eurasia were described early by Semenov-Tien-Shanskij (1935), Kryzhanovskij (1960) and Emeljanov (1974). The first two authors mainly used data for beetles but analyzed other insect groups too. Biogeography of the western part of this territory was discussed by Shumakov (1963, 1974), Kwieton (1983), Kugler (1988), Cowie (1989) *et al.* The pattems of insect distribution in its central parts were described by Mjartzeva (1986), Sergeev (1986, 1988a, 1992, 1993b) *et al.* any articles deal with the eastern part of the Saharan-Gobian Subregion (Kiefer *et al.*, 1982; Pelikan, 1987; Ma *et al.*, 1991 *et al.*).

It should be noted that biogeographically the arid lands of Eurasia may be differentiated at least in four main types: (1) the plains and lowlands of West and Middle Asia are typical areas of the desert insect fauna; (2) the high mountains of this Subregion are inhabited by various insect taxa including a lot of endemics; (3) the plains and mountains of Central Asia properly, mainly in the limits of China and Mongolia, is very distinguishable territory of Eurasia, because it is characterized by the precipitation maximum in the middle of summer, general low level of precipitation, more or less cold winter and hot summer; the monsoons partly reach it and produce abundant summer rainfall (see Chang D., 1983); these conditions are favorable for speciation, so sometimes the significant biological diversity and coexisting forms of different origin may be observed here; (4) the southern edges of these lands, which should be included in the Ethiopian Region.

Biological Diversity of the Orthopteran Insects

The katydids of the Deracanthinae subfamily (Bradyporidae) are mainly Mongolian and Chinese species. Many endemic genera and species of them are distributed through the north-eastern provinces of the Saharan-Gobian Subregion. The Phaneropterinae are chiefly associated with subtropical and tropical regions. Some of them are found in the studied area. A few species of Saga (Saginae) are distributed in the western part of the arid lands of Eurasia. The Tettigoniinae katydids are very various. Among them, the Drymadusini include many species with small ranges. Some of them are the endemics of different montane ridges. Many species are associated with arid areas. The Platycleidini distribution is similar to the Drymadusini one. As a rule, its species are comparatively widely distributed. The only species of the Ctenodecticini is limited by the boundaries of the steppes and semi-deserts. The subfamily Glyphonotinae is endemic of the central part of the Saharan-Gobian Subregion. It consists of plain-montane and montane forms. The Conocephalinae katydids are chiefly connected with tropical regions. But some

species of two tribes - Conocephalini and Copiphorini - are distributed through the southern part of the Palaearctic.

A few families of camel-crickets - Mimnermidae, Stenopelmatidae - inhabit the Southern Eurasian arid areas. *Lezina* sp.sp. from Mimnermidae does not penetrate from the south to the northern deserts.

The crickets of the Gryllidae family are partly associated with the Saharan-Gobian Subregion (especially Gryllini). But they usually inhabit local river and lake valleys. The Myrmecophilidae and Gryllotalpidae are distributed here too.

Most part of the Palaearctic Tridactylidae and Tetrigidae is connected with the forest and forest-steppe zones. Some species resemble the crickets being widely distributed through rivers valleys of an arid area.

The Gomphomastacinae (Eumastacidae) is the endemic group for the mountains of Tien Shan, Pamiro-Allay, Nanshan, Karakoram, the Hindu-Kush and Himalayas. Most species have very localized settlements, which are associated with definite part of each ridge.

The grasshoppers properly (Pamphagidae, Pyrgomorphidae, and Acrididae) are the main group of the Palaearctic Orthoptera. The pyrgomorphid grasshoppers mainly inhabit the arid and semiarid areas but they are associated with local river valleys. The Pamphagidae include usual forms for the arid plains and mountains of Middle Asia. There are many endemic genera and species, which may be connected with the different types of the deserts and semi-deserts (stone, clay, sandy). The family Acrididae includes at least three subfamilies - Romaleinae, Catantopinae and Acridinae. Some Catantopinae tribes are the endemics of the Saharan-Gobian Subregion (Uvaroviini, Dericorythini, Egnatiini, Diexini, Iranellini). The Conophymatini grasshoppers settle the mountains of Middle Asia, including the mountains of Iran, Afghanistan, and the West Himalayas. It includes many wingless endemics, which are chiefly associated with the outer ridges of such mountains. A few species of the Cyrthacanthacridini settles the arid and semiarid lands of Eurasia, but the desert locust is among them. On the contrary, the Calliptamini are characteristic forms for the steppe, semi-desert and desert landscapes of the studied area. They dominate often in the local orthopteran communities. The Eyprepocnemidini are widely distributed in the Saharan-Gobian Subregion. A few tribes of the Acridinae (Acridini, Truxalini, Ochrilidini, Phlaeobini, Acrotylini) are chiefly connected with the Saharan-Gobian Subregion and settle, as a rule, local azonal landscapes. The distribution of the Hypernephiini is very interesting. These short-winged forms settle mainly the arid mountains of East Kazakhstan and Mongolia. Some genera are limited by the mountains of Tien Shan, Zagros, the East Himalayas and Hengduanshan. The Arcypterini and Gomphocerini are distributed over the whole Holarctic area. They include both plain widely distributed forms and montane highly localized species. The Dociostaurini are connected with the arid lands of the Scythian and Saharan-Gobian Subregions. Some of them are provincial endemics. Most species of mainly tropical and subtropical Epacromiini, Locustini, Oedipodini, and Trilophidiini are limited by the southern part of the Palaearctic including its arid and semiarid lands. The Bryodemini and Sphingonotini consist from terricolous grasshoppers, which settle mainly the Saharan-

Gobian Subregion. But the former is chiefly limited by Central Asia properly. The latter is widely distributed through the arid lands of world.

Regionalization of the Arid and Subarid Parts of Eurasia

The scheme of zoogeographical regionalization was early proposed for North and Central Asia (Sergeev 1986, 1992, 1993a, b). I analyzed orthopteran species ranges, compared distribution of their boundaries in connection with ecologo-geographical barriers and tried to classify different boundaries, barriers, and regions.

Now I am able to propose the following provinces for the arid and semiarid areas of Eurasia (see also Uvarov 1921; Emeljanov 1974):

1. The Scythian Subregion:
   - the Sarmathian Province is connected with the steppe life zone proper (in general - the semiarid lands);
2. The Saharan-Gobian Subregion:
   - the Kazakhstan Province,
   - the Mongolian Province,
   - the Turanian Province,
   - the Gobian Province,
   - the Gissar-Tien Shan Province,
   - the Pamirian Province,
   - the Inner Tien Shan Province,
   - the Bogda Shan Province,
   - the Kunlun Province,
   - the Karokoram Province,
   - the West Himalayan Province,
   - the Nan-Shan Province,
   - the Tibetan Province,
   - the East Himalayan Province includes the high mountains of Nepal, Sikkim, Buthan and the southern part of Tibet(Xizang) (generally - the whole eastern part of the Himalayas). Some endemic genera (*Hypernephia*, *Dysanema*, *Orinhippus, et al.*) and many endemic species inhabit this part of Central Asia. Bey-Bienko (1968) emphasized the serious distinction between the western and eastern parts of the Himalayas. He marked that in the eastern one some typical Palaearctic forms settle the high altitudes only. As a result, my scheme partly resembles some proposals for Xizang flora (Li, Wu, 1983),
   - the Hengduanshan Province (perhaps this territory should be included in the Orthrian Subregion, because is situated on the border of the subtropical broad-leaved evergreen forests (e.g. see Chang D., 1983)),
   - the Hindu-Kush Province,
   - the Turkmeno-Iranian Province,
   - the Iranian Province,
   - the Zagros Province,
   - the Hyrcanian Province,

- the Azerbaidzhan Province,
- the East Caucasian Province,
- the Armenian Province,
- the Kurdistan Province,
- the Syrian Province;
- the Mesepotamian Province;

3. The Ethiopian Region
   - the Makran Province,
   - the Arabian Province,
   - the Oman Province. Popov (1980) has described a significant difference between the acridid faunas of Oman properly and Dhofar. The orthopteran fauna of Dhofar includes the representatives of the various Ethiopian taxa. Among them are the geophilous grasshoppers of the genera *Rashidia*, *Fitzgeraldia*, and *Omania*,
   - the Yemen Province.

It has been proved that the Orthoptera fauna of the mountains of Middle Asia is not integrated unity and is generally closer to the Near East fauna than to the Central Asian one properly. A distinction from lowland faunas has been found: hierarchy of faunistic, zonal and subzonal boundaries is not in conformity.

Of course, this scheme is tentative. The positions of many boundaries and ranks of some regions should be re-estimated. But new investigations are needed for progress in this field. Despite of preliminary character of my proposals, I think that they will be useful for development of studies including collecting and analyzing new ecological and biogeographical data in this regions.

Diversity of Orthopteran Populations

Diversity of orthopteran populations can be estimated for the arid parts of the former USSR only, because this territory is well studied.

In South-East Kazakhstan, one can observe a complicated combination of species gravitating mainly towards the deserts and semi-deserts. Actually, the specific orthopteran settlements have been detected for all small local faunistic plots. The localization of such settlements is determined by the complexity of landscapes and reflects their relations to some or other habitat types. Hence, here, just like in the Manchurian Subregion, co-existence of many orthopteran species is maintained first of all by the distribution and weak overlap of settlements of various species. Under local conditions, the species spreading can probably take place along river valleys. Only a few Orthoptera have outlying plots of high density (usually in river valleys).

The Vakhsh basin situated more southward (really near the subtropic border) is a good model for estimating ecologo-geographical barriers for the altitudinal-zonal dividing of population system. On the whole, the sharpest intraregional differences in landscape distribution of the orthopteran population groups are ascertained here. Especially important are the distinctions between plain and montane parts. The definite groups of species are associated with each of them. There are few Orthoptera spreading both in

the mountains and on the plains, or if they cross the plain-mountain junctions their landscape distribution changes drastically. Therefore, the barrier between the plains and mountains of the Vakhsh basin is manifested very well not only in the aspect of restriction of species spreading, but also in the dividing of the orthopteran population systems. In the mountain part of the basin, connection between populations along ridges can be followed up for species gravitating to the middle parts of the main slopes, these are Orthoptera preferably inhabiting the southern (desert and dry-steppe) (*N.albicornis* etc.) or northern (steppe and meadow-steppe) slopes (*Ch.albomarginatus*). The populations of almost all species are local and isolated from each other. These settlements are usually connected with one type of landscape (southern slope, plain, flood-plains, terraces) and, moreover, to definite type of facies within it (solonchaks, watershed shrub deserts, small depressions etc.). On the whole, abundance of local *Orthoptera* are not high, and usually only the most abundant of them penetrate actively into anthropogenic landscapes. That concerns first of all the species connected with river valleys and gray (loess) deserts.

In general, the populations of the native species are divided and their abundance is low. The role of the junction between mountains and plains is very important.

Conclusions

On the whole, it is evident that the pattern of insect distribution is the result of interaction both present natural (geographical, ecological, climatic etc.) conditions and evolutionary history of species spreading. The distribution of many insect orders (including Orthoptera) in the arid and semiarid parts of Eurasia reflects the southern thermophilic character of these groups as well as the connection of the majority of their species with grassland and arid ecosystems.

The complicated environment of the arid and semiarid lands proper is very favorable for many insects. As a result, there are many specific centers of diversity and endemism.

Importantly, some tribes, subtribes, and generic groups of Orthoptera are likely to originate here. Among them are Deracanthinae, some groups of Drymadusini, Gomphomastacinae and Melanoplini, the so-called Filchnerellae group of the Pamphagidae (Uvarov, 1943 *et al.*), Hypernephiini, Bryodemini. They are mainly connected with dry vegetation (plain and montane steppes, stone deserts, and semi-deserts)

- Deracanthini, Drymadusini, Filchnerellae, Hypernephiini (partly), Bryodemini, or with montane cold meadows (other Hypernephiini and Melanoplini). Accordingly the formers settle both mountain and plain biotopes, the latters are limited by the high mountains only.

Some other taxa are distributed more or less widely, but have endemic genera and species in this region (Platycleidini, Gryllini, Sphenariini, Chrysochraontini, Gomphocerini, Epacromiini, Sphingonotini *et al.*). Often they are connected both with the local mountains and with the high plateaus too.

The analysis of distribution of the centers of diversity and genera endemism for each tribe allows us to understand the pattern, which reflects the general situation describing above on the Earth's surface (cf. Kryzhanovskij, 1965; Larsen, 1984). Most centers of tribe diversity and genera endemism are connected with 7 areas of Asia:

1. the deserts of Turan (Drymadusini, Diexini, Dociostaurini *et al.*; endemic - Grylliscus);

2. the arid part of Mongolia and China (Deracanthini, Drymadusini, Gomphocerini, Bryodemini *et al.*, endemics -*Bienkoxenus*, *Eulithoxenus*, *Pseudotmethis*, *Sinotmethis et al.*);

3. the mountains of Tien Shan, Pamiro-Allay, and the Hindu-Kush in Afghanistan (Gomphomastacinae, Drymadusini, Platycleidini, Egnatiini, Conophymatini, Hypernephiini, Dociostaurini *et al.*; endemics - *Ferganusa*, *Squamiana*, *Melanotmethis*, *Mizonocara et al.*).

4. the mountains of West Iran (Odonturini, Pholidopterini, Pamphagini, Iranellini, Teratodini etc.; endemics - *Dinaria*, *Wiltshirella*, *Grigorija et al.*);

5. the mountains of the West Himalayas and South-West Tibet (Gomphomastacinae, Melanoplini; endemics - *Hyphinomos*, *Paedomastax*, *Dicranophyma* etc.);

6. the mountains of South-East Tibet and adjoining slopes of the Himalayas (Melanoplini, Chrysochraontini, Hypemephiini etc.; endemics - *Kingdonella*, *Ptygonotus*, *Dysanema*, *Orinchippus et al.*);

7. the mountains of the Arabian Peninsula (Thrinchini, Eyprepocnemidini, Locustini etc.: endemics - *Dhofaria*, *Xiphoceriana*, *Fitzgeraldia et al.*).

Thus, distribution of the centers of diversity and endemism corresponds in outline to general distribution of Orthoptera. The centers of genera diversity and species endemism distribute similarly. But degree of differentiation is more. There are many locally endemic species in the mountains. As a rule, combination of the centers of diversity and the centers of endemism is observed.

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References

Avinov, A.N. 1913 About separate zoogeographical regions of the Palaearctic parts of British India on the basis of the distribution and assemblages of Lepidoptera Rhopalocera (butterflies). *Izv. Russ. Geogr. Ob-va* **49**: 523-563. (In Russian)

Belyshev B.F. and A.J. Haritonov 1981 Geography of *Odonata* of the Boreal faunistic Region. Nauka, Novosibirsk, 280 pp. (in Russian)

Bey-Bienko, G.J. 1968 On the *Orthopteroid* insects (Orthopteroidea) from Eastern Nepal. *Entomol. Obozr.* **47**:106-130. (In Russian)

Chang, D.H.S. 1983 The Tibetan Plateau in relation to the vegetation of China. *Ann. Missouri Bot. Gard.* **70**: 564-570.

Chang, K.S.F. 1937 Some new acridids from Szechwan and Szechwan-Tibetan border (Orthoptera: Acrididae). *Notes d'Entomologie Chinoise* **4**(8): 177-196.

Cheng, T. and R. Hang 1974 A survey of grasshoppers from Hainan Tsang Autonomous Chou, Chinghai. *Acta entomol. sinica* **17**(4): 428-440. (In Chinese)

Cowie, R.H. 1989 The zoogeographical composition and distribution of the Arabian termite fauna. *Biol. J. Linn. Soc.* **36**(1-2): 157-168.

Emeljanov, A.F. 1974 Proposals on the classification and nomenclature of areas. *Entomol. Obozr.* **53**: 497-552. (In Russian)

Fortescue-Foulkes, J. 1953 Seasonal Breeding and migrations of the Desert Locust (*Schistocerca gregaria* Forskal) in South-Western Asia. *Anti-Locust Mem.* **5**: 1-36.

Huang, F., C. Huang and J. Liu 1981 Studies on the acridoid fauna of Xizang and its evolution. *Entomotaxonomia* **3**(3):157-170. (In Chinese)

Kang, L., Y. Ma, B. Xie, S. Zheng, F. Qiao, J. Pan and F. Li 1990 Studies on the fauna and zonal distribution of Tettigonioidea (Orthoptera) in Nei Mongol Autonomous Region. *Entomotaxonomia* **12**(3-4): 157-169. (In Chinese)

Kiefer, M., S.M. Klimaszewski and M. Krumpal 1982 Zoogeographical regionalization of Mongolia on the basis of flea fauna (Siphonaptera). *Pol. pis. ent.* **52**(1-2): 13-29.

Kryzhanovskij, O.L. 1965 Composition and origin of terrestrial fauna of Middle Asia. Nauka, Moscow & Leningrad, 419 pp. (in Russian)

Kryzhanovskij, O.L. 1980 About zoogeographical differentiation of the Paleotropic Dominion. In: Voronov A.G., Drozdov N.N. (eds.) Sovremennye problemy zoogeographii. Moscow: 61-81. (in Russian)

Kugler, J. 1988 The zoogeography of social insects of Israel and Sinai. In: Zoogeography of Israel. Dordrecht *et al.*: 251-276.

Kwieton, E. 1983 Zoogeographie historique de l'Arabie a la base des Colepteres Tenebrionidae. *Turk. Bit. Kor. Derg.* **7**: 3-16.

Larsen, T.B. 1984 The zoogeographical composition and distribution of the Arabian butterflies (Lepidoptera: Rhopalocera). *J. Biogeogr.* **11**: 119-158.

Li, H., Y. Ma, Z. Zhang, X. Pan and A. Ma 1990 Studies on the composition of Acridoidea fauna and its regional distribution in Nei Mongol (Inner Mongolia) Autonomous Region. *Entomotaxonomia* **12**(3-4): 171-193. (In Chinese)

Li, H. and S. Wu 1983 The regionalization of Xizang (Tibet) flora and the floristic structure of South Himalaya Region. Acta geogr. sinica **38**(3): 252-261. (In Chinese)

Ma, Y., H. Li and L. Kang 1991 The grassland insects of Inner Mongolia. Tianze Eldonejo. 467 pp. (In Chinese)

Mjartzeva, S.N. 1986 Encyrtidae (Hymenoptera, Chalcidoidea) of the deserts and semi-deserts of Middle Asia. Ylym, Ashabad, 303 pp. (in Russian)

Pelikan, J. 1987 Zoogeographical analysis of Mongolian Thysanoptera. In: Populat. struct., genet. and taxon. Aphids and Thysanoptera: Proc. Int. Symp. Bratislava: 496-499.

Popov, G.B. 1980 Acridoidea of Eastern Arabia. J. Oman Studies. Spec. Rep., N 2: 113-148.

Semenov-Tien-Shanskij, A.P. 1935 The limits and zoogeographical parts of Palaeartic Region for terrestrial animals on the basis of geographical distribution of Coleoptera. *Tr. Zoologiches'kogo Instituta* **2**(2-3): 397-410. (in Russian)

Sergeev, M.G. 1986 Patterns of Orthoptera distribution in North Asia. Nauka, Novosibirsk, 237 pp.

Sergeev, M.G. 1988a Regularities of Orthoptera distribution in the mountains of the Middle Asia. *Zool.Zh.* **67**: 530-538. (In Russian)

Sergeev, M.G. 1988b On the boundary between the mountain and plain faunas of Orthoptera (Insecta). *Zool.Zh.* **67**: 1483-1488.

Sergeev, M.G. 1992 Distribution patterns of Orthoptera in North

Sergeev, M.G. 1993a Biogeography of Holarctic Orthoptera:faunas, populations, communities. *Metaleptea* **14**(2): 11

Sergeev, M.G. 1993b The general distribution of Orthoptera in the main zoogeographical regions of North and Central Asia. *Acta zool.cracov.* **36**(1): 53-76.

Shumakov, E.M. 1963 Acridoidea of Afghanistan and Iran. *Horae Soc. Ent. Unionis Sov.* 49: 3-248. (in Russian)

Shumakov, E.M. 1974 Modern results of the study of entomofauna of Iran and Afghanistan. Horae Soc. *Ent. Unionis Sov.* **57**:132-197. (in Russian)

Uvarov, B.P. 1921 The geographical distribution of orthopterous insects in the Caucasus and in Western Asia. *Proc. Zool. Soc. London* **31**: 447-472.

Uvarov, B.P. 1943. The tribe Thrinchini of the subfamily Pamphagidae, and the interrelations of the acridid subfamilies (Orthoptera). *Trans. R. ent. Soc. Lond.* **93**(1): 1-72.

Yin, X. 1984 Grasshoppers and locusts from Qinghai-Xizang Plateau of China. Xining: Northwest Plateau Institute of Biology, Academica Sinica, x+287 pp. (In Chinese)