

Preliminary report on the Euro-Siberian faunal connections of jumping spiders (Araneae, Salticidae)

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The faunal connections between Europe and Siberia are discussed on the basis of a provisional interpretation of eight range types of the North Asiatic salticids. There are three groups, apparently of different origins: 1) Widely distributed: Holarctic, trans-Eurasian and Euro-Siberian species (38 species); 2) Siberian and Siberian-American species (5 species); and 3) amphi-Eurasian species (5 species).

1. Introduction

Traditionally, in analysing the Euro-Siberian faunal connections, particular attention is directed to the late- and postglacial (Holocene) migrations. In most cases the South Siberian refugia are considered to be of utmost importance to survival during glaciation and subsequent dispersal of species (Arnoldi 1957, Varga 1976, Mikkola 1987); these refugia are considered the source for the reinvasion of Europe by a great number of species (Gorodkov 1979).

According to Logunov (1992) the salticid fauna of Northern Asia (Siberia and the Russian Far East) currently numbers 119 species from 29 genera.

Until recently, only Prószyński has regularly treated the problems of the origin and genesis of the Palaearctic salticids (Prószyński 1976, 1978, 1980, 1983, 1986, 1988, 1991, Prószyński & Bohdanowicz 1980). He is of the opinion that the salticid fauna of temperate regions of Eurasia should be considered an indivisible Euro-Siberian fauna, chiefly formed by reinvasion of the Holocene colonizers from the Mediterranean,

Ethiopian and Oriental centers of speciation (10000–12000 years B.P.), no species surviving the Ice Age in the area. I am not going to comment on Prószyński's views here; I will only note that he has paid no attention to the faunal connections between Europe and Siberia.

The purposes of the present paper are to provide a brief review of those salticid species whose distributional patterns, in my opinion, point to the Euro-Siberian connections; to give examples of each distribution type; and to estimate the directions of movements for the mentioned species. The paper comprises a part of a Ph.D. thesis submitted to the Institute of Biology, Novosibirsk (Logunov 1992).

2. Methods

Ranges of individual taxa have been outlined on maps, providing the data from which patterns could be recognized. Only maps necessary for the discussion are included. The nomenclature for range types used is largely adopted from Gorodkov (1984, 1992).

The term "chorological center" is used to indicate a recent center of diversity, caused by expansion of species,

as has been supposed for some other groups (e.g. Varga 1976; not to be confused with a center of origin for a taxon).

In this brief paper, the list of references is restricted to more general works. Thus papers solely dealing with particular localities of single species are not cited.

3. Patterns of distribution

The Euro-Siberian faunal connections in Salticidae can be grouped in eight range types, which can be united into three quite unequal groups.

Group I. Widely distributed species

1. *The Holarctic element* (2 species). Only species widely distributed both in the Palaearctic and Nearctic regions are included in the group. Two species, *Phlegra fasciata* and *Sitticus floricola*, show circumtemperate distributional patterns.

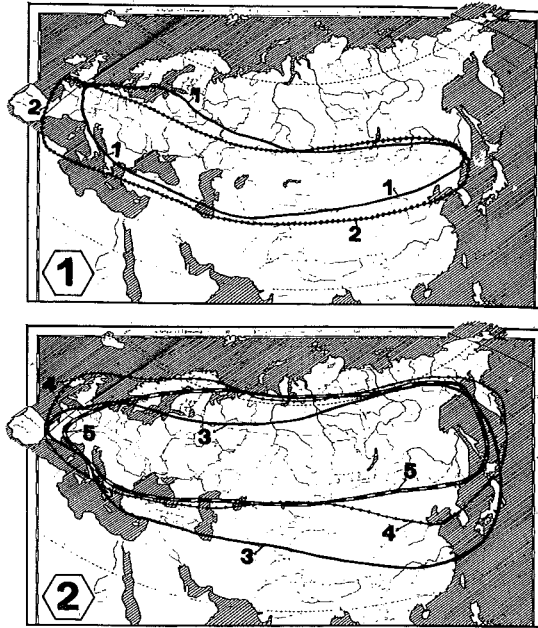
2. *The trans-Eurasian element* (17 species). These species have ranges extending across most of Eurasia. Two latitudinal subgroups are recognized:

a) temperate (13 species): *Aelurillus v-insignitus*, *A. festivus*, *Bianor aurocinctus*, *Dendryphantes rudis*, *Evarcha arcuata*, *E. falcata*, *Euophrys frontalis*, *Heliophanus dubius*, *H. patagiatus*, *Marpissa pomatia*, *Salticus cingulatus*, *Sitticus caricis*, *S. penicillatus* (Fig. 2).

b) subboreal (5 species): *Heliophanus lineiventris*, *Philaeus chrysops*, *Synageles hilarulus*, *S. venator* (Fig. 1).

One species, *Euophrys frontalis*, is in need of additional study, as the previous records from the continental regions of Siberia may actually refer to a closely related species, *E. prozysniskii*. It is possible that the range of *E. frontalis* should be interpreted as amph-Eurasian (see below).

The 19 Holarctic and trans-Eurasian species comprise 16 % of all the North Asiatic salticids. Twelve species of them (63 %) belong to the genera apparently having their chorological centers in Europe (*Dendryphantes*, *Euophrys*, *Neon*), in the Mediterranean (*Synageles*) or even in the Ethiopian (*Heliophanus*, *Philaeus*, *Phlegra*) regions. Thus, I assume that the distributional patterns of these species are chiefly results of



Figs. 1 and 2. Distribution patterns of trans-Eurasian species. — Subboreal species (Fig. 1): 1, *Synageles hilarulus*; 2, *Philaeus chrysops*. — Temperate species (Fig. 2): 3, *Aelurillus festivus*; 4, *Evarcha falcata*; 5, *Heliophanus dubius*.

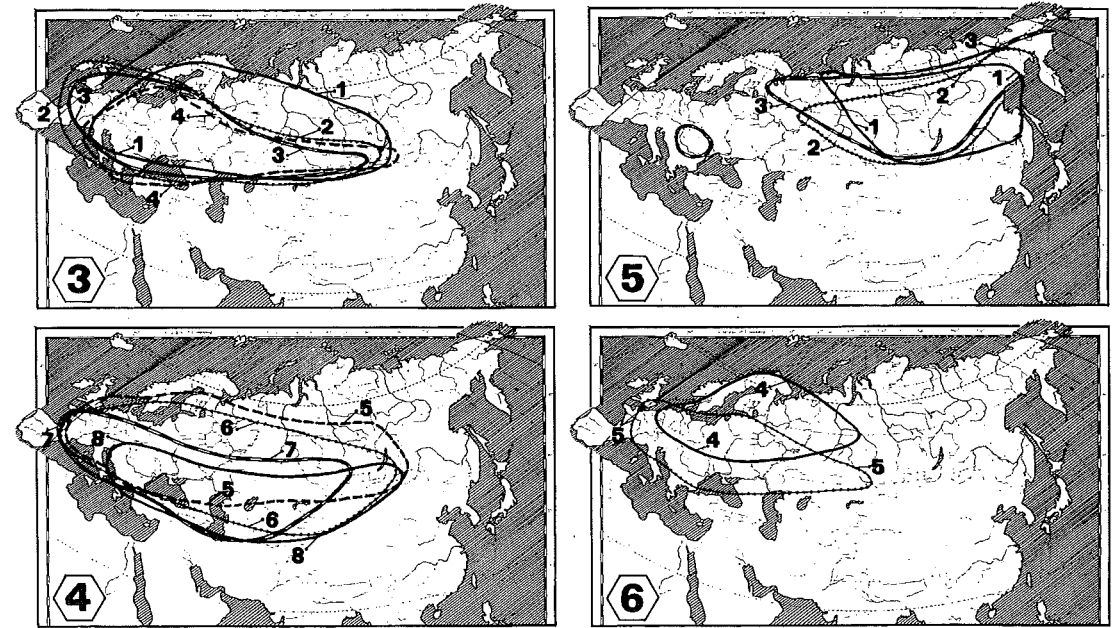
reinvansion from the West to the East, i.e. from Europe to Siberia.

3. *The Euro-Baikalian element* (7 species). All species included in this group are widely spread from Europe throughout Western Siberia eastward to approximately 105–110°E, i.e. as far as to the southern regions of Central and Eastern Siberia (Fig. 3). Two latitudinal subgroups are recognized:

a) temperate, or to be precise, temperate-Southern Siberian (6 species): *Dendryphantes hastatus*, *Pseudeuophrys erratica*, *Marpissa radiata*, *Sitticus distinguendus*, *S. saltator*, *S. zimmermanni* (Fig. 3).

b) boreal (1 species): *Sitticus terebratus* (see Prószyński 1983: fig. 11).

4. *The Euro-Siberian – Central Asiatic element* (9 species). Unlike the two previous groups, the species of this group are widely distributed in Central Asia (Fig. 4) and can also be considered to comprise two latitudinal subgroups:



Figs. 3 and 4. Distribution patterns of Euro-Baikalian (Fig. 3) and Euro-Siberian – Central Asiatic (Fig. 4) species: 1, *Dendryphantes hastatus*; 2, *Pseudeuophrys erratica*; 3, *Sitticus saltator*; 4, *Sitticus zimmermanni*; 5, *Heliophanus auratus*; 6, *Neon laevis*; 7, *Chalcoscirtus infimus*; 8, *Phlegra fuscipes*.

a) temperate (6 species): *Euophrys petrensis*, *Talavera aequipes*, *T. thorelli*, *Heliophanus auratus*, *H. flavipes*, *Neon laevis*. As in group 3a, almost all of them are to be treated as temperate-Southern Siberian species (Fig. 4).

b) subboreal (3 species): *Chalcoscirtus infimus*, *Phlegra fuscipes*, *Pseudeuophrys obsoleta* (Fig. 4).

5. *The European – Western Siberian element* (3 species). The easternmost limit of distribution for the species of this group is usually the Yenisei River. Because of the poor knowledge of the spiders of Western Siberia, only three species can currently be referred to this group (probably all temperate): *Heliophanus dampfi*, *Marpissa muscosa* and *Sitticus rupicola* (Fig. 6). The grounds for including these species in the group are: *Marpissa muscosa* has been recorded from the middle flow of the Yenisei River (Antsiferovo, 59°10'N), *Heliophanus dampfi* was found in

Figs. 5 and 6. Distribution patterns of Siberian and Siberian-American (Fig. 5), and European-West Siberian (Fig. 6) species: 1, *Euophrys flavoater*; 2, *Bianor aemulus*; 3, *Chalcoscirtus alpicola*; 4, *Heliophanus dampfi*; 5, *Sitticus rupicola*. (Distribution in North America is not shown).

Tyumen Area, and *Sitticus rupicola* has been reported from the environs of Novosibirsk.

The species of groups 3–5 comprise 19 % of all North Asiatic salticids. Estimating directions of movements during deglaciation of these species presents difficulties, as about 50 % of them are of the temperate Southern Siberian latitudinal type (sensu Gorodkov 1984), and as their distribution in Central Siberia is restricted to some southern regions (Altay and Sayan Mts.). It is precisely in these regions that the Pleistocene refugia are usually postulated to lie (e.g. Gorodkov 1979, Mikkola 1987). This considered, as well as the presence of the Continental Ice Sheet in Europe during the Ice Ages, Gorodkov and Mikkola postulated a westward direction of the reinvansion of the boreal and arctic species, i.e. from Southern Siberia to Europe.

For the three groups of the Euro-Siberian species, we analyzed the generic composition.

Eight species of them (42%), belong to the genera whose chorological centers are believed to be situated in Europe (*Dendryphantès*, *Talavera*, *Euophrys*, *Pseudeuophrys* and *Neon*), and four species (21%) belong to Mediterranean or Ethiopian genera (*Phlegra*, *Heliophanus*). Together this is 63%, i.e. the majority of species for the three discussed groups.

The refugia of Southern Siberia lie in the territory that at present is under the effect of the Siberian anticyclonic weather system. This extremely continental climate has been influencing Siberia since the Miocene (Sinitsyn 1980), including the Ice Ages. Therefore, it seems surprising that species which would have survived (or even originated) under continental climatic conditions would have spread widely westward to the humid climate zone (Europe), but not throughout Central and Eastern Siberia, where the "related" continental climate predominates. Actually, all Euro-Siberian salticid species are restricted in their distribution in Siberia to the so-called Southern Siberian faunal "corridor" [Gorodkov's (1984) term].

From the above reasoning it seems more appropriate to discuss the Euro-Siberian ranges as having resulted from the Holocene migrations from the West, i.e. from Europe to Siberia. In this case, the extremely continental climatic conditions of Southern Siberia would have formed an obstacle in the way of colonizers to Eastern Siberia.

Group II. Siberian and Siberian-American species

6. *The Siberian* (13 species) and *Siberian-American element s* (12 species). Species of these groups are usually widespread throughout Eastern Siberia (eastward from the Yenisei River) and sometimes reach into surrounding regions, including even Europe. Some of these species have reached East/North-East Europe (e.g. the Polar Urals, Fennoscandia), or even Central Europe (a so-called mountainous European – Siberian disjunction). Among the salticids such distributional patterns are poorly known (only 5 species, 4%, Fig. 5), but in both insect and other spider groups many examples of such ranges can be given (e.g. Eskov 1981, Gorodkov 1979,

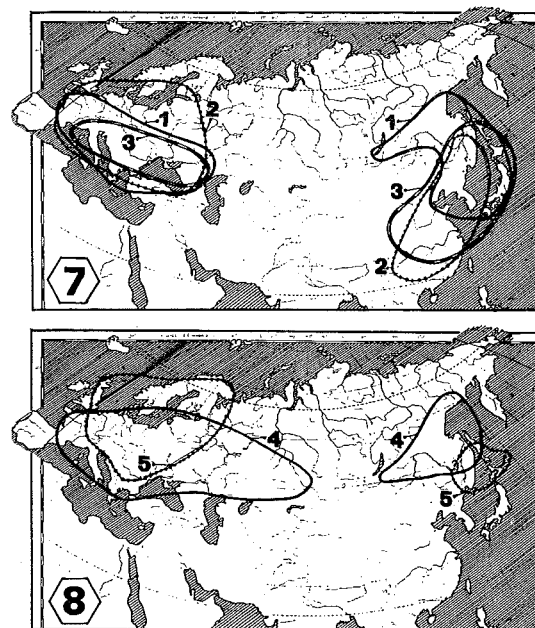
1984). Such cases point to Holocene reinvasions from Siberia to Europe, but does not account for all cases (e.g. Lopatin 1980).

In the present paper I am not considering the faunal connections between Siberia and North America. It is only to be noted that for most of the Siberian-American salticids, e.g. *Chalcoscirtus glacialis*, *Pellenes ignifrons*, *Bianor aemulus*, and *Sitticus lineolatus*, an origin in Siberia is indicated by both chorological and arealogical facts. This question requires more thorough study, however.

Of the 13 Siberian and 12 Siberian-American salticid species, in my opinion only five can be considered when dealing with the Euro-Siberian faunal connections: *Euophrys flavoater* (reaches the Polar Urals), *Bianor aemulus* (reaches the environs of Perm), *Sitticus lineolatus* (known from the Vorkuta area), *Chalcoscirtus alpicola* and *Pellenes lapponicus* (both recorded in the Alps) (Fig. 5).

Group III. Amphi-Eurasian species

7. *The Amphi-Eurasian element* (5 species). These nemoral species usually demonstrate a European – Far Eastern disjunction in their distribution (Figs. 7, 8). Most authors (Stegman 1938, Kurentsov 1965, Anufriev 1979) link the presence of such disjunctions with the disruption of the formerly continuous range, caused by the continentalization and aridization of the climate that is known to have begun since the Miocene (Sinitsyn 1980). What has been shown for many insect groups is true for the Salticidae, too. The Euro-Siberian faunal connections of this kind reflect the oldest (Neogene) interactions between the considered faunas. All the subboreal species belong to the Oriental (*Carrhotus*, *Phintella*) or Pantropical (*Myrmarachne*) genera. Such genera have been widely distributed in North-Eastern Eurasia during the Paleocene, in the so-called Arcto-Tertiary fauna (e.g. Starobogatov 1970). Moreover, all the amphi-Eurasian salticids inhabit the Manchurian nemoral forests, which have been shown to derive from the Arcto-Tertiary mixed-mesophytic forests (Krishtofovich 1958). Such a connection between animals and nemoral forests is generally explained as a relict one (e.g. Kurentsov 1965).



Figs. 7 and 8. Distribution patterns of amphi-Eurasian species.— Subboreal species (Fig. 7): 1, *Carrhotus xantogramma*; 2, *Myrmarachne formicaria*; 3, *Phintella castriesiana*. — Temperate species (Fig. 8): 4, *Evarcha laetabunda*; 5, *Sitticus saxicola*.

The amphi-Eurasian species comprise 4% of all the North Asiatic salticids, and can be divided into two latitudinal subgroups:

- a) temperate (2 species): *Evarcha laetabunda* and *Sitticus saxicola* (Fig. 8).
- b) subboreal (3 species): *Carrhotus xantogramma*, *Myrmarachne formicaria*, *Phintella castriesiana* (Fig. 7).

In summary, I wish to state that the Euro-Siberian faunal connections known up to now have turned out to be heterogeneous and arise from at least three elements represented by unequal numbers of species:

1. Widely distributed: Holarctic, trans-Eurasian and Euro-Siberian (3 groups) species which apparently recolonized Siberia from European/Mediterranean refugia following deglaciation. Such species form the majority of the North Asiatic salticid fauna (38 species or 32%).

2. Siberian and Siberian-American species, being probably of Siberian origin and having migrated from Siberia toward North Europe (5 species or 4%).
3. Amphi-Eurasian species, which for the most part can be attributed to representatives of the Arcto-Tertiary (Oligocene-Miocene) fauna and hence indicate the oldest faunal connections between present Europe and Siberia. These number 5 species, or 4% of the total North Asiatic salticid fauna.

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