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On the Change of Biotopes by Aphidophagous Coccinellids (Coleoptera, Coccinellidae)[1]

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Abstract—Several types of biotope changes have been revealed in aphidophagous coccinellids, based on long-term observations over the territory extending from the Kola Peninsula to the south of Turkmenistan and Tajikistan. Zonal, seasonal, and annual biotope changes are supplemented with zonal changes of the plant organ inhabited by coccinelids. For example, *Anisosticta novemdecimnotata* L. is a typical hygrophilous species occurring in the marshes and shores of various water bodies. In the arid environment of the Chu Valley in Kyrghyzstan, this species preys on aphids sitting on sugar-beet roots, thus changing its normal habit of dweller on green parts of plant to partly soil-dwelling. Such a change of biotopes has not been recorded in this species previously.

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When studying the geographical distribution of locusts in western Siberia, Middle Asia, and Transcaucasia, Bey-Bienko (1930) revealed selective confinement of organisms to certain biotopes, which was called by him "the rule of the biotope change." However, further studies and accumulation of new information showed that the principle of the biotope fidelity was true only when the space and time period were limited. Over their wide ranges, a diametrically opposite phenomenon was observed: species themselves regularly changed their habitats. Bey-Bienko (1959) called this regularity "the principle of the habitat change." The change of habitats, being an ecological regularity, constitutes a complicated assemblage of phenomena. In wide-ranging space, the changes of habitats manifest themselves as the zonal and vertical changes of biotopes and zonal change of vegetation layers, whereas in wide-ranging time, as the seasonal and annual changes of biotopes (Bey-Bienko, 1962).

Zonal change of biotopes is characteristic of widespread species and manifests itself as regularly directed change of the species habitats when passing from one natural zone to another: in moving northwards, dryer, well warmed, open biotopes with sparse vegetation, frequently on light sandy and stony soils are chosen; when going southwards, the same species inhabits more moistened and shaded biotopes with dense vegetation cover (Bey-Bienko, 1966a, 1966b). Such a distinct zonal change of biotopes is observed in the polyzonal and typically mesophilous *Coccinella septempunctata* L. This species is distributed from the Kola Peninsula in the north to the Kara Kum Desert in the south. In strict conformity with the rule of the zonal change of biotopes, this species occupies [in the north (Kola Peninsula)] open, well-warmed plots with southern or south-western exposition. Usually, these plots are used for cultivation of various crops. I observed the mass reproduction of this species during several years only in the Polar Experimental Station (Khibiny settlement) on black currant and in grain-crop sowings. In squares of Kirovsk, I collected only several imagines, but failed to find larvae or pupae.

In the middle part of its distribution range, *C. septempunctata* occupies mesophytic biotopes (various areas with herbaceous vegetation or crop sowings), where it demonstrates the seasonal and, sometimes, annual biotope changes discussed below.

In the southern part of the distribution range (e.g., in western Turkmenistan), *C. septempunctata* inhabits only moistened biotopes: areas with ephemerous vegetation in foothills or foothill plains of the Kopet-Dagh Mt. Range in early spring and humid canyons of Kopet-Dagh or crop sowings in irrigated fields in summer, where beetles migrate when ephemers fade (Semyanov, 1983).

[1] Paper at the session of the Russian Entomological Society in honor of the 100th birthday of Prof. Grigorii Yakovlevich Bey-Bienko, Corresponding Member of the Academy of Sciences of the USSR, President of the All-Union Entomological Society, on February 7, 2003.

The zonal change of biotopes is an ecological implication of the law of the geographical zonality and is accounted for by the increase of heat obtained by earth surface when moving southwards.

Vertical change of biotopes is analogous to the zonal one, but occurs in mountains. The most common case of the vertical biotope changes is expressed in migration of species to more xerophytic biotopes with increasing altitude. This type of the biotope change is yet unknown in coccinellids; it has been recorded in few insect species.

Zonal change of vegetation layers is manifested in the fact that polyzonal species, as shown by Ghilarov (1951), occupy different vegetation layers in different zones. Thus, ground-surface species frequently become at least partly soil-dwelling in dryer zones. Some species pass from a higher vegetation layer to a lower one when moving northwards. Ghilarov (1949) states also that the species ecology, physiology, and biology may change with the zonal change of the vegetation layer.

For a long time, nobody observed, in field studies, the zonal change of vegetation layers in coccinellids. In the Chu Valley (Kyrghyzstan), several specimens were found in a field on roots of sugar beet, where they fed on *Pemphigus fuscicornis* Koch. These specimens were habitually similar to *Anisosticta novemdecimnotata* L., but they were pale and devoid of any spots on the elytra and pronotum. Examination of the male genitalia revealed that it was really *A. novemdecimnotata*, a species distributed from the European Russia to Transcaucasia and Middle Asia and dwelling everywhere on grasses and rushes in either marshes, or shores of various water bodies, i.e. a typically hygrophilous species. Usually, the coloration variability in this species is expressed in larger or smaller sizes of spots on the elytra. After changing vegetation layer and partial transition to soil-dwelling, spots completely disappeared and biology and behavior also changed. Hence, we have here a typical case of the zonal change of the vegetation layer.

Temporal changes of insect habitats are associated with changes in the microclimate during a season or over a period of some years. In the first case, the seasonal change of biotope is observed. It is most sharply expressed in areas with warm and dry climate. Thus, in western Turkmenistan, the first generation of *Coccinella septempunctata* develops on ephemerous vegetation in the foothills of the Kopet-Dagh Mt. Range in early spring (April), when it is damp enough there, whereas the next generations, as mentioned above, develop in humid canyons or crop sowings in irrigated fields (Semyanov, 1983). In southeastern Kara Kum desert (Tedzhen and Murgab oases), where the natural vegetation is absent, the first generation develops on alfalfa or, as observed by me in sovkhoz "Karakum-kanal" in 1983, in sowings of perko (hybrid of *Brassica* spp.). After perko ripening and alfalfa mowing, beetles migrate to crop sowings (cotton, cereals, melons, and gourds), which also may be considered a seasonal biotope change.

Deviation in the weather conditions from the average ones (in both directions) influences the microclimate of insect habitats and leads to annual biotope changes. In dry and warm years, species migrate to more humid biotopes, in damp and cool years, to dryer ones. My long-term observations in Leningrad Province has revealed that *Coccinella septempunctata* usually develops on both herbaceous and wood-shrub vegetation, but in years with dry and warm spring and summer, only on herbs, and in years with damp and cool spring and summer, on woods and shrubs.

In years with very dry and hot summer, even such a typical inhabitant of woods and shrubs as *Adalia bipunctata* L. also migrates to herbaceous vegetation, where the second generation develops.

Many coccinellid species have two obligatory seasonal migrations during the annual life cycle. The first one, autumnal (from biotopes of reproduction to places of hibernation) occurs in the late summer; it is accounted for by the fact that reproduction biotopes in different parts of the distribution range prove to be unsuitable for hibernation for various reasons. The second, the vernal migration (from places of hibernation to reproduction biotopes) is a result of the absence of very possibility to reproduce in places of hibernation. Hence, we have the typical seasonal biotope change. This type of the biotope change occurs in both plains and mountain areas; I observed it in Leningrad Province (Semyanov, 1971) as well as in Tajikistan (Semyanov, 1983).

Dobzhansky (1922), when studying migrations and hibernation congregations in *Coccinella septempunctata* near Kiev, mentioned and, virtually, formulated the rule of the seasonal biotope change: "Thus, we observe periodical seasonal change of habitat, associated with drastic change of habits (tendency toward crowding)."

In the paper at the XIII International Entomological Congress, 1968 (Semyanov, 1971), I proposed to rename "the principle of the biotope changes" as "Bey-Bienko's principle."

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