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The Role of Phylogenetically Young Taxa in Formation of New Weeds: Coenotic Regulation of the Co-evolution of Phytophages

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Microevolutionary changes in populations of adventive species of plants and insects have been insufficiently studied in evolution theory. The most harmful species are phylogenetically young and related to the initial stages of succession. Dispersal of the most advanced taxa, e.g., common ragweed (*Ambrosia artemisiifolia* L; Asteraceae) becomes increasingly disastrous. The early stage of taxon formation, when morphological divergence is completed, is highly variable. If introduction occurs during this stage, the taxon goes out of coenotic control, microevolutionary processes are accelerated, and the range of modifications becomes wider. Biological control of such weeds is hampered by the lack of specific phytophages. The coevolution of phytophages depends on the phylogenetic age of a taxon. The most specialized phytophages are related to the stable levels of succession. However, such groups of phytophages as fungi have high evolutionary rates and one should search for promising control agents among them.

Introduction

Microevolutionary changes in populations of adventive species of insects and weeds introduced into new regions have been insufficiently studied in the evolution theory. Morphological shifts in populations have been found only in few cases. These changes were studied a long time after the introduction, which makes it difficult to study the role of the modifying influence of the environment. Several years, and many generations after introduction, new forms of introduced species have been found. These taxa of insects and plants appeared to have been phylogenetically young and thus related to the initial stages of succession.

For example, the barley aphid, *Diuraphis noxia* (Kurdjumov, not Mordvilko!) (Homoptera: Aphididae) prefers barley in Southern Russia, and has been rapidly spreading in North America since 1980, where it is named "the Russian wheat aphid." The introduced polyphagous form is very different from the initial forms in its host-plant preference. Aggressive forms of common ragweed (*Ambrosia artemisiifolia* L.; Asteraceae) were brought from North America to Russia at the beginning of the 20th century. They are unknown in Western Europe, where it was brought in the middle of the last century.

Analyses of the ecological outbreaks of exotic species on the basis of a study of phylogenetic levels of taxa may answer the question, "What are 'potential new pests?'"

Methods

In the taxonomic study of introduced species of weeds and their phytophages (Kovalev and Belokabylski 1989) particular attention was paid to clarifying coenotic influences in the period of evolutionary formation of the insect-plant relationships (Kovalev 1990). I looked primarily at formation of the level of insect oligophagy. Phyogenetically young taxa (*PYT*) played the major role in disturbed succession systems, formation of new pests, and selection of new cultivated forms.

Discussion

Particularly dangerous in succession systems that have been recently permanently destroyed

are *PYT* of the initial stages of succession that have been introduced into new regions. Formation of any taxon of a species consists of 2 stages; i.e., the initial, unstable polymorphic stage, and the final stage controlled by stabilizing selection.

Palaeontologists (Rasnitzin 1987) state that early stages of evolution of higher taxa are characterized by high variability of organization, when most morphological divergence takes place. Low evolutionary stability of early representatives of a given taxon is reflected by the large number of short, basal branches in many phylogenetic schemes. One can easily follow the stages of low stability of higher taxa by such characters as oligophagy, in particular in identification of specific phytophages for biological control of weeds.

Low stability of oligophagy persists in species of young genera and tribes; e.g. in Chrysomelidae. This low stability of oligophagy may be revealed only experimentally, because in the nature there seems to be strict (generic) oligophagy on the predominant genus of a plant in the succession system.

Stabilization of the mature stage of taxon formation undergoes coenotic influence of a succession system. If as a result of accidental or deliberate introduction the species goes out of coenotic control in the early stage of its formation, its divergence is possible in a new distribution range.

Adventive weeds are particularly important in the ever-expanding disturbed ecosystems. A great many of these species are *PYT*. There appeared a relatively large group of cosmopolitan weeds possessing a powerful allelopathic competition system. Each of these taxa has undergone an incubation period of microevolutionary process of formation of new forms in the areas of introduction. For example, evolutionary young taxa in the genera *Ambrosia*, *Xanthium*, *Cirsium*, *Solanum* and others occupied initial or pioneer stages in succession systems. On these stages, control of stabilizing selection is lower than on the final stage; species with a high biotic potential are predominant (*r*-strategists). The possibility of finding strict oligophages on these taxa for use in biological control may be limited.

An important feature of exotic weeds (i.e., inhibiting succession processes in fallow land) has been found in nature and proven experimentally (Kovalev and Belokobylskij 1989). Delay in the succession process accounts for the process of formation of homogenous nidi of adventive weeds. However introduction of even 1 species of specific phytophage may be a key factor in breakup of a succession.

Phylogenetically young weed species play an important role in the origin of cultivated plants. Many ancestors of cultivated plants occupied disturbed biotopes around human settlements, representatives of the first stages of succession. Chance selection was conducted by man not by introducing the extreme (deviating) variant, but by the average one. The same type of selection by man is still used. Eventually, a mechanism of appearance of a new form of phytophage following introduction was revealed.

We introduced *Zygogramma suturalis* (F.) (Coleoptera: Chrysomelidae), the ragweed beetle, from North America for biological control of common ragweed. The population we selected was not able to fly. In fact, all North American populations of *Z. suturalis* have reduced wing muscles and wing articulations and do not fly.

Z. suturalis is the most advanced taxon among 48 species of the genus that inhabit the most advanced species of the genus *Ambrosia*. Forms of the ragweed beetle capable of flight were found in the fifth generation after release. This new form of *Z. suturalis* inhabits the Palaearctic Region (from Europe to the Far East). The flying forms developed wing muscles and acquired the internal margin of the distal-medial lamella in the shape of a distinctly differentiated sclerite, lacking in ragweed beetles in their native area. Of particular interest is the newly appeared structure, a thick apodema of basisubcostal sclerite fixing wings during the flight.

The only possible interpretation of this process is appearance of "sleeping genes," because all other taxa of the genus are capable of flight.

References

Kovalev, O.V., Belokobylskij, S.A. (eds.). 1989. Theoretical principles of biological control of the common ragweed. *Proceedings of the Zoological Institute* **183:**235 p., Nauka Publishers, Leningrad (In Russian).

Kovalev, O.V. 1990. The role of evolution of the dominant species if succession processes in Cenozoic ecosystems in the formation of oligophagy of recent phytophages. *Proceedings of the VII International Symposium an Insect-Plant Relationships*, Hungary **39:**327-30.

Rasnitsin, A.P. 1987. Evolutionary rate and evolutionary theory (hypothesis in adaptive compromise). *In*: *Evolyutsiya I Biotsenoticheskiye Krizisy* (*Evolution and Biocenotic Crises*), Moscow, Nauka Publishers, pp. 46-64. (In Russian).