

Modes of speciation in planthoppers, leafhoppers and froghoppers : A review based on biosystematic data

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Since more than 20 years biosystematic studies have been conducted on selected species complexes of various genera of planthoppers¹⁻⁵, leafhoppers⁶⁻⁷ and froghoppers⁸⁻⁹ and several other groups¹⁰⁻¹³. This has prompted the author at this stage to present his views on the possible mechanisms of speciation in the lovely material of phyto-phagous Auchenorrhyncha. It is therefore appropriate to present here on this occasion a brief review while an extensive paper on this topic is to be prepared very soon.

In the past, many studies on speciation have been based to a lesser extent on combined field and laboratory research. First and most important is the field work, especially faunistic work as a base for the selection of such groups which promise to be appropriate material for the study of fundamental biological problems. Laboratory work, however is necessary, as many field workers agree, but in most cases it is difficult or impossible to realize. The author therefore feels lucky that he had the opportunity in a very good cooperation with many distinguished colleagues to fill these real gaps of combined investigations.

A striking observation in many field studies is the food and oviposition sites in all species complexes, either observed in the field or tested in laboratory rearings. In the planthopper genera *Muellerianella*, *Ribautodelphax*, *Delphacodes* and *Conomelus* which have been thoroughly studied^{1-5,14} it is so far known that speciation has occurred either allopatrically on what is botanically the same food plant (e.g. *Conomelus* species-complex) or sympatrically on different food plants (e.g. species of *Muellerianella*, *Ribautodelphax* and to some extent as we know so far *Delphacodes*). In the last three genera the phenomena of pseudogamy¹⁵ and parthenogenesis⁵ are involved and these contribute further confusion studying speciation. Although the data of these studies can be interpreted in various ways the author is of the opinion that pseudogamy acts as a reproductive isolation mechanism between closely related species or host plant races of the planthoppers¹⁶. The true *M. extrusa* was recently found and in Greece on its grass species *Molinia caerulea* providing thus, that the reported¹⁷ host race of this species on *Carex* sp. is an additional one. These host races of *Muellerianella* can easily be crossed in the laboratory producing fertile offsprings. Speciation therefor is still in the initial phase and undoubtedly genetic differentiation has not yet been established. These host races in Greece and elsewhere¹⁹ are sympatric and some times syntopic.

In leafhoppers we have studied one of the most complicated species complexes^{6,7} : the genus *Alebra*. Most of the data concerning this complex are yet unpublished. Very briefly, populations of this species-complex have been analysed electrophoretically and it was found that host races have been differentiated, not only on various species of oaks but also on the same host

chestnut (if these trees constitute a pure taxonomic unit). Based on "Nei's genetic distance" it is revealed that some leafhopper species of chestnuts are more distantly related to each other, than to certain oak-feeding species. This will allow further to follow the way of shift of the leafhopper species from one host to the other, since for chestnuts and some oaks it is known when they were introduced in several countries of Europe.

In froghoppers and especially in the genus *Philaenus* it is now known^{8,9} that the monophagous species *P. signatus* and *P. loukasi* can shift from their vanishing hosts to various shrubs or trees for overwintering (April- May until November). Despite the fact that this genus has not yet been well investigated in the Mediterranean, there are indications that populations of *P. signatus* and *P. spumarius* are geographically differentiated. The question remains whether this differentiation occurred on the same food plant or on different ones. In any case, as reported elsewhere, allopatric speciation is at the moment the most plausible.

These examples and several other both from literature and faunistic investigations in Europe suggest that allopatric speciation is common in Auchenorrhyncha. However, sympatric speciation can not be excluded in several species complexes. Thus the dogmatic theory that allopatric speciation is the only one is losing gradually power.

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