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Influence of host plant architecture on the dispersal capability of Delphacid planthoppers

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Historically, habitat persistence has figured prominently in the literature as a critical factor shaping the dispersal strategies of insects [3]. Other dimensional characteristics of the habitat such as host plant architecture may be equally influential, but are poorly investigated (but see Waloff [5]). I have gathered information on habitat persistence and the structure of planthopper host plants in order to investigate how habitat dimensionality might influence their dispersal capability.

Wing dimorphic insects such as planthoppers are ideal for investigating the advantages of wings and the evolution of dispersal because flightless and migratory forms are so easily recognized. Macropterous adults with fully developed wings can disperse long distances. Brachypterous adults have reduced wings, cannot fly, but have higher reproductive capability compared to macropters. Field populations of most delphacids contain both wing forms. Thus, levels of dispersal can be readily assessed by determining the proportion of the macropterous wing form in field populations.

Wings allow for escape from deteriorating local conditions and the colonization of new habitats. However, wings may also function in mate location, particularly in complex 3-dimensional habitats. Thus, the wing form composition of populations likely reflects selective pressures associated not only with habitat escape and the colonization of new habitats, but also negotiation of the current habitat. For this reason, it is important to isolate the effects of habitat persistence from those of habitat structure when assessing their impact on dispersal and other life history characters.

I hypothesized that in persistent habitats selection should favor flightless forms due to their reproductive advantage. In temporary habitats, wings should facilitate the tracking of changing resources. So, as habitats become more ephemeral I expected to find higher levels of dispersal. This prediction was tested by analyzing wing form and habitat characteristics for 35 species of planthoppers in temporary and persistent habitats. The most temporary habitats included agricultural crops such as rice fields and sugar cane plantations which persisted for less than 1 year. Among the most persistent habitats were bogs, fresh water marshes, and salt marshes which have persisted for 2000 to 12,000 years. A significant negative relationship was found between percent macroptery and habitat persistence. The relationship results for both female and male planthoppers and the Spearman Rank Correlations were both about -0.8 and highly significant [1]. Consequently, because of its very strong effect on dispersal characters in planthoppers, habitat persistence must be controlled when examining the influence of other structural features of the habitat on planthopper life histories.

Host plant architecture (tree, shrub or herb) may also have a dramatic influence on the evolution of flight. Two-dimensional habitats close to the ground can be reached by walking, but three-dimensional arboreal habitats may be difficult to negotiate without flight. General habitat

negotiation (mate finding and relocation of feeding site following escape from a predator) may prove difficult for flightless brachypters. Thus, selection may favor the retention of flight capability in arboreal species even if their habitats are persistent.

I tested the habitat dimensionality-flight hypothesis by comparing the wing form composition of delphacid species with the growth form of their host plants. Because most temperate delphacid species are monophagous on grasses and sedges and occupy low profile vegetation, few comparisons with arboreal species are available. By contrast, most Hawaiian planthoppers although monophagous feed on a wide variety of host plants which vary in structure from herbs to tall trees. Importantly, most of the host plants of native Hawaiian delphacids occur in habitats that are relatively persistent such as wet forests. Thus, the analysis was not confounded by major differences in habitat persistence.

Data on the wing form composition of 122 species of delphacids in 12 genera, and the identity and growth form of their host plants were obtained from the literature [2,6]. For ease, I used the height of the mature host plant [4] as an index of host plant architecture and dimensionality.

Frequency distributions of host plant height were very different for macropterous and brachypterous species: Macropterous species fed mostly on trees and large shrubs that averaged 7m in height. Brachypterous species occurred on significantly shorter vegetation, primarily small shrubs and herbs many of which contact the ground and averaged about 1m in height. Overall, the Hawaiian delphacid data provide strong support for the habitat dimensionality-flight capability hypothesis in that macroptery is favored in arboreal habitats and flightlessness has evolved in persistent, low profile vegetation.

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