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Biogeographic area relationships in Venezuela: A Parsimony analysis of Culicidae—Phytotelmata distribution in National Parks

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Abstract

This study represents the first attempt to understand the current distribution and evolutionary history of Culicidae in Venezuela and adjacent areas using cladistic methods. We studied the association between immature mosquitoes and their aquatic habitats in plants (phytotelmata) in 16 protected natural areas of Venezuela. A total of 68 mosquito species was collected from 47 host-plant species. Parsimony Analysis of Endemicity using localities and mosquito species was used to find the most parsimonious cladograms depicting the biogeographic relationships. Varying degrees of mosquito-plant associations were observed, with the greatest specificity existing at the genus and subgenus levels. Implicit enumeration algorithms obtained one parsimonious tree (L=101 steps) with four well-supported groups named "Amazonas" (southern Venezuela), “Bolivar” (southeastern Venezuela), "Los Andes Cordillera” and "Coastal Cordillera" (northern Caribbean mountain range). These results support the hypothesis that the Guayana Shield was an ancestral center of speciation, followed by the Andean Region, whereas the mosquito fauna from the Central Cordillera was derived from the latter.

Key words: Anophelinae**,** Bromeliaceae, cladistics, Culicini, Diptera, endemism, Historical biogeography, mosquitoes, Sabethini

Introduction

The landscape of Venezuela results from past intense geological activity that shaped current coastlines (Caribbean coast), the formation or depression of mountain ranges or cordilleras such as the Andean and Coastal Cordilleras, the emergence of sedimentary land formations (“Los Llanos”) resulting from changes in the course of the Orinoco river, and the ancestral influence of the Guayana Shield (Rod 1981, Hoorn *et al.* 1995). This geological history has produced variable topography and climate in the relatively small territory of Venezuela and adjacent Brazil, Colombia, Guyana and several Caribbean islands (e.g., Trinidad & Tobago), which are expected to have influenced the evolution of its flora and fauna. In agreement with Croizat's postulates (1958, 1964, 1976; “earth and life evolved together"), it is expected that geographical barriers for dispersion “evolved” with their biota.

Historical biogeography has five basic methods of study: dispersalism, phylogenetic biogeography, panbiogeography, cladistic biogeography, and parsimony analysis of endemicity that are not mutually exclusive alternatives (Morrone & Crisci 1995, Crisci *et al.* 2000) with capabilities to resolving different questions. Nelson & Platnick (1980, 1981) and Rosen (1988) developed the use of cladistic methods in biogeography, and Cracraft (1991, 1994) and Morrone & Lopretto (1995) applied this approach to the historical relationships of

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