



<http://dx.doi.org/10.11646/zootaxa.3652.1.4>

<http://zoobank.org/urn:lsid:zoobank.org:pub:10861BBC-FDF6-4520-837C-D4E38AB324D3>

Phylogenetic relationships of *Culex* (*Culex*) species (Diptera, Culicidae) from Argentina based on morphological characters

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Abstract

The purpose of this study was for the first time to establish phylogenetic hypotheses among *Culex* (*Culex*) species from Argentina, and to evaluate the relationships of this subgenus with subgenera *Phenacomyia* and *Phytotelmatomyia*. We employed maximum parsimony to analyse morphological characters derived from the morphology of the adult, pupal and larval stages. More than 30 figures, including photographs, illustrating 87 characters are provided. The cladistic analysis of 61 terminal taxa and 95 characters was undertaken, under implied weighting method, with a range of *K* values from 6 to 9. Three unstable taxa were detected therefore a reduced strict consensus tree was created. The subgenus *Culex* appears polyphyletic relative to subgenus *Oculeomyia*. The internal classification of subgenus *Culex* is shown to be chaotic; the Pipiens Group is polyphyletic relative to the Sitiens and Coronator Groups, the latter being polyphyletic with respect to the Pipiens Group. Phylogenetic analysis combining characters provided by morphology and molecular sources are needed to interpret more fully the relationships in the group.

Key words: Phylogeny, mosquitoes, cladistic, morphological features

Introduction

The genus *Culex* L. comprises species of medical and veterinary importance, including vectors of filarias and arboviruses. Culicini contains 795 species grouped in four genera: *Deinocerites* Theobald, *Galindomyia* Stone & Barreto, *Lutzia* Theobald and *Culex* (Harbach 2011a). *Culex*, with 26 subgenera and seven unplaced species (Harbach 2011a), includes many polymorphic features and exceptional forms (Harbach 2007). Its present subgeneric classification is based on external characters of the adult, especially features of the male genitalia (Harbach 2011b). The cosmopolitan subgenus *Culex* comprises 198 species (Harbach 2011a) in six species groups; the Neotropical species are in the Coronator and Pipiens Groups (Harbach 2011b). The infrasubgeneric categories are based on superficial similarities that may not reflect natural relationships (Harbach 2011b). Achieving an accurate species identification when using only morphological features of the females is a difficult task because most character states are either polymorphic or overlap among species. Characteristics of the larval stage can be useful to identify species; however, overlapping character states and absence of differences may prevent separation of some species. In most *Culex* (*Culex*) species, characters of male genitalia allow accurate specific identification. Various anatomical features support the monophyly of Culicidae, Culicinae and Culicini (Harbach & Kitching 1998). Belkin (1962) indicated that the natural affinities among the subgenera of *Culex* were obscure and surmised that *Lutzia* is an ancient and derived group that appears to have a strong affinity with the subgenus *Culex*. The subgenus *Culex* would be one of the 'most primitive' groups of the genus *Culex*, and *Lutzia* the sister to *Culex* (*Culex*) according to Mallampali (1995) and Miller *et al.* (1996). The relationships recovered by Navarro & Liria (2000) indicated that *Lutzia* is the 'most primitive' clade of Culicini and subgenus *Phenacomyia* Harbach & Peyton was placed as the sister group to subgenus *Culex*. St. John (2007) showed the genus *Lutzia* as the sister to the clade formed by *Culex*, and the subgenera *Phenacomyia* and *Culex* as the 'most primitive' of the genus. Rossi & Harbach (2008) described the subgenus *Phytotelmatomyia* as a monophyletic group, interposed between species of the