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Anostracan (Crustacea: Branchiopoda) zoogeography I. North American bioregions

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Abstract

Nine anostracan biogeographical regions are defined for North America: Appalachia/Ozark, Southwest Arid, Great Plains, Coastal Plain, Neotropical, California, Cold Deserts, Beringia/Canadian Shield, and Transmontane. These regions are quantitatively defined using species distributions compared through Jaccard's Coefficient of Community Similarity, and qualitatively defined using climate data, following the ecoregions protocol of the US Environmental Protection Agency for North America and the Universidad Nacional Autónoma de México for Mexico. Community assemblages are quantified using Fager's Index of Recurring Species Groups. The average Fager's Index for each bioregion, as well as the percentage of taxa co-occurring, generally decreases with the length of time the region has been available for colonisation. The strong Fager's Index/colonisation time availability relationship suggests that the Monopolization Hypothesis of De Meester *et al.* may function at larger landscape scales.

Key words: Fairy shrimp, island biogeography, monopolisation hypothesis, seasonal wetlands

Introduction

The Anostraca or fairy shrimp, occur in inland, seasonally astatic, lentic wetlands and saline lakes on all continents (Belk 1996, Brendonck *et al.* 2008, Rogers 2009). All species live in habitats that dry for part of the year (killing the adults), with dormant, dessication resistant eggs hatching when their habitat reinundates with later precipitation (Brendonck *et al.* 2008, Rogers 2009). Knowledge of anostracan biogeography at continental scales is limited. Packard (1883 for North America) and Daday (1910, for the world) are the only notable exceptions that divided continents into anostracan bioregions. However, both studies were based on limited knowledge of anostracan biodiversity and distribution. In the Daday (1910) classification species richness was observed to be far higher in temperate zones than in polar or tropical zones; a direct result of the greater variation in temperature and precipitation in these areas which is generally required to form seasonally astatic wetland habitats (Belk 1984, Brendonck and Williams 2000, Pinceel *et al.* 2013). This ecological variability drives habitat diversification, and as a result, anostracan diversification as well (Belk 1984, Pinceel *et al.* 2013a).

Daday (1910) and Belk (1977, 1984) related regional anostracan distributional patterns to climate and precipitation patterns. This approach was used to develop anostracan bioregions for species assemblages in Morocco (Thiéry 1987), southern Africa (Hammer 1994, Hamer and Brendonck 1997), Botswana (Brendonck and Riddoch 1997). The role of climate as an important driver for anostracan habitat and population development has been underlined by Pinceel *et al.* (2013a, b) who tied Australian anostracan genetic differentiation to historic climate change using molecular clocks.

North American anostracan biogeography has not been examined at the continental scale since Daday (1910), however localized regions have been examined. Eng *et al.* (1990) and Eriksen and Belk (1999) give general descriptions of anostracan distribution in California from the perspective of the individual species, and provided a generalised summary table outlining species habitat preferences. Maeda-Martínez (1991) and Maeda-Martínez *et al.* (2002) discuss the biogeography of the Mexican Anostraca in general terms, as relating to desert type. Maeda-

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alter the monopolisation of the regions by different taxa. Insular microclimates may provide just the correct conditions for a species or species assemblage outside of its regular bioregion. Stochastic dispersal events by a range of vectors may move species into new areas not previously available for colonisation. It may be that a species does not occur in a specific region not because the habitat is unsuitable, but because it is outcompeted (Urban and De Meester 2009, Waters 2011).

Secondly, it is possible that a species that occurs in two or more very different ecoregions or habitats, may actually be more than one cryptic species, each in its own habitat, and should be verified.

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