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Phenotypical variation and taxonomic correlates of five closely related Andean species of *Poa* (Poaceae) along geographic and climatic gradients

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Abstract

Poa anfamensis, P. jujuyensis, P.lilloi, P. parviceps and *P. scaberula* (Poaceae) are a group of morphologically similar species. These species inhabit cool grasslands and mesic puna. They are highly polymorphic and their circumscriptions are uncertain, especially the entities around *P. scaberula*. Univariate and multivariate analyses (PCA and DA) were conducted to evaluate the morphological variation among 150 herbarium specimens identified as *P. anfamensis, P. jujuyensis, P. lilloi, P. parviceps* and *P. scaberula*. Forty morphological characters were included and their patterns of variation were analyzed among specimens, together with their relationship with environmental variables, using correlation analysis. The relationships between morphological variation and geographical distance, and climatic variables among specimens, were compared with Mantel permutation tests. Taxa were delimited according to the observed clustering of specimens in the PCA plots and DA, and diagnostic characters were identified. The five taxa showed continuous morphological variation. Morphological variation is explained by geographical and climatic factors such as elevation, geographical distance, latitudinal and longitudinal gradients, temperature and precipitation in the different sites in the Andes. Altitudinal and geographical distance are apparently more decisive factors in phenotypic differentiation and could have played a large role in interspecific differentiation among *Poa* entities, as shown by the stronger and significant association between vegetative and reproductive phenotype and altitudinal distance, and between vegetative and reproductive phenotype and geographical distance. In addition, we observed uncoupling among vegetative and floral characters in *Poa* specimens that grow along environmental gradients; these characters are responding independently to different abiotic forces promoting genetic divergence and speciation. Based on the results, *P. anfamensis* and *P. parviceps* are synonymised with *P. scaberula*, and *P. jujuyensis* is synonymised with *P. lilloi*.

Keywords: environmental gradients, geographic variation, Gramineae, morphological variation, multivariate analysis, reproductive characters, vegetative characters

Introduction

Plant morphology is a function of phenotypic changes in response to geographical variation and local climatic conditions, genetic variation within and among taxa, and the biogeographic history of an individual species. Morphological variation and geographical separation among individuals are also necessary for the formation of subspecies and species (Ellison *et al*. 2004). Individuals within a species typically differ in phenotype, and although some of this variation may be random, a large proportion of this variation may represent adaptive matching of phenotypes to variable environments (Clausen *et al*. 1948). This variation can arise from phenotypic plasticity, in which different morphologies are produced from the same genotypes in different environments (Richards *et al*. 2005, Scheepens *et al*. 2010).

Abiotic and biotic environmental processes acting upon isolated taxa are thought to be key factors in species divergence (Still *et al.* 2005). Processes of geographical divergence occur by isolating mechanisms, in part due to the restriction of gene flow between taxa. Among individuals of a widespread species, different ecological environments and independent evolution of individuals through genetic drift may lead to divergence. Many plant species grow in a range of different habitats and have developed adaptive strategies suited to the particular habitats in which they occur (Coyne & Orr 2004). Several studies have shown that plants growing along altitudinal and latitudinal gradients, and under different climatic conditions, are characterized by fixed, locally adapted phenotypes, which have a genetic background (Linhart & Grant 1996, Briggs & Walters 1997, Hufford & Mazer 2003, Schneller & Liebst 2007).

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Poa lilloi Hackel (1911: 153). Type:—ARGENTINA. Tucumán, Cumbres Calchaquies, 4000 m, 29 February 1907, *Lillo 5619*, *herb. T. Stuckert 17741* (holotype W, isotypes BAA, CORD, LIL, SI, US-88760 (fragm. ex W), US-1867542 (ex NY)

Poa parviceps var. *jujuyensis* Parodi ex Nicora (1997: 143). *Poa jujuyensis* (Parodi ex Nicora) Giussani, Soreng & Anton (2011: 91). Type:—ARGENTINA. Jujuy, Humahuaca, Mina Aguilar, no date, *Fernández s.n.* (holotype BAA!, isotype SI!)

Culms 8.2–11 cm tall, rhizomatous, caespitose; blades 2.1–2.8 cm long, convolute; ligule obtuse; number of large internodes 1–3; uppermost vegetative internode 18.3–16.4 mm long. Panicle 22.8–25.1 mm long, number of nodes 7–8, length of the longest branch of the first node 10.6–12 mm. Spikelets 4.3–4.5 × 2.3–2.4 mm; glumes up to ⅔ as long as the florets, lower glumes 3.2–3.3 × 1.8 mm, 3–5-nerved, upper glume 2.8 × 1.3–1.4 mm; callus usually glabrous; lemma 3.5–3.6 × 1.8–2 mm, apex usually acute, nerves usually scabrous, between the nerves slightly scabrous; palea 2.9 mm long, nerves 0.7 mm apart, usually scabrous or ciliate; anthers 1–1.6 mm long. Monoclines, chasmogamous.

Distribution:—South American native grass from Argentina, Bolivia and Perú, from 11º–26º S and 65º–75º W. Inhabits rocky soils in high mountain meadows between 4000 and 5004 m.

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