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Diversity of zonal páramo plant communities in Ecuador

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Abstract. Patterns of vascular plant species diversity in high-altitude Ecuadorian ecosystems ('páramos') are examined. Data from two independent surveys were used: the first from 12 different locations and 192 samples, the other from 18 locations and 243 samples. These surveys included 348 and 284 species, respectively. The data confirmed the occurrence of two main zones in terms of vascular plant species diversity. The grass páramo and superpáramo were distinguished by differences in plant cover, species richness, α-diversity and β-diversity. The transition between these two zones begins at around 4000 m. Grass páramo samples comprised more species but the strong dominance of tussock grasses resulted in low equitability compared with the superpáramo, where safe sites for plant survival are limited and the environment does not permit continuous grass cover. Turnover of species across the altitudinal gradient is higher in the grass páramo than in the superpáramo. This is due largely to agricultural fires at lower altitudes, which create a fine-scale mosaic of burned patches that enhances variability at this scale. Despite the loss of equitability, intermediate levels of fire disturbance appear to promote species richness within the samples. It is suggested that the complex patterns of páramo diversity in the Ecuadorian Andes are largely the outcome of three interrelated factors: altitude, disturbance and the availability of safe sites at the highest altitudes.

Key words. Altitudinal gradient, disturbance, Ecuadorian Andes, species richness, tropical alpine, zonation.

INTRODUCTION

The páramos of the South American Andes host the richest tropical mountain flora in the world (Smith & Cleef, 1988). The recently compiled species list of páramos, ranging from Costa Rica to northern Peru, includes 1298 and 3399 species of non-vascular and vascular plants, respectively (Luteyn, 1999). In the past there have been periods of páramo expansion and contraction due to climatic cycles (van der Hammen & Cleef, 1986; Bosman *et al.*, 1994; Hooghiemstra & Cleef, 1995), accompanied by associated speciation and radiation events (Simpson, 1975; Cuatrecasas, 1986; Reig, 1986). These climatic changes have promoted the evolution of endemic species in numerous plant genera, such as *Espeletia*, *Gentianella* and *Jamesonia* (Cuatrecasas, 1979; Pringle, 1995). Relations between individual páramo floras are complex (Cuatrecasas, 1979; van der Hammen & Cleef, 1986; Ricardi *et al.*, 1997; Sklenár & Jørgensen, 1999), and comparisons of mountains may offer key insights into the processes responsible for observed patterns.

Previous studies divided the páramos in several zones related to altitude (Cuatrecasas, 1934, 1958; Harling, 1979; Cleef, 1981; Acosta-Solís, 1984; Ramsay, 1992; Jørgensen & Ulloa, 1994). Typically, the trees of the upper forest line are replaced by tussock grasses of the grass páramo (Fig. 1); sometimes a transition zone between the two, the shrubby subpáramo, is present but this has been lost in most areas as a result of human disturbance (Ramsay, 1992; Luteyn, 1999). In Ecuador, the tussocks of the grass páramo (typically belonging to *Calamagrostis*, *Festuca* and *Stipa*)

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