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From inselberg to inselberg: Floristic patterns across scales in French Guiana (South America)

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ABSTRACT

Granitic outcrop vegetation was compared in 22 inselbergs of French Guiana, South America, using RLQ and fourth-corner analyses to identify the main relationships between environmental gradients and plant traits. At the scale of the whole territory the distribution of species and species traits was mostly driven by a spatially-structured gradient embracing regional climate (annual rainfall), forest matrix (canopy openness), and inselberg features (altitude, shape, habitats, summit forest, degree of epiphytism, fire events). Biogeographic, environmental and past historical factors contribute to explain the variation observed at coarse scale and two groups of inselbergs are identified. A first group occupies the southern peneplain in a semi-open forest matrix and exhibits a higher representation of suffrutescent species and climbers, a lower representation of upright shrubs, a lower degree of Guiana Shield endemism, and a higher incidence of human use and autochory. All these features suggest an adaptation to more disturbed environments linked to past climate changes and savannization and to human influences. A second group, characterized by opposite plant traits, occupies the northern part of French Guiana and the far south within a closed forest matrix. Within archipelagos (inselbergs at less than 7 km distance), C-score and Mantel tests revealed a random co-occurrence of plant species and an increase of floristic dissimilarity with distance without any concomitant change in plant traits, respectively, suggesting that spatially-structured stochastic factors (limitation by dispersal) were the driving force of vegetation change at fine scale.

1. Introduction

Inselbergs are dome-shaped rocky outcrops rising above surrounding plains (Bornhardt, 1900). They have been reviewed worldwide for their geological origin and for their biotic diversity by Porembski and Barthlott (2000). They vary in size and height, being sometimes limited to only a few meters (Bremer and Sander, 2000). They can be considered as analogous to functional islands (Prance, 1996) in a general matrix such as deserts, savannas or forests. Whatever their dimensions, the crystalline rocky surface of inselbergs is covered by a peculiar vegetation growing in a shallow soil layer, a general property of rocky outcrop vegetation adding an ecological dimension to the geomorphological definition of "inselbergs" (Gröger and Barthlott, 1996).

In northern South America, inselbergs are especially frequent in French Guiana within the Guiana Shield (Fig. 1). They consist of Precambrian granites. Detailed accounts on their geomorphology and geology were provided by some authors (Hurault, 1973; Teixeira et al., 1989; Delor et al., 2003). French Guianan inselbergs are isolated or clustered in groups called archipelagos. They are mainly distributed in all the southern landscapes (Fig. 1): especially large inland plains, plateaus and mountain chains (Guitet et al., 2013). They are covered with discontinuous vegetation form-

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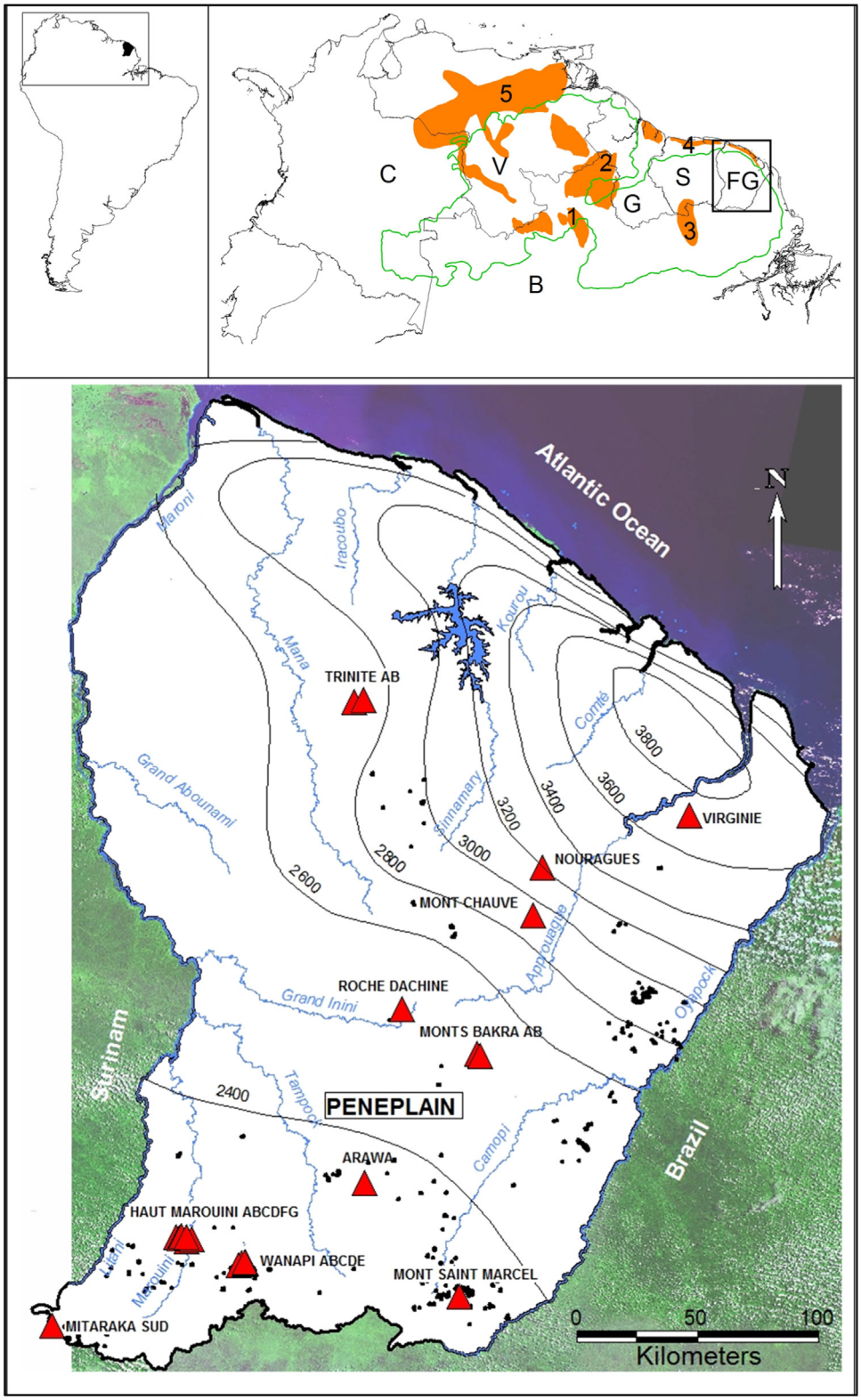

Fig. 1. Map of French Guiana, showing the 22 studied inselbergs (red triangles; each letter designates an isolated inselberg), among the whole set of inselbergs (black dots), the water system and rainfall isohyets. Inserts at the top of the figure indicate the position of French Guiana within South America (left) and within the Guiana Shield (right), with country limits. Country names are indicated by their capitalized initial: B: Brazil; C: Colombia; FG: French Guiana; G: Guyana; S: Suriname; V: Venezuela. Savanna-like vegetation zones are colored. 1: Roraima; 2: Rupununi; 3: Sipaliwini; 4: Coastal savannas; 5: Llanos.

ing a type of mosaic locally called "rock savanna". This vegetation is characterized by numerous scattered herbaceous and shrubby patches separated by bare rock (de Granville, 1978; Sarthou, 1992; Sarthou and Villiers, 1998; Sarthou et al., 2003). The "rock savanna" vegetation is kept in a dynamic state by erosion and fire events (Kounda-Kiki et al., 2008; Sarthou et al., 2009). It undergoes extreme local climate variation during the day-night cycle: high and frequent variations in temperature (18–55 °C) and relative