Palms of the South-West Cordillera Galeras, a Remote Premontane Rain Forest in Eastern Ecuador

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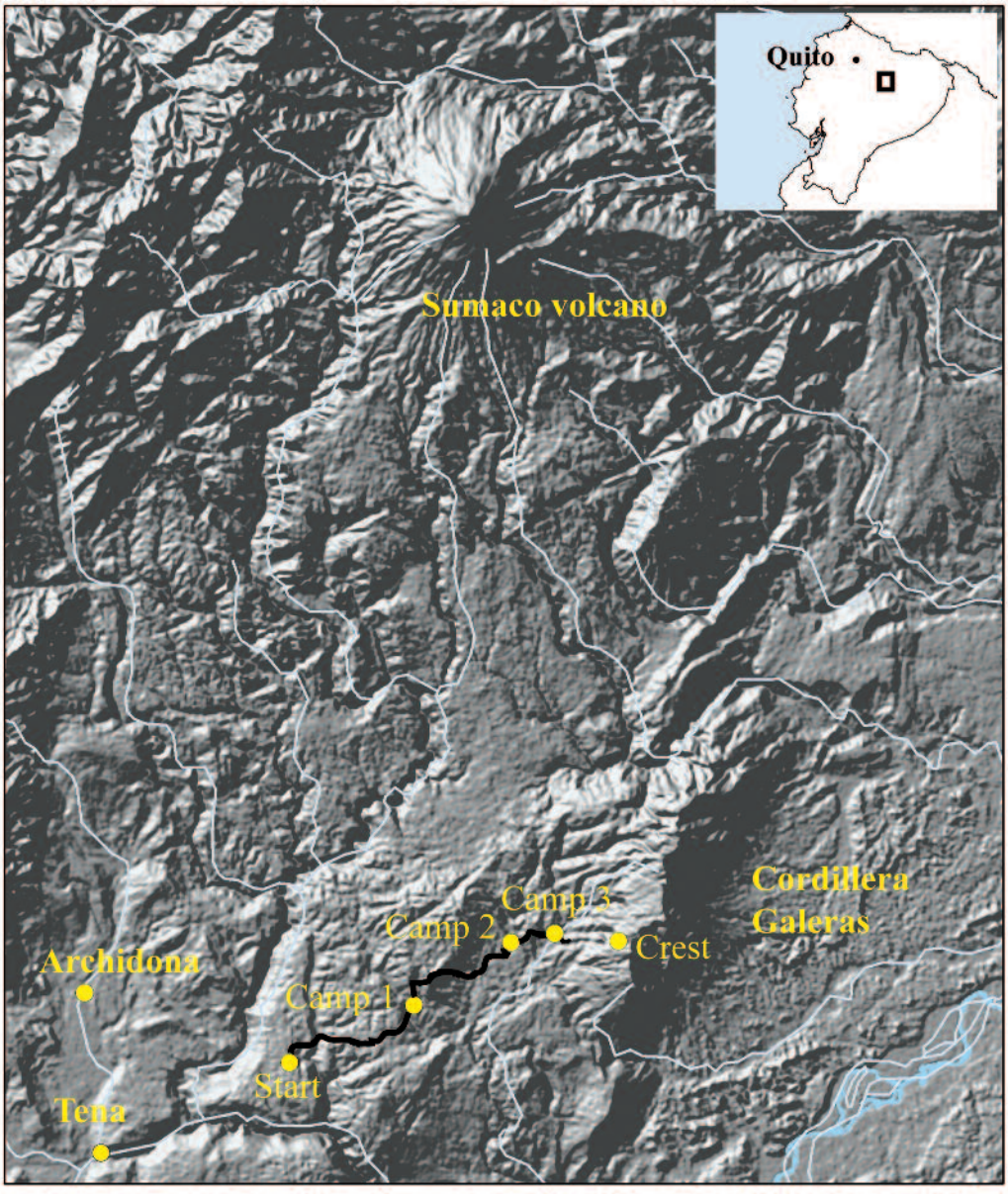
The Sumaco Napo-Galeras National Park in western Ecuador was recently awarded a World Biosphere reserve status, yet it is one of the least botanically known regions in the country, mainly because it is hard to reach. We present here some preliminary results of palm diversity documented during a field trip in June 2009 to the south-west part of the Cordillera Galeras.

Ecuador is famous for many things: the Galapagos, the massive volcano Cotopaxi, the Yasuni National Park, etc. In addition, Ecuador stands out as one of the countries best explored botanically in South America (Schulman et al. 2007). However, a few regions are so remote that they remain hard to access and thus relatively unknown botanically. Such is the case of the Cordillera Galeras (Fig. 1), situated some 130 km south-east from the capital, Quito. The Cordillera is part of the Sumaco Napo-Galeras National Park. This park was classified by the UNESCO in 2000 as a World Biosphere Reserve, becoming the third such reserve in Ecuador after the iconic Galapagos Islands and the Yasuni National Park. The whole Sumaco Napo-Galeras National Park totals about 202,300 hectares with the largest area found around the impressive and largely isolated Sumaco volcano standing at 3900 m

1. View from the Galeras Cordillera. The crown of *Dictyocaryum lamarckianum* is visible.

above sea level (Fig. 2). The Cordillera Galeras is in fact separate and situated about 20 km south of the volcano covering a smaller area of about 11,800 hectares (Fig. 1). The Cordillera emerges abruptly from the lowland Amazonian rain forest to an altitude of 1700 m and represents the first ripple of the Andes, when coming from the Amazon basin. It is part of the smaller, third cordillera of the sub-Andean region, which also includes other mountainous chains such as the Cordillera de Cutucù and Cordillera del Condor further to the south (Neill 1999). Galeras is covered with dense primary premontane tropical rain forest with precipitation around 3000–3500 mm per year and temperatures between 18° and 24°C. The soil of the Cordillera formed from a Cretaceous limestone formation (Neill 1999). Limestone substrates, which are rich in calcite, are known to support a distinct type of flora with



2. Terrain map of the Sumaco Napo-Galeras region showing the Sumaco volcano and the Galeras Cordillera, as well as the route taken to reach the southern part of the mountain range.

numerous endemic species (Neill 1999). The forest is accessible only after one to three days' walking, depending if one wants to reach the north or south sides, respectively.

Palm research in Ecuador has been continuing for many years and has led to important publications such as "Manual to the Palms of Ecuador" (Borchsenius et al. 1998) or the online catalogue of herbarium collections from Aarhus (Denmark, AAU), www.palmbase.org. Because palms are rarely collected by the non-specialist, palm collections from the heart of Galeras are scarce. The main goal of this expedition was to document the palm diversity of the south-west part of the Galeras Cordillera. This field trip was funded in part by the International Palm Society.

The expedition departed from the small town of Archidona located near the city of Tena, ca. 5 hours by bus from Quito (Fig. 1). The team consisted of Thomas Couvreur and Marc Jeanson from the New York Botanical Garden, Juan Ernesto Guevara, a research associate at the Universidad Central in Quito, and Nelson

3. The Pusuno river at the base of the Galeras Cordillera, with *Wettinia maynensis* and *Iriartea deltoidea*.

Mamallacta, a local guide and community leader in Archidona and two of his relatives. After a short sleep in Archidona, a taxi dropped us off at the end of the road at around 6 a.m. We then started the long walk towards our final destination, the Pusuno River, which originates in the middle of Cordillera and then flows south along the east flank of Galeras. We expected to arrive there before nightfall of the same day. However, at noon, we were merely one quarter of the way. We were moving very slowly because of extremely muddy paths, heavy backpacks and asphyxiating heat, which took Marc and me by surprise. We thus spent the first night in a temporarily abandoned Quichua Indian house a little less than half way. The occupants of the house had gone to town to vote a few days earlier. After walking all the next day, we again failed to reach the river before dusk. One problem was that the guides had not returned to the Pusuno River for one year, and parts of the trail were untraceable. We walked in circles for a few hours under pounding rain. Just before sunset, we arrived at our second "hut," which was in a state of total decomposition. The rain forest is quick to eat away any trace of human settlements! Luckily, we brought large plastic tarps and were able to make the place very comfortable (at least by jungle standards). In the end, it took us over two days to reach our destination. Our final camp site was situated at about 1000 m above sea level along the beautiful Pusuno River (Fig. 3). In general, the weather was mostly rainy and the nights were pretty cold, but the day temperatures were extremely pleasant, and the relatively high altitude limited mosquitoes to a minimum. For the next three days we collected palms in the region of the Pusuno River.

The forest on the east side of the river was dominated by two lovely medium-sized palm species, *Wettinia maynensis* and *Iriartea deltoidea* (Fig. 3). The number of *Iriartea deltoidea* seedlings covering the forest floor with their simple eophylls was, in some places, impressive. This species is dominant along the Andean foothills from Ecuador to Bolivia below 1200 m, but in Galeras Cordillera it holds the record for stems per hectare. In a one-hectare plot established to evaluate the tree flora on the west side of Galeras, 323 individuals were counted with dbh ≥10 cm, representing 38% of the plot stems (Mogollón & Guevara 2003; Pitman et al. 2002). On the west side of the river, the dominance of these

4. *Bactris schultesii*, upper photo in fruit, lower photo in flower with weevil beetles feeding on the pollen.

palms continued, but we also noted a strong presence of another medium-sized palm, *Socratea exorrhiza*, not encountered, however, on the other side.

In addition, the understory was dominated by *Bactris schultesii* (Fig. 4), and several forms of *Geonoma stricta* and *G. macrostachys*.

A fruiting specimen of *Geonoma hollinensis* (Fig. 5) was also collected, making it just the third collection of this recently described palm (Henderson et al. 2008). This is one of the two *Geonoma* species with three stamens, the other one being *G. triandra* (Henderson et al. 2008).

Geonoma stricta is a common, widespread and very variable species, occurring throughout the Amazon region, with outliers in the Andes and Chocó (Henderson & Martins 2002). Because of its variability, it is better considered a species complex (Henderson 1995) – a widespread species with one or more forms at one locality but with intermediates or slightly different forms at other localities. On the eastern Andean slopes, where there are many isolated mountains and valleys, there are many local forms of *G. stricta*. Three quite different forms were collected during our trip to Galeras which we consider important to describe here briefly. The first form (Fig. 6, top middle) has undivided leaves and short, often recurved and densely flowered inflorescences. In addition, we also collected a specimen very similar to the

5. *Geonoma hollinensis*. Top: whole plant with infructescence; bottom: detail of infructescence.

6. Different forms of *Geonoma stricta* found in the cordillera Galeras region. Top left: *densely flowered thick inflorescence/pinnate leaf* form; Top middle: *densely flowered thin inflorescence/simple bifid leaf* form; top right: *densely flowered thin inflorescence/simple bifid leaf* form, smaller leaf form; bottom left: inflorescence detail of the *sparsely flowered thin inflorescence/pinnate leaf* form; bottom middle: *sparsely flowered thin inflorescence/pinnate leaf* form). Arrows indicate position of inflorescence/infructescence.

above but with considerably smaller leaves and inflorescences (Fig. 6, top right). This latter form was frequent in the understory, more so than the larger version. It could be a smaller version of the first form, or something new. The second form (Fig. 6, top left) is intermediate between the varieties *pycnostachys* and *trailii* (Henderson 1995). It has the non-raised veins of the former and pinnate leaves of the latter. It also has densely flowered, longer, erect inflorescences. Finally, the last form has pinnate leaves with long but sparsely flowered, recurved inflorescences (Fig. 6, bottom).

There was also a more limited presence of two wonderful *Chamaedorea* species, *C. pinnatifrons* and *C. pauciflora* (Fig. 7), as well as several *Oenocarpus bataua* individuals restricted mainly to the banks of the river.

On the fifth day we set out to climb the western flank of the Cordillera. As we climbed steadily upwards, we saw a spectacular emergent palm, *Dictyocaryum lamarckianum*, which gradually replaces the lower elevation *Iriartea deltoidea*. This palm is endemic to the Andes above 1000 m and generally grows on steep slopes (Henderson 1990). Although there were several individuals seen along this crest, it did not form a conspicuous component of the forest canopy, as has been reported from other localities. Indeed, *D. lamarckianum* can

7. Top photos: *Chamaedorea pinnatifrons*. Left: whole infructescence; right detail of infructescence. Bottom photos: *Chamaedorea pauciflora*. Left: whole plant; right detail of infructescence.

become very abundant within a narrow altitudinal range of 1500–1800 m, forming dense patches in the premontane forest canopy of the eastern flanks of Ecuadorian Andes (Borchsenius et al. 1998; Mogollón & Guevara 2003). As we arrived towards the summit, after five hours of steep climbing, the understory of the crest became dominated by *Prestoea* and *Pholidostachys synanthera* (Fig. 8). The yellow-orange light of the late afternoon provided a paradisiacal scene well worth the effort of the climb. *Pholidostachys synanthera* had already been spotted a few times at lower altitudes near the river, but became dominant above about 1300 m. The *Prestoea*, although as abundant as *Pholidostachys*, was never found in flower or fruit. It is hard to know precisely which species this is, but it could be juveniles of *P. acuminata*, a species we had seen at lower altitudes and along the river.

8. Understory forest of the Galeras Cordillera at ca. 1400 m, dominated by *Pholidostachys synanthera* (with wide pinnae) and *Prestoea* sp. (with narrow pinnae).

Table 1. List of species collected in the Galeras Cordillera, Ecuador, with their respective biogeographical element (Montufar & Pintaud 2005) in brackets. An=Andean; WA=Western Amazonian; N=Neotropical; Am=Pan-Amazonian; SA=South American.

Aiphanes ulei (Dammer) Burret [WA]

Bactris schultesii (L.H. Bailey) Glassman [WA]

Chamaedorea pauciflora Mart. [An]

Chamaedorea pinnatifrons (Jacq.) Oerst. [N]

Desmoncus polyacanthos Mart. [Am]

Dictyocaryum lamarckianum (Mart.) H. Wendl. [An]

Geonoma hollinensis A.J. Hend., Borchsenius & Balslev [An]

Geonoma macrostachys Mart. var. *macrostachys* [WA]

Geonoma stricta (Poit.) Kunth complex (three forms) [Am]

Geonoma supracostata Svenning [WA]

Geonoma triglochin Burret [An]

Iriartea deltoidea Ruiz & Pav. [N]

Oenocarpus bataua Mart. [SA]

Pholidostachys synanthera (Mart.) H.E. Moore [SA]

Prestoea acuminata (Willd.) H.E. Moore var. *acuminata* [An]

Prestoea schultzeana (Burret) H.E. Moore [An]

Socratea exorrhiza (Mart.) H. Wendl. [N]

Wettinia maynensis Spruce [An]

The next day it rained continuously, the sort of downpour that does not allow you to do much collecting. Because the rivers had swollen and changed from translucent to light brown (not really a good sign), we filled our water tanks with rainwater, which was pleasantly tasty (a bit like Evian™ water).

On the following day we headed back to Archidona, and this time we did reach the road in one day thanks to lighter backpacks and a cleaned trail. The last bit was the worst part (secondary forests near villages), because the trail was very muddy and quite dirty. The local inhabitants lay logs on the ground to help, but one has to use one's acrobatic skills to get by. The hardest part is to stay focused especially after a 10-hour non-stop hike. One mistake, and you fall flat in the mud, which can be potentially hazardous. Luckily all went well, and we returned safely to Archidona.

For the four days spent at the Pusuno River, we collected a total of 18 species and 12 genera (Table 1). All specimens are deposited at the NY and QCA (Pontificia Universidad Catolica del Ecuador, Quito, Ecuador) herbaria. Following definitions in Montufar and Pintaud (2005) and without having undertaken any detailed ecological studies, we believe the west side of the cordillera has a strong Andean component with 1/3 of species belonging to this biogeographical group (Table 1). This is, of course, not surprising given the cordillera's proximity to the Andes. The rest of the species belong to other groups such as western Amazonian, Neotropical or South American elements (Table 1). Although no new species were collected, we were able to cover only a small area of this mountain range. The east side of the cordillera is a steep slope down to the Amazon plain. This side might be of interest, as well as the lower east side, where lowland Amazonian elements meet montane rain forests. To date, the presence of ca. 60 tree species has been confirmed to occur within the cordillera (Mogollón & Guevara 2003). Moreover two new species of *Brownea* (Fabaceae) and *Guatteria* (Annonaceae) have been discovered in the west side of Galeras from previous collections (B.B. Klitgaard & P. Maas, pers. comm.). In this sense, the potential for finding a new palm species is high, particularly for genera such as *Geonoma*, if more extensive collections are made in this area. Our trip might be viewed as preliminary, and further trips could possibly provide a better overall knowledge of palm diversity in this small but fascinating region of eastern Ecuador.

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