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Las palmeras en América del Sur

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Novelties in the genus *Ceroxylon* (Arecaceae) from Peru, with description of a new species

Novedades en el género *Ceroxylon* (Arecaceae) del Perú, con la descripción de una nueva especie

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Abstract

A new species of *Ceroxylon* from Peru, *C. peruvianum*, is described and illustrated. The finding of disjunctive populations of *C. quindiuense* in Peru is discussed.

Keywords: Arecaceae, *Ceroxylon*, new species, phytogeography.

Resumen

Se describe e ilustra una nueva especie de *Ceroxylon* del Perú, *C. peruvianum*, y se discute el hallazgo de poblaciones disyuntas de *C. quindiuense* en Perú.

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Palabras clave: Arecaceae, *Ceroxylon*, fitogeografía, nueva especie.

Introduction

The genus *Ceroxylon* Bonpl. is distributed all along the Andean montane forest, from Venezuela and Colombia to Ecuador, Peru and Bolivia, ranging from 800 to 3500 m in elevation. Following its description, the genus was monographed by Burret (1929), who recognized 16 species and mentioned other three names of dubious identity. In the last 30 years, five species have been described as new and many names have been reduced to synonymy, most of them corresponding to morphotypes of *C. vogelianum* and *C. parvifrons*, the two most widespread species of *Ceroxylon* (from Venezuela to Bolivia). The most recent attempt to clarify species identities within the genus was included in the Field Guide to the Palms of the Americas (Henderson et al., 1995), in which 11 species were recognized. This treatment was based on intensive field work in Colombia and Ecuador, but unfortunately not in the remaining Andean countries.

The Andes region in Peru is believed to harbor many unknown species; however, it is one of the most poorly collected areas in America (Gentry, 1993). This is true for many plant groups, including palms. In the case of *Ceroxylon*, the Peruvian Andes is an area that deserves special attention: in his monograph, Burret (1929) described seven new species, four of them from Peru, collected by the German botanist August Weberbauer between 1902 and 1915. Most of Burret's types were kept at the Berlin Herbarium and some of them were destroyed during the Second World War. For many species the only existing data are often imprecise descriptions. In consequence, the reconstruction of species identity in *Ceroxylon* has been an arduous task. In order to resolve doubts about taxonomic identity of these large and dioecious palms more field work needs to be done, especially in Peru.

Recent palm exploration in the Peruvian Andes has resulted in new, interesting information on the genus (Pintaud & Anthelme, 2008), and in the discovery of a new species of *Ceroxylon* that is here described. We also report the finding of another species, not previously recorded in Peru.

Ceroxylon peruvianum Galeano, Sanín & Mejía **sp. nov.**

(Figs. 1-3)

Type. PERU. Department of Amazonas. Province Bongará, District Jazán, Pedro Ruiz trail to Gocta Falls, 06°03'0.4" S 77°53'18.2" W, 1800 m, 14 Nov 2007, *B. Millán, J.C. Pintaud & L. Noblick 1488* (mat.fr.)(holotype: USM; isotypes: COL, AAU).

A ***Ceroxylon echinulatum*** *differt foliis pinnis irregulariter dispositis, et floribus masculis staminibus 12—15.*

Trunk 8—12 m tall, 20—26 cm diameter, silver to light grey with a thin layer of wax; leaf scars conspicuous, dark brown or gray. **Leaves** 13—21, forming a hemispheric crown; sheath 130—168 cm long, 5—7 cm wide at apex, with scarcely fibrous margins, covered with white tomentum; petiole 25—60 cm long, 3,5—8 cm wide, flat to convex, green and with scarce indumentum above, convex and densely covered with white to light brown tomentum below; rachis 240—362 cm long, the upper side flattened up to 165—218 cm from base, with a well-defined hastula, and concave, covered with thick, white tomentum below; pinnae 96—140 on each side, irregularly arranged in groups of 2—6, inserted in several planes, usually the proximal pinnae ascendant, the distal descendent, pinnae stiff until the middle of their length, then pendulous, apex slightly asymmetric, midrib prominent, adaxial surface glabrous, glossy, dark olive green, abaxial surface covered with white to yellowish scales, arranged in non-interlocking rows of persistent, elongate, thin, slightly membranous, mid-fixed, 0,5—1,0 mm long, 0,08 mm wide scales, consisting of a base and a short blade, and arranged in linear files, revealing the pinnae surface in between files in about the same width as the scales (with about 6 rows of scales per mm); lowermost filiform pinnae 7,0—41,5 x 0,2—1,0 cm, basal pinnae (10th pair, from base) 37—51 x 0,8—1,3 cm, middle pinnae 63—93 x 3,5—5 cm, apical pinnae 21—46 x

Figure 1. *Ceroxylon peruvianum* sp. nov. a. Habit (Pomacochas, Peru). b. Male Inflorescence (*B. Millán et al. 1498*). c. Infructescence (from *B. Millán et al. 1497*). d. Habitat (Pomacochas, Peru). e. Pinnae (abaxial side) (*B. Millán et al. 1499*). f. Fruit surface (*B. Millán et al. 1488*). Photos: a, d: by Filomeno Encarnación; b, e, f: by Gloria Galeano.

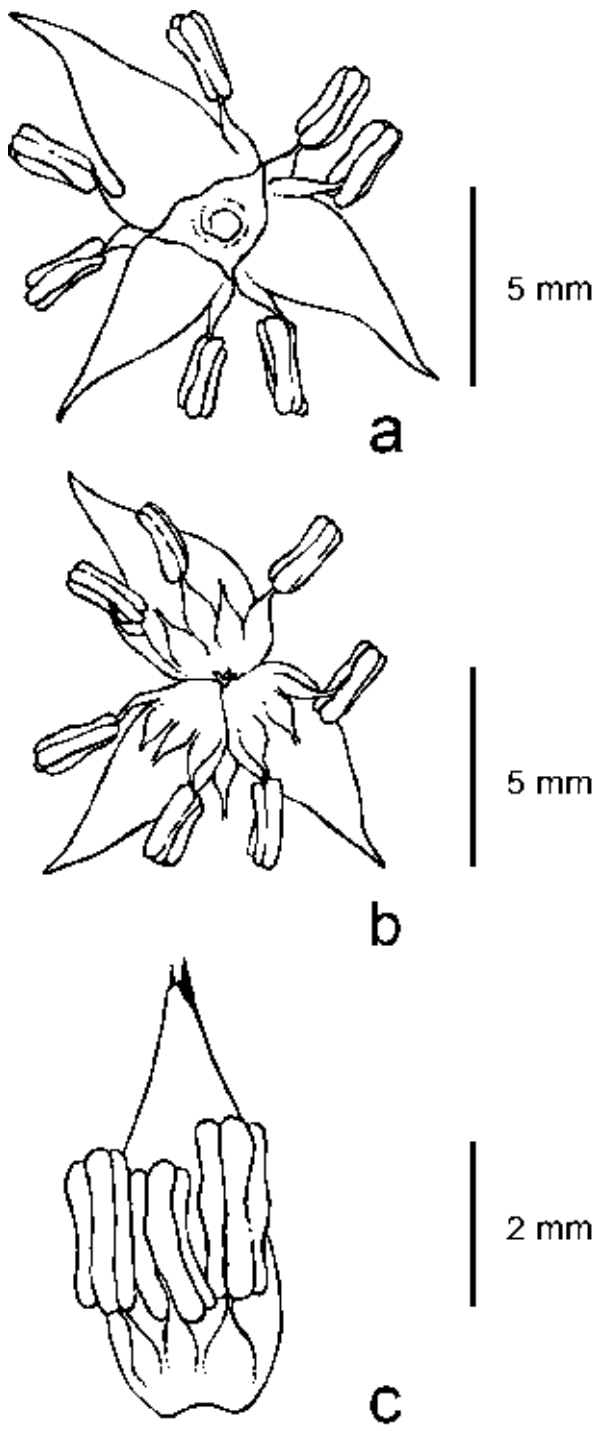

Figure 2. *Ceroxylon peruvianum*. sp. nov. Male Flowers (from *B. Millán et al. 1498*). **a.** Bottom view. **b.** Top view. **c.** Detail of a removed petal. Illustrations by Eduard Martínez.

0,7—3 cm, 2—9 most apical pinnae united along margins. **Inflorescences** 2—6 contemporaneous**:** female inflorescences 144 cm long in the fruiting stage, branched to 3rd order; peduncle 62—90 cm long, 5,7 cm wide at apex; prophyll 2-keeled, 31 cm long, inserted 7 cm above the base of the peduncle; the lower peduncular bracts 118-220 cm long, inserted at ca. 27 cm above the base of the peduncle; rachis 77—134 cm, with 61—78 primary branches, basal branches 21—79 cm long, middle branches 21-45 cm long, apical branches 2,5—4,3 cm long. Male inflorescences branched up to 3rd order; peduncle 48—67 cm long, 4 cm wide at base; peduncular bracts 149—169,5 cm long, 23—27 cm wide; rachis 81—102 cm long, with 72—99 branches, basal branches 18—36 cm, middle branches 24—42,5 cm long, apical branches 3—6,5 cm long, not branched. **Flowers** pedicellate, the pedicel 0,5 mm long, subtended by a small, triangular acuminate, 2 mm long bract. Pistillate flowers not seen. Staminate flowers light yellow when fresh**;** sepals 3, ovate, 1 mm long, connate for 1/2 their length, lobes reaching 1/2 to the total height of the corolla tube; petals 3, ovate-acuminate, 4—7 mm long, including a 1 mm long acumen, connate up to 1—1,5 mm (1/6—1/4 of their length); stamens 12—15, 1—3 opposite each sepal and 2—3 opposite each petal, filaments 1—1,5 mm long, anther 2—2,2 mm long, round at apex; **pollen** elliptical, monosulcate, tectate, 25,65 ± 1,01 µm diam, exine reticulate, exine thickness 0,52 ± 0,10 µm, with reticule aperture 0,75 ± 0,43 µm diam, reticule width 0,48 ± 0,06 µm; pistillode trimerous, minute**. Fruits** globose, 2—2,3 cm long, 2—2,2 cm wide, green turning red when ripe, mature exocarp densely covered with irregular and acute bulges; stigmatic residue small, lateral; seeds brown, globose, 1,5 cm diam. Fruit perianth with a persistent calyx about 1 mm long, reaching 1/2 the total height of the corolla tube; petals 4—5 mm long, connate for up to 2 mm (1/3—1/2 their length); staminodes 12—13, 1—2 opposite each sepal, and 2—3 opposite each petal. **Eophyll** bifid, the abaxial surface covered with white tomentum.

Distribution and natural history

Known only from the Eastern slopes of the northern Peruvian Andes, this species has a rather wide ecological range, with respect to both temperature, as indicated by its altitudinal distribution (1500 to 2300 m) and humidity, as the species is found from semi-deciduous forest to wet Andean forest (after Onern, 1976), as a canopy component. Known populations develop mostly on soils derived from limestone rocks. The original vegetation of Andean forests is characterized by small to medium-sized trees (15—20 m tall), with a semi-closed to closed canopy, from which the crowns of the wax palms stand out. The woody component of these forests includes species of the genera *Pourouma* and *Cecropia* (Cecropiaceae); *Nectandra*,

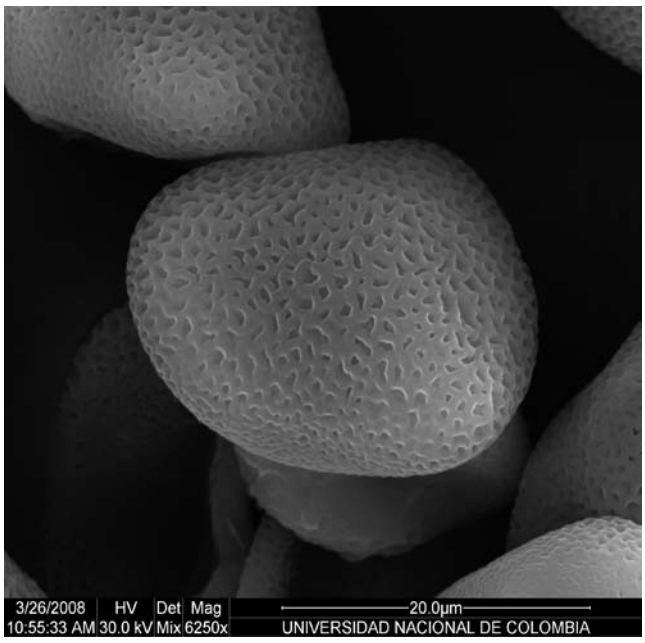

Figure 3. *Ceroxylon peruvianum*. sp. nov. Pollen, SEM image (from *B. Millán et al. 1498*).

Ocotea and *Persea* (Lauraceae); *Manilkara* (Sapotaceae); *Calyptranthes* (Myrtaceae); *Schefflera* (Araliaceae); *Ficus* and *Brosimun* (Moraceae); *Inga* (Leguminosae/Mimosoideae); *Protium* (Burseraceae); *Licania* (Chrysobalanaceae); and *Clusia* (Clusiaceae), as well as arborescent ferns of the genera *Alsophylla* and *Cyathea* (Cyatheaceae). These forests, specially those to the south of the Utcubamba River and on the sides of the roads between Pedro Ruiz Gallo, Pomacochas and the Abra Pardo Miguel, have been replaced by agricultural fields since the 70's, affecting palm populations. Hence, the area where *C. peruvianum* grows is currently heavily deforested with the palms remaining in the midst of farms. A few wild individuals were seen, and these were surrounded by forest on hardly accessible, steep slopes.

Little is known about the growth and development of this species, but the locals in the town of San Carlos reported that the palm attains chest-height in approximately 10 years.

Local names and uses

The Pona, as called by the locals, is considered a valuable ornamental plant, and it is cultivated in the town of San Carlos, being fairly common along dirt roads, the principal tracks leading to small villages and bordering the houses and chacras. Additionally, the species is often cultivated as a timber tree in coffee agroforestry systems, and the trunk is used for posts, supporting houses or huts, and to make fences; the leaves are eventually used for thatching farmyards; the fruits are fed to pigs.

The fact that this species is being cultivated is particularly interesting; the inclusion of *Ceroxylon* in agroforestry systems has been documented by Pintaud & Anthelme (2008) for *C. echinulatum* in northern Peru, and it was known also for *C. sasaimae* in Colombia (Galeano & Bernal, 2005). It is possible that the inclusion of *C. peruvianum* in agroforestry systems could constitute a real conservation opportunity despite the threat of extinction among the natural populations, a case similar to *C. echinulatum* (Pintaud & Anthelme, 2008).

Etymology

The species is named for Peru, where it was discovered.

Additional specimens examined: **PERU,** Department Amazonas, Province Bongará, District San Carlos, cultivated in the town of San Carlos, 05°57'51.1" S, 77°56'50.4" W, 1830 m, 15 Nov 2007, *B. Millán, G. Galeano, M.J. Sanín, J.C. Pintaud, F. Borchsenius, L. Noblick, P. Trénel & J. Roncal 1497* (mat. fr.) (USM); cultivated in the town of San Carlos 05°57'57.8" S 77°56'37.2" W, 1880 m, 15 Nov 2007, *B. Millán, G. Galeano, M.J. Sanín, J.C. Pintaud, F. Borchsenius, L. Noblick, P. Trénel & J. Roncal 1498* (st. fl.) (AAU, COL, NY, P, USM); same locality, 15 Nov 2007, *B. Millán, G. Galeano, M.J. Sanín, J.C. Pintaud, F. Borchsenius, L. Noblick, P. Trénel & J. Roncal 1499* (inm.fr.) (AAU, COL, NY, P, USM). Province Bongará, District Jazán, cultivated near way to San Pablo, Pedro Ruiz road Chachapoyas, 06°03'31.8" S, 77°55'38.28" W, 1569 m, 16 Mar 2006, *B. Millán & J.C. Pintaud 1354* (inm. fr.)(USM); same locality, 16 Mar 2006, *B. Millán & J.C. Pintaud 1356* (seedling)(USM). Province Bongará, road from Pedro Ruiz to Moyobamba, km 12, Oct 1990, *F. Kahn and F. Moussa 2704* (inm.fr.) (USM). Province Bongará, Road Pedro Ruiz to Moyobamba, km 340-350, Buenos Aires, 5° 45'S 77° 47'W, 2300 m, 30 Aug 1983, *D. Smith & S. Vásquez 4854* (mat.fr.) (MO, USM).

Comments

Ceroxylon peruvianum is very distinctive in its irregularly arranged pinnae, combined with staminate flowers bearing 12-15 stamens and the fruit exocarp densely covered with acute bulges. The latter character was so far only known from *C. echinulatum*, which has a similar altitudinal range (1500—2300 m) but this palm has regularly arranged pinnae set in one plane and staminate flowers with 9—12 stamens. Other differences between these two especies are listed in table 1. Except for the pinnae insertion character (in groups vs. regular), none of the remainder characteristics contrasted in table 2, are by themselves, strong enough for the delimitation of a *Ceroxylon* species; however, the combination of them makes the new species unmistakable.

Ceroxylon echinulatum has been recently found in northern Peru (Pintaud & Anthelme, 2008), at less than 100 km North from the area where *C. peruvianum* is known to grow. It would be very interesting to explore neighboring areas to see if the distributional ranges of these species come closer or perhaps even overlap.

Ceroxylon quindiuense (Karst.)H. Wendl.

C. quindiuense is characterized by its stout and tall stems, covered by a thick layer of white wax, hemispherical crowns of horizontal leaves with straight rachis and regularly arranged, pendulous pinnae that are covered with a thick indumentum beneath, and smooth fruits. This species was previously known only from Colombia, where it grows all along the Andes, between 2000 and 3000 m, in montane forests, usually forming characteristic, large populations of thousands of individuals (Fig. 4c). Nevertheless, recent field work in Northern Peru has revealed new records of palms that, besides growing in the same

Table 1. Distinctive morphological characters between *Ceroxylon peruvianum* sp. nov. and *Ceroxylon echinulatum*.

	Ceroxylon peruvianum	*Ceroxylon echinulatum*
Trunk height (m)	9—12	12—20
Length of petiole (cm)	25—60	70—75
Pinnae insertion	In groups	Regular
Pinnae orientation	In several planes	In one plane and notoriously pendulous
Length of middle pinnae (cm)	63—76	72—106
Length of peduncle of the infructescence (cm)	62—90	114—166
Petals of staminate flowers (mm)	Ovate-lanceolate, 4-7	Triangular-alesnate, 6,5—8
Number of stamens	12—15	9—12

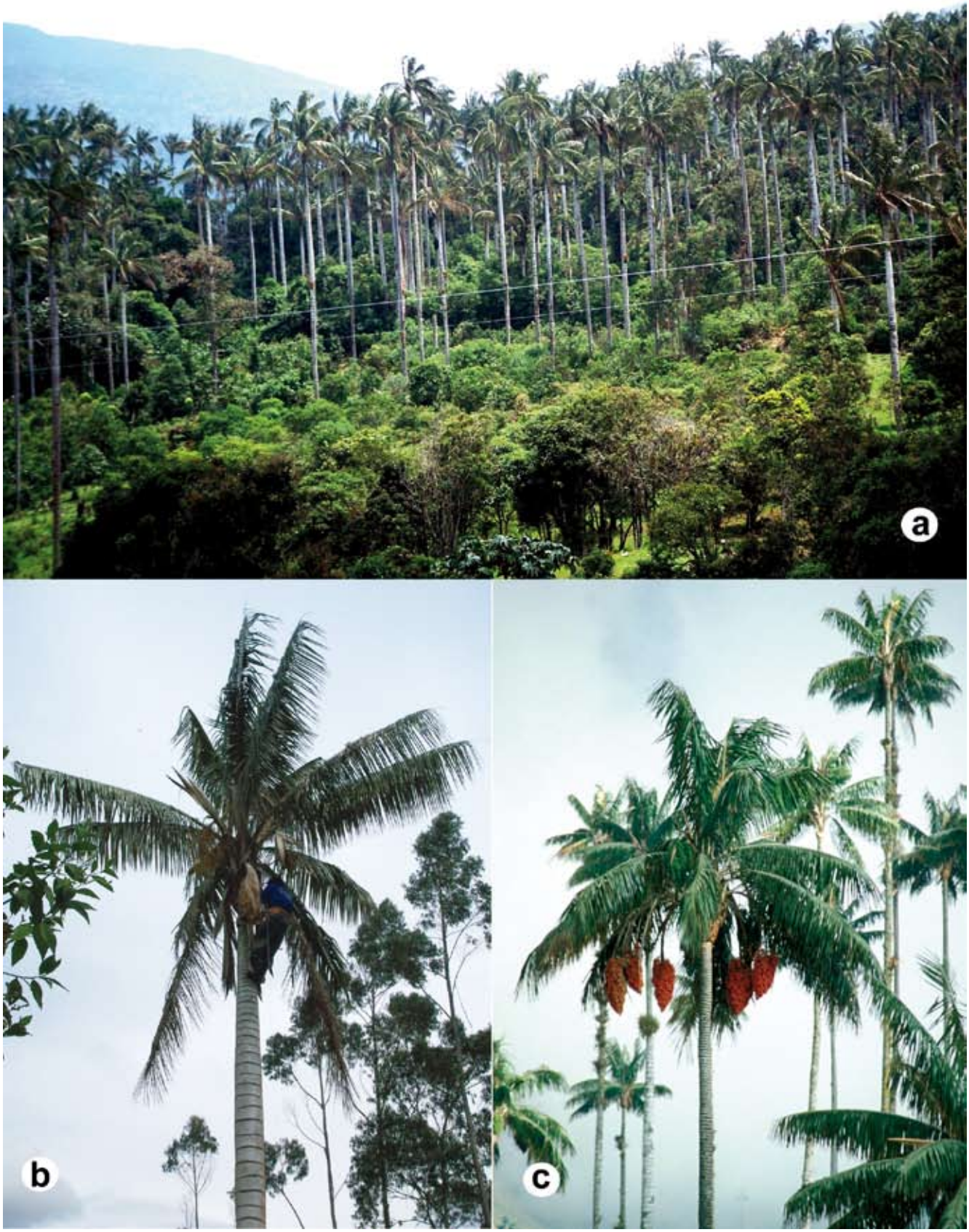

Figure 4. *Ceroxylon quindiuense*. a. Population in Ocol, Peru. Photo by K. Mejía. b. Habit. Ocol, Peru. Photo by K. Mejía. c. Habit. Quindío, Colombia. Photo by R. Bernal.

Table 2. Differences between *Ceroxylon quindiuense* from Colombia and Peru.

Character		Peruvian material	Colombian material
Floral parts (fig.5)	**Number of sepals**	(3-)4	3
	Number of petals	(3-)4—5	3
	Pistillode	trifid-tetrafid	Trifid
	Stamens	12—17	9—11
Petal shape (staminate fl.)		ovate-long acuminate	ovate-acuminate
Petal acumen length (mm) (staminate fl.)		3—3,5	1—1,5
Filament length (mm)		4,5	2,5—3,5
Pollen diameter (µm)		22,46; sd 1,38	28,32; sd 3,17

habitat type, form dense populations, and perfectly match the vegetative and reproductive macro-morphological characters of *C. quindiuense* (Fig. 4a—b). These similarities have led us to consider that these newly found Peruvian individuals can indeed be circumscribed under *C. quindiuense*, despite the distributional gap.

The few differences found between the Colombian and the Peruvian palms are listed in Table 2.

Combinations such as 3 sepals-5 petals-trifid pistillode, or 4 sepals-4 petals-tetrafid pistillode, were common in the single Peruvian staminate individual observed (Fig. 5). While variation in the number of floral parts has been experimentally induced in diverse angiosperm taxa of ornamental plants, this phenomenon has also been reported in wild population. Such variations can occur, for example, between populations, which is the case of *Sanguinaria canadensis* (Spencer, 1994), or along different parts of the inflorescence, which is the case for *Drimys winteri* (Winteraceae)(Doust, 2001). The latter type of variation could also occur in *Ceroxylon*, but it has not been observed in detail, especially as the *Ceroxylon* inflorescence can reach considerable size and weight, reason for which just small portions are collected in the field and kept in herbarium specimens. As for other palm genera, this particularity has not been discussed in detail. However, in *Wettinia*, flowers of some species, can have 3(-4) sepals and/or 3(-4) sepals (Uhl & Dransfield,1987).

Another aspect of floral morphology that needs more attention is the variation in the number of stamens and staminodes, which has been usually thought of as determinant for some species in the genus (ex. *C. alpinum*, *C. parvum*, *C. vogelianum*). Nevertheless, it is known, for example, that in *Allagoptera*, the number of stamens varies among the species, but, interestingly, *A. leucocalix* has 9-15 stamens, with 14-15 stamens in the proximal flowers of the inflorescence, and 9-10 in the distal ones (Moraes, 1996).

The difference in number of stamens found in the Peruvian material could be attributed to the high proportion of tetramerous and pentamerous staminate flowers found, but at least one individual with 3 petals and 15 stamens was observed, indicating that more stamens can occur in spite of an otherwise normal floral morphology.

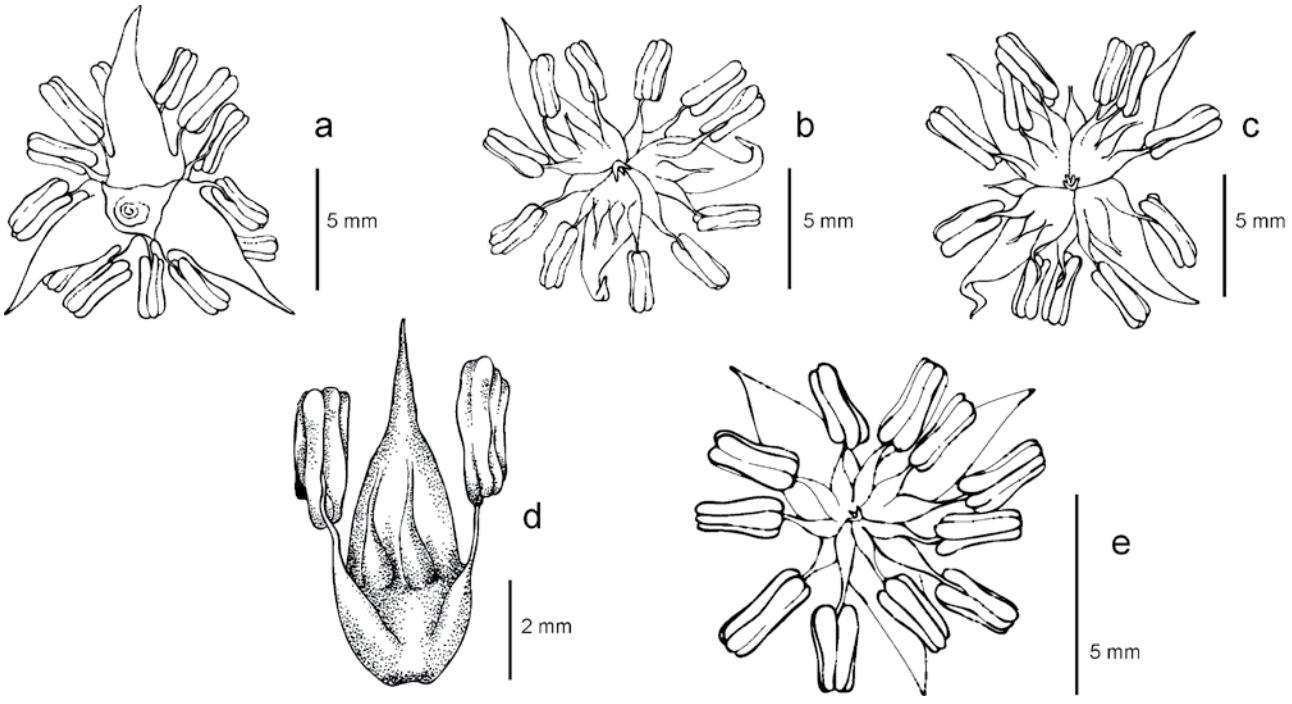

Figure 5. *Ceroxylon quindiuense*. Staminate flowers. a-d. Peruvian material (from K. Mejía et al. *4301*). a. Bottom view, trimerous flower. b. Top view, trimerous flower. c. Top view, tetramerous flower. d. Detail of a removed petal. e. Top view, Colombian material (from *Cuatrecasas 20964*). Illustrations by Eduard Martínez.

On the other hand, the long acumens of the petals and the greater length of the filaments in the staminate flowers of the Peruvian individual studied constitute a difference from the known specimens of *C. quindiuense* from Colombia. In the polyandrous Iriarteinae with stamen numbers that range from 17 to 145, Henderson (1990) observed that, in some species, the proximal flowers on a rachilla are larger and have more stamens than the apical flowers on the same rachilla. This is an example of how quantitative characters are only trustworthy when sampling has been exhaustive and discreteness in an otherwise continuous numerical scale can be affirmed. The range for many quantitative characters has been proven to be quite large, and one individual displaying an outlying score cannot be considered to accurately cover the variability within a population, and thus doom it to exclusion from a species' taxonomic domain.

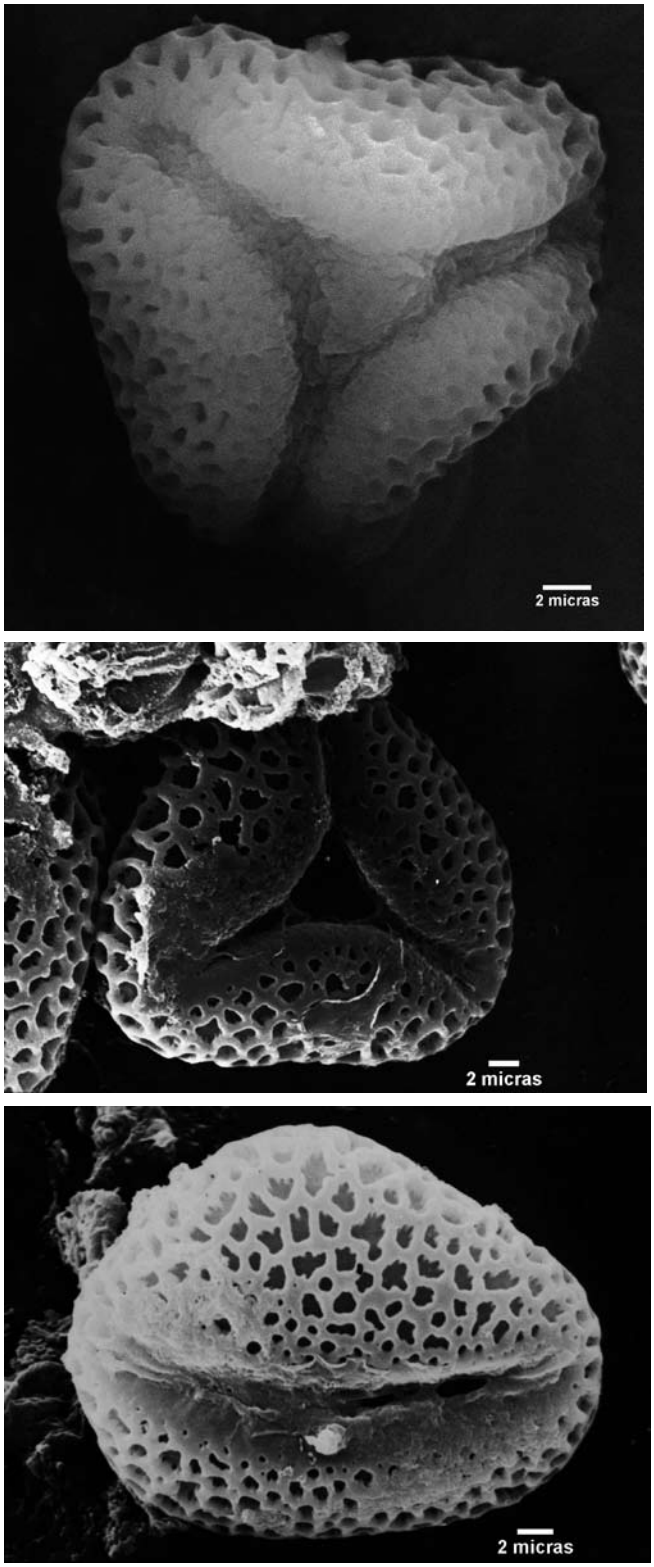

Figure 6. *Ceroxylon quindiuense*. Pollen. a. Pollen from Peruvian material showing trichotomosulcate aperture (from K. Mejía et al. 4301). b. Pollen from Colombian material showing trichotomosulcate aperture (from Karsten s.n.). c. Pollen from Colombian material showing monosulcate aperture (from Karsten s.n.).

Likewise, the differences in pollen measurements can not be evaluated as weighty evidence, since, for example, pollen grain diameter in *C. amazonicum* Galeano ranges from 19,6 to 27,6 µm in different individuals.

Consequently, it is here remarked that without substantial sampling and knowledge of more Peruvian individuals, it is hard to decide whether these differences constitute character states or traits. We emphasize that studies of all kinds are however still needed, including morphological, and molecular ones, in order to prove whether this material deserves the status of species.

On the other hand, when comparing material from both countries, we found an additional shared character, interestingly found nowhere else within the genus, which is the pollen form and aperture. The pollen of *Ceroxylon* has been said to be monosulcate and elliptical. The pollen sample of *C. quindiuense* from Colombia can have both monosulcate or trichotomosulcate aperture and globose to elliptical or triangular ambit (Fig. 6). The sample from Peru has only trichotomosulcate, triangular pollen (Fig. 6a), but still, these are two morphologies nowhere else seen in the genus. Trichotomosulcate apertures have been considered as typically derived from the monosulcate condition (Walker & Doyle, 1975), the latter of which is considered ancestral among the monocots (Penet et al., 2004), and pollen shape or ambit can be considered to be closely related with the type of aperture. Some authors (Penet et al., 2004; Harley, 2004) consider that trichotomosulcate pollen is related to regular tetrahedral tetrads in the developmental pathway, and that developmental options eventually select against one of the morphologies. Additionally, trichotomosulcate pollen is only known in the subfamily Ceroxyloideae from *Pseudophoenix sargentii* subsp. *saonae*, where it has been observed as a mixed condition, involving pollen with both one and three apertures (Machado, 2003). The same scenario could be considered for *C. quindiuense*: a pollen dimorphism in which both the derived and ancestral states are simultaneously present in one species, probably due to active differentiation processes.

The relevance of this character for the delimitation of species in *Ceroxylon* is a topic that deserves more attention, as it could be a valuable source of morphological information. Thus, the data available, as well as the micro-morphological character provided, constitute the reasons for which, until more morphological and molecular observations and studies can be gathered, we consider it is most reasonable to include these Peruvian records under *C. quindiuense*.

We also note with interest that the distribution range of *C. ventricosum*, morphologically the most similar species to *C. quindiuense,* matches closely the distributional gap of about 800 km in Ecuador and southern Colombia, where *C. quindiuense* has not been recorded yet. Moreover, Trénel (2007) proposed, in his phylogeny of *Ceroxylon* based on molecular

data, that *C. ventricosum* and *C. quindiuense* form a species complex, given that *C. ventricosum* was recovered as a paraphyletic assemblage, with the two analyzed accessions of *C. quindiuense* nested inside *C. ventricosum*.

These new insights into the distribution range of *C. quindiuense* impinge on other significant topics. *C. quindiuense* is known to have been a very abundant species in Colombia until the beginning of the last century, and even if some numerous populations persist in the Central Cordillera, it has been classified as ENDANGERED according to the IUCN categories (Galeano & Bernal, 2005). Most of the forests where this species grows have been turned into pastures devoted to massive livestock production, and while the adult palms are sometimes left standing, the young seedlings do not grow. Additionally, it was only until a few years ago that the leaves of this species were used for Palm Sunday celebrations during Holy Week, causing in some cases, the death of many individuals, and in other cases, a delay in normal growth and development rates. What is worse, in the last decade a new and unknown disease has been causing the death of many adult palms. In this panorama, the new records for *C. quindiuense* are very encouraging. However, the conservation situation in Peru does not differ substantially from the Colombian one. In the province of Chachapoyas, few individuals were seen surrounded by forest and were standing on very steep slopes, suggesting that all those which had grown on more even landscapes had been cut down. This palm has been seen in numerous and dense populations in Ocol, the District of Molinopampa, but, as locals report, it is being widely harvested as wood for housing and posts, and the trunk ripped for covering indoor walls.

Ecological research of all scopes is seriously needed, including phenological, pollination, and demographic studies. As these new records also raise many issues in taxonomic, distributional, geographical, and evolutionary domains, genetic population structuring of these accessions is strongly advocated.

Specimens examined: Peru, Department Amazonas, Province Chachapoyas, District Leimebamba, dirt road to the Archeological Museum, 06°45'14.7" S 77°48'3.7" W, 2523 m, 13 Nov 2007, *B. Millán, G. Galeano, M.J. Sanín, J.C. Pintaud, F. Borchsenius, L. Noblick, P. Trénel & J. Roncal 1487* (inm. fr.) (AAU, COL, P, USM). Department Amazonas, Province Chachapoyas,District Molinopampa,locality Ocol, 06°15'48" S 77° 34'41" W, 2373 m, 20 Sep, 2007, *K. Mejía* et al. *4301* (st. fl.) (USM). Department Amazonas, Province Chachapoyas, District Molinopampa, locality Puma Armana near Ocol, 06°15'27.72" S 77°34'24.54" W, 2360 m, 16 Mar 2006, *B. Millán & J.C. Pintaud 1352* (inm.fr.)(USM).

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