

Richness and uses in a diverse palm site in Bolivia

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The study site is located in the southern part of the Iturralde Province, Department of La Paz, in western Bolivia. This area is generally characterized by mixed vegetation types from the tropical mountain forests as well as lowland forests and savannas. It lies in an altitudinal range of 400–1850 m, with an average temperature of 24–28°C and a rainfall of 2000–5000 mm per year. The richness in palms of this region is the highest reported for Bolivia; it comprises 19 genera, 70% of all genera known in Bolivia and 29 palm species (34%). Three main phytogeographic elements are mixed and integrated in the area; palms from the Andean, Amazonian, and Central Brazilian (Cerrado) units are found in approximately 4.5 ha. Nearly 66% of these palm species are concentrated in the mountain forests between 500–1800 m, reaching the highest altitudinal limit in this area, of which the most common species is *Iriartea deltoidea*. Approximately 55% of the palm species are used by local people – the original ethnic group, the Tacanas, and settlers – in order to get materials for construction, different qualities of thatching, fruit for food and beverages, fibres for artesanal products, medicines and handicrafts.

Keywords: Bolivia; palm; diversity; uses

El área de estudio está localizada en la región sur de la Provincia Iturralde, del Departamento de La Paz, al oeste de Bolivia. Está caracterizada por una mezcla de tipos de vegetación, que incluye desde bosques montanos tropicales hasta bosques de tierras bajas y sabanas. Se encuentra en un rango altitudinal de 400–1850 m, con un promedio de temperatura de 24–28°C y una precipitación de 2000–5000 mm por año. La riqueza de palmas en esta región es la más alta reportada para Bolivia: 19 géneros, que significan el 70% del total de géneros de palmas registrado para Bolivia y 29 especies de palmas (34%). Tres elementos fitogeográficos están mezclados e integrados en el área: en ca. 4.5 ha se encuentran palmas de los Andes, de la Amazonia y del Centro brasileño (cerrado). Aproximadamente el 66% de las especies de palmas está concentrado en los bosques montanos entre 500–1800 m, que alcanzan su mayor límite altitudinal en el área y donde la especie más común es *Iriartea deltoidea*. Cerca al 55% de las especies de palmas es utilizado por la gente local—como el grupo originario Tacanas y colonos – para la obtención de material de construcción, diferentes calidades de techos, frutos para alimento y bebidas, fibras para productos artesanales, medicinas y artesanías.

Introduction

Biological studies carried out in the southern part of the Iturralde Province, Bolivia, indicate a high floristic diversity, from 275 to 988 plant species per 0.1 hectare in the different types of forests and savannas (Gentry and Foster, cit. in Parker and Bailey, 1991).

The fauna is also rich with 51 species of mammals and 403 species of birds (Parker and Bailey, 1991). Many factors such as climatic, geological and edaphic conditions account for the high ecological diversity and the richness in species due to its location in Amazonian and Andean regions with transitional sites consisting of virtually intact ecosystems.

Although the local original ethnic group, the Tacana, has a long traditional and historical relationship with the environment and the use of natural resources, today several symptoms of transcultural changes have become visible. Recently many colonists are also settling in towns and ranches. During the dry season, local agriculturists depend on trading their agricultural and cattle products along the roads between Ixiamas and San Buenaventura, to supply markets in the city of La Paz.

Timber exploitation reached peak activity during the 1980s in the south of the Iturrealde Province and an organized camp was built in the Alto Madidi, which was abandoned in 1990. In other regions of the Department of La Paz, timber extraction has increased.

Palms are associated with many different vegetation types in Bolivia, but in terms of species diversity they are mostly represented in the altitudinal range of 140 to 1200 m (Moraes, 1989). Balslev and Moraes (1989) reported 29 Bolivian palm genera, and this number has been increased to 31 due to new records gathered in the Iturrealde Province (Moraes, 1990). According to recent systematic generic rearrangements, the palm flora of Bolivia currently consists of 27 genera and approximately 85 species.

This contribution is part of the first phase of the project, 'Diversity and Uses of Bolivian Palms', carried out by the National Herbarium of Bolivia in order to investigate the national palm flora and its uses.

Materials and methods

Study Area

The study site is located in the southern part of the Iturrealde Province (Fig. 1) and covers less than 45 000 km². It lies in an altitudinal range between 250 and 1650 m, and extends from 13°30'S to 14°40'S and from 67°30'W to 68°40'W. Geographically it includes the last Andean ridges, hills and valleys of the *Cordillera Oriental* with a marked NW-SE orientation, the piedmont, and a wide alluvial plain to the northeast covered with recent sediments. The precipitation is estimated to be 2000 mm per year and the average annual temperature is 26°C. The dry season spans from May to August, and the rainy season from November to April. Both seasons have the influence of cold southern winds.

The boundary of the Iturrealde Province (Department of La Paz, western Bolivia) is formed by many rivers, such as the Beni river to the east, the Heath and Madre de Dios rivers to the west and north, and the Tuichi and Yariapo rivers on the south-eastern side.

The vegetation is generally characterized by moist montane forest with patches of dry and cloud forest, distributed as riparian forests, forests on slopes and ridges, as well as a range of evergreen premontane forest, and with humid savannas in the lowlands. Both Amazonian and Andean elements are typified by different palm genera which have distinctive distributions in this area.

The habitat heterogeneity, the presence of both Amazonian and Andean forests, relatively high precipitation, and nearly complete absence of long-term human influence supports the recommendation to declare the south of the Iturrealde Province as a conservation unit (Parker and Bailey, 1991). During the last two years the Bolivian National Park Service proposed it as a national park with ca 1 800 000 ha.

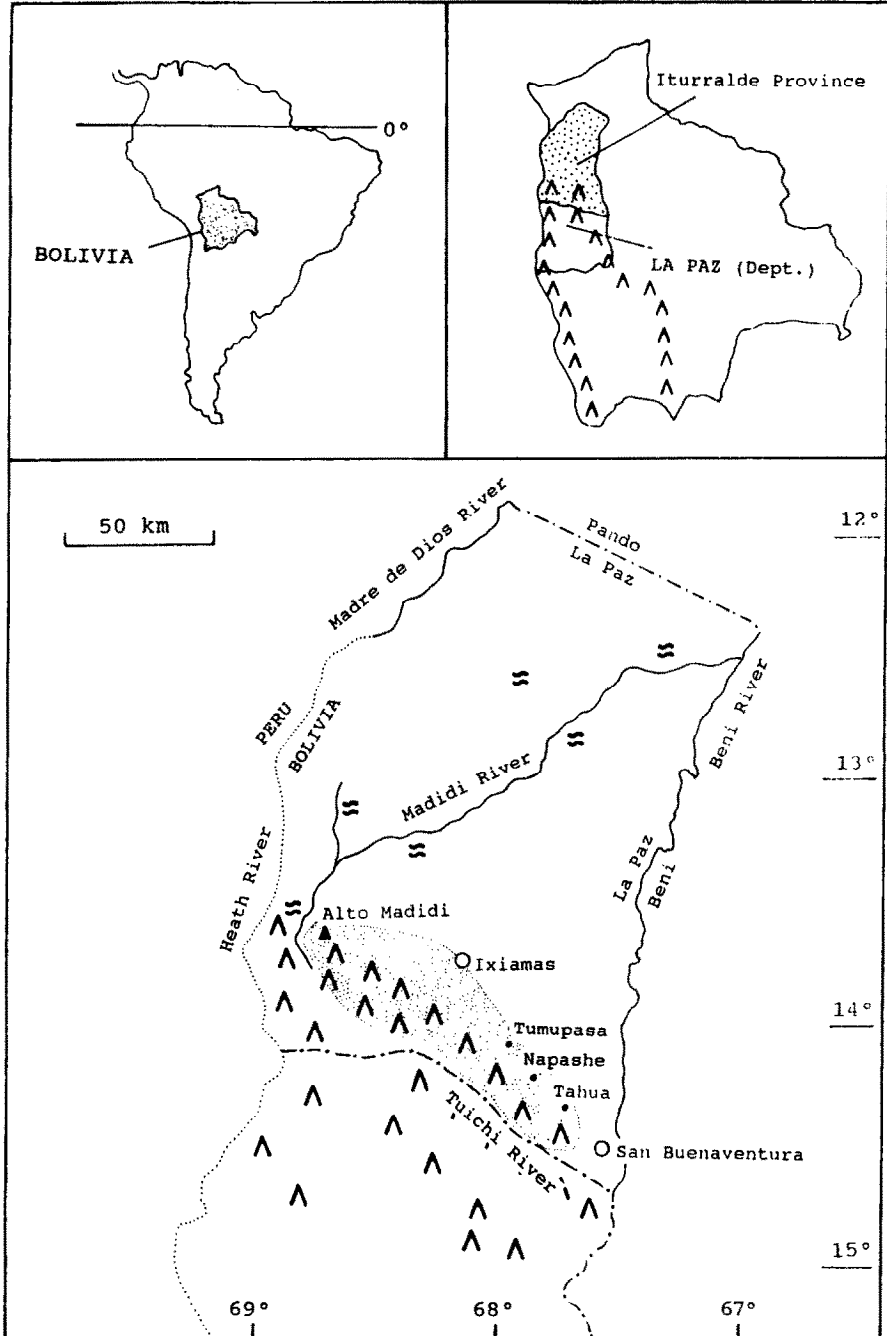


Figure 1. Study site area indicated by black dots (Iturralde Province, Department of La Paz, NW Bolivia), ○ = Towns; ● = Tacana settlements; ▲ = abandoned timber exploitation camp; ▲▲▲▲ = mountain relief; ≈ = seasonally flooded lowlands; = national boundary; -.-.- = departmental and provincial boundary.

Table 1. Palm diversity and distribution

Species	Height class	Vegetation type			Altitude range	
		Mountain forest		Savanna		
		Dry	Humid			
<i>Acrocomia aculeata</i> (Jacq.) Lodd. ex Mart.	4–8 m	–	–	+	–	200–450 m
<i>Aiphanes aculeata</i> Willd.	3–6 m	+	–	–	–	750–1800 m
<i>Allagoptera leucocalyx</i> (Dr.) Ktze.	2–4 m	–	–	+	–	200–400 m
<i>Astrocaryum murumuru</i> Mart.	5–12 m	–	–	–	+	200–800 m
<i>Attalea butyracea</i> (Mutis ex L.f.) Wess. Boer	6–18 m	–	–	–	+	250–500 m
<i>Attalea phalerata</i> Mart. ex Spreng.	5–25 m	+	+	+	+	250–1000 m
<i>Bactris concinna</i> var. <i>sigmoidea</i> Mart. ^a	2–3 m	–	+	–	+	200–500 m
<i>Bactris gasipaes</i> Kunth ^c	6–10 m	–	+	–	+	250–700 m
<i>Bactris major</i> Jacq.	2–3 m	–	+	–	–	400–700 m
<i>Chamaedorea angustisecta</i> Burret	2–6 m	–	+	–	–	250–1500 m
<i>Chamaedorea linearis</i> ^a (Ruiz and Pav.) Mart.	1–3 m	–	+	–	–	400–700 m
<i>Chamaedorea pinnatifrons</i> (Jacq.) Oerst.	0–1 m	–	+	–	–	600–1600 m
<i>Desmoncus mitis</i> Mart.	2–5 m	+	+	–	–	400–900 m
<i>Desmoncus polyacanthos</i> Mart.	2–5 m	+	+	+	–	250–600 m
<i>Dictyocaryum lamarckianum</i> (Mart.) H. Wendl.	8–25 m	–	–	–	–	1500–1650 m
<i>Euterpe precatoria</i> Mart.	10–25 m	–	+	–	–	250–1700 m
<i>Geonoma brevispatha</i> Barb. Rodr.	1–4 m	–	+	–	–	250–400 m
<i>Geonoma brongniartii</i> Mart.	1–3 m	–	+	–	–	250–450 m
<i>Geonoma deversa</i> (Poit.) Kunth	1–4 m	–	+	–	–	250–450 m
<i>Hyospathe elegans</i> Mart.	2–5 m	–	+	–	–	400–1000 m
<i>Iriartea deltoidea</i> Ruiz and Pav.	3–25 m	–	+	–	–	250–1500 m
<i>Mauritia flexuosa</i> L.f. ^d	12–30 m	–	+	–	–	250–500 m
<i>Oenocarpus bataua</i> Mart.	3–12 m	–	+	–	–	250–400 m
<i>Oenocarpus mapora</i> H. Karst.	6–15 m	–	+	–	–	250–1000 m
<i>Phytelephas macrocarpa</i> Ruiz and Pav.	3–8 m	–	+	–	–	250–800 m
<i>Socratea exorrhiza</i> (Mart.) H. Wendl.	12–25 m	–	+	–	–	250–700 m
<i>Socratea salazarii</i> ^a H.E. Moore	5–10 m	–	+	–	–	300–600 m
<i>Wendlandiella gracilis</i> Dammer ^b	0–1 m	–	+	–	–	250–600 m
<i>Wettinia augusta</i> ^b Poepp. and Endl.	4–8 m	–	+	–	–	800–100 m

New records for Bolivia: ^aPalm species; ^bPalm genera; ^cCultivated in domestic sites; ^dWith azonal distribution, associated to black water.

Data collection

Fieldwork data were compiled using traditional botanical collection of herbarium specimens (pressing, conserving in 60–70% alcohol, drying) and through gathering of ethnobotanical data. Due to access difficulties and logistical support, fieldwork was carried out during the dry season for three years in the surrounding towns of Ixiamas and Alto Madidi, in the Tacana's settlements of Tumupasa, Napashe and Tahua. Although the flowering phase of palms is generally concentrated in the wet season, several records were

based on observations of non-flowering individuals of known species without making botanical collections. In cases of unknown taxa, and under the same phenological conditions, collections of (non-flowering) sterile specimens were made.

A database which includes a total of 40 palm collections and 60 records represents the main reference for this report. The information gathered in Parker and Bailey (1991) and other botanical collections with recent identifications is also considered. Identifications for sterile and unknown species were made possible by comparison with specimens at the National Herbarium of Bolivia.

In order to obtain information related to the density of palms, five plots in different types of forests, each of 1 ha (100 × 100 m), were floristically and ecologically surveyed by counting and measuring vegetative categories such as adults, juveniles and seedlings. All axes of multistemmed palm species were counted.

Results

Diversity of palms

Of the 85 palm species and genera estimated to occur in Bolivia, 29 species and 19 genera are represented in the south of the Iturrealde Province, equivalent to 34 and 70% respectively.

The area has a mixture of phytogeographical elements which belong to three main units: Andean (*Aiphanes*, *Euterpe*, *Dictyocaryum*, *Wettinia*), Amazonian (*Astrocaryum*, *Bactris*, *Mauritia*, *Oenocarpus*, *Phytelephas*), and Central Brazilian or Cerrado (*Allagoptera*).

Most of the palm species are found in humid mountain forest in an altitudinal range between 600–1000 m, while only eight palm species are distributed in savannas and gallery forests of the lowland alluvial area down to 250 m (Table 1). Azonal distribution in both middle and low altitudes is typical for *Mauritia flexuosa* forests.

The understory (under 3 m) of montane and premontane forests is represented by several species of *Bactris*, *Geonoma*, *Chamaedorea*, and species such as *Hyospathe elegans*, as well as *Wendlandiella gracilis*. Many palm trees occupy the medium to high strata (4–20 m) into the mountain forest like *Iriartea deltoidea*, *Euterpe precatória*, *Astrocaryum murumuru*, *Oenocarpus mapora*, and *O. butaua*. The genus *Desmoncus* has a climbing habit in open and secondary forests. Multistemmed palms occur in some species like *Oenocarpus mapora*, and different species of *Geonoma* and *Bactris*. The stilt-root palm species consist of *Socratea exorrhiza*, *S. salazarii*, *Iriartea deltoidea*, *Dictyocaryum lamarckianum*, and *Wettinia augusta*. Open moist forests and dry forests are characteristic for *Aiphanes aculeata*, *Attalea phalerata*, and for the genus *Desmoncus*. *Allagoptera leucocalyx* and *Acrocomia aculeata* are exclusively part of savanna vegetation, while *Attalea butyracea* and species of *Bactris* are found mostly in riparian forests and on river banks. Finally, *Dictyocaryum lamarckianum* shows the highest altitudinal range of distribution up to 1650 m, and sometimes grows together with *Euterpe precatória* and *Iriartea deltoidea*.

Two new generic records have been added to the Bolivian palm flora: *Wettinia*, which now has its extreme southern distribution in the study area, and *Wendlandiella*, which was previously only found in the Peruvian Amazon. At the specific level, four species are new records for Bolivia: the palm species *Socratea salazarii* was reported to be mostly distributed in Peru and Brazil, with *Attalea butyracea* being found in alluvial lowlands. The

two remaining species, *Chamaedorea linearis* and *Bactris concinna* are representative of mixed Andean and Amazonian transitional sites.

In the study site, the palm diversity varies from 8 to 11 species and 6 to 10 genera per 1 ha plot (Table 2). The palm density average is 918 per ha, remarkably dominated by a medium size palm, *Iriartea deltoidea*, which ranges between 19.3 to 81.3%. In plot 5, this species is represented by 71.8% (seedlings), 20.4% (juveniles) and 7.8% (adults). Although this inventory shows a seedling-adult relationship of 9:1, this palm species has a wide distribution and is frequently common in different kinds of mountain and piedmont humid forests.

Other species which are poorly represented are *Attalea phalerata*, *Astrocaryum murumuru*, and *Socratea exorrhiza*.

Uses

As Table 3 shows, 16 palm species are considered useful by the local people. This represents 41% of the total number of species occurring in this study area. Multiple products are obtained from *Attalea phalerata* ('motacú'), *Euterpe precatoria* ('asaí'), and *Bactris gasipaes* ('chima' or 'chonta fina'). This last species is being domesticated in cultivated areas close to local settlements, as found in other regions of the Neotropical lowlands.

Selected sources for construction of building walls are derived from stems of *Iriartea deltoidea* ('copa'), *Astrocaryum murumuru* ('chonta') and *Socratea exorrhiza* ('pachiuba'). Thatching materials ('surubí' in the Tacana language) come from leaves of *Geonoma deversa* ('jatata'), *G. brongniartii* ('jatata macho'), *Euterpe precatoria*, *Oenocarpus mapora* ('majillo'), and *Attalea phalerata*.

The lifespan of thatch material differs greatly, depending on the palm species. For example, roof made of leaves of *Geonoma deversa* lasts up to 25 years, while *Euterpe precatoria* thatch may last between 12 to 15 years, *Oenocarpus mapora* up to 10 years and *Attalea phalerata* between 2 to 6 years.

The Tacana emphasized that *Geonoma deversa* stands are now found further and further away from their settlement sites, probably due to the high regional extractive pressure of this palm species. This species is highly valued all over the Bolivian lowlands and many local groups are exploiting it for thatching.

Edible fruits like those of *Bactris gasipaes*, *Attalea phalerata*, and *Allagoptera leucocalyx* ('motacú-chí') are part of the local subsistence diet. Nevertheless, they have a high economic potential for production and regional trade. Other palm species have a regional importance as forage for wild and domestic animals such as *Acrocomia aculeata* ('totai'), *Bactris* spp., and *Astrocaryum murumuru*. Oils are also being extracted from boiled fruits such as *Oenocarpus bataua* ('majo'), *O. mapora* and *Attalea phalerata*.

Fibres are generally obtained from the leaf rachis of *Attalea phalerata* and *Euterpe precatoria* and are utilized for the production of baskets ('ditiducu' in the Tacana language) and carpets.

Other uses not recorded in Table 3 include ceremonial rituals as observed with *Phytelephas macrocarpa* ('marfil') and use of the adventitious roots of *Attalea phalerata* which possess medicinal curative properties when prepared as a vermifuge. The oil of motacú (*Attalea phalerata*) is applied for muscular and pulmonary sickness, and the leaves of *Euterpe precatoria* are used for respiratory relief.

Some palm species, such as *Mauritia flexuosa* ('palma real') and *Phytelephas*

Table 2. Palm diversity (%) in 1 hectare plots

Palm species	Plots				
	1	2	3	4	5
<i>Astrocaryum murumuru</i> Mart.	6.4	8.5	34	0.5	8.3
<i>Attalea phalerata</i> Mart. ex Spreng.	–	3.9	0.2	–	0.9
<i>Bactris concinna</i> var. <i>sigmoidea</i> Mart.	–	1.3	–	–	–
<i>Bactris major</i> Jacq.	–	–	0.1	–	–
<i>Chamaedorea pinnatifrons</i> (Jacq.) Oerst.	–	1.6	1.3	–	0.2
<i>Euterpe precatoria</i> Mart.	6.8	6.1	8.1	12.8	1.1
<i>Geonoma brongniartii</i> Mart.	6.4	–	–	5.5	–
<i>Geonoma deversa</i> (Poit.) Kunth	37.9	18.8	24	1.8	2
<i>Iriartea deltoidea</i>	30.8	53.3	20.8	19.3	81.3
<i>Oenocarpus bataua</i> Mart.	6.2	0.3	1.3	31.2	5.6
<i>Oenocarpus mapora</i> H. Karst.	2.7	0.3	3.8	20.2	0.1
<i>Phytelephas macrocarpa</i> Ruiz and Pav.	–	–	2.6	–	–
<i>Socratea exorrhiza</i> (Mart.) H. Wendl.	2.9	5.8	2.2	8.7	0.4
N-total	487	377	843	218	1618

Plot 1: High forest on terra firme with trees up to 35 m, situated on a steep hill, rocky substrate.

Plot 2: High forest on alluvial plain with trees up to 30 m, with dominance of ferns and *Heliconia* spp.

Plot 3: Medium forest in flooded areas on alluvial plain, dense understorey and in some places permanently flooded with common lowland species like *Bactris* and *Callycophyllum spruceanum*.

Plot 4: Low and dense forest of 20 m high on steep hills, only some trees up to 30 m. If flooded, *Mauritia flexuosa* and different species of *Heliconia*.

Plot 5: High forest similar to plots 1 and 2, but in the Tuichi river valley. Highest trees of medium to canopy size and with thick trunks. Some places this type of forest has a high pendent, they are very wet and well drained. There are some isles of a dry forest in the tops of hills.

Plots 1–4 are located in the mountain slopes of the last hills to the NE. Plot 5 is close to S Iturralde Province, on the Yariapo valley which drains to the Tuichi river.

macrocarpa, are under-valued and have almost no local uses, although both are important economically in neighbouring countries like Peru and Brazil.

Conclusion

As a general conclusion, the southern part of the Iturralde Province (Department of La Paz, NW Bolivia) has the highest palm diversity in Bolivia. Approximately 34% of the species and 70% of the genera of all Bolivian palms are represented in this area.

Results obtained during this project show that this area represents an important gap for information on palms of Bolivia. The occurrence of *Dictyocaryum lamarckianum* in high Andean ridges, as well as *Wettinia augusta*, *Socratea salazarii*, and *Wendlandiella gracilis* which are common in premontane forests, confirms the influence of the Andean palm flora on the western lowlands of the Amazon basin of Bolivia. These phytogeographical elements, combined with other Amazonian taxa like *Astrocaryum murumuru*,

Table 3. Useful native palms

	Food			Construction Thatching	Oils	Fibres	Arts and crafts	Others
	Fruit	Palmito	Beverage					
<i>Acrocomia aculeata</i> (Jacq.) Lodd. ex Mart.	+	-	-	-	-	-	-	-
<i>Allagoptera leucocalyx</i> (Dr.) Ktze.	+	-	-	-	-	-	-	-
<i>Astrocaryum murumuru</i> Mart.	(+)	-	-	-	+	-	+	-
<i>Attalea phalerata</i> Mart. ex Spreng.	+	+	-	+	-	+	+	+ ^a
<i>Bactris gasipaes</i> Kunth	+	-	-	+	-	-	-	-
<i>Bactris major</i> Jacq.	+	-	-	-	+	-	-	-
<i>Chamaedorea angustisecta</i> Burret	-	-	-	-	-	-	-	+ ^b
<i>Euterpe precatoria</i> Mart.	-	+	+	+	+	-	+	+ ^c
<i>Geonoma brongniartii</i> Mart.	-	-	-	+	-	-	-	-
<i>Geonoma deversa</i> (Poit.) Kunth	-	-	-	+	-	-	+	-
<i>Iriartea deltoidea</i> Ruiz and Pav.	-	+	-	+	+	-	+	-
<i>Mauritia flexuosa</i> L.f.	+	-	-	(+)	-	-	-	-
<i>Oenocarpus bataua</i> Mart.	+	-	+	+	(+)	+	-	-
<i>Oenocarpus mapora</i> H. Karst.	+	-	+	+	+	+	-	-
<i>Phytelephas macrocarpa</i> Ruiz and Pav.	+	-	-	+	-	-	-	+ ^d
<i>Socratea exorrhiza</i> (Mart.) H. Wendl.	-	-	-	-	+	-	-	-

(+) Not very common.

^aLye; medicinal: adventitious roots as vermifuge and oil for muscular sickness. ^bMedicinal: tea made of flowers used against diarrhoea. ^cMedicinal: leaves as respiratory relief. ^dRituals.

Bactris concinna, *Desmoncus polyacanthos*, *Mauritia flexuosa*, and *Socratea exorrhiza*, as well as the Cerrado's influence seen by *Allagoptera leucocalyx* and *Acrocomia aculeata*, emphasize a mixed biogeographical origin for this particular region, as already suggested for birds and mammals by Parker and Bailey (1991).

Sixteen palm species are gathered traditionally by local people, of which the most intensively used are *Geonoma deversa* for thatching, *Iriartea deltoidea* for wall construction, and *Oenocarpus mapora*, *O. bataua* and *Attalea phalerata* for fruit and oils.

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References

- Balslev, H. and Moraes, M. (1989) Sinopsis de las palmeras de Bolivia. *AAU Reports* **20**, 1–107.
- Moraes R.M. (1989) Ecología y formas de vida de las palmas bolivianas. *Ecología en Bolivia* **13**, 33–45.
- Moraes R.M. (1990) Claves dicotómicas preliminaras para las subfamilias y géneros de palmas nativas de Bolivia. *Mus. Nac. Hist. Nat. (Bolivia) Comunicación* **10**, 3–18.
- Parker, T. and Bailey, B. (1991) A biological assessment of the Alto Madidi Region and adjacent areas of Northwest Bolivia. *RAP Working Papers* **1**, 1–108.