



Revista Peruana de Biología

ISSN: 1561-0837

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Universidad Nacional Mayor de San Marcos  
Perú

Kahn, Francis; Millán, Betty; Pintaud, Jean-Christophe; Machahua, Miguel  
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Revista Peruana de Biología, vol. 18, núm. 3, diciembre, 2011, pp. 279-282  
Universidad Nacional Mayor de San Marcos  
Lima, Perú

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## Detailed assessment of the distribution of *Astrocaryum* sect. *Huicungo* (Arecaceae) in Peru

### Evaluación detallada de la distribución de *Astrocaryum* sec. *Huicungo* (Arecaceae) en Perú

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#### Abstract

Detailed distribution of *Astrocaryum* sect. *Huicungo* (Arecaceae) in Peru is presented and discussed. Twelve out of the 15 species that compose this section are found in the Peruvian territory from North to South in the eastern Andean foothills and western Amazonian lowlands. All these species have a parapatric distribution, except for *Astrocaryum macrocalyx* and *A. urostachys*, which share a very limited area. Limits of distribution areas may be related to geographical, geomorphological and ecological barriers (river, geological rising, soil drainage). In some cases, however, the contact between species is almost contiguous; no natural barrier could be detected in the field.

**Keywords:** biogeography, palms, *Astrocaryum*, western Amazonia, Peru

#### Resumen

Se presenta y se discute la distribución detallada de las especies de *Astrocaryum* sect. *Huicungo* (Arecaceae) en Perú. Doce de las 15 especies que componen esta sección se encuentran en el territorio peruano, del Norte al Sur en el piedemonte de los Andes orientales y en la llanura amazónica. Todas las especies presentan una distribución parapátrica, salvo *Astrocaryum macrocalyx* y *A. urostachys* que se superponen en una franja muy reducida. Las áreas de distribución son separadas por pasillos estrechos, que se pueden relacionar a barreras geográficas, geomorfológicas y ecológicas (ríos, levantamientos geológicos, drenaje del suelo). En algunos casos, las especies se suceden en el espacio sin que se haya podido identificar barreras naturales separándolas.

**Palabras claves:** biogeografía, palmeras, *Astrocaryum*, Amazonía occidental, Perú

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Presentado: 03/07/2011  
Aceptado: 21/11/2011  
Publicado online: 08/02/2012

#### Introduction

High diversity of the palms in the western Amazon has been reported in several works (Kahn & Granville 1992, Montufar & Pintaud 2006, Pintaud et al. 2008a, Galeano & Bernal 2010, Balslev et al. 2011). The section *Huicungo* of the genus *Astrocaryum* illustrates this fact, with 14 out of 15 species present in the western Amazon, most of them endemic to this area, with only one species growing in the eastern Amazon and in the Guianas (Kahn 2008). Previous studies of the genus *Astrocaryum* have demonstrated that most species (12 of 15) of the sect. *Huicungo* are found in Peru (Kahn & Millán 1992, Kahn 2008, Vargas & Pintaud 2008, Kahn & Millán 2009), with four species being endemic to Peru (Millán 2006). In bordering regions the number of species is notably lower (5 in western Brasil – States of Amazonas, Acre, and Rondonia, 5 in Colombia, 3 in Bolivia, and 1 in Ecuador).

In order to obtain a detailed distribution of species as a support to phylogenetic and biogeographical studies in the section *Huicungo*, Peruvian species have been collected throughout their distribution areas since 2008. It is now possible to draw the geographical limits between species and analyze in more detail their distribution patterns. Data and maps are presented and discussed here.

#### Material and methods

**Material studied.**– The Neotropical genus *Astrocaryum* includes 40 species (excluded *Astrocaryum mexicanum* and *A. alatum*, treated as *Hexopetion* by Pintaud et al. 2008b); 39 species are found in South America, 2 in Central America.

The genus is divided into three subgenera: *Astrocaryum* with

20 species. The section *Huicungo* in the subgenus *Monogynanthus* groups 15 species distributed in three subsections: (i) *Huicungo* with 7 species, 6 of them are found in Peru; *Sachacungo* with 5 species, 4 of them in Peru; and *Murumuru* with 3 species, 2 of them in Peru.

The species of the section *Huicungo* grow in tropical rain forests. They are distributed in the low fluvial terraces on swampy soils or on periodically flooded alluvial soils, as well as in the upper terraces and hills on terra firme forests on well-drained and poorly-drained soils. These species tolerate deforestation rather well and are frequently found in open areas. Ecology of the genus was reviewed in Kahn (2008).

**Study area.**– The vast Peruvian region commonly known as Amazonia was visited using road networks and waterways for four years. It includes the Amazonian lowlands, the eastern Andean foothills and the central Andean valleys whose rivers run towards the Amazon basin (Fig. 1).

**Data sample.**– Palms were generally sampled at a distance of 1 to 20 km between each other, according to the frequency of the species and the accessibility of the plants. The shortest distance between two individuals was 200 m. For each specimen, elevation and coordinates of latitude and longitude were reported with a Garmin GPS, and dry leaf material was collected for further DNA analysis. Herbarium vouchers were collected from flowering and/or fruiting individuals. At least one herbarium voucher with fertile material was collected per locality. When no fertile material was available, the locality was visited again until flowers and fruits for appropriate identification of the species were obtained. Herbarium vouchers were deposited at USM, Lima.

The total number of points used for mapping includes (i) all the palms sampled during the study, (ii) the data from vouchers collected by other members of the FP7-Palm project team (H. Balslev), and (iii) the data in schedula at USM, where most vouchers of *Astrocaryum* formerly collected in Peru are conserved.

The number of points varies among species. These depend on (i) the total area covered by the species (e.g. *Astrocaryum carnosum* distribution is clearly smaller than that of *A. faranae*), (ii) the accessibility of the region, and (iii) the number of previous collections available at the herbarium.

*Astrocaryum carnosum* — 39 points

Herbarium specimen — Kahn 1839-40, 1933-34, 2031, 4476, Millán & Kahn 629, 636-37, 1483-84, 1679, 1681A, 1683, 1683A, Millán et al. 1377.

*Astrocaryum chonta* — 39 points

Herbarium specimen — Balslev et al. 7658-59, 7852, 7870, 7873, Gentry 26925, Kahn 2081, Kahn & Mejia 1782, 1823, Mejia 106, Millán 141, Millán & Albán 149, 164, Millán & Mejia 60, 61, Millán & Canayo 63, 97, 99, 107, 109-10, 112, Millán & Kahn 1704, Millán & Vargas 1461, Millán et al. 706-11, 718.

*Astrocaryum ciliatum* — 1 point

The species is only known from one place in Peru; it was identified by FK from a photograph sent by Robin Foster.

*Astrocaryum faranae* — 90 points

Herbarium specimen — Balslev et al. 7885, 7897, 7929, 7971, 7998, 8005, 8012, 8056, 8092, Kahn 4442-44, 4451-55, 4475, 4477, 4489, 4490, 4492, Millán 173, 174, Millán & Clavo 1525, 1527, 1529, Millán & Kahn 627, 638, 642, 645, 647-48, 1692, 1694, Millán & Machahua 1697-98, Millán et al. 1385, 1387, 1399.

*Astrocaryum gratum* — 70 points

Herbarium specimen — Alexiades & Pasha 357, Kahn 4456-58, 4467, 4473-74, Kahn & Llosa 2128, 2143, 2144, 2147, Kahn et al. 4479, Millán & Couturier 118-20, Millán & Kahn 1703, Millán & Pintaud 558, Nuñez et al. 21798, Vargas 18574, 18718.

*Astrocaryum huicungo* — 35 points

Herbarium specimen — Kahn 4493, 4497-99, Kahn & Borchsenius 2654-55, Kahn & Moussa 3203-04, 3206-08, 3211-12, Killip & Smith 28840, 28698, Millán & Kahn 655-56, 1709, Millán & Pintaud 447, 449, Weberbauer s.n.

*Astrocaryum javarense* — 51 points

Herbarium specimen — Fleck SWF 371, Gentry & Revilla 20873, Gentry et al. 56347, 76490, Kahn 2340, Kahn & Mejia 1776-77, 1780, 1786, 1858, 1971, 2055, 2057, 2069, Kahn & Moussa 3201-02, Kahn et al. 2408, Mejia 96, Millán 89, 90, Millán & Canayo 114, Millán et al. 32, 746, 888, 894, 1078-81, 1082-83, 1087-89, 1096, 1108.

*Astrocaryum macrocalyx* — 40 points

Herbarium specimen — Gentry et al. 54253, 55618, 65743, Kahn 2296, Kahn & Couturier 3334, Millán 664, 674 Millán & Meija 49, 50, Millán & Perera 64, Millán et al. 523, 906

912-13, 916, 919-21, 922, 933-34, 1005-07, Moore et al. 8420, 8482, Pintaud 593, 595, Pipoly et al. 13685, 13839, Ruokolainen et al. 5461, Tessmann 5117, Vásquez & Jaramillo 544, Vásquez et al. 2360.

*Astrocaryum perangustatum* — 69 points

Herbarium specimen — Kahn 3230-32, 4436-39, 4445, 4450, 4501-02, Millán 830, 839, 846, Millán & Kahn 1592, 1597, 1600, 1696, 1706-07, Smith 4045.

*Astrocaryum scopatum* — 56 points

Herbarium specimen — Berlin 831, Kahn 4484-88, Kahn & Borchsenius 2563, Kahn & Machahua 4480-83, Millán & Kahn 526-29, 543-544, 556, 571, 577-79, 610.

*Astrocaryum ulei* — 32 points

Herbarium specimen — Kahn 4459-63, 4465, 4466, 4469-72, Millán 386.

*Astrocaryum urostachys* — 29 points

Herbarium specimen — Albán 14039, Kahn 4139, 4140, Millán 925, 934, 982, Millán & Vargas 762, Millán et al. 1001-03, Pintaud 587-92.

*Map design* — Maps were designed using ArcMap 9.3, Environmental Systems Resource Institut (2008), Redlands, California.

## Results and discussion

Distribution of *Astrocaryum* sect. *Huicungo* species in the Peruvian Amazonia forms a mosaic of rather contiguous areas from North to South and East to West (Fig. 1).

Two species are strictly limited to the subandean region: (i) *Astrocaryum carnosum* grows in the upper Huallaga valley between Tocache and Tingo María. (ii) *Astrocaryum perangustatum* grows in the Pozuzo, Palcazu and Pichis valleys, reaches the Amazonian lowlands to the Pachitea valley northeastwards, but does not extend into it, and follows the Perene and Ene River (Apurimac) valleys in Junín and Cusco-La Convención southwards.

Five species extend from subandean foothills to Amazonian lowlands: (i) *Astrocaryum scopatum* grows in the upper Marañón river valleys, from Cenepa valley northwest to San Lorenzo southeast. It is found along Nieva, lower Morona and Santiago river valleys. (ii) *Astrocaryum huicungo* is found in the Rioja-Moyobamba region and extends to the Huallaga valleys in the Amazonian lowlands southeastwards. (iii) *Astrocaryum faranae* grows from the river Huallaga to Acre in Brazil, from South of Tarapoto to southern Huanuco department. The northeastern limit in the Ucayali river valley is not well defined yet. (iv) *Astrocaryum gratum* extends from the Urubamba valley (Cusco) northwestwards to the upper Tambopata valley southwestwards, it does not cross the Madre de Dios river eastwards. (v) *Astrocaryum urostachys* covers the northern region of the Amazonian lowlands, limited to the Morona river valley westwards and to the western border of Iquitos Arch southeastwards.

Five species are strictly found in the Amazonian lowlands: (i) *Astrocaryum javarense* grows in the region between the southern margin of Ucayali and Amazonas rivers northwards and the

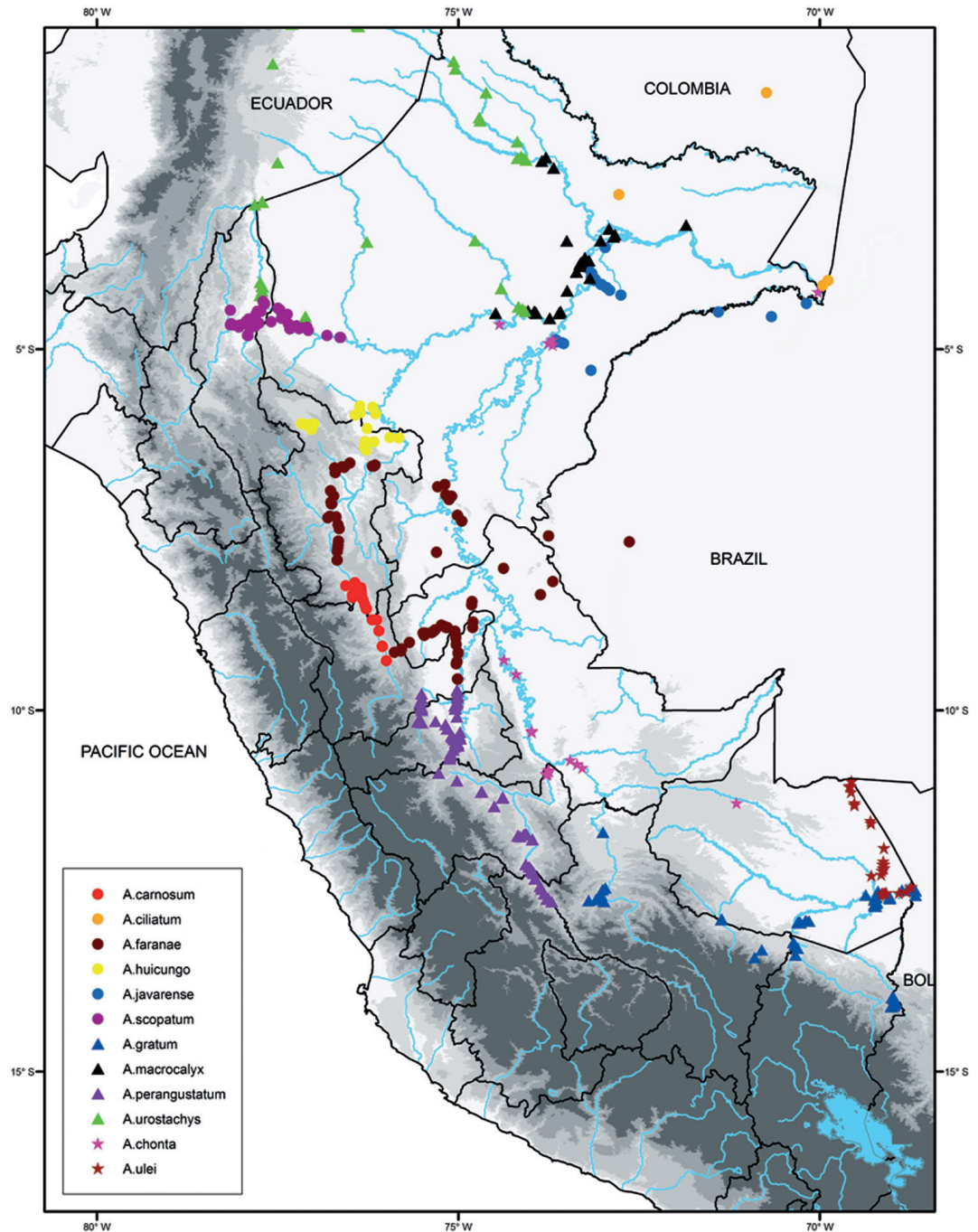


Figure 1. Distribution of *Astrocaryum* sect. *Huicungo* (Arecaceae) in Peru.

the eastern part of the Amazonas northern margin, along Iquitos Arch eastern border. (iii) *Astrocaryum ciliatum* is known from the Maijuna area, north of Sucusari, halfway between the Napo and Algodon rivers, near the Colombian border. The species is rather frequent in the neighboring Colombia (Galeano & Bernal 2010). (iv) *Astrocaryum chonta* follows the terraces along the Amazonas-Ucayali-lower Urubamba and lower Tambo rivers; it is punctually found in the lower Marañon and the Manu river valley. (v) *Astrocaryum ulei* extends from the eastern margin of

All species are usually found below 1000 m elevation, except for *Astrocaryum faranae* collected in Peru from 167 to 1650 m.

The species of the subsection *Huicungo* (represented by rounds in Fig. 1 – *A. carnosum*, *A. ciliatum*, *A. faranae*, *A. huicungo*, *A. javarense*, *A. scopatum*) are grouped together in the northeastern half of the country. Those of the subsection *Sachacungo* (triangles) form two groups, two species (*Astrocaryum macrocalyx* and *A. urostachys*) in the northern part and two species (*Astrocaryum gratum* and *A. perangustatum*) in the southern part

and *A. ulei*) are located in the southeastern half of the country in Amazonian lowlands.

All the Peruvian species of the section *Huicungo* have a parapatric distribution, except for *Astrocaryum macrocalyx* and *A. urostachys* which share a very limited area (Vargas & Pintaud 2008). Such contact was not observed with the other species. Several limits of the distribution areas may be related to geographical, geomorphological and ecological barriers. These are (i) rivers — Ucayali and Amazonas rivers in the case of *Astrocaryum javarense*/*A. macrocalyx* or Madre de Dios river in the case of *Astrocaryum gratum*/*A. ulei*, (ii) geological rising — in the case of the Iquitos Arch for *Astrocaryum macrocalyx*/*A. urostachys* (Vargas & Pintaud 2008), and of the Cordillera Vilcabamba (northern part) for *Astrocaryum perangustatum*/*A. gratum*, (iii) geomorphological location with differences in soil drainage and vegetation — the case of *Astrocaryum javarense*/*A. chonta* (*A. javarense* grows in terra firme forest on high terraces, while *A. chonta* grows in restinga forest, which covers low terraces on periodically flooded alluvial soils), or of *Astrocaryum carnosum*/*A. faranae* (*A. carnosum* being strictly restricted to the bottom of the Huallaga river valley, *A. faranae* is found on the slopes of Cordillera Azul). In other cases no barrier could be detected in the field — e.g. between *Astrocaryum scopatum* and *A. urostachys* along Santiago and Morona rivers, between *Astrocaryum huicungo* and *A. faranae* in Tarapoto region, or between *Astrocaryum faranae* and *A. perangustatum* in the Pachitea river valley. These last cases need further study to reach more detailed conclusions regarding their distribution.

#### Acknowledgments

This work was done under the agreement between UNMSM/ San Marcos National University, Peru and IRD/Research Institute for Development (UMR DIADE/DYNADIV), France, and supported by the PALMS project funded by the European Community, 7<sup>th</sup> Framework Programme, Grant Agreement N°212631. We are indebted to Catherine Sahley for her valuable comments on the manuscript.

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