Palms

Journal of the International Palm Society Vol. 63(1) Mar. 2019

THE INTERNATIONAL PALM SOCIETY, INC.

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Palms (formerly PRINCIPES)

Journal of The International Palm Society

An illustrated, peer-reviewed quarterly devoted to information about palms and published in March, June, September and December by The International Palm Society Inc., 56 Autumn Oaks Drive, The Hills, Texas 78738 USA.

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Annual membership dues are US$55.00 for Individuals (or US$150 for three years) and include a subscription to the Journal. Donor memberships are US$500 per year. Individual Lifetime memberships are available for a one-time fee of US$1000. Benefactor memberships require a one-time payment of US$2500. Subscription price is US$55.00 per year for libraries and institutions. Dues include mailing of the Journal by airlift service to addresses outside the USA. Dues may be paid on-line at www.palms.org.

Change of Address: Send change of address, phone number or e-mail to The International Palm Society Inc., The International Palm Society Inc., 56 Autumn Oaks Drive, The Hills, Texas 78738 USA., or by e-mail to info@palms.org.

Claims for Missing Issues: Claims for issues not received in the USA should be made within three months of the mailing date; claims for issues outside the USA should be made within six months of the mailing date.

Periodical postage paid at Austin, TX, USA and additional mailing offices. Postmaster: Send address changes to The International Palm Society Inc., The International Palm Society Inc., 56 Autumn Oaks Drive, The Hills, Texas 78738 USA.

PALMS (ISSN 1523-4495)

Mailed at Lawrence, Kansas 15 Mar. 2019

The full text of PALMS is available on EBSCO Publishing's database.

This publication is printed on acid-free paper.

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BACK COVER

Leaf bases of *Saribus rotundifolius*. See article by A. Henderson, p. 31.

PALM NEWS


Bernard DuPont

An experimental study of how **heat affects the germination of seeds of *Borassus aethiopum* dispersed by elephants** was published late last year. Researchers T.F. Lado, W.F. Jibi and P.T. Moilinga studied how bush fires on the savanna affected seeds of woody species that had been dispersed by African elephants (*Loxodonta africana africana*). Responses varied by species, but in the case of *B. aethiopum*, the only palm included in the study, germination was significantly improved after heat treatments. A five-minute treatment in a dry oven at 100°C (212°F) brought the rate of germination up to ca. 100%, but a similar treatment at 220°C (428°F) was also an improvement over the ambient control (27°C/81°F). Germination was fastest after the 220°C treatment, and germination after the 100°C treatment was the second fastest. The implications of this study for horticulturists are obvious, in that similar treatments could be employed to improve germination of this palm. The study was published in *Biotropica* 50: 483–486. 2018. https://doi.org/10.1111/btp.1255.


Carsten ten Brink

For those interested in **the debate over palm-oil and efforts to produce and market sustainable palm oil**, the UK Independent newspaper has an excellent topic on its website, frequently added to, and proving to be an excellent source of up-to-date news. It can be accessed at https://www.independent.co.uk/topic/palm-oil.

Our member **Hugh Harries, doyen of the world of coconuts, passed away** on 7 February 2019, after a short illness. He was preeminent in the field of natural history, origin and dissemination of the coconut and held many stimulating ideas. While contributing learned papers of the highest order, he also wrote several more light-hearted papers, published in *Principes* (and then *PALMS*); these papers are most entertaining but at heart were serious discussions. He will be much missed.


John L. Dowe

John L. Dowe published a note on **a name change in the palm long known as *Livistona lorophylla***. The correct name for this palm is now *Livistona leichhardtii*. The species is distinguished from other species by its tall stem, deeply divided leaves with pendulous segments, and ovoid-obovoid, dull black fruits. The paper was published in *Nuytsia* (29: 245-250. 2018) and can be freely downloaded here: https://florabase.dpaw.wa.gov.au/nuytsia/article/902.

Hydriastele gibbsiana, a Remarkable Belly Palm from New Guinea

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1. Two mature palms standing out among the vegetation by the Anggi Lakes in the Arfak Mountains. Photo by AS.

***Hydriastele gibbsiana* is a beautiful palm with a pronounced belly and is found in western New Guinea.**

2. Stems of *Hydriastele gibbsiana* lashed together to form rafts. Photo by A.E. Pratt. Reproduced from Gibbs (1917).

In December 1913, Lilian Suzette Gibbs, a British botanist and field naturalist, collected plants by the Anggi Lakes in the Arfak Mountains of the then Dutch New Guinea. Among other novelties, the collecting trip yielded a new palm species that was described by Odoardo Beccari as *Kentia gibbsiana* in Gibbs's subsequent account: *A contribution to the Phytogeography and Flora of the Arfak Mountains* (Beccari 1917). In her account, Gibbs (1917) described how, to the north and northeast of the lakes, she observed "…the graceful palm *Kentia gibbsiana*, standing out among the mass level, both on the slopes and ridges." The palm has undergone some taxonomic changes, being transferred first to *Gronophyllum* (Moore 1963) and then finally to *Hydriastele* (Baker & Loo 2004) but has remained poorly known in nature.

A century later, Kew orchid expert André Schuiteman (AS) returned to the type locality north of the Anggi Lakes and, like Gibbs, came across this striking palm. His photographs record the conspicuously bellied trunk of this handsome species (Figs. 1, 3 & 4). When dried, these trunks are very light and pithy, which makes them suitable for making rafts, as they provide significant buoyancy. A photograph in Gibbs (1917) illustrates *H. gibbsiana* trunks lashed together for exactly this purpose (Fig. 2), although no mention of this is made in the accompanying text. Matthew Jebb (pers. comm.) of Glasnevin, the National Botanic Gardens of Ireland, observed the palm being used in this way at Anggi Lakes as recently as the 1990s.

Recently, *H. gibbsiana* was collected by WJB at another locality in the adjacent Tamrau Mountains (Fig. 5–7). Here, the species is reportedly used for flooring and roofing. At this site the palm is also strongly ventricose, with a massive, irregularly swollen "belly" in the middle of the otherwise quite slender stem, differing somewhat from the images recorded by AS at Anggi Lakes.

A new description of *H. gibbsiana* based on Gibbs's original material and WJB's collection has been completed and has been published as part of a monograph of *Hydriastele* in New Guinea (Petoe et al. 2018). For field identification purposes, however, such a description seems scarcely necessary with the species being immediately recognizable on account of its conspicuously ventricose stem. The data available at present would suggest that *H. gibbsiana* could be threatened, as it is known from only two localities relatively near to each other, and its notable uses among local people may pose a threat to the survival of these populations. In addition, the passage from Gibbs's account gives the impression, even if

3. Habit photo of a mature individual from the population by the Anggi Lakes. Photo by AS.

4. Crown view of the same individual as in Figure 3. Photo by AS.

5. Crown view of a mature individual from a relatively newly discovered population in the Tamrau Mountains. Here the conspicuous belly is situated in the middle of the otherwise quite slender stem. Photo by WJB.

6 (left). A portion of inflorescence showing rachillae with triads. Photo by WJB. *7* (right). A portion of infructescence showing rachillae with mature fruit. Photo by WJB.

vaguely, that *H. gibbsiana* used to be more frequent by the Anggi Lakes than it is today, suggesting a decline.

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Diversity, Ecology and Ethnobotany of the Palms of the Yasuní National Park (Ecuador)

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Students of the Natural History of Palms Course, 2018

Research and conservation of palm species relies on training new generations of palm biologists, especially in tropical countries. Such trainings pave the way to answer new questions related to palm biology, sustainable management, the cultural and economic links between humans and palms, and build conservation strategies through education and civil empowerment.

Ecuador is home to a vast amount of plant biodiversity (Jørgensen & León-Yánez 1999). Palms, with 134 native species in 30 genera (Pintaud et al. 2008), represent an important part of this biodiversity occurring from sea level to 3000 m (Borchsenius et al. 1998). A large array of palm species also plays vital roles throughout the country as a food source, for construction and crafts, and for medicine. As such, palms are iconic across the country and attract much attention from researchers and students. However, to date, an active course on palm biology has not been part of the local teaching curricula in major universities. In this context the Pontifical Catholic University of Ecuador (PUCE), with the support of French National Institute for Research for Sustainable Development (IRD) and the International Palm Society (IPS), the International Mixed Laboratory BioInca (LMI BioInca) and the Universidad Autónoma de San Luis Potosí-México (UASLP), joined efforts to host the first "Natural History of Palms" course held in Ecuador, August 3–12, 2018. The scope of this course was to train students from different universities and institutions in Ecuador, Peru and Colombia, under the concept of "talking, learning and doing science with palms." The 22 participants mostly came from eight Ecuadorian institutions, but also two from Colombia (Universidad de Los Andes), two from Perú (Universidad Nacional Mayor de San Marcos, IIAP), in addition to two European students from Switzerland and Poland.

The course started with a two-day introduction to palms at the PUCE campus in Quito. Several talks were given about the morphology, anatomy, systematics and ethnobotany of palms. The second day was based at the PUCE herbarium (QCA), which contains one of the largest and best-conserved collections of Ecuadorian palms. Here, students learned to identify and study the morphology and classification of palms. The day ended with a walk through the PUCE campus where we were able to observe several palm species such as the

1. The Yasuní Scientific Station-PUCE. Top: Drone photo of the Station, next to the Tiputini river. Bottom: The station by night on a full moon. Photos: Rubén Jarrín.

Andean native *Parajubaea cocoides*, the planted *Phoenix canariensis*, *P. roebelenii* and an old and impressive *Jubaea chilensis*.

The next part of the course took place in the world-famous Yasuní National Park (YNP), one of the most biodiverse places on Earth (Bass et al. 2010). We departed by bus at the crack of dawn on a Monday. Getting an early start out of Quito is important to avoid the start-of-the-week rush hour. Quito is nested at 2900 m above sea level in the Andean cordillera, and the trip down to the Amazon basin is a fantastic experience for any naturalist. We crossed the cold and misty Andes and descended into the warm and humid eastern Andean slopes down to 250 m elevation, driving through a panoply of vegetation types including paramo, montane forests and tropical rainforests. As we progressed down into the Amazon, palms started to appear here and there, first high elevation species such as *Ceroxylon ventricosum*, *Dictyocaryum lamarckianum, Geonoma undata* and then more common species such as *Iriartea deltoidea* and *Wettinia maynensis*. Below 800 m palms become the most conspicuous plants of the scenery. After an 8-hour trip on the twisting roads, we arrived at the majestic and wide Río Napo river, a tributary of the Amazon. At this point we embarked in motorized canoes to the entry of YNP. Just after we crossed the Río Napo, a huge tropical storm whooshed up the river lifting waves and crashing thunder, a kindly reminder that we had arrived at the largest tropical rainforest in the world. From there onwards we continued into YNP and drove another hour to reach the PUCE Yasuní Research Station (YRS).

Yasuní National Park is located deep in the tropical rain forest of eastern Ecuador that is part of Western Amazonia (Fig. 1). It covers an area of ca. 1,022,736 ha and is adjacent to the Waorani Ethnic Reserve (WER) of ca. 900.000 ha. Yasuní was declared a National Park in 1979, and in 1989 YNP and WER were both incorporated into the World Network of Biosphere Reserves as Yasuní Biosphere Reserve (YBR). Yasuní is one of the most biodiverse areas of the planet with the world record of species richness per area for trees, amphibians, reptiles, birds and fishes (Bass et al. 2010).

The YRS is located on the southern bank of the Tiputini River (Fig. 1), within YNP. It is an internationally recognized research center where several long-term research programs on tropical rain forest ecology have been implemented, such as the Yasuní Forest Dynamics plot (Valencia et al. 2004). YRS is surrounded by several terrestrial habitats such as *tierra firme* forest, seasonally flooded forest and swamps, as well as by lagoons and whitewater and blackwater streams. Finally, three Waorani communities are settled near the YRS, which allows the interaction of researchers and students with this Amazonian culture.

2. Top: R. Montúfar (with the hat) explaining the taxonomy of the genus *Geonoma* to part of the students, here *Geonoma deversa*. Middle: S. Espinosa (black shirt) taking georeferenced data for camera traps. Bottom: T. Couvreur teaching students how to take measurements for a good botanical collection of *Ammandra decasperma*. Photos: Thomas L.P. Couvreur, Anna Woyciechowska.

We spent six days in YNP. During the day we walked through the different ecosystems (Fig.

3. A sample of the different *Geonoma* species seen in Yasuni. Top left: The understory palm *Geonoma brongniartii*, note the spicate inflorescence and reddish young leaf. Top right: The understory palm *Geonoma stricta*, with bifid leaves and short robust and spicate inflorescences. Bottom left: The mid-sized clustering *Geonoma maxima*, with highly divided leaves. It is the tallest species of *Geonoma* in Yasuní. Bottom right: The single stemmed *Geonoma triglochin*, with its bifid or little divided leaves. Photos: Thomas L.P. Couvreur.

4. A sample of different palm flowers and fruits seen in Yasuni. Top left: Male flowers of *Geonoma macrostachys*, note the jointed connectives. Top right: Male flowers of *Geonoma brongniartii*, note the bifid connectives. Bottom left: The spectacular male inflorescence of *Ammandra decasperma*. Bottom right: Erect infructescence of *Astrocaryum murumuru*, note the old male rachillae above the fruits. Photos: Thomas L.P. Couvreur.

2), discussing the ecology and systematics of the species we encountered. We divided the course into four palm research themes, based on the expertise of the teachers: Systematics, diversity, seed dispersal ecology and ethnobotany. For the first three days of the course and for each theme, students were introduced to the field, the methodology and analytical tools. Thus, students learned how to make palm herbarium specimens as well as anatomical and physiological samples, set camera traps, do transects, and undertake ethnobotanical surveys. For the last two days, five or six students were assigned a small project related to one of the four themes and the following questions: How diverse is the Yasuní palm flora, and how can we identify the major genera? What are the ecological preferences of palms across different landscapes? What animals disperse palms? Which palm species are used most by the local community?

Here we present the results based on these short projects undertaken by the students. The results provide interesting insights into the palms of Yasuní that we deemed important to report.

How diverse is the Yasuni palm flora?

During the course, students collected a total of 36 herbarium specimens (Table 1; vouchers listed as CP2018 numbers). In some cases, a species was seen but was not collected. We also made herbarium collections of seedlings, and taught students to identify species based on seedlings, an important component for diversity studies (see below). In total, we observed 18 genera and 34 identifiable species (Table 1), representing 60% of genera in Ecuador and over 78% of genera reported for the Ecuadorian Amazon. As always, a couple of *Bactris* and *Geonoma* (Figs. 3 & 4) species remain undetermined and put our knowledge of palm taxonomy to the test.

By far the most species rich habitat is *tierra firme* (Table 1) with 13 genera observed. Where we walked away from the research station and arrived into the hilly part of the reserve, the understory is dominated in places by the phytelephantoid species *Ammandra decasperma* (Fig. 5), an acaulescent palm with spectacular, strong-scented, male inflorescences. Less common is the other phytelephantoid palm *Aphandra natalia*, recognizable by its visible stem and silvery indumentums on the leaflet undersides. We were lucky to have seen the only liana palm genus of the Neotropics, *Desmoncus*. Because of its climbing habitat, it is quite hard to spot, but given we had 30 pairs of palm-refined eyes, we were able to see it not once but several times! Encountering *Desmoncus* always leads to interesting discussions about liana evolution and morphology in palms (Couvreur et al. 2015).

Omnipresent across the understory are numerous species of *Geonoma* (Fig. 3), which provide the ideal opportunity to discuss species complexity and diversification in tropical rain forests. Some *Geonoma* species are truly wonderful understory palms, such as *G. triglochin* (Fig. 3) with its single thick stem topped by several bifid leaves, *G. macrostachys* (Fig. 4) an acaulescent species with large bidif leaves and a spicate inflorescence or *G. maxima*, the tallest *Geonoma* of the Amazon basin, with several clustering stems that reach 5 m tall and finely pinnate leaves (Fig. 3). Among the large canopy palms, the *tierra firme* of Yasuní is dominated by species such as *Iriartea deltoidea* (Fig. 5) and *Socratea exorrhiza* with their amazing and characteristic stilt roots. *Oenocarpus bataua* with its white-silvery leaflet undersurfaces and *Attalea maripa* with its razor-sharp petiole margins are also very common.

Yasuní consists of an intricate mix between *tierra firme* and periodically inundated forests or internal valleys, each with its distinctive community of palm species (see below). Inundated areas near the station are dominated by *Geonoma brongniartii* (Fig. 3), a species that replaces the *tierra firme G. macrostachys*. We also encountered *Prestoea schultzeana*, a smallish understory palm with amazingly bright red rachillae and *Wettinia maynensis*, which has strange-looking, sausage-like infructescences.

Swampy areas can be found scattered across the Yasuní landscape. The dominant and most characteristic palm in this habitat is by far *Mauritia flexuosa*, one of the most abundant species in the Amazon (ter Steege et al. 2013). From above, it appears as a monodominant vegetation including only *Mauritia*. However, once you penetrate the swamp, armed with your best boots, of course, you discover a large diversity of species growing in the swampy understory, several of them also found in periodically inundated soils. To the students' delight, we visited one swamp near the station. Swampy habitats provide the opportunity to spot the "real" field botanists – those willing to get their feet wet. A number of palm species

5. Other palm species seen in Yasuni. Top left: The acaulescent *Attalea insignis*, note the erect infructescence arising from within the leaves. Top right: The riparian *Bactris riparia*, forming very dense impenetrable colonies along rivers. Bottom left: The arborescent and very spiny *Astrocaryum chambira*. Bottom right: The arborescent and very common *Iriartea deltoidea*. Photos: Thomas L.P. Couvreur.

6. A sample of the different palm uses within the Waorani Guiyero community. Top left: A traditional Waorani house made using *Attalea butyracea* and *Geonoma macrostachys* leaves. Middle left: Handicrafts made by Waorani women with *Astrocaryum chambira* fibers. Top right: Detail of the weaving of *Geonoma macrostachys* leaves for thatching. Bottom left: Basket made by Isabel Ahua using *Oenocarpus bataua* leaves and used to carry forest fruits or animals. Bottom right: A sample of different palm products used by the Waorani Guiyero community: forefront: *Mauritia flexuosa* fruits, one of the most edible palm fruits in the Amazon; background: the *O. bataua* basket made by Isabel Ahua; left: *A. chambira* fibers with its natural color (yellow) or tinted into purple using a natural dye. Left photos: Rommel Montúfar; right photos: Thomas L.P. Couvreur.

Students of Natural History of Palms course, 2018. Top row, from left to right: Kenny Moreno, Ángel Rodríguez, Josué Sanmiguel, Karol Echeverría, Sebastián Escobar, Jhonny Jiménez, Fernanda Landeta, Héctor Reyes, Daniel Franco, Mariana Duque, Jaime Gavidia, Marinoli Rivas, Angel Cajas, Gwendolyn Peyre, Agnieszka Wojciechowska. Bottom row, from left to right: Mathew Tello, Ivonne Jalca, Daniela Pasquel, Hakim Schepis, Esteban Messa, Francisco Sánchez, Paolo Vallejo, Alvaro Rivera, Kabir Montesinos, Rommel Montúfar, Thomas Couvreur, Tim Tranbarger, Santiago Espinosa. Photo: Rubén Jarrín.

grow happily here, such as the acaulescent *Attalea insignis* (Fig. 5), *Astrocaryum chambira, Geonoma macrostachys* var. *acaulis*, several species of *Bactris*, such as *B. maraja*, and *Euterpe edulis*. Another swamp species is *Mauritiella armata*. Although it is present in YNP, we did not see this species in the swamps we visited; however, we did observe it on the roadside just before arriving to the park. Finally, we also encountered *Bactris riparia* (Fig. 5), a riparian species forming dense stands along the margin of the lagoons close to the Tiputini river. One species we did not encounter was *Chelyocarpus ulei*, the only Coryphoideae in Ecuador. While populations are known in Yasuní, they were too far to reach on our daily walks.

What are the densities of palms across different landscapes?

The students established three transects where all palm individuals were registered in order to explore the density and the ecological preferences. Two transects of 100 × 5 m were placed on a *tierra firme* forest and one transect of 80 × 5 m was set on a mixed forest (*tierra firme* and internal valley). The inclination of transects varied from zero to 45 degrees.

The mixed transect (0.04 ha) reported 95 individuals representing 19 species composed of typically *tierra firme* palms such as *Iriartea deltoidea*, *Ammandra decasperma*, *Geonoma macrostachys* and *Geonoma stricta,* but also several species characteristic of floodplains such as *Euterpe precatoria*, *Astrocaryum murumuru*, *Geonoma brongniartii*, *Attalea insignis* and *Wettinia maynensis*. Transects on *tierra firme* (0.05 ha) contained 127 and 99 individuals of eight and 14 species, respectively. *G. macrostachys*, *Phytelephas tenuicaulis*, *Prestoea schultzeana* and *I. deltoidea* were the most abundant palms. Other typically *tierra firme* palms were *Aiphanes ulei*, *Hyospathe elegans*, *Aphandra natalia*, *Chamaedorea pauciflora* and *Hyospathe elegans*. Based on the analyses of these transect data, the students suggested that topography had a strong influence over the abundance of palm species given that an increment in inclination decreased species abundance in the transects.

Which animals disperse palms?

It is well known that palms produce nutrient-rich fruits that are widely consumed by animals, especially birds and mammals,

Table 1. List of species collected and identified during the Natural History of Palms at Yasuní Scientific Station.

genus	epithet	collection number	habitat
Aiphanes	*ulei*	CP2018-17	*tierra firme*
Ammandra	*decasperma*	CP2018-18	*tierra firme*
Aphandra	*nathalia*	no collection	*tierra firme*
Astrocaryum	*chambira*	CP2018-19	inundated forest
Astrocaryum	*murumuru*	CP2018-14	inundated forest
Attalea	*butyracea* [a]	no collection	*tierra firme*
Attalea	*insignis*	CP2018-9	swamp/inundated forest
Attalea	*maripa* [a]	CP2018-22/23	*tierra firme*
Bactris	*concinna*	CP2018-3	inundated forest
Bactris	*corossilla*	CP2018-13	inundated forest
Bactris	*maraja*	CP2018-11	inundated forest
Bactris	*riparia*	CP2018-4	riparian forest
Bactris	*schultesii*	CP2018-036	inundated forest
Bactris	*simplicifrons*	CP2018-037	inundated forest
Chamaedorea	*pauciflora*	no collection	*tierra firme*
Desmoncus	*giganteus*	CP2018-23/27	*tierra firme*
Euterpe	*precatoria*	no collection	swamp/ inundated forest
Geonoma	*camana*	no collection	*tierra firme*
Geonoma	*brongniartii*	CP2018-2	inundated forest
Geonoma	*deversa*	CP2018-7	*tierra firme*
Geonoma	*macrostachys*	CP2018-5/34	*tierra firme*
Geonoma	*maxima*	CP2018-6	*tierra firme*
Geonoma	*sp.*	CP2018-25	inundated forest
Geonoma	*sp.*	CP2018-26	*tierra firme*
Geonoma	*stricta*	no collection	*tierra firme*
Geonoma	*triglochin*	CP2018-8	*tierra firme*
Hyospathe	*elegans*	CP2018-16	*tierra firme*
Iriartea	*deltoidea*	CP2018-31	*tierra firme*
Mauritia	*flexuosa*	CP2018-10/30	swamp
Mauritiella	*armata*	no collection	swamp
Oenocarpus	*bataua*	CP2018-20/32	*tierra firme*
Oenocarpus	*mapora*	CP2018-12	*tierra firme*
Pholidostachys	*synthera*	CP2018-15	*tierra firme*
Prestoea	*schultzeana*	CP2018-1/28	inundated forest
Socratea	*exorrhiza*	CP2018-24	*tierra firme*
Wettinia	*maynensis*	CP2018-21/29	inundated forest

[a] Recent advances in *Attalea* taxonomy suggest new identifications (Pintaud et al. 2016): *A. butyracea* reported from Yasuní corresponds to *A. bassleriana* and *A. maripa* to *A. tessmannii*. However, these taxonomic changes need to be better explored.

including humans (Howe & Smallwood 1982). These interspecific interactions are essential for palm dispersal and, therefore, the effect of forest defaunation can have negative consequences on the recruitment and survival of palm species. For our course we intended to show participants some principles and techniques to study plant-animal interactions, with an emphasis on fruit dispersal by terrestrial vertebrates. We focused on two important species: *Oenocarpus bataua* and *Mauritia flexuosa*. The ecology of these two species is very different: *M. flexuosa* inhabits swampy areas and forms monospecific aggregations or "*moretales,*" whereas *O. bataua* grows in *tierra firme* forests and does not form such aggregations. We looked for palms of these two species that had dropped fruits on the ground. After searching in *tierra firme* and a swampy *moretal*, we selected four individuals of *O. bataua* and three individuals of *M. flexuosa*. We used two camera traps to survey each palm and placed them on trunks of nearby trees, at a distance of 2–3 m from the target palm. Cameras faced the fruits on the ground and trunk of the palm and were programed to work continuously, day and night, for three days.

Even though this time period is too short to register the animal community that could visit palms, we were able to capture some animals interacting with these palm species. We photographed two large rodents that are important dispersers of palm seeds: agouti (*Dasyprocta fuliginosa*) and paca (*Cuniculus paca*), which were feeding on fruits of *O. bataua* and *M. flexuosa*, respectively. We also photographed nine-banded armadillos that may have been looking for insects on rotten fruits. Likely due to the short time cameras were in the field, we were not able to photograph large mammals that live in Yasuní, such as tapir (*Tapirus terrestris*), deer (*Mazama zamora* and *M. murelia*) and peccaries (*Pecari tajacu* and *Tayassu pecari*), which are also important for seed dispersal. However, we were able to observe tracks of those large mammals by the sites where we placed our cameras, an indication that they were there, also looking for the sweet palm fruit.

Which palm species are the most used by the local Waorani community?

The Waorani community of Guiyero, located 20 min by car from the research station, is where we headed to undertake our survey. Given time limitations, we restricted ourselves to ask two main questions to 16 people (8 male, 8 female): which are the most useful palm species and what are their uses? The palm uses were grouped into seven general categories: medicinal, cultural (handicrafts, social, ludic, ritual), hunting supplies, household utensils, building, food, and cosmetics.

A staggering 18 useful palm species were named, about half of the total palm diversity we observed (Table 1, Fig. 6). The most important palms for this community were *Oenocarpus bataua*, *Iriartea deltoidea*, *Mauritia flexuosa*, *Astrocaryum chambira* and *Bactris gasipaes* var. *gasipaes*. All of them are arborescent and widespread across the Amazon basin (Henderson et al. 1995). This brief ethnobotanical exploration showed that the main use categories for palms were housing, food and hunting supplies, while to a lesser extent, household utensils, cultural, medicinal and cosmetics. Taking into consideration their uses, the most mentioned species were *M. flexuosa* and *B. gasipaes* for food, *M. flexuosa* for household utensils, *I. deltoidea* for hunting utensils, *O. bataua* and *I. deltoidea* for building, *Astrocaryum chambira* for cultural uses and *O. bataua* for medicine.

Interestingly, the perception of importance varied between gender. *Astrocaryum chambira* and *O. bataua*, used as a source of fibers and medicine, were considered the most useful palms by women, while *O. bataua* and *I. deltoidea* used for construction were mentioned as the most useful palm species by men. In addition, *Chamaedorea pauciflora,* used as a perfume, was mentioned only by women, whereas *Attalea maripa*, *Geonoma macrostachys* and *Bactris gasipaes*, used for thatching, were cited only by men.

The last day, we decided to treat our students to a surprise, and rented a motorized canoe to travel down the Tiputini river. These outings are important as we can see the palms from far in all their splendor, which changes from the understory view we generally have. We saw large river bank areas covered with *Bactris riparia*, majestic *Attalea butyracea*, and *Phytelephas tenuicaulis*. All along the river we also saw the usual suspects, such as *Iriartea deltoidea*, *Socratea exorrhiza* and *Euterpe precatoria*. However, the highlight of our river trip was not palms – students almost tipped over the canoe, when, in the blink of an eye, we spotted a small family of pink river dolphins (*Inia geoffrensis*). The mother and her

calf seemed amused by our boat and followed us, popping up now and then to the sound of camera shutters.

Finally, after six days of teaching, we left the calm hot and humid YRS and drove back up into the Andes to the noisy dry and cool city of Quito. Overall this was a great experience both for the students and teachers (Fig. 7). Focusing on different scientific disciplines centered around palms allowed a dynamic learning environment, in which students learned about the wide range of palm related research. We hope this course inspired several students to follow in the foot paths of some of the most eminent Latin American palm biologists.

Acknowledgments

This field course was made possible by an International Palm Society grant to R. Montúfar. Additional funding was secured from the Pontifical Catholic University of Ecuador (PUCE), the support of French National Institute for Research for Sustainable Development (IRD), the International Mixed Laboratory Bio_INCA (LMI_Bio_INCA) and the Universidad Autónoma de San Luis Potosí-México (UASLP). We thank the Guiyero community, who kindly allowed us to learn more about the Waorani culture, particularly Bolívar Enomenga, Isabel Ahua and Tepeña Ahua who accompanied us during our walks in the forest. We are so grateful to the authorities of YRS and its staff. We thank Esteban Baus, Rubén Jarrín and Alfredo Salazar, for video-recording the whole teaching experience, and R. Valencia for his suggestions to the text.

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The Conservation Status of *Attalea nucifera* (Palmae), an Endemic Species of Colombia

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Attalea nucifera **(Figs. 1 & 2) is an acaulescent palm endemic to the middle and lower Magdalena River valley in Colombia (Galeano & Bernal 2010). In 2005, it was considered a threatened species, ranked as Vulnerable, because only five, highly altered localities were known in an areal of around 10,000 km^2 (Galeano & Bernal 2005).**

Due to its edible seeds, *A. nucifera* has been listed among the useful plants of Colombia (Pérez-Arbeláez 1994) and as a native fruit of the Neotropics (Patiño 2002). There are old reports of the use of this palm, specifically in the municipality of Guaduas (department of Cundinamarca). During the Royal Botanical Expedition of the New Kingdom of Granada (1783–1816), José Celestino Mutis described in his personal notes the extraction of oil and its use as a food by the peasants of the area (Galeano 1985). Likewise, the German botanist Hermann Karsten (1856) pointed out that the seeds of the palm were sold as a snack by peasants in the market of Guaduas and were said to taste like almond or nuts. However,

1. *Attalea nucifera* in the municipality of Guaduas, Cundinamarca, Colombia.

interest in their consumption has decreased, and inhabitants of Guaduas rarely consume the palm seeds today.

Mutis did not describe the palm – locally known as *cuesco* or *cuesco de guaduas* (Pérez-Arbeláez 1994), *mangué* (Galeano & Bernal

2. *Attalea nucifera*, mature fruits, municipality of Guaduas, Cundinamarca, Colombia.

2005) or *almendrón* (Galeano & Bernal 2010) – but botanical illustrations were painted by two well-known botanical artists of that expedition, Francisco Escobar Villareal and Manuel Martínez (Galeano 1985). In 1856 Karsten described *Attalea nucifera* as a new

species for science, indicating that the type specimen had been collected in the vicinity of Guaduas. Subsequently, Karsten included his description and an illustration of *A. nucifera* in his publication *Florae Columbiae* (Karsten 1868–1861). Galeano and Bernal (2010) reported that the species is found only in the departments of Bolívar, Cundinamarca and Santander, between 200 and 800 meters above sea level. Characters that distinguish *Attalea nucifera* from other species in the genus include its underground stem, its leaves with pinnae regularly distributed in the same plane, the apical ones not united, and flowers with six or seven stamens (Galeano & Bernal 2010).

In this paper we update the occurrence records of *A. nucifera*. We verified the factors that affect its natural populations and made a reassessment of the conservation status of the species, following the IUCN guidelines, which recommend making a new assessment every ten years (IUCN 2012). Therefore, we have revised previous knowledge about the distribution of *A. nucifera*, have made new fieldwork in search of new localities and have made new observations on their state of conservation. We update the information on the occurrence of *A. nucifera* in protected areas.

Materials and methods

We have recorded all distribution data available at the National Colombian Herbarium (COL), the Global Biodiversity Information Facility (GBIF) and in the literature (Henderson et al. 1995, Galeano & Bernal 2005, Galeano & Bernal 2010). We verified four historical occurrences, ruled out two and included other localities not covered in the conservation assessment made in 2005. Extent of occurrence (EOO) and area of occupancy (AOO) were obtained through the use of the geospatial conservation assessment tool GeoCAT (Bachman et al. 2011). The number of localities and the decrease in AOO and in the quality of the habitat were based on our verification in the field during 2017. Finally, an IUCN evaluation (IUCN 2012) was applied to assign the degree of threat.

Results and Discussion

The number of occurrence records for *A. nucifera* increased (Table 1). In total, 18 occurrences were revised and geo-referenced, and two of them were excluded, as follows: the specimen *G. Galeano and L. Núñez MJS505* (IAvH-CT) from the municipality of Chaguaní (Cundinamarca), because in 2016 we visited the area and did not find any individuals, and also the altitudinal range does not correspond to that of the species; the specimen *R. Romero Castañeda 5339* (COL) near Puerto López (Meta) had an incorrect geo-reference. The occurrence records reported for the departments of Antioquia and Bolívar were included, although they still need verification by reviewing the specimens. They extend the area of distribution of *A. nucifera* up to the western margin of the Magdalena River.

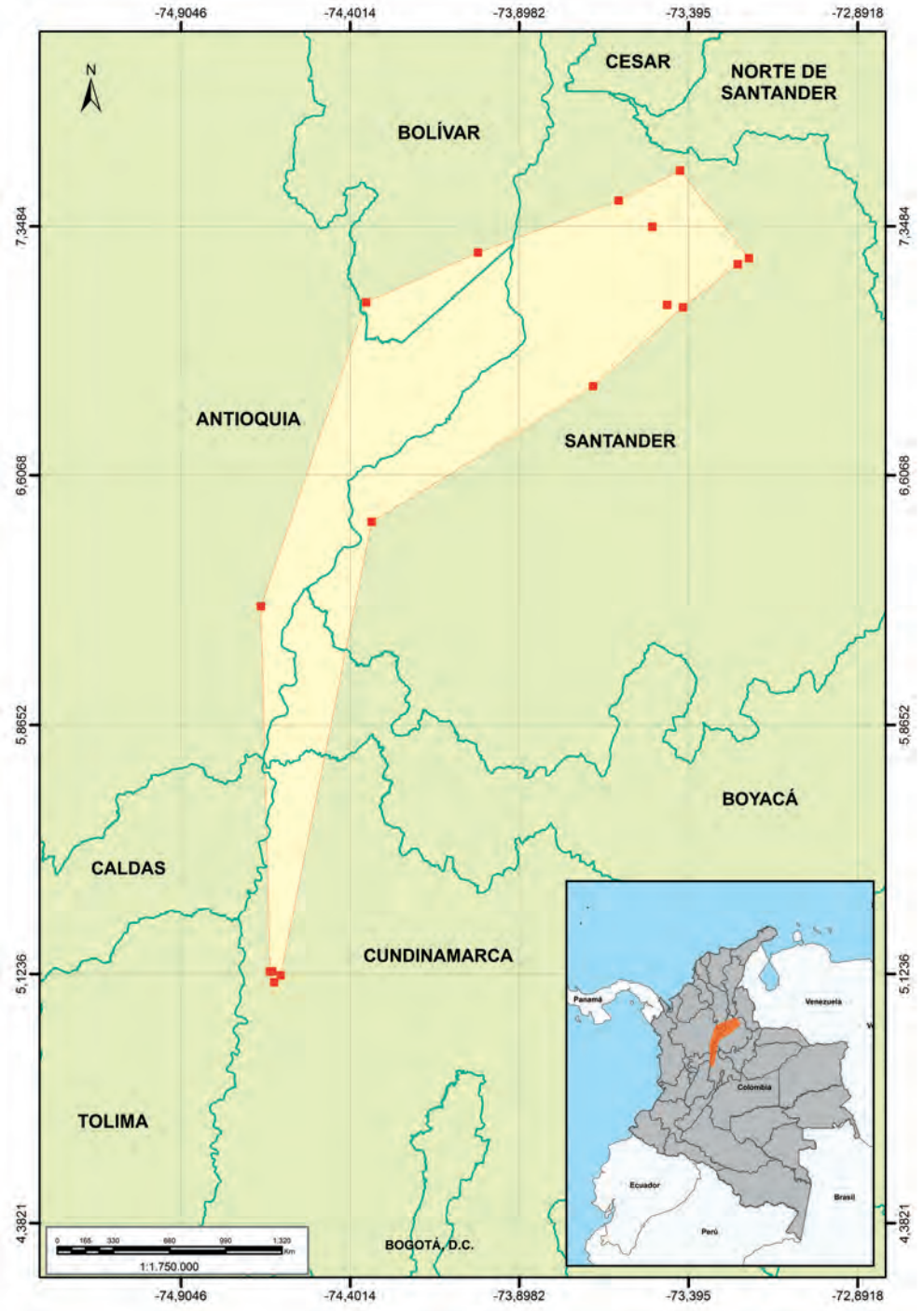
Based on the remaining 16 occurrence records (Table 1), an EOO of 18,510 km^2 and an AOO of 60 km^2 were calculated for the species (Fig. 3). Likewise, its presence was inferred in ten localities; in at least five of them, there was a decrease in habitat quality and in area of occupancy (AOO).

In Guaduas (Cundinamarca), the palm grows in forest fragments along stream margins that are strongly altered by cattle. A recent study shows that this subpopulation is decreasing, probably as a consequence of habitat degradation (Prada 2018). However, in the same general area there is another subpopulation within a private protection area (Loma Aventura Ecological Park).

In the municipality of Cimitarra (Santander) the species grows within a forest relict that is surrounded by livestock. In the municipality of Sabana de Torres (Santander) the palm occurs in some forest relicts along the road connecting the village of La Gómez and km 80 of the Atlantic railway, where it had been identified as early as 1960 (*R. Romero Castañeda 8392*, COL). Only a small part of this forest relict is conserved, since the original cover was eliminated for the cultivation of African oil palm (*Elaeis guineensis*). Also in this municipality the species is found within the Cabildo Verde Natural Reserve, and this population has been recovering for about 25 years.

In the municipality of San Vicente de Chucurí (Santander), *A. nucifera* grows scattered among the vegetation along streams. The original cover in this area was eliminated to give way to extensive cattle ranching and African oil palm cultivation. Finally, in the municipality of Betulia (Santander), we observed a few individuals of the species isolated in pastures and with no regeneration.

According to IUCN Red List Categories and Criteria (IUCN 2012), *Attalea nucifera* is categorized as Vulnerable [VU B1 + 2ab(ii,iii)], since its EOO is less than 20,000 km^2 (B1), its AOO is less than 2000 km^2 (B2), it occurs in



3. Area of distribution of *Attalea nucifera* in the Magdalena River valley, Colombia

10 localities (a) and there is a continuous observed decrease (b) in AOO (ii) and in the quality of the habitat (iii). Although there is no change of category in relation to the previous evaluation (Galeano & Bernal 2005), the parameters did change. The new localities recorded in recent years increased the extent of occurrence (EOO), as the number of known localities increased from five in 2005 to ten. However, our observations in five localities of Cundinamarca and Santander corroborate an increasing transformation of the species'

Table 1. Updated occurrence records for *Attalea nucifera* in its area of distribution in the Magdalena River valley, Colombia.

Place	Municipality (department)	Record	Geographical coordinates	Comments
Vereda Cerro Sargento	Guaduas (Cundinamarca)	*N. García and J. Prada-Ríos* (2017)	5.131694 N, 74.63335 W	Direct observation; no specimen
Ecological Park Loma Aventura	Guaduas (Cundinamarca)	*N. García and J. Prada-Ríos* (2017)	5.098856 N, 74.627858 W	Direct observation; no specimen
Vereda Cucharal, banks of the La Bermeja river, Villa María-San Luis	Guaduas (Cundinamarca)	*G. Galeano et al.* 8927 (FMB) (2012)	5.119517 N, 74.608122 W	Specimen preserved in the Federico Medem Herbarium (FMB). Verified by N. García and J. Prada-Ríos (2017)
ca. 10 km beyond the village Guaduas	Guaduas (Cundinamarca)	*G. Galeano et al.* 505 (COL) (1985)	5.130833 N, 74.639722 W	Specimen preserved in the Colombian National Herbarium (COL)
	Puerto Nare (Antioquia)	*J.G. Vélez et al.* 4421 (MO) (2001)	6.21666 N, 74.66666 W	Specimen preserved in Missouri Botanical Garden Herbarium (MO)
Near village Ojos Claros (Remedios - Antioquia), within the limits of San Pablo (Bolívar)	San Pablo (Bolívar)	*J.P. Tobón* 1201 (JAUM)(2015)	7.122111 N, 74.353806 W	Specimen preserved in the Herbarium of the Botanical Garden of Medellín Joaquín Antonio Uribe (JAUM)
Yanacué, road between El Salado & Bajos Cacaotera	Cantagallo (Bolívar)	*B. Villanueva et al.* 3801 (TOLI) (2017)	7.2704 N, 74.021533 W	Specimen preserved in the Herbarium of the University of Tolima (TOLI)
Cabildo Verde Natural Reserve	Sabana de Torres (Santander)	*N. García & J. Prada-Ríos* (2017)	7.346889 N, 73.502833 W	Direct observation; no specimen
Between La Gómez & km 80	Sabana de Torres (Santander)	*N. García and J. Prada-Ríos* (2017)	7.425361 N, 73.603111 W	Direct observation without collecting. Location originally identified without coordinates by R. Romero Castañeda 8392 (COL) (1960)

Table 1. (continued)

Place	Municipality (department)	Record	Geographical coordinates	Comments
Corregimiento Puerto Olaya, El Bosque, El Encanto Reserve	Cimitarra (Santander)	*R. Fonnegra* 8077 (HUA)(2004)	6.468333 N, 74.337778 W	Specimen preserved in the Herbarium of the University of Antioquia (HUA). Verified by N. García and J. Prada-Ríos (2017)
ca. 4 km NE of Yarima on the road to San Vicente	San Vicente de Chucurí (Santander)	*R. Bernal et al.* 4809 (FMB) (2012)	6.87184 N, 73.67929 W	Specimen preserved in the Federico Medem Herbarium (FMB). Verified by N. García and J. Prada-Ríos (2017)
Near Hidrosogamoso	Betulia (Santander)	*N. García and J. Prada-Ríos* (2017)	7.11376 N, 73.45873 W	Direct observation; no specimen
Highway between Barrancabermeja and Bucaramanga, about 1 hour before Bucaramanga	Girón (Santander)	*G. Galeano and A. Barfod 1276* (COL) (1987)	7.106652 N, 73.411157 W	Specimen preserved in the Colombian National Herbarium (COL)
Corregimiento Bocas, old railroad, hillside forest above Puente Negro	Rionegro (Santander)	*A. Dueñas et al.* 3341 (FMB) (2013)	7.235 N, 73.248583 W	Specimen preserved in the Federico Medem Herbarium (FMB)
Corregimiento Llano de Palmas, vereda La Honda, Finca La Meseta	Rionegro (Santander)	*D. Ariel and M.F. González* (2013)	7.2525 N, 73.21491 W	Direct observation; no specimen
Corregimiento of San Rafael de Lebrija	Rionegro (Santander)	*G. Galeano et al.* 1241 (COL) (1986)	7.514167 N, 73.420278 W	Specimen preserved in the Colombian National Herbarium (COL)

natural habitat, supporting the inference of a decrease in habitat quality and area of occupancy (AOO).

Only two subpopulations are located in protected areas, one in the Cabildo Verde Natural Reserve (Sabana de Torres, Santander), and one in the Los Yariguíes Regional Management District (Betulia, Santander). The subpopulation located in the municipality of San Pablo (Bolívar) is part of an area that is in the process of being declared a National Natural Park (NNP Serranía de San Lucas). This information updates the information included in the *Conservation, Management and Sustainable Use Plan of Colombian Palms* (Galeano et al. 2015) on the presence of *A. nucifera* populations in protected areas.

Although *A. nucifera* remains as Vulnerable, its fate is uncertain, since at least three subpopulations in the department of Santander (municipalities of San Vicente de Chucurí, Sabana de Torres, and Betulia) are in highly disturbed areas that are subject to strong habitat transformation, such as extensive cattle ranching and African oil palm cultivation. Since the process of environmental decline is not easily reversed, habitat degradation could result in a decrease in the number of localities where the species is present. Therefore, we recommend a reassessment of the species' conservation status in ten years, incorporating any new information that may arise, including new occurrences and state of the populations throughout the area of distribution.

Acknowledgments

We are grateful to the Research Fund of the Pontificia Universidad Javeriana for financial support (ID 0006776), through the project "*Demografía, manejo y conservación de Attalea nucifera (Arecaceae) en la cuenca del río Magdalena*." We thank Rodrigo Bernal for his critical review of the manuscript and important suggestions, and the anonymous reviewers for their constructive feedback on this manuscript. We also thank Mery Molina for producing the map of *Attalea nucifera*. The results are part of JPR's MSc thesis in Biodiversity Conservation and Use.

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An Introduction to the Palms of Sulawesi

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In this article, I give a review of the palm flora of the fascinating island of Sulawesi, Indonesia.

Sulawesi is one of the larger islands of the Indonesian archipelago, situated just to the east of Borneo and just to the west of the Maluku Islands and New Guinea. It is supposed to be the eleventh largest island in the world. From north to south, in a straight line, it is about 800 km long, and from west to east about 700 km wide, but you cannot really go in a straight line for very far, because the island has a peculiar shape with several peninsulas jutting out in easterly and southerly directions.

Sulawesi is poorly known botanically compared with the rest of Indonesia, and yet it is a very interesting island, situated as it is in the center of Wallacea. This is the biogeographical region east of Borneo (and east of Wallace's Line) and west of the New Guinea/Australia region. Wallacea comprises not only Sulawesi but also the Lesser Sunda Islands and the Maluku Islands. The islands of Wallacea have had a complicated geological history and have been isolated from areas to the west and east for a long time. As such they have a highly endemic fauna and flora, with few species in common with other areas. For example, in Sulawesi, only seven species of dipterocarps have spread eastwards from Borneo (where there are over 260 species), and only one species of *Eucalyptus* has spread westwards from the New Guinea/Australia region (where there are almost 700 species).

There are still large areas of forest remaining in Sulawesi, especially in the mountains. Most of the lowlands are deforested, and most of the southwestern peninsula, but there are still huge areas of forest in other parts of the island, particularly in central Sulawesi. I recently spent several months there, working on a project on rattans. Although my main concern was with *Calamus*, I did see various other palms. In this article I give my first impressions of the palms of the island. There have been two published articles on palms of specific areas in Sulawesi: Mogea (2002) on Lore Lindu National Park and Powling (2009) on Buton Island. Mogea (2002) also gave a checklist of all species from the island, listing 71 species, 72% of which he considered endemic. Kew's Monocot Checklist recognizes 65 species of palms occurring in Sulawesi. We still do not know enough about some genera, particularly *Pinanga* and *Calamus*, to be able to give a definite figure on the number of species.

There are five genera of fan palms: *Corypha, Saribus, Licuala, Pholidocarpus* and *Borassus*. *Corypha utan* is common in Sulawesi. It is most

1. *Pholidocarpus ihur* near Tolitoli.

2. Fruits of *Pholidocarpus ihur*.

3. *Arenga undulatifolia* near Tolitoli.

often seen in disturbed areas near roads and seems to be able to persist in such places. We never saw it in anything resembling a natural habitat, but it was very abundant on the deforested hills west and east of Gorontalo. In the eastern peninsula, east of Luwuk along the coast from Dondo to Pangkalaseang, *C. utan* was quite common, growing amongst the coconuts and in disturbed areas. We saw one fruiting and another, a long way off, in full flower. It is a widespread species, occurring from the Andaman Islands in the west to Australia in the east.

Saribus rotundifolia (formerly *Livistona rotundifolia*) is common and widespread, both in the forest and planted as an ornamental. It is a beautiful palm, especially when young with its perfectly round leaves. The leaf bases form a characteristic pattern along the upper part of the stem (Back Cover). Locally, it is known as *nimbung*. *Saribus rotundifolia* is widespread in the Philippines, Sulawesi and the Maluku Islands.

Licuala is a genus that needs more study in Sulawesi. There are supposedly two species, both endemic to the island, *Licuala bissula* and *L. celebica*. We only saw rather scrappy plants of *Licuala* on two occasions. Mogea (2002) also listed *L. spinosa*, and certainly one of the plants we collected looked a lot like this species.

Just south of Tolitoli, in a wet, swampy area, we came across a grove of *Pholidocarpus ihur* (Fig. 1). One plant was in fruit, and we picked up some of the curious, warty fruits from the ground (Fig. 2). This was the only place we saw this species. It is native to Sulawesi and the Maluku Islands.

Borassus flabellifer is cultivated in Makassar, in the southwestern peninsula, and surrounding areas, but we did not see in the rest of the island. Powling (2009) noted that it also occurs on Buton Island, just off the southeastern peninsula. The natural range of this widespread and useful species is not known (Bayton 2007), and it may well have been introduced into Sulawesi.

Two caryotoid genera, *Caryota* and *Arenga*, occur in Sulawesi. After coconuts, *Arenga pinnata* is the commonest palm, not only in disturbed areas along the roads but also in the forest, where it seems to occur naturally. It is known as *areng*, and all parts are used. The most important use seems to be the preparation of palm wine, from tapping the inflorescences. A second species of *Arenga* is common in the forests, the acaulescent *A. undulatifolia* (Fig. 3). It is also known from Borneo and Palawan in the Philippines, but my impression is that the Sulawesi ones have much wider pinnae. Two *Caryota* are seen in the forest, the clustered-stemmed *C. mitis* and

4. *Caryota angustifolia* (left) growing with *Arenga pinnata* (right).

5. *Areca vestiaria*. A. Habit. B. Crownshaft. C. Stilt roots. D. Ripe fruits.

6. *Oncosperma horridum* near Manado.

7. Calamus zollingeri.

the larger, single-stemmed *C. angustifolia* (Fig 4). Apparently, this latter species was first noticed by Dransfield (1974a) but not described until recently (Jeanson et al., 2011). A third species of *Caryota*, *C. rumphiana*, is on the Monocot Checklist, but it is not clear if it is present in Sulawesi or not (Jeanson 2011).

Five arecoid genera are said to occur in Sulawesi: *Areca, Pinanga, Oncosperma*, *Hydriastele,* and *Orania*. *Areca vestiaria* is extremely abundant and easy to identify, with its stilt roots, red crownshaft and bright red fruits (Fig. 5). Plants are quite variable, particularly in the color of the crownshaft (see also Dransfield 1974b). It is endemic to the Wallacea region. There is one other species of *Areca* in Sulawesi, apart from the cultivated *A. catechu*, and that is *A. oxycarpa*. We did not see this species, but Heatubun et al. (2012) described it as having small, solitary stems and dark brown or black crownshafts. It is known only from northeastern Sulawesi.

Pinanga is more diverse, and the Monocot Checklist gives seven species in Sulawesi, while Mogea (2002) listed 12, eight of them undescribed. We saw quite a few obviously distinct species but were able to identify only one with any certainty, *P. caesia*. One species from near Luwuk was quite distinct in its spirally arranged flowers and fruits and may represent *P. rumphiana*, known from the Maluku Islands and New Guinea. Powling (2009) mentioned that *P. rumphiana* also occurs in Buton Island.

Oncosperma horridum (Fig. 6) is relatively common, and in some places has extraordinarily tall, clustered stems. It is unusual for an arecoid palm in having spiny stems, leaves and inflorescences. This species is widespread from Peninsular Thailand through Sumatra, Borneo and Sulawesi, and also occurs in the Philippines.

There are two other genera that are reported for Sulawesi that we did not see, *Hydriastele* and *Orania*. There are four species of *Hydriastele* described from the island. I think these may be more common in southern parts of the island, where we did little field work.

According to Dr. John Dransfield, the only evidence for the occurrence of *Orania* in Sulawesi is from David Fairchild's book on his travels in tropical Asia (Fairchild 1943). Fairchild certainly knew *Orania* because he described collecting *O. palindan* in Luzon, in the Philippines, but the only other mention in the book of an *Orania* is in a caption of a photograph of a palm from Sulawesi: "Though this *Orania* palm from Celebes [Sulawesi] looks much like a coconut, its fruits are no larger than billiard-balls." The palm in the photograph looks like an *Orania*, but exactly where it is from is unclear.

There are six calamoid (scaly-fruited) genera of palms in Sulawesi: *Calamus, Daemonorops,*

8. *Pigafetta elata* near Tinombala, growing with *Pandanus*.

9. Coconuts near Gorontalo.

Korthalsia, Pigafetta, Salacca and *Metroxylon*. Of these, the first three genera are climbers, rattans, and the last three non-climbing. Rattans are important plants commercially in Sulawesi, and large amounts of raw cane are collected from the forests and exported, mostly to the furniture factories of Java. Because of their economic importance there have been several studies of their ecology in Sulawesi (e.g., Siebert 1997, 2005; Clayton et al. 2002; Stiegel et al. 2011; Pritchett et al. 2016). Siebert (2012) also gave much information on the economic and cultural aspects of rattan in Sulawesi. However, taxonomic knowledge of the species is still incomplete, despite some relatively recent studies (Rustiami 2011, Rustiami & Henderson 2017), and there are no doubt new species to be discovered.

We found about 28 species of *Calamus*, several of them undescribed. All these species are endemic to the island except for two. One, *C. siphonospathus* from the Philippines, just reaches the northwestern tip of the island, and the second, *C. ornatus* from Borneo, is common throughout the island. One of the commonest species, and the most commonly harvested is *Calamus zollingeri* (Fig. 7). The relatively high number of *Calamus* species gives the palm flora of Sulawesi a lop-sided appearance. There are almost as many species of *Calamus* as there are all other species combined. The other interesting thing about *Calamus* is its diversity in Sulawesi, especially when the size of the island is taken into account. There are 73 species of *Calamus* in Borneo and 59 species in New Guinea, but both these islands are more than five times the size of Sulawesi. In proportion to its size, Sulawesi has more species than either of the larger islands. There are a few species of *Daemonorops* in Sulawesi, probably about five, and a single *Korthalsia, K. celebica*. This is a common and almost weedy species.

Of the non-climbing calamoid palms, *Pigafetta elata* (Fig. 8) becomes abundant in more upland areas, its straight trunks reaching more than 30 m tall. It is a beautiful palm, and the great stands of this species growing on steep mountain slopes are a wonderful sight. Most of Sulawesi is near the equator, and the equator itself runs through the northern peninsula, and so the island does not suffer from typhoons. This may be one of the reasons that *Pigafetta*, and the forests, can grow so tall, at least in the central part of the island – that and the volcanic soil. *Pigafetta elata* is endemic to Sulawesi, and the second species in the genus, *P. filaris* is known from the Maluku Islands and western New Guinea (Dransfield 1998).

The two other non-climbing calamoid genera are represented by one species each, *Metroxylon sagu* and *Salacca zalacca*. These two are very

common and commonly used, but both are apparently introduced from other areas. Mogea (2002) also listed *Eugeissona* for Sulawesi, but I do not think it occurs there.

Last but not least, *Nypa fruticans* is quite common in Sulawesi. We saw it in many places near the coast.

There are several cultivated palms in Sulawesi. By far the commonest of these is the coconut. There are millions and millions of coconuts especially in low elevation areas near the sea (Fig. 9). They are one of the most important crop plants in Sulawesi, along with rice, cloves and cacao. They appeared to me to be unusually tall-stemmed, and every coconut in Sulawesi seems to have notches cut into the trunk for climbing. Coconuts are grown for copra production, and it is a common sight to see copra drying by the side of the road. Most of it is apparently exported to Java for oil extraction. In towns and villages, one sees a variety of other cultivated palms grown as ornamentals, such as *Actinorhytis calapparia*, *Dypsis lutescens*, *Ptychosperma macarthurii*, *Rhapis excelsa, Roystonea regia, Thrinax radiata*, *Veitchia merrillii* and *Wodyetia bifurcata*.

Acknowledgments

Fieldwork in Sulawesi was funded by a Fulbright Scholar Award. I thank the Rector of Tadulako University for his support, and Dr. Ramadanhil Pitopang, Professor in the Department of Botany for his friendship and support. I also thank the Ministry of Research Technology and Higher Education Republic of Indonesia for research and collection permits and the staff of the American Indonesian Exchange Foundation (AMINEF) for their help with logistics.

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Aiphanes graminifolia, One of the World's Most Endangered Palms

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With a population of 30 individuals located in a small relict of premontane forest in the Eastern Andes of Colombia, the spiny *Aiphanes graminifolia* has an unusual growth habit in the forest understory and ranks among the most critically endangered palms worldwide.

The genus *Aiphanes* is distributed along the Andes, from Venezuela to Bolivia (Borchsenius & Bernal 1996) and comprises 32 described species (Govaerts et al. 2018), plus at least four species currently in the process of description (R. Bernal, unpublished data). The genus includes small to medium-sized, solitary or cespitose, spiny palms, easily recognized by the pinnae with a praemorse apex and the inflorescences with a long peduncle and a narrow peduncular bract (Borchsenius & Bernal 1996, Dransfield et al. 2008). *Aiphanes* is most diversified in Colombia, where 27 species are found, including the above-mentioned four species currently under description (Bernal et al. 2015, Bernal et al. 2017).

About one half of the species in the genus have small distribution ranges, and the prevalence of narrow endemism in the genus has been pointed out (Bernal et al. 2017). At least 15 of the Colombian species of *Aiphanes* are threatened (vulnerable, endangered or critically endangered) (Galeano et al. 2015, Bernal et al. 2017, Bernal unpublished data), and 12 of these species are endemic to that country. For some of them, like *A. argos, A. graminifolia, A. killipii* and *A. leiostachys*, the known populations are quite reduced, and the number of known subpopulations is unlikely to increase after further exploration, if habitat availability is considered. These four species have been assessed as critically endangered (CR) by Galeano et al. (2015), according to the parameters of the IUCN (2012).

Aiphanes graminifolia was discovered as recently as 2001, in a small area of wet premontane forest in the department of Santander, in the eastern Cordillera of Colombia (Galeano & Bernal 2002). It differs from other species in

1. Young sucker of *Aiphanes graminifolia*. Note the praemorse leaf tips.

the genus in its numerous leaflets that are extremely narrow and delicate, thus resembling grass leaves (Fig. 1), whence the epithet *graminifolia*. The palm forms loose clumps (Fig. 2), with slender stems that reach up to 7 m long and 2 cm in diameter. The stems do not grow straight but spread from the base in all directions, variously bending

2. An individual of *Aiphanes graminifolia*, the numerous stems marked with aluminum tags.

and leaning (Fig. 3), until the longest ones eventually end up with their crowns landing on the ground. Because the stems usually have aerial sprouts (Fig. 4), these ultimately root in the soil. The original stem eventually decays and a new clump is thus formed. This mechanism of asexual reproduction has been recorded only in two other species of *Aiphanes*, viz. *A. erinacea* and *A. macroloba* (Borchsenius & Bernal 1996). The stems of *A. graminifolia* are very hard and resistant, and they were formerly used by local people to make spears for hunting.

In order to estimate the current population size of *A. graminifolia* and to study its sexual and vegetative reproductive strategies, we monitored the only known population of this species between March 2017 and March 2018. This population grows at the private reserve La Meseta, located near the village of San José de Suaita, in the department of Santander, northeastern Colombia (Fig. 5). This protected area comprises ca. 615 hectares of premontane very wet forest according to Holdridge's life zone system (IGAC 1977), and ranges from 1550 to 2050 m of elevation, with an average temperature of 20°C and an annual rainfall of 2100 mm. We explored the forest with our local guide, Francisco Bautista, who knows the entire reserve, and documented all individuals so far recorded by him, as well as any additional ones found during our work. For each individual, we marked all its shoots with aluminum tags (Fig. 2), as well as the youngest expanded leaf of each stem, in order to determine the production of new shoots and the leaf production rate respectively.

We found only 30 individuals of *Aiphanes graminifolia* in the forest relict. The number of stems per clump was four on average, and the longest one reached up to 7 m. On average, each stem had five expanded leaves, and produced around four new leaves during the one-year study period. Combining this figure with the count of leaf scars on the stems (Fig. 3), we estimated the age of each individual. The oldest stems recorded were about 50 years old, and the youngest reproductive stem ca. 8 years old. Each clump produced on average four new shoots per year, although some individuals produced up to 11 shoots (Fig.4). Aerial sprouts were found on 10 stems, at 0.55–5.60 m from the base (Fig.5). We did not find any seedlings or juveniles resulting from sexual reproduction. During the sampling period, three stems from three different individuals died, hit by falling trees after heavy rains. In all cases, the remaining stems in the clump were not affected.

Aiphanes graminifolia is monoecious, producing male and female flowers on the same in-

3 (top). A typical decumbent stem of *Aiphanes graminifolia*. The darker areas are the spiny internodes; the light brown areas are the leaf scars. 4 (bottom). Aerial sprouts high on the stem of *Aiphanes graminifolia*.

5. The forest remnant (yellow ellipse) where *Aiphanes graminifolia* occurs. Google Earth image.

florescence. Development of the inflorescence is protandrous, i.e., the male flowers reach anthesis before the female ones. All clumps were observed to have stems bearing flowers and stems bearing fruits simultaneously. Adult stems produced on average two inflorescences per year. As in other species of *Aiphanes*, the flowers are disposed on the rachillae in spirally arranged triads (one central pistillate and two lateral staminate flowers). However, while triads are present towards the base of the proximal and middle rachillae, only staminate flowers arranged in dyads and monads, occur in the distal portion of the basal and middle rachillae and throughout the distal rachillae. At anthesis, the staminate flowers are sessile, about 3 mm in diameter, cream or light purple basally, and darker towards the apex (Fig. 6A). The pistillate flowers are 4 mm long, also sessile, with purple sepals and whitish petals (Fig. 6B). The fruits are globose, 3–4 mm in diameter, green when immature and turning to yellowish green as they mature (Fig. 7). Mature fruits were not recorded during our study. Fruit production is low, and only 230 developing fruits were recorded during the one-year study period.

The long-term survival of *A. graminifolia* is not guaranteed. The area of the forest where it grows is just 6 km^2, and the reserve that protects it, ruled by a private NGO, is under strong pressure from local people, in an area where forest has disappeared altogether (Fig. 5). The potential habitat for the species in the Eastern Cordillera is limited to several small forest fragments that sum up to ca. 45 km^2 (Galeano & Bernal 2005), but there are no records of the species in those areas. The extremely low number of individuals (30 clumps), combined with the scarce fruit production, bespeak a low rate of sexual reproduction, which is shown by the absence of seedlings or sexual juveniles. Some of the clumps we observed appeared to have developed from neighboring plants via vegetative propagation. Thus, the genetic variability within the population might be extremely low.

Thus, *Aiphanes graminifolia* ranks among the world's most threatened palms. According to the IUCN Red List of Threatened Species (IUCN 2018), only 36 species of palms (Appendix 1) have populations known to comprise 30 individuals or fewer. Yet, as with other Colombian endemics categorized as threatened (Galeano & Bernal 2005, Bernal & Galeano 2006, Galeano et al. 2015), *A. graminifolia* has not been included so far in the IUCN Red List. Hopefully, it will deserve attention before it has to be included as extinct.

Acknowledgments

We thank the International Palm Society and the Biodiversity Studies Group (GeBio) of the Industrial University of Santander (UIS) for funding this project. We thank also the San Cipriano Foundation for allowing us to do this research in the Reserva La Meseta, to Francisco Bautista for being an excellent guide in the forest and for sharing with us his knowledge on *A. graminifolia*.

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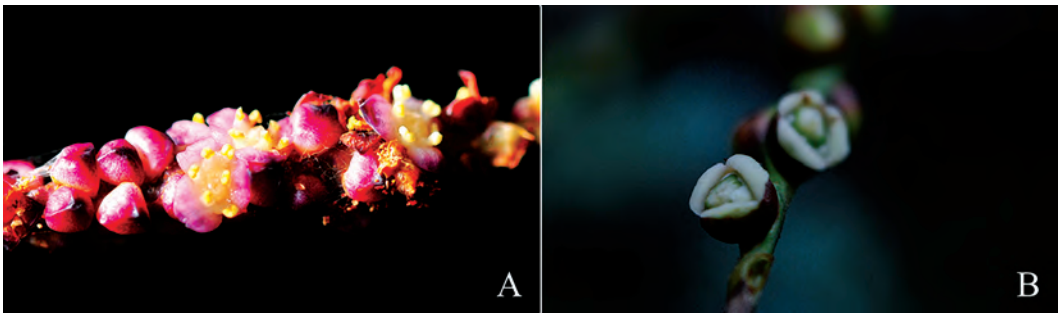

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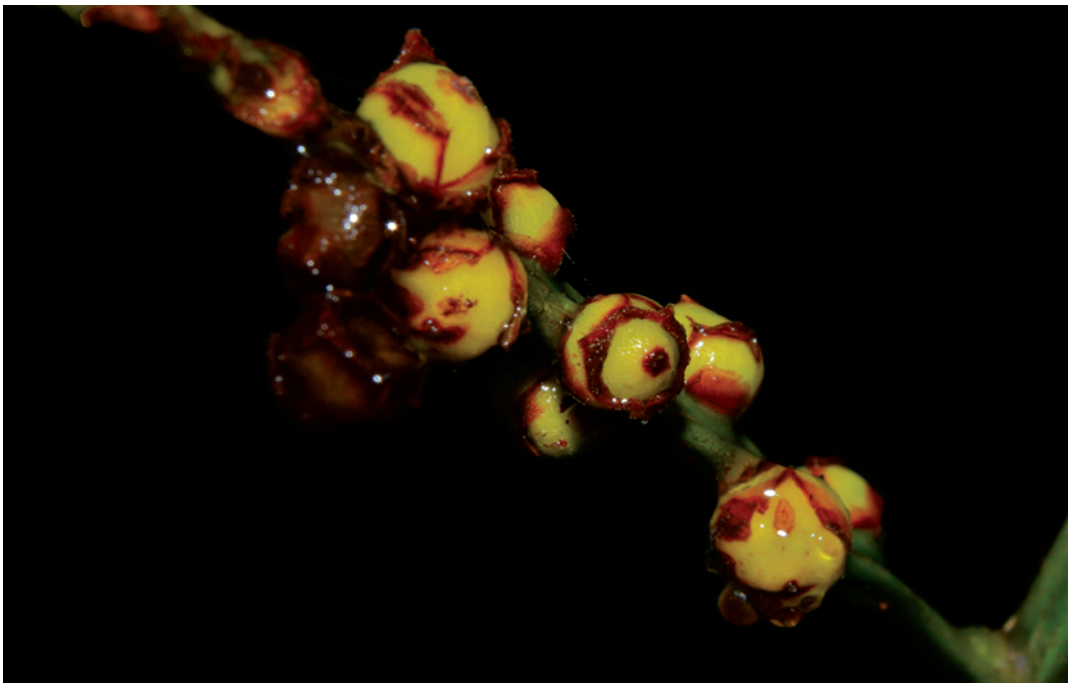

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Appendix 1. Palm species known to have populations as large as or smaller than that of *Aiphanes graminifolia* (30 individuals). Source: IUCN (2018).

Species	Distribution	Known number of individuals
Dypsis ambanjae	Madagascar	30
Dypsis ampasindavae	Madagascar	30
Dypsis basilonga	Madagascar	30
Dypsis beentjei	Madagascar	30
Dypsis nauseosa	Madagascar	30
Dypsis pumila	Madagascar	30
Dypsis tokoravina	Madagascar	30
Dypsis vonitrandambo	Madagascar	30
Masoala madagascariensis	Madagascar	30
Pritchardia hardyi	Hawaii	30
Ravenea lakatra	Madagascar	30
Tahina spectabilis	Madagascar	30
Dypsis nossibensis	Madagascar	25
Dypsis ramentacea	Madagascar	25
Dypsis albofarinosa	Madagascar	20
Dypsis cookei	Madagascar	20
Dypsis pulchella	Madagascar	20
Dypsis remotiflora	Madagascar	20
Dypsis carlsmithii	Madagascar	15
Dypsis elegans	Madagascar	15
Voanioala gerardii	Madagascar	15
Pritchardia schattaueri	Hawaii	12
Dypsis brittiana	Madagascar	10
Dypsis canaliculata	Madagascar	10
Dypsis humilis	Madagascar	10
Dypsis jeremiei	Madagascar	10
Ravenea louvelii	Madagascar	10
Dypsis ovobontsira	Madagascar	9
Dypsis tanalensis	Madagascar	8
Dypsis pervillei	Madagascar	7
Dypsis leptocheilos	Madagascar	5
Ravenea latisecta	Madagascar	4
Bactris nancibensis	French Guyana	2
Ravenea moorei	Comoros	2
Dypsis robusta	Madagascar	1
Saribus jeanneneyi	New Caledonia	1

Photo Feature

Jubaeopsis caffra, the Pondoland Palm

The Pondoland palm, *Jubaeopsis caffra*, grows on the north bank of the Mtentu River in the Mtentu Nature Reserve, Eastern Cape (South Africa).

Ingrid Hardman
South Africa

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