Kapawi: A Mega-Diverse Palm Community in the Eastern Amazon of Ecuador

Thomas L.P. Couvreur[1,2]*, Roberto Carrillo-Flores[3], Rodrigo Cámara-Leret[4], Juan Carlos Copete[5] and Henrik Balslev[6]

The Achuar Kapawi community is located in the eastern Amazonian region of Ecuador. It is adjacent to the Kapawi river, a tributary of the large Pastaza river and is just 20 km from the Peruvian border. Because of its proximity to Peru, this region might harbor several species of palms not yet recorded in Ecuador. The present article is a personal account from a 5-day expedition to the region by the first author, and a preliminary synthesis of results from an expedition led by Henrik Balslev (ecology) and Rodrigo Cámara-Leret (ethnobotany) to investigate the diversity, abundance, and uses of palms in the region.

Ecuador is one of the richest countries in palm diversity of South America when related to its size. To date, around 140 species in 32 genera are recorded (Valencia et al. 2013). Yet, some areas of the Amazon remain relatively little explored for palms (Borchsenius et al. 1998, Couvreur et al. 2008, 2021), especially those close to the Peruvian border. This is the case

[1]*Institut de Recherche pour le Dévelopemment IRD, DIADE, CIRAD, Université de Montpellier, Montpellier, France. thomas.couvreur@ird.fr*

[2]*Pontificia Universidad Católica del Ecuador, Facultad de Ciencias Exactas y Naturales, Av. 12 de Octubre 1076 y Roca, Quito, Ecuador.*

[3]*Director de la Organización Turismo & Conservación, Av. Machala N-54 225 y Jorge Piedra, Quito, Ecuador. rcarrilloflores@turismoyconservacion.org*

[4]*Department of Evolutionary Biology and Environmental Studies, University of Zurich, Zurich, Switzerland. rodrigo.camaraleret@ieu.uzh.ch*

[5]*Corporación Autónoma Regional del Centro de Antioquia, Cra. 65 #44A-32, Medellín, Antioquia, Colombia. juan_copete@corantioqia.gov.co*

[6]*Department of Bioscience, Ecoinformatics and Biodiversity Group, Aarhus University, Aarhus, Denmark. henrik.balslev@bios.au.dk*

1. A view of Kapawi Eco Lodge, deep in the Ecuadorian amazon, in the region of Pastaza, close to the Peru border. Notice *Astrocaryum chambira* (tall palm), and just under a juvenile *Iriartea deltoidea*. Photo by Thomas L.P. Couvreur.

of the Kapawi community of the Achuar, one of the most recent Indigenous ethnic groups to have been contacted.

The Achuar are one of the 13 Indigenous ethnic groups living in Ecuador. The word "Achuar" comes from the union of the words "shuar" or person and "achu" or *morete* palm (*Mauritia flexuosa*). The 'Achuar' are thus the people of the *morete* palm. The lifestyle and traditions of Achuar were famously described by the French anthropologist Phillipe Descola who visited Kapawi in the 1970s (Descola 1993). And yet, far too little is known about the Achuar people's knowledge of Amazonian biodiversity or about palms and their uses.

Kapawi, which refers to the name of a sort of flat fish in the Achuar-Shiwiar language (Descola 1993), is located deep in the Ecuadorian Amazon in the region of Pastaza, some 175 km southeast from the Amazonian town of Puyo and 20 km from the Peruvian border. This region is covered by a dense lowland rainforest drained by the large Pastaza river, which starts high in the Andes near Baños, and ends in the Mariño river in Peru (a tributary of the Amazon). Besides the relatively flat region close to Pastaza, there is a hilly area to the north, with peaks of about 350–400 m, providing some geological diversity to the region.

Kapawi was the focus of two palm expeditions that took place ten years apart, one in October 2011 led by Henrik Balslev (ecology team) and Rodrigo Cámara-Leret (ethnobotany team) and one in February 2021 led by Thomas Couvreur. The base for both expeditions was the Kapawi Eco Lodge (www.kapawi.com) (Figs. 1 & 2), a community-based project which aims to use ecotourism for the economic, social, and cultural development of local Achuar communities. The project, which is managed by the indigenous residents themselves, serves as an added source of income for the Kapawi, Wachirpas, Ishpingo, Kusutkau, Wayusentsa, Sharamensa and Suwa communities. Ecotourism revenues have served to increase local incomes. Importantly, ecotourism provides an added incentive for local communities to conserve the natural resources in the area.

To reach Kapawi, one needs to take a plane from the aerodrome located in the village

2. Example of the understory rain forest near Kapawi the common *Hyospathe elegans* subsp. *elegans* in the foreground. Photo by Thomas L.P. Couvreur.

called Shell, just north of Puyo. Once in the air, the small 3-passenger plane takes an eastern bound direction, leaving behind the mighty Andes. On a good day, one can see to the right the Sangay, one of the numerous active volcanoes in Ecuador spitting its fumaroles. As we progress into the Amazon, the impact of humans on the rainforest becomes less and less apparent. After a short 45 min flight, the plane makes an expert

3. Our Achuar guide, Jhonny Saant in the Kapawi rainforest. Photo by Thomas L.P. Couvreur.

landing on the short dirt runway of the Kapawi community. Several people come out of nowhere and check with the pilot if some relatives in Puyo sent them some food or a letter. After a short stop, the plane turns and takes off again.

One of our guides was Jhonny Saant, a 30-year-old Achuar student in pedagogy and father of three (Fig. 3). After being a guide for the lodge for several years, he decided to resume higher education thanks to a government scholarship. Thomas was also accompanied by two other young Achuar students at the Kapawi community school.

The plan for Thomas's teamwas to walk as much as we could and collect as many palms as we saw. This general collecting approach allows one to cover more ground but with less detail. In contrast, the ecology team set up a much more thorough protocol to document palm diversity, results of which are partially presented here. A total of 11 transects measuring 5 × 500 m each were installed, covering different lowland evergreen forest types: terra firme (4 transects), intermediate (1 transect) and floodplain (6 transects). In these transects, all palm individuals including seedlings, juveniles, sub-adults and adults are meticulously counted, measured, identified and photographed. Finally, the ethnobotany team undertook several interviews to document to the importance of palms and their uses across the Achuar communities.

A mega-diverse palm community

After one week of painstaking work in October 2011, the ecology team (led by Henrik Balslev) documented 7505 palm individuals representing a total of 40 palm species in 21 genera across the 11 transects covering 2.75 ha (Table 1). That means there are 2729 palms per hectare and between 9 to 29 species per transect! In addition, four species were documented outside of the transects (*Bactris gasipaes* var. *gasipaes* (Fig. 4), *Cocos nucifera*, *Syagrus sancona* and *S. smithii*) leading to 44 palms known from Kapawi. *Oenocarpus bataua* was by far the most abundant palm in the region with 1529 individuals registered over the 11 transects. We can refer to such species as being super-abundant. The two other most abundant palms were the understory *Geonoma macrostachys* (953 individuals) and *Geonoma stricta* subsp. *arundinacea* (857 individuals reported). Both species are morphologically very variable and taxonomically hard to classify. *Geonoma macrostachys* is, in fact, so

4 (left). *Bactris gasipaes* var. *gasipaes*, or *uví* in Achuar. Here one morphotype with red fruits (left) and one with white fruits (right) growing in Jhonny's *chacra* (community garden). Photo by Thomas L.P. Couvreur. 5 (right). *Wendlandiella gracilis* var. *simplicifrons* in flower (a new genus and species record for Ecuador). Photo by Henrik Balslev.

variable that it was impossible to define into different subspecies (Henderson 2011). Nevertheless, it is a spectacular understory palm with large (to 2 m tall) generally undivided leaves and a long erect generally unbranched inflorescence. It is common across the Ecuadorian Amazon growing sympatrically with many different morphotypes. Even though this morpho-diversity is a headache for taxonomists, it is a blessing for evolutionary biologists who are using the *Geonoma macrostachys* species complex model to unravel the impact of Amazonian environmental heterogeneity on understory plant speciation (Roncal 2006, Bacon et al. 2021).

In terms of species richness, the 2011 fieldwork showed that Kapawi is one of the most species rich palm communities across the whole of tropical America (Balslev et al. 2011). The terra firme evergreen forest was the most diverse with 29 species, while the intermediate lowland was the poorest, with 18 species. Even when we compare with similar habitats, Kapawi stands out as very species rich. For example, Kapawi is comparable to Yasuni, in lowland Ecuador Amazon and one of the most biodiverse places on earth. A recent survey documented between 30 and 33 palm species on terra firme over a surface of 2.5 ha (Balslev et al. 2011, although there might be different species concepts between studies). The region around Kapawi is thus a truly mega-diverse palm community in western Amazon.

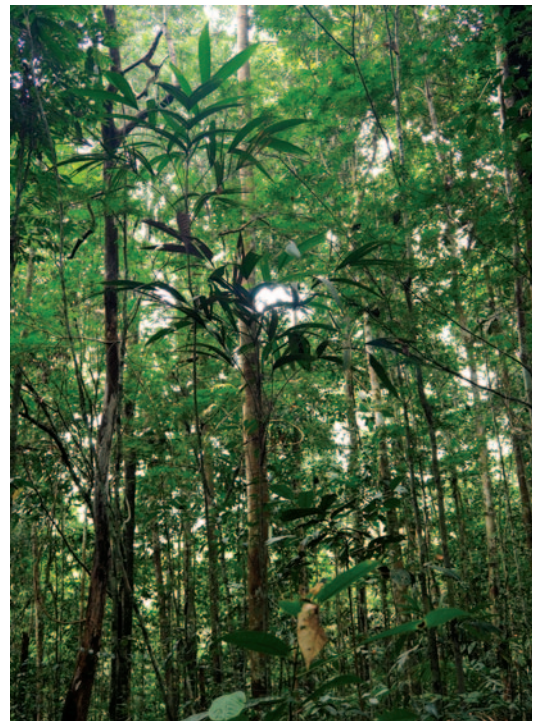
Most of these species were already documented from Ecuador, although generally not reported for this region. Interestingly, and as we hypothesized before our expeditions, we documented the presence of two genera, one species and one subspecies as new records for Ecuador.

The two genera new to Ecuador are the monotypic genus *Wendlandiella* and *Iriartella* (two species). *Wendlandiella* represents a single polymorphic species, *W. gracilis*, distributed mainly in Peru and the State of Acre in Brazil (Eychenne et al. 2018). Kapawi harbors the most northern population of *W. gracilis* representing the variety var. *simplicifrons* (Fig. 5). It is a small understory palm, with entire-bifid leaves and an erect once branched inflorescence with several rachillae. It can easily be confused with other understory bifid-leaved palms such as *Chamaedorea pauciflora*

6. *Iriartella stenocarpa* in fruit (another new genus and species record for Ecuador). Photo byThomas L.P. Couvreur.

(*yaun*) also present in the Kapawi region. This species is locally abundant, with 157 individuals all being recorded in a single transect (HB032) in a floodplain habitat.

Iriartella stenocarpa (Fig. 6) is a small understory palm up to 5 m tall with fishtail leaves and small stilt-roots, typical of the Iriarteinae subtribe (which also contains the genera *Dictyocaryum*, *Iriartea*, *Socratea*, *Wettinia*). One needs to be very careful with species of *Iriartella*, because, unlike the other genera, the leaf sheath is covered in small spines. If you inadvertently grab the leaf sheath, you will spend the rest of the day and night with tweezers plucking away at the spines like the first author experienced once in Brazil. Despite

7 (left). *Wettinia drudei*, a new species record for Ecuador. 8 (right). *Geonoma maxima* subsp. *camptoneura*, a new subspecies record for Ecuador. Photos by Thomas L.P. Couvreur.

being the first record of the genus for Ecuador, the species is quite common and can be present in dense populations.

The genus *Wettinia* is a mainly Andean centered genus (Pintaud et al. 2008), but one species occurs in the lowland rainforests of the Amazon, *Wettinia drudei* (Fig. 7). It is the smallest species of the genus, reaching to about 5 m, and is similar to *Iriartella stenocarpa* but without the nasty spines of the leaf sheath. In Kapawi, it is locally common, being quite abundant when present.

Finally, we also documented a new subspecies for Ecuador: *Geonoma maxima* subsp. *camptoneura* (Figs. 8 & 9). *Geonoma maxima* is a beautiful widespread Amazonian palm, reaching to about 5 meters. It is morphologically very variable in the number and arrangement of its pinnae. In the latest revision of the genus, Henderson described 10 subspecies. To date, only *G. maxima* subsp. *multiramosa* was documented from Ecuador, occurring in the northern part of the Amazon (Yasuni and Cuyabeno). The *camptoneura* subspecies has few (3 or 4) irregularly inserted and sized pinnae forming a sharp angle with the midrib. It differs from the numerous regularly inserted pinnae found in subsp. *multiramosa* (Henderson 2011). We were lucky enough to have collected it in flower, during the female phase, revealing its bright white petals and stigmas.

Besides these new records for Ecuador, we also documented the presence of other interesting palms. One of them is the impressive *Elaeis oleifera*, the South American relative of the infamous African oil palm (*Elaeis guineensis*). Its documentation in Ecuador is fairly recent, dating to 1986 (Balslev & Henderson 1986, Montufar et al. 2018). This species grows in swampy areas and has a prostrate stem with only the terminal part erect and topped by several 6 m long leaves (Fig. 10). Its presence in the swamps brings a special feel to the forest. Another interesting species recorded for Kapawi is *Bactris simplicifrons*. Even though it is widely distributed and abundant (Henderson 2000), it is one of the few species of *Bactris* (together with *B. schultesii* and *B. killipii*) that have almost no noticeable spines, which is very unusual for this genus. One has to pass one's fingers along the margin of the leaves to feel them.

Palm uses

Besides species richness and abundance, diversity of uses is an important way to evaluate the dependence between a community and the environment. Palm uses

9. Flower (female phase) of *Geonoma maxima* subsp. *camptoneura*. Photo by Thomas L.P. Couvreur.

were documented in 2011 by the ethnobotany team (led by Rodrigo Cámara-Leret) with the assistance of Justo Saant by interviewing 65 informants of the Kapawi, Kusutkau and Wayusentsa communities, noting the common name of the species mentioned and the different associated uses. Uses were categorized into seven major groups: Animal food (a), Construction (b), Cultural uses (c), Human food (h), Medicinal and veterinary (m), Utensils and tools (u), and Other uses (o). In addition, in 2021 the first author had open and informal discussions with the guide Jhonny Saant. The 2011 survey noted a total of 36 species used by Achuar in Kapawi, with 1–24 uses reported for each species. Below and

in Table 2, we present a summary of important palm species for the Achuar, based on the book co-authored with the Achuar (Cámara-Leret et al. 2018):

Iriartea deltoidea, *tuntuam*, was the most used species with 24 uses documented in five categories. Out of the 65 informants, it was cited 542 times! This means that on average, tuntuam was mentioned eight times per informant. This is one of the most important Construction palms: the whole stems serve as house posts, the split stems are used as house

10. *Elaeis oleifera* in a swampy forest near the Kapawi community. Notice the young inflorescence at the base of the leaves. Photo by Thomas L.P. Couvreur.

floors and walls, the strips from the stem serve for the lower tapes of the roof and as support on which to weave leaves for thatch, while the rods from the stem are used to make chicken pens. Also, the split stem is used to make spears and blowguns and the strips from the stem are used to build fences on the river banks where plant poisons are used to fish. Beds are also made from boards obtained from the stem. The Achuar built the houses of the

11. *Muntish* (Achuar), grubs extracted from the rotting trunk of *Mauritia flexuosa* and ready to be eaten. Photo by Thomas L.P. Couvreur.

12. *Uví* (*Bactris gasipaes* var. *gasipaes*) fruits. The white ones are called *Kuyu uví*, and the red ones *Kapuku uví*. Photo by Thomas L.P. Couvreur.

Kapawi Ecolodge entirely with *tuntuam* and not a single iron nail was used in the building process!

In addition to being the most abundant palm species, *Oenocarpus bataua* or *kunkuk* is also one of the most used for the Achuar community, used in 16 different ways across five of the seven uses categorized. For instance, the leaves are used for thatching forest huts, the spear leaves for making brooms, the fibers of the leaf sheath are extracted to weave the Achuar headdress or *tewasan*, the raw palm heart is edible, the fruit is matured in water and eaten or drunk in juice, and its oil is applied directly on the hair as a pomade.

Mauritia flexuosa, or *achu*, was another well cited species in the surveys, and the second most used palm in terms of different categories. The fallen and rotting stems of achu are a well-known breeding ground for palm grubs called *mundish* (Fig. 11). After a full day walking in the forest with Jhonny one day, Thomas stopped near a fallen *Mauritia flexuosa*. Jhonny then pulled out his machete and began chopping away at the trunk. After a few minutes, he found several large white larvae, with a black head. He swallowed them raw one after the other. Thomas tasted a raw one handed by Jhonny. As you chew, the head cracks under your teeth like a chip, before giving way to a warmish liquid. The taste is quite neutral, but on the greasy side, and is not unpleasant. Palm larvae are delicacies across the tropics. Jhonny explained the culinary variety of palm larvae depending on the palm species. "Each palm species has its own larva, with its own distinct taste," he said. That of the *puntish* Achu is described as being greasy with a sweet flavor, while the one of *tuntuam* (*Iriartea deltoidea*) is said to be less greasy with a more watery taste.

One important spot when visiting Amazonian communities is at the *chacra*, or the community garden. The most important palm is *uví* or *Bactris gasipaes* var. *gasipaes* (Fig. 4), the only fully domesticated palm of the Amazon. *Uví* was the only species in the survey to have been cited in all seven categories, underlining its central importance for Amazonian communities. The main product is the fruit which is eaten boiled or used to make the traditional *chicha* across the Amazon.

13. Harvesting of *chapi* (*Phytelephas tenuicaulis* leaves) for thatching of the Achuar houses. The living plant is in the background. Photo by Thomas L.P. Couvreur.

Jhonny's *chacra* contained three different morphotypes, mainly distinguished by the color and shape of the fruits: yellow, red and, the most weird one of all, white (Fig. 12). Every morphotype can be characterized by a different taste, from oily to floury, depending on what they use it for.

After visiting the *chacra* we made a brief stopover in Jhonny's house. All seated around the fire, Jhonny's wife served us typical cassava beer, or *nijiamanch* (this brew was not yet fermented, luckily!). It is a creamy, whitish drink with a slightly acid taste. Jhonny lives in a typical Achuar house, which is oval with

a high roof made of the leaves of *Phytelephas tenuicualis* (*chapi*) which can last 10 to 20 years (Fig. 13). The interesting thing about Achuar houses is the fact that they do not have walls, which gives an impression of openness and freedom.

Conclusion

These two expeditions underlined the importance of Kapawi for palm diversity and the Achuar's diverse palm knowledge. Kapawi's proximity to Peru allowed us to document several species and genera not previously recorded for Ecuador. As we flew back towards Shell (yes, our 3-passenger plane did come back to pick us up!), we waved goodbye to Jhonny and Kapawi Eco Lodge and hoped that ecotourism will protect this palm paradise for many generations to come.

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Table 1: Checklist of palm species recorded for Kapawi with total number of individuals recorded across 11 transects. HB: Henrik Balslev (vouchers deposited at AAU, QCA); TC: Thomas Couvreur (Vouchers deposited at QCA, WAG).

Species	Total individuals in 11 transects	Voucher
Aiphanes ulei (Dammer) Burret	20	HB8509
Aphandra natalia (Balslev & A.J.Hend.) Barfod	4	HB8520
Astrocaryum chambira Burret	32	HB8515
Astrocaryum urostachys Burret	237	HB8534
Attalea butyracea (Mutis ex L.f.) Wess. Boer	218	HB8517
Attalea maripa (Aubl.) Mart.	33	
Attalea phalerata Mart. ex Spreng.	6	
Bactris acanthocarpa Mart.	110	HB8527
Bactris corossilla H. Karst.	134	HB8531
Bactris gasipaes var. *gasipaes* Kunth	n.a.	
Bactris hirta Mart. var. *hirta*	13	HB8540; TC1367
Bactris maraja Mart. var. *juruensis* (Trail) A.J.Hend.	2	
Bactris maraja Mart. var. *maraja*	34	TC1337
Bactris schultesii (L.H.Bailey) Glassman	46	HB8526; TC1351
Bactris simplicifrons Mart.	54	TC1357
Chamaedorea pauciflora Mart.	43	HB8519; TC1372
Chamaedorea pinnatifrons (Jacq.) Oerst.	121	HB8513
Cocos nucifera L.	n.a.	
Desmoncus giganteus A.J.Hend	2	HB8530
Desmoncus mitis Mart. var. *mitis*	3	
Desmoncus polyacanthos Mart.	21	
Elaeis oleifera (Kunth) Cortés	72	HB8512; TC1365
Euterpe precatoria Mart.	190	
Geonoma brongniartii Mart.	6	HB8529
Geonoma camana Trail	2	
Geonoma longepedunculata Burret	161	HB8522
Geonoma macrostachys Mart. (var. *acaulis* (Mart.) Skov)	441	HB8536; TC1339
Geonoma macrostachys (var. *macrostachys*)	31	HB8511
Geonoma macrostachys (var. *atrovirens* Borchs. & Balslev)	13	
Geonoma macrostachys (as *Geonoma supracostata* Svenning)	468	HB8521

Table 1: Continued.

Geonoma maxima Kunth subsp. *multiramosa* A.J.Hend.	79	HB8537; TC1369
Geonoma poeppigiana Mart.	59	HB8525
Geonoma multisecta (Burret) Burret (as *Geonoma polyandra* Skov)	49	
Geonoma stricta (Poit.) Kunth subsp. *arundinacea* (Mart.) A.J. Hend. (*stricta* var. *piscicauda* (Dammer) A.J.Hend.)	180	HB8510
Geonoma stricta subsp. *arundinacea* (*stricta* var. *stricta*)	630	HB8506
Geonoma stricta subsp. *arundinacea* (*stricta* var. *trailii* (Burret) A.J.Hend.)	47	HB8532; HB8538; TC1338
Hyospathe elegans Mart.	256	HB8524
Iriartea deltoidea Ruiz & Pav.	536	HB8514
Iriartella stenocarpa Burret	371	HB8528; HB8535; TC1350; TC1373
Mauritia flexuosa L. f.	11	
Oenocarpus bataua Mart.	1529	HB8516
Oenocarpus mapora H. Karst.	43	HB8523
Phytelephas tenuicaulis (Barfod) A.J.Hend.	558	HB8533
Prestoea schultzeana (Burret) H.E.Moore	37	
Socratea exorrhiza (Mart.) H.Wendl.	260	HB8518
Syagrus sancona H.Karst.		
Syagrus smithii (H.E.Moore) Glassman		
Wendlandiella gracilis Dammer var. *simplicifrons* (Burret) A.J.Hend.	157	HB8507; TC1356
Wettinia drudei (O.F.Cook & Doyle) A.J.Hend.	143	HB8539
Wettinia maynensis Spruce	43	HB8542

Table 2: Scientific and Achuar names of palms mentioned, different categories, number of uses mentioned and number of times the name was cited after 64 interviews. The table is ordered based on the decreasing number of citations. Animal food (a), Construction (b), Cultural uses (c), Human food (h), Medicinal and veterinary (m), Utensils and tools (u), and Other uses (o).

Species	Local names	Use categories	No. of uses	No. of citations
Iriartea deltoidea	Tuntuam	b, c, h, u, o	24	542
Oenocarpus bataua	Kunkuk	b, c, h, u, o	16	452
Astrocaryum chambira	Kumai	a, c, h, u, o	18	401

Table 2: Continued.

Bactris gasipaes var. *gasipaes*	Uví	a, b, c, h, m, u, o	16	398
Mauritia flexuosa	Achu	b, c, h, m, u, o	16	344
Attalea butyracea	Katira	b, h, o	10	342
Astrocaryum urostachys	Awan; Kurugurupish	b, c, h, u, o	9	286
Attalea maripa	Iñayoa; Tsentsak	b, h, u, o	13	270
Aphandra natalia	Kintiuk	a, b, c, h, u, o	14	267
Attalea phalerata	Kuñua	b, h, u, o	11	259
Euterpe precatoria	Saké	b, c, h, o	11	244
Phytelephas tenuicaulis	Chapi	b, c, h, o	7	219
Oenocarpus minor	Shimpi	b, c, h, u, o	11	186
Socratea exorrhiza	Kupat	b, c, u, o	12	175
Wettinia maynensis	Teren	b, h, u, o	11	159
Attalea sp.	Kamacriña	b, h, u, o	10	148
Bactris corossilla	Murayá kamanchá	b, c, h, m, u	11	85
Syagrus sancona	Chuchuk	b, u, o	5	80
Bactris maraja	Pakaña kamanchá	b, c, h, m, u	9	79
Hyospathe elegans	Sapap	b, u	3	68
Iriartella stenocarpa	Kuuntas	b, u	4	66
Geonoma macrostachys var. *acaulis*	Turuji	b	1	65
Pholidostachys synanthera	Kampanak	b	1	63
Elaeis oleifera	Yunchik	a, h, u	5	62
Chamaedorea pauciflora	Yaun	c	1	61
Geonoma sp.1	Shushui turuji	b	1	61
Geonoma cf. *deversa*	Yunkup	b, h, u	3	57
Aiphanes ulei	Tuntuam janki	h, m, u	5	56
Syagrus smithii	Koemiank	b, u	2	48
Geonoma cf. *longe-pedunculata*	Murayá turuji	b	1	47
Desmoncus spp.	Makayai	b, m, u	5	45
Bactris concinna	Kamanchá	b, h, u	5	31
Geonoma stricta	Wapas turuji	b	1	16
Mauritiella armata	Achuku	b, u	4	15
Astrocaryum jauari	Wiriria	a, b, m	3	4
Geonoma sp.2	Pakaña turuji	b	1	3
Bactris riparia	Miririao	-	0	0