Lanjak Entimau Wildlife Sanctuary – a Palm Hotspot in the Heart of Borneo

Peter Petoe*[1,2]
Benedikt G. Kuhnhäuser*[1,3]
Connie Geri[4]
and
William J. Baker[1]

[1]*Royal Botanic Gardens, Kew, Richmond, Surrey, TW9 3AE, UK*

[2]*Department of Biology, Aarhus University, 8000 Aarhus C, Denmark*

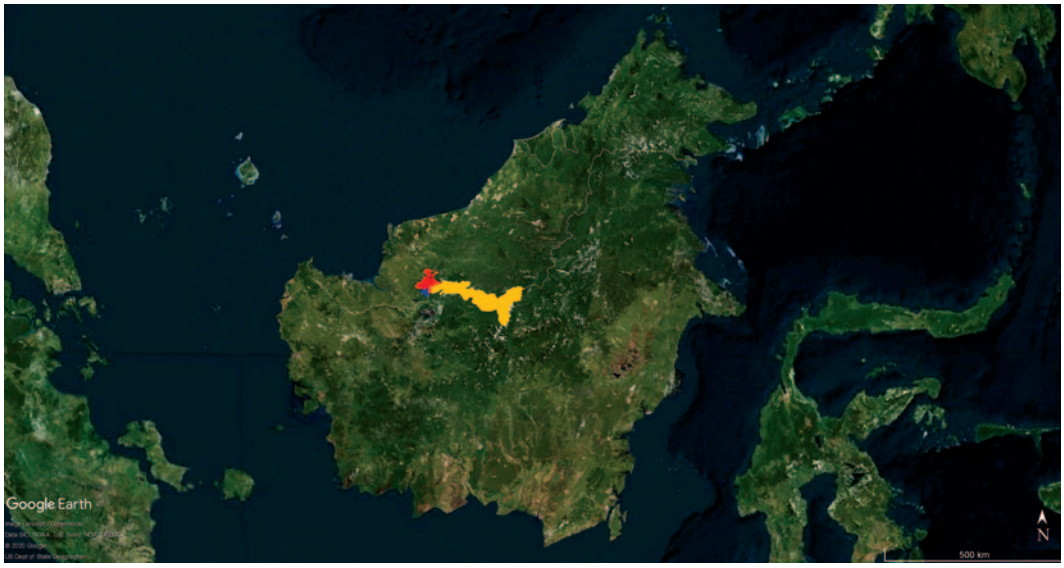
[3]*Department of Plant Sciences, University of Oxford, Oxford, OX1 3RB, UK*

[4]*Sarawak Forestry Corporation, Kuching, Sarawak, Malaysia*

**peter.petoe@bios.au.dk, benedikt.kuhnhaeuser@bnc.ox.ac.uk, equal contributors.*

With over 300 species, Borneo has the richest palm flora of any Malesian island. Here, we describe an expedition to Lanjak Entimau Wildlife Sanctuary, a remote region of Sarawak in the heart of Borneo and provide a checklist of the 46 palm species that we found there.

Our expedition started in Kuching, the state capital of Sarawak in western Malaysian Borneo. We used the city as a base from which to access nearby localities including Gunung Matang in Kubah National Park, which is known for its astounding palm diversity and for Beccari's efforts to describe it during the 19th century (Beccari 1904), and Bako National Park, home to several populations of the iconic palm *Johannesteijsmannia altifrons*. Although exploring and collecting within these popular sites was rewarding, we were particularly excited about what was yet to come: an expedition to the remote and incompletely known Lanjak Entimau Wildlife Sanctuary (LEWS). LEWS is the largest of Sarawak's 66 Totally Protected Areas and is only accessible to scientists and local people living within its immediate vicinity (Forest Department Sarawak 2020). It is probably most widely known for its significant role in the conservation of the critically endangered northwest Bornean orangutan (Ancrenaz et al. 2016). However, the sanctuary protects a large diversity of wildlife, including an estimated 2000 species of plants (Chai 2000). The sanctuary abuts the vast

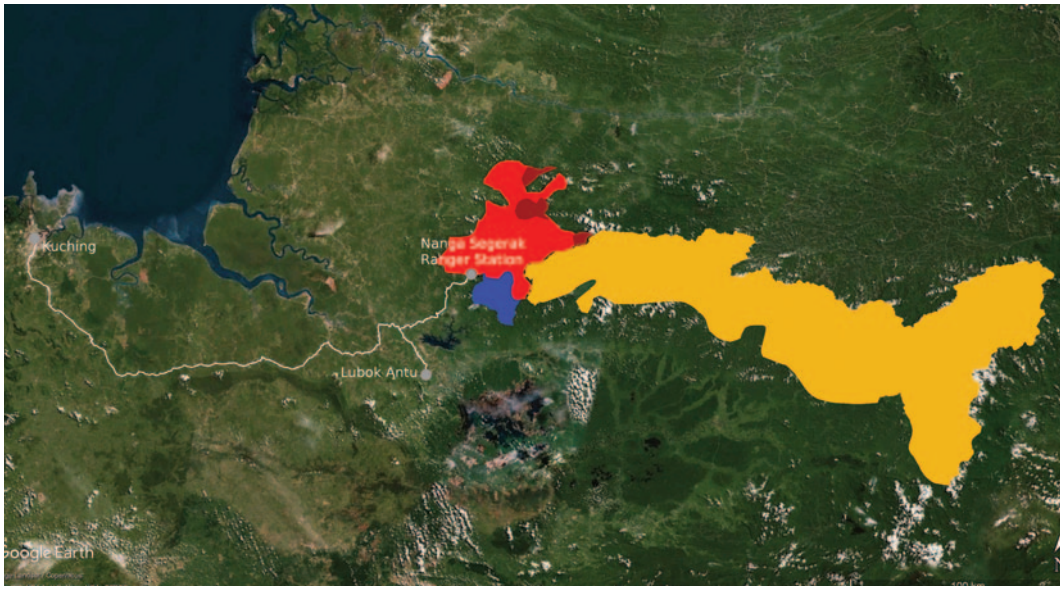


1. The island of Borneo showing Lanjak Entimau Wildlife Sanctuary (red) with extensions (dark red), Betung Kerihun National Park (yellow) and Batang Ai National Park (blue).

Betung Kerihun National Park across the border in Kalimantan, which is more than five times the size of LEWS. Together, the two reserves form the Transboundary Biodiversity Conservation Area (Fig. 1; Brouwer 2012), a core part of the Heart of Borneo initiative, which aims to conserve the remaining intact forests in the center of the island (Rautner et al. 2005). However, the biodiversity of LEWS remains insufficiently known. A checklist of the plants of LEWS has been published, which records over 100 palm species (Chai 2000), but many palm records are yet to be formally confirmed and further ground-truthing is required.

At 6:30 in the morning of 1 November 2018, we departed Kuching in a fully loaded pickup-truck with the objective of undertaking a rigorous inventory of the palm diversity around Nanga Segerak Ranger Station, which is located in Ulu Engkari, in the southwestern portion of

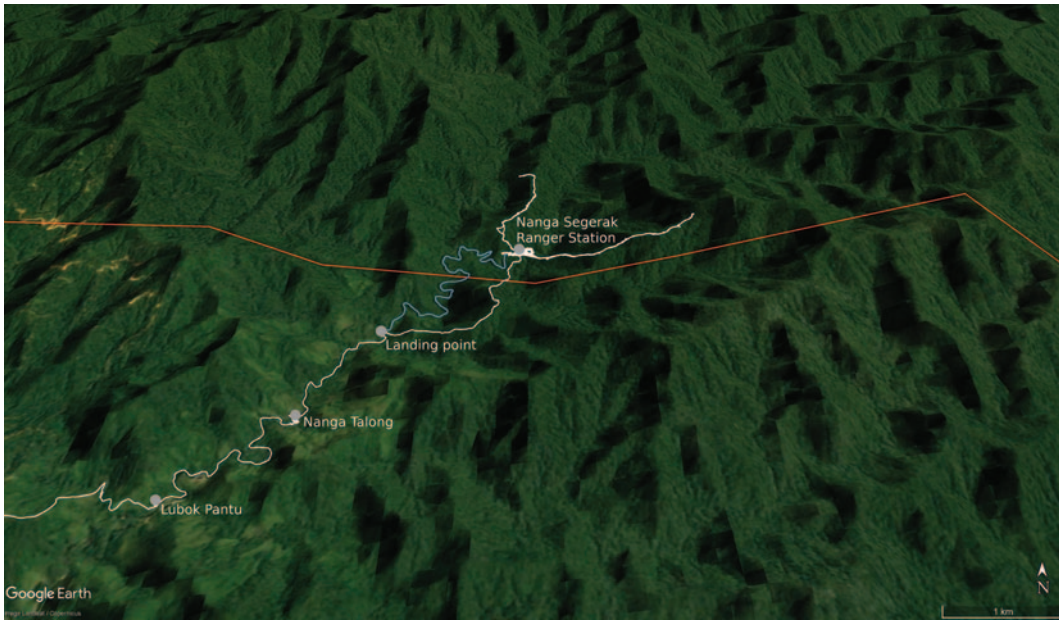
2. Our route from Kuching to Lanjak Entimau Wildlife Sanctuary. Protected areas color coded as in Figure 1.



3. Palm cabbage of *Plectocomiopsis geminiflora* (left) and *Eugeissona utilis* (right) sold at local stall near Lubok Antu. Photo: B.G. Kuhnhäuser.

LEWS (Fig. 2). Sirukit anak Dubod from the Sarawak Forestry Corporation accompanied us and had already proven to be a versatile and indispensable companion during our fieldwork in Sarawak. We started out by driving for several hours along the main road to Lubok Antu. Upon reaching this small town, which is near the border with Indonesia, we transferred to a 4-WD truck. We had a brief stop on the roadside where palm cabbage, or *umbut* in Malay, of *Plectocomiopsis geminiflora* and *Eugeissona utilis* was being sold by local people (Fig. 3) and then branched off the main road onto a dirt track that had been constructed for logging purposes and would take us north of Batang Ai National Park toward LEWS. Some common palms, such as *Plectocomiopsis geminiflora* (Fig. 4) and *Eugeissona utilis* flourished in the disturbed vegetation along this stretch of the journey, which lasted for roughly 50 km. Eventually, we reached Lubok Pantu on the Sungai Engkari where we were greeted by our boatmen. The journey upstream would take us first to Nanga Talong and, the following day, on to Nanga Segerak Ranger Station (Fig. 5). The longboats were lined up and ready for departure on the riverbank opposite an idyllic Iban village adorned by *Arenga pinnata*, *Cocos nucifera* and *Areca catechu* (Fig. 6). After a short and pleasant journey up the river we arrived at Nanga Talong, the last longhouse on Sungai Engkari before LEWS. We were heartily welcomed and hosted by the Headman Bada anak

4. *Plectocomiopsis geminiflora.* Photo: B.G. Kuhnhäuser.



5. Routes travelled in and around Lanjak Entimau Wildlife Sanctuary. The boundaries of the sanctuary are marked with a red line.

Chendai, who gladly accepted several of the *umbut* we had bought earlier in the day, and enjoyed them incorporated into our dinner.

Early on the following morning we took off again in two longboats, which sat low in the water due to the combined weight of us and our provisions. Upstream of Nanga Talong, the river soon became shallow, with emergent rocks and boulders, forcing us to disembark occasionally to push the boat upstream. Lush vegetation clothed both sides of the river with common riverside palms including *Arenga undulatifolia*, *Salacca vermicularis* (Fig. 7) and several species of *Calamus*. Our three boatmen, Mugu anak Sanggap, Dellie anak Medie and Medie

6. River view of Lubok Pantu showing *Arenga pinnata*, *Cocos nucifera* and *Areca catechu* in the background. Photo: W.J. Baker.

7. *Salacca vermicularis.* Photo: B.G. Kuhnhäuser.

anak Aloh, would be our local guides for the remainder of the expedition. These fearless masters of the river swapped deftly between outboard engine, paddle and punting stick to navigate the shallows, rapids and narrow bends of Sungai Engkari. They also possessed extensive knowledge of the area and the natural resources of the forest. Before the river became impassable for the heavily laden boats, we landed at a riverbank ("Landing point" in Fig. 5) to allow Mugu, Dellie and Medie to continue upstream with the now considerably lighter boats to deliver our provisions to the research station. After a short trek of about two kilometers through the forest we arrived at the station, which is located right inside the boundary of LEWS. Being equipped with electricity, a field laboratory and even internet, the ranger station provides basic but comfortable accommodation and facilities for field workers. In addition, a nearby suspension bridge gives immediate access to excellent collecting grounds for a multitude of palm species. For each of the five following days, we would explore the trails radiating from the research station from early in the morning until the rains set in, normally during the mid-afternoon, at which point we sought shelter back at base. We were able to make herbarium specimens of almost every palm species that we found. These were deposited at the Sarawak Forest Department herbarium in Kuching, with duplicates for the herbaria at the Royal Botanic Gardens, Kew and Aarhus University. As a result, we were able to confirm our field identifications by comparisons with expertly named specimens after the expedition. The palms we recorded are described in this article and enumerated in Appendix 1.

Palm habitats in LEWS

The sanctuary is geologically complex with several different forest types including riparian, old secondary, lowland mixed dipterocarp and hill mixed dipterocarp forests (ITTO 2001). All of these forest types occur to varying extents within our inventoried area, within an elevational range from 320 m (Nanga Segerak Ranger Station) to 780 m. Although the mixed dipterocarp forest is known to be the most extensive and biologically diverse habitat within the sanctuary, we found the highest species richness and abundance of palms in wet valley bottoms of the riparian forest (Fig. 8). Palms remained conspicuous in the hill slopes and ridge tops of the adjacent mixed dipterocarp forest, although at lower densities and local species richness.

Calamoideae

In the subfamily Calamoideae, we recorded 30 species belonging to the genera *Calamus* (18 spp.), *Eugeissona* (1 sp.), *Korthalsia* (5 spp.), *Plectocomia* (1 sp.), *Plectocomiopsis* (3 spp.), and *Salacca* (1 sp.). They displayed an extraordinary array of morphological and ecological diversity.

Asian calamoid palms are often associated with the climbing growth form. However, about 10% of Calamoideae are not climbing, but self-supporting or stemless

8. Riparian forest understory with *Pinanga* aff. *brevipes*, *Pinanga tomentella*, *Calamus sabalensis* and *Licuala petiolulata* (from front to back). Photo: W.J. Baker.

9. *Calamus ursinus.* Photo: B.G. Kuhnhäuser.

(Couvreur et al. 2015). At LEWS, we encountered five of these species. The remarkable *Calamus ursinus* grew in large numbers on a steep riverbank near the research station (Fig. 9). It was formerly placed in the genus *Pogonotium* (now a synonym of *Calamus* [Baker 2015]), which is immediately distinguished by the long, erect auricles flanking the petiole. Having met with *Calamus ursinus* before on the top of Gunung Matang, we were surprised to find it here again in such a different environment. Indeed, it was previously thought to be constrained to submontane ridgetops (Dransfield 1992).

Calamus collarifer, a self-supporting, litter-trapping palm up to 3 m tall, was one of the most abundant components of the understory (Fig. 10). *Calamus sabalensis*, a slender, stemless species with the appearance of a young palm seedling (Fig. 11), would almost have gone unnoticed, had we not discovered an individual bearing an old inflorescence. Besides these species, we encountered the aforementioned *Salacca vermicularis* and the massive tree palm *Eugeissona utilis* (locally known as *pantu*), several specimens of which having been felled for their delectable palm hearts (Back Cover).

The aesthetic value of rattans is generally underappreciated! Near the river, we were attracted to the beautiful, bright orange flowers of *Calamus sparsiflorus*, which emitted a sweet fragrance of jasmine. In the specimen we collected, the six stamens were consistently arranged in groups of one, two, and three (Fig. 12). Nearby grew *Calamus pilosellus*, a neat rattan whose regularly arranged, closely adjacent leaflets were interlocked by bristly hairs on the leaflet margins (Fig. 13) and *Plectocomia mulleri*, a robust high-climbing palm with golden spines arranged like eyelashes (see p. 55).

Contrasting with the appeal of these species, several rattans at LEWS lived in close association with belligerent ants. Several species of *Korthalsia* provided living space in their inflated ocreas, i.e. papery elongations of the leaf sheath

10. *Calamus collarifer*. Photo: W.J. Baker.

11. *Calamus sabalensis*. Photo: W.J. Baker.

12. Inflorescence branch of *Calamus sparsiflorus*, with stamens of each flower arranged in groups of one, two and three. Photo: B.G. Kuhnhäuser.

13. *Calamus pilosellus*. Photo: B.G. Kuhnhäuser.

beyond the insertion of the petiole. *Korthalsia rostrata*, *K. cheb* (Fig. 14) and *K. echinometra* (Fig. 15) could be easily distinguished by the shape, size and armature of their ocreas. The long, divergent ocreas of *Korthalsia hispida* (Fig. 16) were inhabited by "noisy ants" producing a rattling sound upon disturbance before rushing out to attack. In *Calamus sabut*, interlocking whorls of spines formed so-called ant galleries (Fig. 17). These were connected by carton tunnels made of bitten off spines. Not all *Korthalsia* species accommodate ants; *Korthalsia debilis* bore a tightly sheathing, disintegrating ocrea (Fig. 18).

Other rattans displayed morphological extremes and curiosities. Whilst *Calamus corrugatus* was the most slender of all palms we encountered with a stem diameter of only 5 mm (Fig. 19), *Calamus comptus* had the longest inflorescence at over 7 m. In stark contrast to these rather slender rattans was the massive *Calamus ornatus*, which we encountered only as a seedling. *Calamus myriacanthus*, a usually

14. Inflated ocrea of *Korthalsia cheb* with entrance hole at the right. Photo: W.J. Baker.

15 (left). Inflated ocrea of *Korthalsia echinometra*. Photo: B.G. Kuhnhäuser. 16 (right). Divergent ocrea of *Korthalsia hispida*. Photo: W.J. Baker.

short-stemmed palm widespread throughout Sarawak, here climbed to 8 m despite possessing no specialized climbing organs. The diamond-shaped, discolorous leaflets of *Calamus hallierianus* were strongly reminiscent of *Korthalsia* (Figs. 20 & 21). Apart from this superficial resemblance, *Calamus hallierianus* was easily distinguished from *Korthalsia* by its extraordinary inflorescence, which was enclosed entirely within the pod-like prophyll, a character diagnostic for the group of species formerly included in the genus *Ceratolobus* (now a synonym of *Calamus* [Baker 2015]). The inflorescence is accessible to potential pollinators only via narrow openings at the prophyll tip. *Calamus pseudoulur* caught our interest as it possessed both a cirrus and a vestigial flagellum, whereas most rattans have either one or the other of these two highly specialized climbing organs . The fruits of *Calamus didymophyllus* were covered in red glossy resin, so-called "dragon's blood," and *Plectocomiopsis mira*, immediately distinguished by its truncate, orange ocrea, was the only rattan considered poisonous by our local guides.

Further calamoid palms we encountered at LEWS were *Calamus* cf. *periacanthus*, *C. javensis*, *C. korthalsii* with long, slender spines at the mouth of the sheath, *C. laevigatus var. mucronatus*, whose basal leaflets were reflexed across the stem, *C. maculatus*, *C. zonatus, Plectocomiopsis geminiflora* and a potentially undescribed species of *Plectocomiopsis* with discolorous leaves and a triangular ocrea.

Coryphoideae

Five species of coryphoid palm belonging to the genera *Arenga* (1 sp.), *Caryota* (1 sp.) and *Licuala* (3 spp.) were recorded. The relatively low diversity of *Licuala* was somewhat surprising given that the genus is particularly diverse in Borneo with 48 known species (Govaerts et al. 2020), but it is possible that the narrow endemism of many of the species causes high species-

17. *Calamus sabut* with interlocking whorls of spines forming ant galleries. Photo: B.G. Kuhnhäuser.

18. *Korthalsia debilis*. Photo: W.J. Baker.

19. *Calamus corrugatus*. Photo: B.G. Kuhnhäuser.

20 (left). *Calamus hallierianus*. Photo: W.J. Baker. 21 (right). Enclosed inflorescence of *Calamus hallierianus*. Photo: W.J. Baker.

turnover within the genus. Nevertheless, *Licuala petiolulata* made up for the dearth of species in its sheer numbers of individuals. It was one of the commonest palms that we found growing around the ranger station, where it occurs in the soggy riparian forest as well as on drier slopes and ridges. Fertile individuals of *L. petiolulata* were very rare at the time of collecting but we could easily identify the palms we saw on account of their conspicuously petiolulate terminal leaf segments (Fig. 22). *Licuala rheophytica* was also rather common but occurred only in the riparian forest and a bit further up the mountain slopes. In contrast to *L. petiolulata*, this is a dainty palm and all the individuals we saw had short 4-segmented leaves and spicate inflorescences (Fig. 23). Very occasionally we would come across mottled licuala leaves, which were later attributed to *Licuala* cf. *maculata*. This palm could not be identified unequivocally due to the lack of fertile material, but is likely to be *L. maculata*, which is known from nearby Batang Ai National Park.

The largest coryphoid palm that we collected was *Caryota mitis*, which grew in the riparian forest to about 12 meters in height. The only other caryotoid palm to be recorded was *Arenga undulatifolia*, which occurred frequently along the banks of Sungai Engkari. Both of these species have broad distributions that extend well beyond Borneo.

Arecoideae

We recorded 11 species of arecoid palm belonging to the genera *Areca* (1 sp.), *Iguanura* (1 sp.) *Oncosperma* (1 sp.) and *Pinanga* (8 spp.). The arecoid palm seen most frequently was *Pinanga* aff. *brevipes*, which was particularly abundant in the riparian forest but also occurred on higher slopes and ridges. The individuals we observed were all small, acaulescent understory palms with relatively short leaves that had three or four pairs of

22. *Licuala petiolulata* with conspicuously petiolulate terminal leaf segments. Photo: P. Petoe.

23. *Licuala rheophytica*. Photo: P. Petoe.

relatively broad pinnae inserted onto the rachis, and bifid inflorescences. Despite demonstrating clear affinities with the type of *Pinanga brevipes*, known from Kuching, the form that occurs around the ranger station seemed altogether smaller and with broader leaflets. Most strikingly, the specimens that we encountered produce their inflorescences buried in the leaf litter or even deeper in the soil, where they successfully flower and set fruit (Figs. 24 & 25).

Areca chaiana, *Oncosperma horridum*, *Pinanga tomentella*, *P. albescens* and *P.* sp. 1 all grew within a relatively short distance from the river. Of these palms, *Areca chaiana* was perhaps the most exciting discovery as it is the only species of *Areca* with a spicate inflorescence (Figs. 26 & 27). Having so far been regarded an anomalous member of the genus (Dransfield 1984), the placement of this species in the genus *Areca* may yet be challenged (Bellot pers. comm.). We found only a few, scattered individuals of *Pinanga tomentella* and *P. albescens*, which are both small single-stemmed species like *Pinanga* aff. *brevipes* but differ in having entire leaves. In addition, all the individuals of *P. tomentella* that we recorded appeared to be of an unusual form with conspicuously bullate leaves (Fig. 28). Though common elsewhere in Borneo, *Oncosperma horridum* was rare in this area, and we observed only a single, fertile individual of *Pinanga* sp. 1. Despite the existence of a good collection, the identity of *P.* sp. 1 with its sigmoid leaflets and bright red, spicate infructescence (Fig. 29) remains unresolved.

On higher slopes and ridges we collected *Pinanga* cf. *ligulata*, *P. lepidota* and *Iguanura chaiana* and recorded, but did not collect, *Pinanga salicifolia* and *P.* sp. 2. These species were all occasional except for *Iguanura chaiana* and *Pinanga* sp. 2 each of which were only represented by one individual. The latter species could not be identified due to a lack of fertile material, although the variegated,

24 (left). *Pinanga* aff. *brevipes*. Photo: W.J. Baker. 25 (right). Entirely subterranean infructescence of *Pinanga* aff. *brevipes*. Photo: P. Petoe.

pinnate leaves displayed by this species stood out among the surrounding vegetation (Fig. 30). Attaining 8 m in height, *Pinanga* cf. *ligulata* was the most imposing of the pinangs we saw in LEWS and was referred to by our guides as *pinang mureng*. *Iguanura chaiana* was an exciting find because few records exist of this rare species (Fig. 31). In contrast, *Pinanga lepidota* and *P. salicifolia* are widely distributed and rather common throughout much of Borneo.

26. *Areca chaiana*, note the spicate inflorescence. Photo: P. Petoe.

Conclusion

After six intense days, we had to leave LEWS behind us. Having focused on taking an as complete as possible inventory of the palms of Nanga Segerak Ranger Station, we had met with an astonishing diversity of palms in its immediate surroundings. In a radius of less than 2 km around the research station, focusing mainly on easily accessible habitats such as riparian forest and ridge tops, we had recorded 46 palm species and collected herbarium vouchers for 42 of them, with accompanying leaf samples for ongoing research on palm evolution. We had also gained insights into the many uses of the palms of the

27. *Areca chaiana*. Photo: W.J. Baker.

28. *Pinanga tomentella*, form with bullate foliage. Photo: P. Petoe.

29. *Pinanga* sp. 1. Photo: W.J. Baker.

30. *Pinanga* sp. 2. Photo: P. Petoe.

wildlife sanctuary. We had eaten the freshly cooked *umbut* of two *Calamus* species for lunch while sitting on the leaves of *Licuala petiolulata*, had enjoyed a delicious vegetarian curried *pantu*, and had watched our guides collect canes of the slender and flexible *Calamus corrugatus* and *Calamus laevigatus var. mucronatus*.

Now, we had to surrender our precious collections to the mercy of the winding rapids of the Sungai Engkari (Fig. 32). The ride down the narrow river was both thrilling and terrifying, adrenalin peaking when one of our boatmen fell overboard. Drenched to the skin, we were glad to reach the calmer waters of Nanga Talong

31. *Iguanura chaiana*. Photo: P. Petoe.

safely with our collections intact. As our onward journey was planned for the next day, we took the opportunity to collect a specimen of *Arenga pinnata* growing next to the longhouse. Being well aware of the old tradition of headhunting practiced by the Iban people in the past, we couldn't resist the temptation to ascertain whether skulls from former times still existed at the longhouse. When we were presented with an unearthly assortment of nine skulls (Fig. 33), we were amazed to find that some of these were kept in harnesses made of woven rattan canes! On the next morning, we continued our journey back to Kuching, passing through a melancholy landscape of secondary forest necklaced with low-hanging clouds (Fig. 34). At Kuching, our specimens were pressed and dried at the Sarawak Forestry Corporation's Semenggoh Arboretum, and sorted into duplicates.

The richness of palms we documented around Nanga Segerak Ranger Station bears witness to the importance of LEWS as a refuge for Borneo's palm diversity. As indicated by the existing checklist of the flora of LEWS (Chai 2000), we feel confident that further fieldwork would bring to light many more palm treasures.

Acknowledgments

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32. Boat journey from the ranger station to Nanga Talong. Photo: W.J. Baker.

33.

33. Nanga Talong longhouse resident with collection of headhunting skulls in rattan harnesses. Photo: B.G. Kuhnhäuser.

Saw for helping with determining specimens and for general advice on palms. Dr Paul Chai provided valuable information about the field site. Sarawak Forest Department kindly granted permission to collect (permits No. (207)JHS/NCCD/600-7/2/107 and No. WL107/2018) and export plant specimens (permit No. 18642). This work was supported logistically by the Royal Botanic Gardens, Kew. It was made possible thanks to generous funding from the Aarhus University Research foundation (grant AUFF-E-2017-7-19 to Wolf L. Eiserhardt), a Bentham-Moxon Trust grant (BMT1-2017) to WJB and BGK, a Society of Systematic Botanists Graduate Student Research Award to BGK, and a Brasenose College Student Support Funding grant to BGK.

Literature Cited

Ancrenaz, M., M. Gumal, A.J. Marshall, E. Meijaard, S.A. Wich and S. Husson. 2016. *Pongo pygmaeus* ssp. *pygmaeus*. The IUCN Red List of Threatened Species 2016. https://www.iucnredlist.org.

Baker, W.J. 2015. A revised delimitation of the rattan genus *Calamus* (Arecaceae). Phytotaxa 197: 139–152.

Beccari, O. 1904. Wanderings in the Great Forests of Borneo; Travels and Researches of a Naturalist in Sarawak. Constable, London.

Brouwer, M. 2012. The Ecosystem Promise. Bunnik Meindert Brouwer Partner in Communicatie, Bunnik.

Chai, P.K. (ed.) 2000. Lanjak Entimau Wildlife Sanctuary, a check-list of flora, fauna, food and medicinal plants. Forest Department Sarawak and International Tropical Timber Organization (ITTO), Yokohama and Kuching.

Couvreur, T.L.P., W.D. Kissling, F.L. Condamine, J.C. Svenning, N.P. Rowe and W.J. Baker. 2015. Global diversification of a tropical plant growth form: environmental correlates and historical contingencies in climbing palms. Frontiers in Genetics 5: 1–18.

Dransfield, J. 1984. The genus *Areca* (Palmae: Arecoideae) in Borneo. Kew Bulletin 39: 1–22.

Dransfield, J. 1992. The rattans of Sarawak. Royal Botanic Gardens Kew and Sarawak Forest Department, Richmond and Kuching.

Forest Department Sarawak. 2020. Wild Life Sanctuaries. https://forestry.sarawak.gov.my.

Govaerts, R., J. Dransfield, S. Zona, D.R. Hodel and A. Henderson. 2020. World Checklist of Arecaceae. Facilitated by the Royal Botanic Gardens, Kew. Published on the Internet; http://wcsp.science.kew.org.

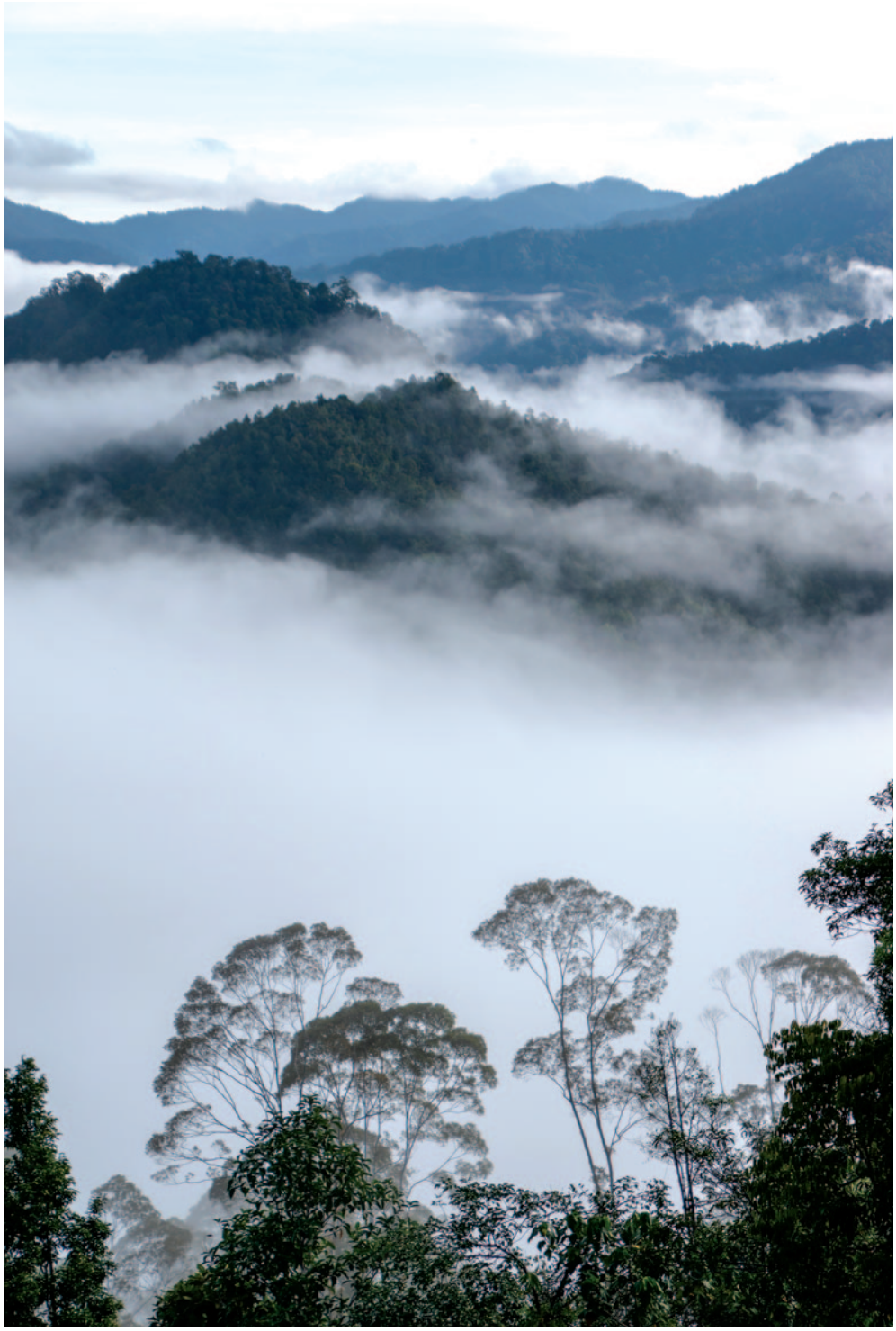
ITTO. 2001. Lanjak Entimau Wildlife Sanctuary: A Conservation Project Supported by International Tropical Timber Organization (ITTO). ITTO/Forest Department Sarawak.

Mohd-Azlan, J. and L. Engkamat. 2013. Camera trapping and conservation in

Lanjak Entimau Wildlife Sanctuary, Sarawak, Borneo. The Raffles Bulletin of Zoology 61: 397–405.

Rautner, M., M. Hardiono, R.J. Alfred and WWF Malaysia. 2005. Borneo: Treasure Island at Risk. WWF Germany.

34. Landscape near Lanjak Entimau Wildlife Sanctuary. Photo: W.J. Baker.



Appendix 1. Palms recorded around Nanga Segerak Ranger Station, Lanjak Entimau Wildlife Sanctuary. Specimen codes represent herbarium collections: BK = Benedikt G. Kuhnhäuser, PP = Peter Petoe, X = no voucher specimen collected (sight record).

Subfamily	Genus	Specific epithet	Specimen
Arecoideae	*Areca*	*chaiana*	PP35, PP50
	Iguanura	*chaiana*	PP45
	Oncosperma	*horridum*	PP41
	Pinanga	aff. *brevipes*	PP32, PP34
		albescens	PP39
		cf. *ligulata*	PP38
		lepidota	PP43
		salicifolia	X
		sp. 1	PP36
		sp. 2	X
		tomentella	PP37
Calamoideae	*Calamus*	cf. *periacanthus*	X
		collarifer	BK25
		comptus	BK27, BK46
		corrugatus	BK41
		didymophyllus	BK48
		hallierianus	BK37
		javensis	BK32
		korthalsii	BK33, PP33
		maculatus	BK39
		myriacanthus	BK28, BK30, BK45
		ornatus	PP44
		pilosellus	BK52, BK53
		pseudoulur	PP42
		sabalensis	BK31
		sabut	BK36
		sparsiflorus	BK51
		ursinus	BK26
		zonatus	BK43
	Eugeissona	*utilis*	BK38
	Korthalsia	*cheb*	PP40
		debilis	BK47, BK55
		echinometra	BK50
		hispida	BK40
		rostrata	BK34
	Plectocomia	*mulleri*	BK54
	Plectocomiopsis	*geminiflora*	BK49
		mira	BK44
		sp.	BK35
	Salacca	*vermicularis*	BK56
Coryphoideae	*Arenga*	*undulatifolia*	X
	Caryota	*mitis*	PP48
	Licuala	cf. *maculata*	PP46
		petiolulata	PP47
		rheophytica	PP31, PP49, PP51