Palms of Samar Island, Philippines

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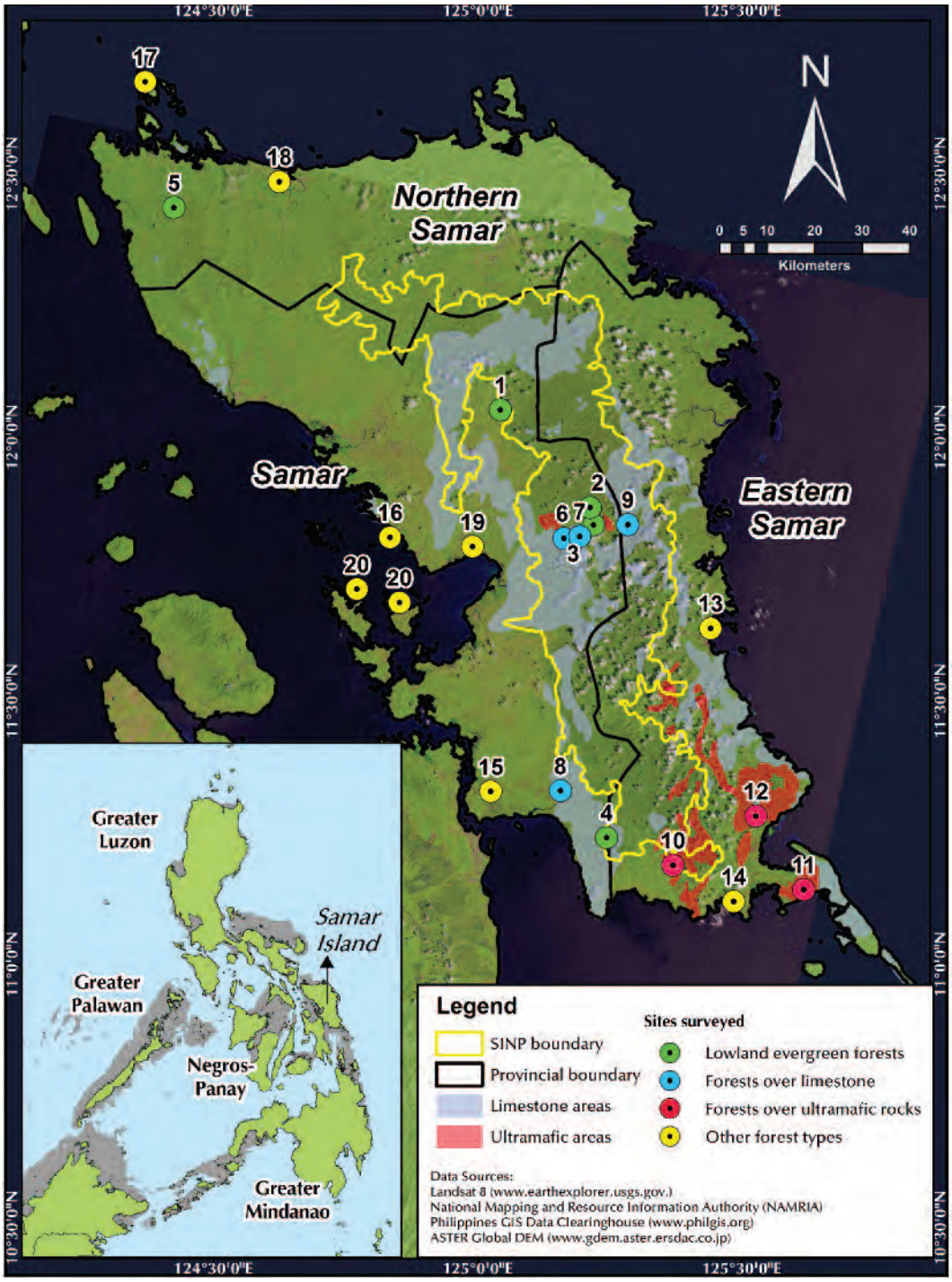
Surveys of palms (Arecaceae) on Samar Island in the Philippines were conducted in view of the island's diverse but extremely threatened forest ecosystems, its old conglomerate geology, its significant biogeography and its poor palm collection history. Inventories of palms were carried out in selected sites between 2013 and 2016. The inventories yielded 50 species of which about 70% are Philippine endemics. Twelve are new island records, and there are 11 probable novel taxa (five in *Calamus*, and one each for *Areca*, *Oncosperma*, *Heterospathe*, *Orania*, *Pinanga* and the Ptychospermatinae) while one is a recollection. Overall, the palm flora of Samar reflects its biogeographic affinity and diverse habitat types. Notes on the observed morphological variations of most species will be utilized in the future taxonomic re-evaluation of some Philippine palm species and their complexes. The wealth of information generated in this study will ultimately be used for the conservation of palms and their habitats on the island.

Samar Island is the third largest island in the Philippines archipelago with an approximate land area of 13,107 square kilometers, extending between 10°45′ and 12°45′ N latitude and between 124°15′ and 125°45′ E longitude (PhilGIS 2016). The island's regional geomorphology includes (1) the volcanic hills and mountains at the northwest tip, (2) the heavily dissected plateau in the north, (3) the limestone area that rims the central portion, (4) the basement area in the central and southern parts, (5) the rolling hills in the southwest and (6) the Guiuan peninsula (Travaglia et al. 1978). Based on the modified

Corona's climate classification, the island is divided into two regions. The northeastern part manifests the Type II climate, which has no dry season and has a very pronounced rain period particularly during December and January, while the southeastern portion

1. Various sites visited and surveyed from 2013–2016. The site numbers correspond with the enumeration in Apppendix 1. Geologically, limestone areas approximate the Oligocene-Miocene, whereas ultramafic sites fit in the Cretaceous-Palaeogene. The inset map shows the present-day Philippines archipelago with 100 meters below sea level bathymetry line (gray shade) where several Pleistocene Aggregated Island Complexes (PAIC) can be reconstructed.



2 (top). The vast unexplored intact lowland forests viewed atop Mt. Huraw, San Jose de Buan, Samar.
3 (bottom). The contiguous lowland forests over rugged terrain towards the central mountains viewed atop a karst formation in Paranas, Samar. Photos by J.T. Adorador.

manifests the Type IV climate, which has rainfall more or less evenly distributed throughout the year.

Samar is part of the Greater Mindanao biological region, which corresponds to the Mindanao Pleistocence Aggregate Island

4 (top). Secondary forests adjacent to local gold mining excavations in Guinmayuhan, Balangiga, E. Samar.
5 (bottom). A low karst forest along Sohoton River, Basey, Samar where *Heterospathe intermedia* abounds.
Photos by J.T. Adorador.

Complex (PAIC) that also includes Leyte, Bohol, Mindanao, Dinagat and Siargao (Heaney 1986) (see inset map in Fig. 1). Together with the eastern portion of Luzon (Sierra Madre range and Bicol peninsula), this PAIC formed a continuous island arc into Halmahera and New Guinea in the late Oligocene, about 25 Ma (Heaney 1986, Brown & Diesmos 2009, Vallejo 2011). This island chain has been used by plants and animals to

migrate north and southwards (Lam 1945, Hall 2001, Heads 2003, Vallejo 2011). The island is one of the centers of botanical diversity in the country and in the Malesian Region (Madulid 2000). According to him there are at least six forest formations found in the island, which include (following the scheme of Fernando et al. 2008) lowland evergreen rainforest, lower montane forest, forest over limestone, forest over ultramafic rocks, mangrove forest and beach forest. Additionally, peat swamp forest was hypothesized to occur in Dolongan, Basey (Davies 2006), whereas freshwater swamp forests were observed by us along the seaward-flooded plains of Balangiga-Giporlos-Quinapondan. These two poorly documented vegetation types in the island were found to be degraded and converted into cultivated areas or fishponds.

The contiguous forests found in central portions of the island inevitably provide its inhabitants with abundant water supply and renewable forest products; likewise, it offers sanctuary to its rich flora and fauna. It was declared a natural park (Samar Island Natural Park or SINP) in 2003 through Presidential Proclamation No. 422. The park comprises 333,300 hectares of protected area and 125,400 hectares of buffer zone – the largest terrestrial protected area in the Philippines (UNDP-GEF 2014). Despite this effort, the island's environment has been extensively degraded by logging and forest clearing for agriculture in the past 70 years (UNDP-GEF 2014). Likewise, the proliferation of small-scale illegal logging significantly contributes to forest destruction. Coal and chromite mining activities also pose a major threat to the island's biodiversity, while other threats include unregulated quarrying of limestone, charcoal-making, over-harvesting of non-timber forest products (including rattans), pollution by industries and invasion of alien species (SEARCA 2004).

Although Samar Island is considered among the under-collected places for palms in the country (Fernando 1990a, c), an extensive review of literature revealed about 35 species of indigenous palms listed for the island (Beccari 1919a, b, Pelser et al. 2011-onwards, Fernando 1990a, b, c, Madulid 2000, Gruezo & Harries 1984, SEARCA 2004, Baja-Lapis

6. (left). *Calamus urdanetanus* – recollected and rediscovered in Arizona, Hinabangan, Samar since its description in 1919. 7 (right). *Calamus daemonoropoides* – note its densely bristly leaflets, sheath armed with dense partial whorls of spines, and unarmed sharply bulging knee. Photos by J.T. Adorador.

8 (left). Habit of *Calamus ochrolepis* – note the characteristic elevated whorls of spines in the leaf sheath.
9 (right). Dense infructescence of *Plectocomia elongata* var. *philippinensis*. Photos by J.T. Adorador.

2010). Definitely, more taxa remain unaccounted since no taxonomic studies focusing on palms have been undertaken on the island. Preliminary site visits and subsequent research and consultations, suggest several probable new species of *Pinanga* and *Calamus* and a possible new genus in the Ptychospermatinae.

SINP's diverse and conserved but extremely threatened forest ecosystems, its old conglomerate geology, its significant biogeography and its poor palm collection history altogether suggest the timeliness of this endeavor and the likelihood of discovering novel palm taxa. A robust taxonomic treatment of palms and knowledge of their ecology essential for conservation were the goals for this study.

Methods

Identification of potential sites for field surveys was done through Geographic Information System (GIS)-based processing techniques through the aid of ASTER-DEM and various thematic maps (e.g. forest cover, geology, administrative boundaries, and SINP boundary) (Fig. 1). All the eight forest formations (Fernando et al. 2008) that occur in accessible and secured sites of the island were visited (Appendix 1, Figs. 2–5). The necessary gratuitous permit to carry out such surveys within SINP was granted by the Department and Natural Resources-Region 8 (DENR-8) on July 9, 2015.

Complete palm specimens were collected (following Dransfield 1986), fertile if available, on several sites. Likewise, silica-dried leaf tissue samples of most species were collected for future molecular studies. Oven-drying and mounting were executed in the Department of Forest Biological Sciences, College of Forestry and Natural Resources, University of the Philippines Los Baños (UPLB). The first set of palm specimens are deposited at the Forestry Herbarium (LBC), UPLB Museum of Natural History, while the other sets will be sent to the Philippine National Herbarium (PNH) and the Herbarium of the Royal Botanic Gardens, Kew (K).

All available and relevant palm taxonomic literatures were reviewed. Palm specimens were carefully examined at the following herbaria: (1) LBC [Forestry Herbarium] and (2) CAHUP [College of Agriculture Herbarium–UP], both managed by the UPLB Museum of Natural

10. The habit of *Saribus rotundifolius* – note its highly-branched infructescence. Photo by J.T. Adorador.

11. Habit of the stilt-rooted *Areca costulata* – note the closely-set multifold leaflets and yellowish crownshaft. Photo by J.T. Adorador.

12. The diminutive *Pinanga* sp. "*tagibungang-liitan*" – note its short coriaceous leaves and distichously-set fruits. Photo by J.T. Adorador.

History and (3) EBL [ERDB Botanical Laboratory and Herbarium (formerly known as FORI)] under the ERDB-DENR. Appropriate parts were measured in herbarium sheets and of specimens in situ.

The morphological species concept of different Philippine-occurring palm lineages provided through the works of Beccari (1919a, b), Baker (2015), Baker et al. (1999), Dransfield (1980, 1984, 1997), Dransfield et al. (2008), Fernando (1988a, b, 1990b, 2014), Baja-Lapis (1989), Madulid (1981), Lewis (2002), Hahn (unpublished), Heatubun et al. (2012, 2014), Dowe (2009), Bacon and Baker (2011), and Keim and Dransfield (2012), were circumspectly analyzed and utilized in species delimitation. The syntheses of data gathered from numerous taxonomic articles, herbarium material and field observations generated the

13. The spiny *Oncosperma* sp. *"anibong-kinis"* – note the glabrous prophyll and few-branched Infructescence. Photo by J.T. Adorador.

14 (left). The terminal portion of *Calamus siphonospathus* var. *dransfieldii* – note the dense brown sheath spines and indistinct ocrea. 15 (right). Habit of flowering *Calamus moseleyanus* – note its broad-ellipsoid dull green leaflets and diffusely yet stiff paniculate inflorescence. Photos by J.T. Adorador.

functional broad morphological species concept used herein to delimit the indigenous palms of the island.

Results and Discussions

The Palm Flora of Samar Island

The series of surveys across the island revealed a total of 50 palm species distributed in 16 genera together comprising 26 calamoids, 16 arecoids, seven coryphoids and the sole nypoid (Appendix 2). *Calamus* is the most species-rich genus on the island with 23 species, distantly followed by *Pinanga* and *Areca* (each with 4 species), then *Heterospathe* (3 species). Twenty-seven species were previously recorded from the island, while 12 are new records and 11 are probable new taxa. Overall, it represents a quarter (39/139) of the currently known palm species (not including varieties and subspecies) in the country. Meanwhile, Philippine endemicity is about 70% (34/50), which is locally similar to the palm flora of the 16-ha Palanan Forest Dynamics Plot (Yap 2010) and regionally consistent with the total vascular flora of the Philippine archipelago (Myers et al. 2010). Among the recognized taxa, only one (*Pinanga samarana*) is reported endemic to the island, while most of the probable new species are believed to be similarly restricted. Despite the island's relative smaller geographic area, species richness is comparable with that of Sulawesi Java and Moluccas with 62, 46 and 40 species, respectively (Baker & Couvreur 2012). The transitory biogeographic setting of the island could partially explain the species compositional trend found there.

It is notable that *Calamus urdanetanus* (Fig. 6), previously known only from its type locality, Mt. Cabadbaran (Mt. Urdaneta) in Agusan del Norte, Mindanao island, was recollected for the first time since its description by Beccari in 1919. For the new island records, seven species were already predicted to occur since these palms were then known to be distributed across Greater Mindanao (except Samar) and Greater Luzon island complexes (*e.g. Calamus daemonoropoides*, *C. ochrolepis, Plectocomia elongata* var. *philippinensis* (Figs. 7–9). Meanwhile, two species are recorded for the first time outside Mindanao, *C. multinervis* and

16. The infructescence of *Pinanga insignis* – note its robust peduncle and distichously-set shortly-beaked fruits. Photo by J.T. Adorador.

17. Habit of fruiting *Orania decipiens* – note highly branched inflorescence axes. Photo by J.T. Adorador.

the recollected rattan, whereas *Saribus* cf. *merrillii* and *Livistona saribus* are now found outside Luzon (Fernando et al. 2008). This conspectus of updated geographic distribution resolves the palm disjunction of Luzon-Mindanao pattern (Fernando 1990a).

18. *Areca* sp. "*mudulan*" showing its slender habit and immature Infructescence. Photo by J.T. Adorador.

Eleven are believed to be novel taxa but still warrant further investigation through study of all available herbarium material and/or application of molecular techniques: five in *Calamus*, and one each for *Areca, Oncosperma, Heterospathe, Orania, Pinanga* and the Ptychospermatinae. The species in the last four genera are morphologically distinctive and are currently being formally described, while those in the first three require more in-depth studies. The discovery of these new palm taxa is a function of new collections from a poorly-known area, correspondence with several palm experts and recent taxonomic updates.

The morphological characters that were found to be very variable and diverse in herbarium specimens and in situ include leaflet venation, the shape of the fruits and leaf sheath indumentum for the arecoids, while such characters are sheath armature, inflorescence length and number of fruits scales for the calamoids. On the contrary, characters that were found to be consistent across different habitats and developmental stages for all palms comprise general stem form, leaflet bristles and covering, and overall inflorescence architecture.

Habitat and Ecology

There remain vast tracts of dense forests scattered throughout the island, especially those growing over limestone areas and in the central portions where communist rebels inexorably make camps. Among the island's forest types, only three were surveyed comprehensively on selected sites, which include the lowland evergreen, over limestone, and over ultramafic rocks. Several palms were noted to be widespread amidst the perceived ecological differences between the three vegetation types. Such rattans include *Calamus mollis, C. ochrolepis, C. ornatus* and *Plectocomia elongata* var. *philippinensis*; on the other hand, *C. aidae* and *C. merrillii* were rarely found over limestone areas. Meanwhile, the widespread erect palms include *Saribus rotundifolius* (Fig. 10), *Areca caliso, A. costulata* (Fig. 11), *Pinanga samarana, P. copelandii, P.* sp. *"tagibungangliitan," Caryota cumingii* and *C. rumphiana*; *Oncosperma* sp. *"anibong-kinis"* was occasionally spotted over limestone-derived soils.

The widespread though sporadic occurrence of a single new species of *Pinanga* (Fig. 12) across different forest types is rather surprising. It was first encountered near the summit of Mt. Huraw (800 m elevation) then atop tower karsts of Tenani (400 m), ridges of Arizona (300 m) and Vigan (200 m). Its several morphotypes were then regarded to be distinctive species but were dismissed to be just ecotypic variations. Generally, this taxon could be characterized by its clustering diminutive and very slender habit, the typically pluricostulate coriaceous leaflets, and short inflorescence with few reflexed rachillae bearing two rows of ovoid-ellipsoidal fruits. This novel taxon generally prefers ridges where vegetation is intact and light is abundant.

The probable new species of *Oncosperma* (Fig. 13) shares morphological affinity with the Luzon-restricted *O. gracilipes* and the

19. Rattan sapling diversity in the lower slopes of Mt. Huraw – in the foreground (left to right) are *Plectocomia elongata* var. *philippinensis*, *Calamus mollis* and *C. filispadix*, while in the background are *C. aidae* and *C. daemonoropoides*. Photo by J.T. Adorador.

Mindanao-widespread *O. horridum* and could represent a distinctive race of hybrid origin. This clustering palm is characterized by its median leaflets abaxially bristly on the distal portions (first report for the genus), unarmed prophyll and fruits developing only on the central portions of the rachillae. It grows well in sheltered valleys but becomes spindly towards the ridges.

Lowland evergreen forests

The lowland evergreen forests occupy the greatest vegetation coverage within the park, which gradually merge with other forest types hence creating ecotonal boundaries. Those species observed to be restricted to this vegetation include the rarities (e.g. *Calamus pedicellaris, C. siphonosphathus* var. *dransfieldii* (Fig. 14) and *Saribus* cf. *merrillii*) and a probable new *Calamus* (*C.* sp. *"tagsa-on"*). Likewise, several species were shared with forests over ultramafic areas, which comprise *Calamus elmerianus, C. filispadix, C. megaphyllus, C. moseleyanus* (Fig. 15), *C. vidalianus, Pinanga insignis* (Fig. 16) and *Orania decipiens* (Fig. 17). Such habitat sharing also occurs in the suspected new *Areca* sp. "*mudulan*" and *Calamus* sp. "*malubagacay-bilog.*"

The inferred new *Areca* (Fig. 18) was observed to be sympatric (in some areas) with the limestone-preferring *A. caliso* and the eurytopic *A. costulata*. It is more similar to the former but is distinctive in its much more slender habit, shorter leaves with generally 2-costulate leaflets and its much shorter inflorecsence with the uppermost rachillae still bearing at least one floral triad on its basal portions. Such variations in the vegetative traits could be dictated by the differences of the substrate but those of the floral characteristics need to be re-evaluated (along with other Philippine *Areca*) – if this really represents a new species.

Meanwhile, the other inferred new taxa in *Calamus* approach the "*C. mindorensis* group" (including *C. mindorensis, C. moseleyanus, C. multinervis* and *C. reyesianus*), which local people generally refer to as *malubagacay* or *lokuan*. Beccari (1919a) recognized this artificial group (except *C. reyesianus*) but did not provide a conspectus of it. Nevertheless, *C.* sp. "*tagsa-on"* (Back Cover) is distinctive in its glabrous coriaceous leaflets typically in pairs and shorter erect inflorescence. On the other hand, *C.* sp. "*malubagacay-bilog"* though only non-fertile

20 (left). *Pinanga samarana* – notice the peeled portion of the crownshaft, evidence of palm-heart extraction by monkeys. 21 (right). *Calamus filispadix* with a bird's nest hanging from its flagellum. Photos by J.T. Adorador.

22. *Calamus aidae* with its interwoven basal leaflets made as a nest by a forest rodent. Photo by J.T. Adorador.

plants were seen, is rather distinctive in its very chartaceous broad-lanceolate leaflets and fine, continuous tertiary veins. These two rattans together with the "*C. mindorensis* group" need taxonomic reappraisal since several morphological heterogeneities were observed in the field, such as leaflet groupings upon development or exposure to light and persistence and/or absence of sheath armature on mature individuals.

Among the intact lowland forests visited, the slopes of Mt. Huraw in San Jose de Buan offered the highest palm diversity with 29 species (17 rattans and 12 erect palms). Along the forest edges, there could be as much as five different species of juvenile rattans in a 3m × 3m plot (Fig. 19) – not including the seedlings of *Oncosperma* and *Areca*. The uniqueness of palm composition in this locality could be due to the dense canopy, hence very little light reaching the understory. *Pinanga samarana* was uncommon along the trails.

Meanwhile, the secondary forests of Arizona, Hinabangan and Ulot, Paranas possessed an almost similar palm floristic composition to Mt. Huraw but differed in the abundance of *Pinanga samarana, Calamus aidae,* and *C. filispadix*. Thus, the proliferation of these palms could be due to the increased light intensity penetrating the forest floor of these relatively disturbed forests. Interestingly, traces of palm heart extraction by monkeys were observed in *P. samarana* (Fig. 20) and the two rattans mentioned were recorded to provide suitable shelter for forest animals (Figs. 21 & 22).

Forests over limestone

The forests over limestone are arguably the most intact vegetation type on Samar Island. This is due to the difficulty of penetrating the thickets of its abruptly variable terrain; thus, illegal logging is simply not profitable. It is locally known as the *kaigangan* with karst formations, which reach up to 400 m elevation. Across the sites surveyed, *Heterospathe intermedia* (Fig. 23), *Areca caliso, Pinanga copelandii* (Front Cover), *Calamus discolor* (Fig. 24), *C. multinervis* (Fig. 25) and *C. ochrolepis,* are the most characteristic species within the valleys and mid-slopes of this forest formation. The palm floristic gradient then changes towards the peaks of karst towers. There abounds *Pinanga samarana,* morphologically different from the lowland counterparts in having more slender stems, unicostulate leaflets and more reflexed rachillae with obovoid fruits. However, all these trait shifts could be attributed to environmental differences of their habitats, especially light and soil conditions.

23. The habit of *Heterospathe intermedia*. Photo by J.T. Adorador.

24 (left). *Calamus discolor* – note its dense brown spines and petiolate leaves with leaflets glaucous abaxially. 24 (right). Habit of *Calamus multinervis* – note its brown sheath indumentum and plaited leaflets grouped in pairs which are observed in individuals under dense forest cover. Photos by J.T. Adorador.

Interstingly, four new taxa were discovered atop this forest type. The novel rattans include two slender clustering *Calamus, pudlos-uban* (Fig. 26) and *pudlos-liitan* (Fig. 27) of San Rafael, Taft (Eastern Samar) and Tenani, Paranas (Samar), respectively. The former differs from typical *C. discolor* in having less spiny, glaucous green sheaths and epetiolate leaves with less bristly leaflets. Meanwhile, the latter species is apparently allied to *C. microsphaerion* but ultimately differs in the unarmed rachis and concave short-lanceolate apiculate leaflets, which are grouped in pairs. This rattan was recorded to produce shoots on cut stems, which could be the reason for its abundance on the summit. Aside from these traits, their inflorescences details ultimately segregate them from their respective analogous counterparts.

The new species of slender *Orania* (Fig. 28) atop the calcareous mountain is rather surprising since its counterparts thrive in areas where there is much thicker soil. Its closest match is *O. littoralis* of Papua New Guinea using the artificial key by Keim and Dransfield (2011). However, the inflorescence morphology is the most unusual among all known *Orania* species, in developing an all-staminate inflorescence (without triads along the rachillae) and a bisexual type (with floral triads). Moreover, its fruit traits (color, mesocarp thickness and embryo shape) are recorded to be different with those of *O. decipiens* when compared in fresh state – which could be used in re-annotating useful characters for the Philippine species.

Perhaps, the most thrilling discovery of the entire palm flora of the island would be the member of Ptychospermatinae, known locally as *amuring* (Fig. 29). It is morphologically embedded within the subtribe in its praemorse leaflet apices and bullet-shaped buds of staminate flowers. Moreover, after consultations with several experts on the subtribe (S. Zona, W. Baker and C. Heatubun), review of recent literature (Alapetite et al. 2014, Heatubun et al. 2012) and herbarium studies, we believe this taxon merits a unique generic placement. It deviates from other members in details of its inflorescence and fruit structure. It is restricted to the summits of karst formations in the central part of the island.

26 (left). The slender *Calamus* sp. "*pudlos-uban*" – note its epetiolate discolorous leaves and less spiny sheath. 27 (right). *Calamus* sp. "*pudlos-liitan*" with its short lanceolate leaflets grouped in pairs. Photos by J.T. Adorador.

The observed populations of *amuring*, which comprise several fruiting individuals, few juveniles but numerous seedlings generally suggest its adaptability but slow growth and establishment to the unique habitat. Fruit doves (*Ptilonopus* spp.) were observed to feed on the thin but fleshy and bland-tasting mesocarps of this palm.

Forests over ultramafic rocks

In contrast, the remaining vegetation over ultramafic areas on southeast portions of the island were generally disturbed. Aside from the mining activities and illegal timber extraction of nearby communities, such areas were devastated by one of the history's strongest typhoons (Haiyan) in November 3, 2013 and most of them subsequently succumbed to wild-(or man-induced) fires in the summer of 2014. The forest surveys were carried-out in the most accessible intact forests outside mining concession areas due to the difficulty of acquiring permits from the companies.

Nevertheless, the fieldwork showed the general palm floristic make-up across the three metal-rich sites, which are dominated by the widespread *Pinanga samarana, Areca* spp., *Calamus aidae* and *Plectocomia elongata* var. *philippinensis*. It is within these forest types that the extent of morphological variation of *P. samarana* was observed and verified. The encountered populations from these sites differ from the typical lowland and limestone morphotypes in having 3-pluricostulate leaflets and twisted rachillae with globose-ovoid fruits. Meanwhile, *Orania decipiens, Calamus elmerianus, C. megaphyllus* (Fig. 30), *C. vidalianus* (Fig. 31) and *C.* sp. "*tagda*" were locally abundant in Guinmayuhan, Balangiga, whereas the new slender *Pinanga*, *Calamus ochrolepis, C.* sp. "*malubagacay-bilog*" and *Heterospathe* sp. "*saguisi-mina*" were very abundant in Vigan, Gen. MacArthur.

The sites' unique edaphic conditions characterized by heavy metal concentration and low litter-nutrient inputs paved way for the niche specialization of certain plants such as *Nepenthes* spp. This habitat differentiation might also explain occurrence of the two new ultramafic-restricted palms, *Calamus* sp. "*tagda*" (Fig. 32) and *Heterospathe* sp. "*saguisi-mina*" (Fig. 33). The novel flagellate rattan is characteristic in its long-petiolate leaves and its sheath armature, reminiscent of cirrate *C. loherianus* in Luzon. It is unique among Philippine species in having the proximal joint of the flagella ornamented with a crown of

28. *Orania* sp. "*banga-igang*" with its very slender habit. Photo by J.T. Adorador.

29. The habit of Ptychospermatinae or *amuring* with its broadly-truncate, apically praemorse leaflets and whitish inflorescence axes. Photo by J.T. Adorador.

spines. Fertile collections would make such comparisons more complete. Meanwhile, the latter slender clustering erect palm has similarities with wider-ranging *H. philippinensis* but is different in the shorter leaf outline, thus having fewer leaflets and purplish inflorescence axes. Across different sites, this palm likewise exhibited noteworthy variation in inflorescence branching order and number of its peduncular bracts and leaflets. These two palms commonly prefer exposed ridges where the canopy is more open, but they are locally more abundant on reddish soil.

Other habitats (freshwater swamp, beach, and mangrove)

The freshwater swamps along seaward coastal portions of the island were mainly converted into rice fields or coconut plantations. Remnants of natural vegetation in these waterlogged sites mainly comprise discontinuous stands of *Teminalia, Anthocephalus* and *Pandanus*. The palms sporadically thriving here include *Metroxylon sagu* (Fig. 34) and *Livistona saribus* (Fig. 35). The latter fan palm is characterized by its heavily armed petiole, drooping leaf apices and bluish fruits, while the former clustering palm has erect dark-green leaves and trunks die after a massive apical flowering. Sago palm stands were not communally maintained and utilized since the fragmented clusters seemed to be only established by chance. Meanwhile, *Nypa fruticans* typically borders rice fields where they border brackish water zones towards the mangroves.

Beach forests of appreciable extent can only be encountered in uninhabited coasts or smaller islands where *Heterospathe elata, Calamus discolor, C. usitatus* and *Caryota cumingii* flourish. These narrow coastal vegetation strips are separated from the central lowland forests by large expanses of cultivated lands or abandoned clearings where few plants of *Arenga pinnata* can be found.

Economic use of some palms

Among the rattans, at least five robust species (*Calamus aidae, C. merrillii, C. moseleyanus, C. multinervis* and *C. ornatus*) were recorded as used in furniture-making industry. Meanwhile, those slender-cane taxa used in handicrafts (such as weaving material and cordage) include

30 (left). Sapling of *Calamus megaphyllus* with its broad oblanceolate leaflets. 31 (right). Habit of clustering *Calamus vidalianus* with its irregularly arranged leaflets. Photos by J.T. Adorador.

32. The flagellate Calamus sp. "*tagda*" – note the dense brown spines of the sheath and short lamina outline. Photo by J.T. Adorador.

33. Heterospathe sp. "*saguisi-mina*" – note its several undivided leaves and purplish inflorescence axes. Photo by J.T. Adorador.

34 (top). Young stand of the clustering *Metroxylon sagu*. 35 (bottom). Remnant population of *Livistona saribus* in Basey, Samar with several cultivated *Cocos nucifera* in the background. Photos by J.T. Adorador.

C. daemonoropoides, C. discolor, C. filispadix, C. megaphyllus, C. mollis, C. sp. *"tagda"* and *C.* sp. *"pudlos-liitan."* Some species provide food for inhabitants such as *C. ornatus* for its sour fruits and *C. aidae* for its bitter palm heart.

As for the erect palms, the leaves of several species (*Corypha utan*, *Livistona saribus* and *Saribus rotundifolius*, *Metroxylon sagu, Nypa fruticans* and *Cocos nucifera*) are used for thatching and roofing materials. Aside from

the conventional uses of coconut, its fruit and fermented sap are commercially utilized for copra (coco-meat) and *lambanog*, respectively. Local people seldom utilize the durable wood of *Orania decipiens* as house posts. On a lesser scale, the three forest *Areca* species were observed to serve as substitutes for *A. catechu* for their traditional *mamâ*. Likewise, *Caryota rumphiana* and *Pinanga insignis* are known for their palatable palm heart, while those of *P. samarana* are also said to be edible though bitter to taste.

Threats to their habitat

The never-ending small-scale timber poaching and slash-and-burn (*kaingin*) practices always pose significant threats to the island's rich forest biodiversity. Several widespread palms were recorded to thrive in heavily disturbed lowland forests (such as *Pinanga samarana* and *Plectocomia elongata* var. *philippinesis*), but this does not correspond to their general ecological tolerance as a lineage. These palms are natural inhabitants of intact forests wherein their population dynamics respond to natural disturbances such as canopy gaps and soil erosion. Thus, prolonged exposure to such man-induced environmental stresses could result to the decrease of palm species composition or even to the extirpation of their respective populations. Such is the case for the two annihilated populations of the new diminutive *Pinanga* in the carbon-mined wasteland of Arizona, Hinabangan (Samar), wherein *kaingin* is frequently practiced for cassava cultivation (Fig. 36). Moreover, the 1980s agricultural conversion of the entire Dolongan peatlands at Basey (Samar) could have inflicted the same drastic trend to its palm flora before we even knew what existed there.

Over-harvesting of the rattan canes for the furniture industry in past decades has resulted in the absence of mature rattans but abundance of juvenile plants in almost every forest type visited. In Mt. Huraw, Arizona, Marabut, and Guinmayuhan, long canes of

36 (left). The extirpated cluster of *Pinanga* sp. "*tagibungang-liitan*" in Arizona, Hinabangan, Samar – note the rolled and scorched leaves which could be due to extreme heat following *kaingin* practice. 37 (right). One of the numerous saplings of *Calamus merrillii* – a remnant of the over-collection of mature canes in Mt. Huraw, San Jose de Buan. Photos by J.T. Adorador.

Calamus merrillii (Fig. 37) and *C. aidae* were not seen since local people had eagerly harvested these prime species. The current economic-paucity of the said industry could pave the way to the re-establishment of the natural populations, which must be sustainably managed in the future.

Several sites on the entire island are declared mineral reservations (e.g. laterite, bauxite, gold) – just waiting for any legal propositions for these ores to be extracted. In several sites, fuel-wood gathering and unproductive farming practices incessantly pressurize the spoiled vegetation. These destructive activities likely jeopardize the habitats of ultramafic-restricted palms. Naturally, the rapidly transformed environment suppresses their respective ecological niches and consequent reproductive strategies. The surveyed burnt forests of the previous laterite-exhumed concession area in Carapdapan, Salcedo (Eastern Samar) revealed the sparse occurrence of *Calamus* sp. "*tagda"* and the disappearance of the new *Heterospathe*.

On the other hand, the palm species found on the inaccessible interior rugged terrains of forests over limestone (e.g. Ptychospermatinae, *Orania* sp. "*banga-igang*," *Calamus* sp. "*pudlos-liitan"*) are projected to be among the least threatened by human extracting activities. However, natural disasters such as typhoons and prolonged droughts could bring the palm flora to its ecological tipping point in this limiting environment.

Summary and Conclusions

A survey of palms on Samar Island has revealed that its palm flora is very rich and particularly diverse and unusual, comprising 50 species with 70% Philippine endemism, 12 new records and 11 probable new taxa. Across different vegetation types and degree of disturbances, several palm species were observed to present morphological plasticity. Scrutiny of taxonomic literature, herbarium material and field observations required the application a broad morphological species concept on the island's palms. When taken in a broader context, this realization inevitably calls for a thorough review of several Philippine palm species and their complexes. Despite most of the island's remaining forests being declared "protected," human-induced activities constantly exert significant environmental pressures to the palms found there. The results of these surveys will ultimately be used towards the conservation of palms and their habitats on the island.

Recommendations

Population surveys of the economically important rattans subject to commercial extraction should be carried out so that sustainable management can be proposed. Thorough habitat surveys of the novel palms and knowledge on their ecology and phenology are also recommended.

The interior swamps of Bermudahan in Hinabangan, Samar, the highlands of the central portions of the island (Mts. Capotoan and Concord), and the volcanic soils in the northwestern part (Victoria-Calbayog) could support unique palm flora, but these sites were not included due to security reasons. Thus, if rebel tensions dissipate and funds are available, surveys in these areas could produce further botanical novelties.

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Appendix 1. Reconnaissance surveys and fieldwork conducted in various localities across Samar Island (2013–2016).

LOCALITY	TOWN	PROVINCE	DATES SURVEYED						
			Dec. 2013	Feb. 2014	Mar. 2014	Jul. 2015	Oct. 2015	Dec. 2015	Feb. 2016
Lowland evergreen rainforests									
1. Mt. Huraw	San Jose de Buan	Samar				X			X
2. Ulot River, Tula	Paranas	Samar		X				X	X
3. Arizona, Cansulabao	Hinabangan	Samar		X	X	X	X	X	X
4. Km 16, Tinabanan	Marabut	Samar						X	
5. Luisita	Victoria	N. Samar	X						
Forests over limestone									
6. Tenani	Paranas	Samar	X	X	X	X	X	X	X
7. San Isidro	Paranas	Samar							X
8. Sohoton Cave	Basey	Samar				O			
9. San Rafael	Taft	E. Samar				X		X	X
Forests over ultramafic rocks									
10. Guinmayuhan	Balangiga	E. Samar							X
11. Carapdapan	Salcedo	E. Samar						O	X
12. Vigan	General MacArthur	E. Samar							X
Other forest types (mangrove, beach, and freshwater swamp forests)									
13. Coastal areas	Borongan	E. Samar	X	X					O
14. Roadsides	Quinapondan-Giporlos	E. Samar	O						O
15. Dolongan	Basey	Samar						O	O
16. Buri Airport, Cabugawan	Catbalogan	Samar	O						X
17. Biri Rock Formation	Allen	N. Samar					O		
18. Coastal areas	Catarman-Lavezares	N. Samar	X				O		
19. Coastal areas	Motiong	Samar	X						
20. Coastal areas	Daram & Zumarraga	Samar	X						

Legend: X = actual fieldwork was conducted, O = visual surveys only.

Appendix 2. Palm species surveyed on Samar Island and observed distribution in different forest types.

Species	Local name	Forest Types (as per Fernando et al. 2008)[1]			
		A	B	C	D
Climbing palms (rattans)					
1. ***Calamus aidae*** Fernando	*ilihian, ulasi, ulisi*	X	(X)	X	-
2. ***Calamus daemonoropoides*** Fernando*	*sambunotan, uai balau*	X	(X)	-	-
3. ***Calamus discolor*** Mart.	*uban-uban, sungo-ng-orang*	X	X	-	-
4. ***Calamus elmerianus*** Becc.*	*pudlos*	X	-	X	-
5. ***Calamus filispadix*** Becc.	*tawin, pudlos*	X	-	X	-
6. ***Calamus megaphyllus*** Becc.*	*abangan, malubagacay*	X	-	X	-
7. ***Calamus merrillii*** Becc.	*parasan, pagiti*	X	(X)	X	-
8. ***Calamus mollis*** Blanco	*nukot, sungo*	X	X	X	-
9. ***Calamus moseleyanus*** Becc.	*malubagacay*	X	-	X	-
10. ***Calamus multinervis*** Becc.*	*lokuan*	(X)	X	-	-
11. ***Calamus ochrolepis*** (Becc.) W.J.Baker*	*balala, likbong, nukot*	X	X	X	-
12. *Calamus ornatus* Blume	*kalape*	X	X	X	-
13. ***Calamus pedicellaris*** (Becc.) W.J.Baker*	*hiyod*	X	-	-	-
14. *Calamus siphonosphathus* Mart. var. *dransfieldii* Baja-Lapis*	*pi-jai*	X	-	-	-
15. *Calamus symphysipus* Mart.	*uai-bangkau, palanog*	-	X	-	-
16. ***Calamus urdanetanus*** (Becc.)W.J.Baker*	-	X	-	-	-

Appendix 2 (continued).

Species	Local name	Forest Types (as per Fernando et al. 2008)[1]			
		A	B	C	D
17. *Calamus usitatus* Blanco	*pudlos*	X	(X)	-	-
18. ***Calamus vidalianus*** Becc.*	*sambunotan, tipunan, gachan*	X	-	X	-
19. ***Calamus*** sp. *"**tagda**"*	*tagda*	-	-	X	-
20. ***Calamus*** sp. *"**pudlos-uban**"*	*pudlos-uban*	-	X	-	-
21. ***Calamus*** sp. *"**pudlos-liitan**"*	*pudlos-liitan*	-	X	-	-
22. ***Calamus*** sp. *"**tagsa-on**"*	*tagsa-on*	X	-	-	-
23. ***Calamus*** sp. *"**malubagacay-bilog**"*	*malubagacay-bilog*	X	-	X	-
24. *Korthalsia laciniosa* (Griff.) Mart.	*talubag-angan, pahan, danan*	X	X	-	-
25. ***Plectocomia elongata*** Mart. ex Blume var. ***philippinensis*** Madulid*	*uai babae*	X	X	X	-
Erect palms (non-rattans)					
26. ***Areca caliso*** Becc.	*bugiking*	X	X	X	-
27. *Areca catechu* L.	*bunga, mama*	Cultivated			
28. ***Areca costulata*** Becc.	*ajibi, muren*	X	X	X	-
29. ***Areca*** sp. *"**mudulan**"*	*mudulan*	X	(X)	X	-
30. *Arenga pinnata* (Wurmb) Merr.	*kaong*	Cultivated			
31. ***Caryota cumingii*** Lodd. ex Mart.	*pugahan, bagsang*	X	X	X	-
32 *Caryota rumphiana* Mart.	*pugahan, bagsang*	X	X	X	-

Appendix 2 (continued).

Species	Local name	Forest Types (as per Fernando et al. 2008)[1]			
		A	B	C	D
33. *Cocos nucifera* L.	*lubi*	Cultivated^			
34. *Corypha utan* Lam.	*buri*	(X)	-	-	X
35. *Heterospathe elata* Scheff.	*saguisi*	-	-	-	X
36. ***Heterospathe intermedia*** (Becc.) Fernando	*marighoi*	X	X	-	-
37. ***Heterospathe*** sp. "***saguisi-mina***"	*saguisi-mina*	-	-	X	-
38. *Livistona saribus* (Lour.) Merr. ex A. Chev.*	-	(X)	-	-	X
39. *Metroxylon sagu* Rottb.	*lumbia, lubi-lubi*	-	-	-	X
40. *Nypa fruticans* Wurmb	*nipa*	-	-	-	X
41. ***Oncosperma*** sp. "***anibong-kinis***"	*anibong-kinis*	X	(X)	X	-
42. ***Orania decipiens*** Becc.	*banga*	X	-	X	-
43. ***Orania*** sp. "***banga-igang***"	*banga-igang*	-	X	-	-
44. ***Pinanga copelandii*** Becc.	*muren, muring*	X	X	X	-
45. *Pinanga insignis* Becc.	*buyungaw*	X	-	X	-
46. ***Pinanga samarana*** Becc.	*tagibunga, salangisog*	X	X	X	-
47. ***Pinanga*** sp. "***tagibungang-liitan***"	*tagibungang-liitan*	X	X	X	-
48. **Ptychospermatinae gen. & sp. indet.**	*amuring*	-	X	-	-

Appendix 2 (continued).

Species	Local name	Forest Types (as per Fernando et al. 2008)[1]			
		A	B	C	D
49. ***Saribus*** cf. ***merrillii*** (Becc.) Bacon & W.J. Baker*^^	*anahaw, bigo-bukid*	X	-	-	-
50. *Saribus rotundifolius* (Lam) Blume	*anahaw*	X	X	X	-

Legend:

1 Habitats: A = lowland evergreen. B = over limestone, C = over ultramafic rocks, D = swampy (fresh or brackish)

Taxa in **bold** are Philippine endemic species (which is also likely to apply to possibly new species). Those with asterisk (*) are new records for the island.

The symbol '(X)' indicates that the species was encountered very rarely in such forest type.

^The reported population of native *C. nucifera* (Gruezo & Harries 1984) in the Guiuan peninsula was not visited.

^^This palm superficially resembles *S. merrillii* based on gross vegetative morphology (Dowe, pers. com.), but fertile collections are needed to verify its identity.