The Palms of Taiwan

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Unlike several other large islands with rich assemblages of palms such as Madagascar, New Caledonia and Cuba, the palm flora of Taiwan is conspicuous by its paucity of genera and species. Just five genera and seven species occur there, with only three genera and five species on the main island. Two other genera and two species, *Livistona chinensis* and *Pinanga tashiroi*, occur on the smaller offshore islands of Guishan and Lanyu respectively. Two additional species, *Areca catechu* and *Cocos nucifera*, are cultivated, sometimes commonly so, and have naturalized in many areas, especially in the southeast. Despite their paucity, Taiwan's indigenous palms are interesting, and two, *Arenga engleri* and *Livistona chinensis*, are hardy, durable, dependable and widely cultivated ornamentals.

Straddling the Tropic of Cancer and about 180 km off the southeastern coast of mainland China, Taiwan is about 330 km long and 120 km wide in a nearly north-south configuration, comprises 35,883 km^2 and encompasses several small islands or island groups, including Guishan (Turtle Island) and Lanyu (Orchid Island), which figure significantly in this discussion. Taiwan has several tall (to 3952 m), rugged mountain ranges stretching along

two-thirds of the eastern side of the main island. These slope to flat or gently rolling plains in the western third where most of Taiwan's 24 million people live.

Taiwan's climate is primarily subtropical in the north to tropical in the south, with some seasonal variation in temperatures and precipitation. Island-wide hot, humid, wet weather occurs from June through September, a period typically punctuated with often numerous typhoons (hurricanes). The northern part of the island has rain mostly evenly distributed year round while the southern part is rainy in the summer and somewhat dry in the winter. The average annual temperature is about 22°C in the north and 24°C in the south. Average winter temperatures are about 15°C in the north and 19°C in the south. The wettest areas are along the eastern slopes of the mountains (up to 6700 mm annually), while the driest areas are along the western plains (less than 1000 mm annually) (TCWB 2014).

Because of its location, topography and climate, Taiwan encompasses a wide variety of vegetation types, from wet to dry, tropical lowland to subalpine cold-temperate, including coniferous, broad-leaved evergreen, monsoon, thickets, grasslands, swamps and bogs, bamboo and mangrove communities. Indeed, the vegetation types of Taiwan are a microcosm of those found in the world (Song & Xu 2003).

Taiwan's seven indigenous and two naturalized species of palms encompass three subfamilies of the palm family: Calamoideae (*Calamus*); Coryphoideae (*Arenga, Livistona*, and *Phoenix*); and Arecoideae (*Areca*, *Cocos*, and *Pinanga*). For the most part, affinities of the palm flora are with mainland China although the two indigenous palms on tiny Lanyu Island (*Calamus siphonospathus* and *Pinanga tashiroi*) extend to or are more closely allied with species from the Philippines to the southeast. While the family occurs island wide, it is most diverse and more common in the wetter areas of the mountainous eastern two-thirds of the main island. Of the indigenous palms only *Phoenix loureiroi* occurs in the drier western one-third of the main island.

1. *Areca catechu* is commonly cultivated in Taiwan and frequently naturalizes, as here on Lanyu Island (D.R. Hodel).

Key to Species of Taiwan's Indigenous and Naturalized Palms

1a. Leaves palmate . . . . . *Livistona chinensis*

1b. Leaves pinnate 2

2a. Pinnae induplicate (trough formed by pinna fold facing adaxially or upwards) . . . 3

3a. Proximal pinnae reduced to spines, pinnae apices pointed, abaxial pinnae surfaces green . . . . . *Phoenix loureiroi*

3b. Proximal pinnae not reduced to spines, pinnae apices jaggedly toothed, abaxial pinnae surfaces silvery gray . . . . . *Arenga engleri*

2b. Pinnae reduplicate (trough formed by pinna fold facing abaxially or downwards) . 4

4a. Climbing palms armed with needle-like spines; fruits scaly 5

5a. Leaves with flagellum (clawed, whip-like climbing organ derived from the inflorescence) but lacking cirrus (clawed, whip-like leaf extension) . . . . . *Calamus beccarii*

5b. Leaves with cirrus but lacking flagellum 6

6a. Habit solitary; leaf sheath spines ± uniform, arranged in partial combs . . . . . *Calamus siphonospathus* var. *sublaevis*

6b. Habit clustered; leaf sheath spines variable, solitary . . . . . *Calamus formosanus*

4b. Erect palms; unarmed; fruits not scaly . . 7

7a. Leaf bases not forming a crownshaft; fruits typically 25 cm diam. or more . . *Cocos nucifera*

7b. Leaf bases forming a crownshaft; fruits typically 6 cm in diam. or less 8

8a. Major nerves on abaxial pinna surface with brownish scales . . . . . *Pinanga tashiroi*

8b. Major nerves on abaxial pinna surface lacking brownish scales . . . . . *Areca catechu*

Descriptions are from Pei et al. (2014), Henderson (2005, 2006, 2009), Hodel (1998) and supplemented with our observations on living plants in the field. Readers can also consult Phil Markey's on-line accounts of Taiwanese palms for additional information (Markey 2014a).

Areca catechu L. – betel nut palm, *bin lang*.

Moderate, solitary, tree palm to 20 m tall (Fig. 1). Stem to 15 cm diam., smooth, green, conspicuously ringed, aging gray to brown. Leaves 10–12, pinnate, ascending to spreading, eventually drooping, typically recurved and forming a compact canopy in high light, ± straight and forming an expansive canopy in low light, ± stiff; leaf bases 80–100 cm long, tubular, forming a well-developed, dark green, sometimes swollen crownshaft; petiole short, to 5 cm long; rachis 1.5–2 m long; pinnae 20–30 per side, 30–60 × 3–7 cm, close-set, regularly arranged, often ascending from rachis in high light; apical ones with truncate, coarsely toothed tips. Inflorescences 3–5, infrafoliar, to 60 cm long; peduncle short, to 3 cm long; rachis 25–40 cm long with several main branches; rachillae numerous, 20–25 cm long, slender, flexuous, erect and stiff in flower, drooping in fruit. Fruit 7–8 × 5–6 cm, ovoid, green, becoming orange.

Distribution and Ecology: The betel nut palm is cultivated from the tropical eastern coast of Africa and India to China, Southeast Asia, Taiwan, Micronesia, Malesia, New Guinea, Solomon Islands and Vanuatu, from sea level up to about 1000 m elevation. It frequently escapes cultivation or is intentionally planted in moist to wet, disturbed or even primary forest around homes and villages, where it readily naturalizes (Fig. 1).

Notes: Primarily cultivated for the hard seed, called betel or betel nut, it contains a mild narcotic that produces a pleasant, soothing feeling. Betel nut palms are extensively planted in central and southern Taiwan, and vast plantations containing 1000s of trees are a common sight. Taiwan is home to a thriving betel nut industry, both for domestic use as well as export. Small shops or stands selling betel nut, typically with flashing red lights, are a common sight along roads and in villages and towns throughout Taiwan.

Areca catechu is difficult to distinguish from *Pinanga tashiroi* on Lanyu Island, especially with juvenile and sterile adult plants, where the former has naturalized and the ranges of the two overlap. However, they can be distinguished in any instance because *A. catechu* has glabrous major nerves on the abaxial pinnae surface while *P. tashiroi* has nerves with brownish, scale-like hairs (see Fig. 34).

For a complete list of synonyms consult the World Checklist of Selected Plant Families (*http://apps.kew.org/wcsp/synonomy.do?name_id=14517*).

2. Robert M. Hodel provides scale for *Arenga engleri*, one of the most common and widespread palms of Taiwan. It typically forms large attractive clumps in the shady forest understory, as here at Pingtung (D.R. Hodel).

3. This narrow-leaved form of *Arenga engleri* is at Pingtung (D.R. Hodel).

Arenga engleri Becc. – Formosan sugar palm, *shan zong*.

Arenga tremula var. *engleri* (Becc.) Hatus.

Didymosperma engleri (Becc.) Warb.

Medium, moderately to densely clustered, shrubby, hapaxanthic, often gregarious, understory palm, forming clumps to 6 m tall and wide (Figs. 2 & 3). Stems several, erect to leaning, to 4 m tall, 15 cm diam., typically densely covered with persistent, fibrous leaf

4 (left). Pinnae margins of *Arenga engleri* are most often prominently lobed. 5 (right) Sometimes pinnae margins of *A. engleri* are unlobed (both by D.R. Hodel).

6. Fruits of *Arenga engleri* on Lanyu Island are about full size but still not reddish purple and ripe (D.R. Hodel).

bases. Leaves 6–8 per stem, pinnate, ascending to spreading; leaf bases deeply split opposite petiole, margins fibrous-netted, fibers extending more than half way to petiole of next upper leaf; petiole to 1.8 m long; rachis to 3 m long; pinnae up to ca. 40 per side with a triangular terminal pinna, to 70 × 2–4 cm, linear, regularly arranged, mostly flat in one plane except proximally, glossy dark green adaxially, silvery gray abaxially, briefly lobed mid-pinna or sometimes unlobed (Figs. 4 & 5), tips jaggedly toothed. Inflorescences several per stem, initiating distally and progressing proximally on stem, stem eventually dying, solitary at a node, to 60 cm long; rachillae 15, spreading, to 30 cm long. Fruit 1.5–2 cm diam., globose, orange to purplish or purplish red (Fig. 6).

Distribution and Ecology: *Arenga engleri* is widespread and now considered endemic in Taiwan, occurring nearly throughout the island from sea level up to about 1000 m elevation. Appearing to be a forest palm, it looks more luxuriant, graceful and natural in shaded situations. Although it is frequently encountered in exposed places, such as windswept coastal grasslands, rocky areas and disturbed forest, the plants in these harsher habitats never have the beauty and grandeur of their more protected, shaded counterparts.

Conservation Status: Because it is abundant and widespread, *Arenga engleri* is not considered threatened.

Notes: The range of *Arenga engleri* once extended into the Ryukyu Islands of southern Japan. However, Henderson (2006) concluded that the Japanese plants were a distinct species, and he named them *A. ryukyuensis*. He stated that *A. ryukyuensis* differed in its pinnae with prominent ribs adaxially and lacking mid-pinna lobes. Nevertheless, an examination of plants growing in Taiwan and the Ryukyu Islands showed variability in pinna lobing and adaxial ribbing, suggesting only one, highly variable species. *Arenga engleri* is hapaxanthic but not monocarpic because, while individual stems die after flowering, the plant lives on through the production of new stems from the base.

A handsome, relatively cold-tolerant (to -5°C) ornamental, widely cultivated around the world in suitable climates, *Arenga engleri* does best with a little shade during the hotter times of the day. Judiciously remove dead or unwanted stems to manage clump height, width, and density. Beware of the attractive fruits; while unusually colorful and eye-catching, they contain a highly irritating juice that cause severe, burning itch if it contacts tender skin.

7 (upper left). *Calamus beccarii* in Pingtung is a clustered rattan. 8 (upper right). Leaf sheaths are densely armed with short whorls of spreading, needlelike, black spines interspersed with shorter spines. 9 (bottom). The inflorescence of *Calamus beccarii* is up to 3 m long. (all by D.R. Hodel).

Calamus beccarii A.J. Hend. – *tu teng*.

Moderate, clustered, high-climbing, rattan palm to 50 m long (Fig. 7). Stems to 4 cm diam. with leaf bases, to 2 cm diam. without; internodes to 30 cm. Leaves pinnate, spreading; leaf base tubular, light green but densely covered with dark brown tomentum that ages to tan and then weathers away, densely armed with short whorls of spreading, needlelike, black spines to 2.5 cm long and interspersed with shorter spines to 5 mm long (Fig. 8), ocrea 1–2 cm high and densely spiny; knee poorly developed, flagella to 3 m long; petiole to 30 cm long; rachis to 1 m long; pinnae up to ca. 60 per side, to 40 × 1.5 cm, linear, regularly arranged and flat in 1 plane, closely set, veins minutely bristly; cirri lacking. Staminate and pistillate inflorescences somewhat similar, flagelliform, to 3 m long, branched to 2 orders (Fig. 9); partial inflorescences up to 6, these to 50 cm apart,; staminate partial inflorescences to 15 cm long (Fig. 10), rachillae up to 8, to 10 cm long, flexuous; pistillate partial inflorescences up to 45 cm long (Fig. 11), rachillae up to 12, to 8 cm long. Fruit to 2 × 1.2 cm, globose-ellipsoid, brown, scales fringed.

10 (top). Staminate plants of *Calamus beccarii* have relatively short partial inflorescences with congested flowers. 11(bottom). Pistillate partial inflorescences of *Calamus beccarii* are longer, with more remotely placed flowers than their staminate counterparts (both by D.R. Hodel).

12. Juveniles of *Calamus beccarii* are especially attractive (D.R. Hodel).

Distribution and Ecology: Endemic to the main island, *Calamus beccarii* is uncommon at several locations in Kaohsiung and Pingtung counties in southern Taiwan, where it occurs in lowland moist to wet forest up to about 500 m elevation.

Conservation Status: Because *Calamus beccarii* is known from relatively few, scattered locations and is frequently cut to extract the edible apical meristem ("heart"), it is likely threatened and perhaps should be considered vulnerable. Fortunately, this species is of clustered habit so cutting the stems to remove the edible meristem does not kill the plant but might help to maintain it in a perpetually immature or juvenile state, thus reducing its chances to reproduce sexually and enhance or spread populations through seed dispersal.

Notes: Although long recognized as one of the three rattan species in Taiwan but confused with *Calamus formosanus*, *C. beccarii* was without a name until Henderson (2005) formally described it. Juvenile, non-climbing plants are especially leafy and attractive (Fig. 12).

Calamus typically has pistillate inflorescences branched to two orders and staminate branched to three; thus, *C. beccarii* is unusual in that staminate inflorescences apparently are branched only to two orders rather than three.

Calamus formosanus Becc. – *huang teng, sheng teng*.

Calamus orientalis C. E. Chang

Calamus quinquesetinervius Burret.

Moderate, clustered, high-climbing, rattan palm to 40 m long (Fig. 13). Stems to 5 cm diam. with leaf bases, to 2.5 cm diam. without; internodes to 25 cm. Leaves pinnate, spreading; leaf base tubular, light green to yellowish brown, sparsely covered with tan tomentum that ages to gray and then weathers away, densely armed with solitary, spreading to ascending, narrowly triangular, greenish-based, brownish spines to 2.5 cm long (Fig. 14), ocrea to 1 cm high; knee conspicuous; flagella absent; petiole nearly lacking to 10 cm long; rachis to 2.5 m long; pinnae up to ca. 30 per side, to 45 × 5 cm, lanceolate to broadly lanceolate, more or less regularly arranged, sometimes irregularly arranged (nearly always irregularly arranged in juvenile, non-climbing individuals (Figs. 15 & 16), tips drooping, distantly spaced, veins bristly; cirri to 2 m long. Staminate and pistillate inflorescences dissimilar, flagelliform, staminate to 1 m long, branched to 3 orders, pistillate to 1.5 m long, branched to 2 orders; staminate partial inflorescences up to 8, to 20 cm long, to 10 cm apart, rachillae up to 12, to 3 cm long, flexuous; pistillate partial inflorescences up to

13 (upper left). *Calamus formosanus*, fairly common and widespread in Taiwan, is a moderate, clustered, rattan, as here in Pingtung. 14 (upper right). Leaf bases are densely armed with solitary, spreading to ascending, narrowly triangular spines. 15 (bottom). Leaves frequently have irregularly arranged pinnae. (all by D.R. Hodel).

16 (top). Juvenile, non-climbing plants of *Calamus formosanus* nearly always have irregularly arranged pinnae. 17 (bottom). Rachillae of pistillate inflorescences are up to 10 cm long. Inset: Fruits of *Calamus formosanus* are ellipsoid and ripen white (all by D.R. Hodel).

14, to 6 cm apart, rachillae up to 12, to 10 cm long (Fig. 17). Fruit to 2.2 × 1 cm, ellipsoid, yellowish brown to whitish (Fig. 17).

Distribution and Ecology: Endemic to the main island, *Calamus formosanus* is common and widespread, occurring in lowland moist to wet forest up to about 1000 m elevation.

Conservation Status: Because *Calamus formosanus* is common and widespread, it is not considered threatened although, like *C.*

18 (clockwise from upper left). On Lanyu Island *Calamus siphonospathus* var. *sublaevis* is a solitary, high-climbing rattan. 19. Once devoid of leaf bases, stems are about 2.5 cm in diameter. 20. Its leaf bases are densely armed with short combs or partial whorls of spreading, needle-like spines. 21. Leaves have up to 75 pairs of narrow, close-set, regularly arranged pinnae. 22. Fruits are globose-ellipsoid and ripen white. 23. Pistillate inflorescences are about 2 m long, branched to 3 orders. (all by D.R. Hodel).

beccarii, stems are sometimes cut to remove the edible meristem.

Notes: *Calamus formosanus,* still widely known as *C. quinquesetinervius*, is somewhat variable across its wide range. Juvenile, non-climbing specimens have clustered, irregularly arranged pinnae, a condition that remains sometimes even after the plants have started to climb (Fig. 16). This variability has resulted in the two synonyms and is responsible for the confusion that "hid" *C. beccarii* until recently.

Calamus siphonospathus Mart. var. **sublaevis** Becc. – *lanyu sheng teng, guan bao sheng teng*.

Large, robust, solitary, high-climbing, rattan palm to 40 m long (Fig. 18). Stem to 10 cm diam. with leaf bases, to 2.5 cm diam. without; internodes to 25 cm. (Fig. 19). Leaves pinnate, spreading; leaf base tubular, green to yellowish brown, densely covered with whitish tomentum that ages to gray and then weathers away, densely armed with short combs or partial whorls of spreading, needle-like, greenish-based, brownish spines to 2 cm long (Fig. 20); ocrea 1 cm high, membranous; knee conspicuous to obscure; flagella lacking; petiole to 25 cm long; rachis to 2.5 m long; pinnae up to ca. 75 per side, to 35 × 2.5 cm, linear, regularly arranged (Fig. 21), slightly elevated off rachis, closely spaced, veins bristly; cirri to 2.5 m long. Staminate and pistillate inflorescences probably dissimilar, not flagelliform; staminate not seen but reported (Beccari 1908) to be to 1 m long with several partial inflorescences (Fig. 23), rachillae to 1.5 cm long, flexuous; pistillate to 2 m long, branched to 3 orders, curved, fairly stout, partial inflorescences up to 10, to 15 cm apart, to 20 cm long, each branch with up to 6 rachillae to 8 cm long. Fruit to 0.6 × 0.4 cm, globose-ellipsoid, yellowish brown to whitish (Fig. 22).

Distribution and Ecology: *Calamus siphonospathus* is more widespread in the Philippines and extends into Taiwan only on Lanyu Island, where it occurs in moist to wet forest up to 500 m elevation. It also occurs in Indonesia in North Sulawesi.

Conservation Status: Because *Calamus siphonospathus* var. *sublaevis* is localized on the small island of Lanyu, it should be considered locally vulnerable, although in the Philippines it is not threatened.

Notes: *Calamus siphonospathus* var. *sublaevis* is a big, impressive, conspicuous rattan palm on Lanyu, where it is found with *Pinanga tashiroi*. In the Philippines it is much more variable and several additional varieties have been recognized.

As mentioned above, *Calamus* typically has pistillate inflorescences branched to two orders and staminate branched to three; *C. siphonospathus* var. *sublaevis* is unusual in that pistillate infloresces are branched to three orders.

24. *Cocos nucifera* is cultivated and infrequently naturalizes in southern Taiwan (C.-F. Chen).

25. *Livistona chinensis* forms vast, gregarious stands on Guishan Island where its grayish leaves and bright yellow inflorescences are conspicuous against the green vegetation (C.-F. Chen).

Cocos nucifera L. – coconut palm.

Mostly large, solitary, tree palm to 25 m tall (Fig. 24). Stem to 40 cm diam., often curved or leaning, expanded at based with exposed roots. Leaves 25–40, pinnate, ascending to drooping in a graceful canopy; leaf bases deeply split, stout, woody, margins with dense fibers, not forming a crownshaft; petiole to 1.5 m long, stout, yellowish; rachis to 7 m long; pinnae up to 100 per side, to 100 × 10 cm, linear, regularly arranged, drooping, dark green with prominently elevated midrib. Inflorescences up to 12, interfoliar, spreading, to 1.5 m long; peduncle to 50 cm long, stout; rachillae up to 50, to 45 cm long, stiffly spreading. Fruit to 30 × 25 cm, ellipsoid-globose, 3-sided, greenish yellow.

Distribution and Ecology: *Cocos nucifera* has occasionally naturalized in southeastern Taiwan, mostly in Kaohsiung, Pingtung, and Taitung Counties at low elevations. It is widely cultivated and has naturalized in many tropical regions of the world, especially in coastal areas.

Notes: Although its exact date of introduction is unknown, *Cocos nucifera* has long been cultivated in southern Taiwan, especially Pingtung County, for more than 500 years, mostly for its fruit but also leaves, fiber, and wood (stem). Fruit production likely peaked in the late 20th century but has declined since then because of less expensive, South Asian imports. Its primary use now is as an ornamental landscape subject.

Livistona chinensis (Jacq.) R. Br. ex Mart. – Chinese fan palm, Chinese fountain palm, *pu kui*.

Moderate, solitary, tree palm to 15 m tall. Stem to 30 cm diam., typically initially covered with persistent leaf bases and petiole stubs, these weathering away and then surface rough from leaf scars; internodes to 5 cm. Leaves to 45, palmate, ascending to drooping; leaf bases short, becoming deeply split opposite the petiole, stout, distal margins armed like petiole; petiole to 1.8 m long, margins armed with recurved, green or black teeth; hastula to 3 cm long; blades nearly circular, to 1.8 m wide, green, regularly divided to about one-half into up to 90 segments, these split and pendulous at tips. Inflorescences to 1.5 m long, interfoliar, yellowish in flower. Fruit to 2.6 × 1.8 cm, globose to ellipsoid or pear-shaped, green to blue-green.

Distribution and Ecology: In Taiwan, *Livistona chinensis* is known only from Guishan Island, where it occurs gregariously on steep slopes in low, wind-battered forest below 400

26 (upper left). Co-authors Adam Hsu (left) and Chien-Fan Chen (right) provide scale for this tall *Phoenix loureiroi* just inland from the beach on Lanyu Island. Note the salt-wind-burned leaves. 27 (upper right). This *Phoenix loureiroi* grows in dry forest on the western side of Taiwan near Taichung. 28 (bottom). This *Phoenix loureiroi* grows on alluvial soil just above the Beinan River on the wetter western side of Taiwan near Taitung (all by D.R. Hodel).

29 (top). Pistillate inflorescences of *Phoenix loureiroi* elongate beyond the protective acanthophylls and are orange when carrying mature fruit. 30 (bottom). Dry, grassy, disturbed, frequently burned slopes on the western side of Taiwan near Taichung are home to these *Phoenix loureiroi* (both by D.R. Hodel).

m elevation (Fig. 25), although it is widely cultivated around the main island. It is more widespread in mainland China, where it is found in Guangdong and Hainan, and in Japan, where it occurs in the Ryukyu Islands and southern Kyushu, mostly in moist forest at low elevations, often near the sea coast. Markey (2014a) noted that it also occurs on the tiny island of Uotsurijima (Japanese) or Diaoyudao (Chinese), which is the largest

island of the Senkaku (Pinnacle) Islands, currently controlled by Japan but claimed also by China and Taiwan. On this island, Markey estimated the population of the palms at over 100,000 individuals, making it by far the largest population of this species in the world.

Conservation Status: Because *Livistona chinensis* is localized on the small island of Guishan, it should be considered locally vulnerable in Taiwan. Indeed, human activity has much affected and disturbed its range from China to southern Japan. Its discontinuous, isolated populations, with often localized distribution on small islands within this range, likely make it vulnerable but its conservation status has not yet been thoroughly assessed.

Notes: Likely tolerating temperatures to about to -5°C or lower (depending on its provenance) with little or no damage, *Livistona chinensis* is widely cultivated in Taiwan and worldwide wherever palms can be grown. A highly variable species across its range, the conspicuously pendulous segment tips, set on tiered leaves, give the canopy the impression of a fountain; hence, the other common name for this palm. The infructescences are especially attractive when heavily laden with ripe, blue-green or turquoise fruit.

Livistona chinensis was represented in Taiwan by var. *subglobosa* but now most authorities simply consider this variety to be a synonym of the species. Markey (2014b), who provided an otherwise interesting account, maintained, however with some doubt, var. *subglobosa* for the Taiwanese *L. chinensis*, stating that it is "a much more attractive form than the usual form of *Livistona chinensis* found in Southern China, and is also more cold-hardy." Furthermore, he stated that the seed of the mainland China form (var. *chinensis*) "produces a typically elongate, smaller seed (15–9 mm) than the Japan/Taiwan form which produces a larger, more globose seed (18–12 mm)." His claim, though, that "no wild populations [of *L. chinensis*] exist in Taiwan today" is untrue (unless he is referring to the island of Taiwan proper) because the population on Guishan Island is certainly indigenous and natural.

For a complete list of synonyms consult the World Checklist of Selected Plant Families (*http://apps.kew.org/wcsp/synonomy.do?name_id=114913*).

Phoenix loureiroi Kunth. – *haizao*, *ci kui*.

Small to moderate, mostly solitary, rarely clustered, tree palm to 5 m tall (Figs. 26–28 &

31. On the wetter, eastern side of Taiwan *Phoenix loureiroi* grows just in back of the beach near Gangxi in Pingtung (D.R. Hodel).




32 (upper left). Restricted to Lanyu Island, *Pinanga tashiroi* is a solitary, understory tree palm. 33 (upper right). *Pinanga tashiroi*. 34 (lower left). Pinnae of *Pinanga tashiroi* have the major nerves on the lower surface covered with brownish, scale-like hairs (left) while those of the similar *Areca catechu* are glabrous (right). 35 (lower right). Inflorescences of *Pinanga tashiroi* are drooping (all by D.R. Hodel).

31). Stems to 40 cm diam., typically covered with persistent, diamond-shaped leaf bases for many years, these eventually weathering away and then surface rough from leaf scars; internodes to 4 cm. Leaves pinnate, ascending to drooping; leaf bases short, deeply split, stout; petiole lacking or to 10 cm long; pseudopetiole to 30 cm long, armed with up to 15 acanthophylls per side; rachis to 2 m long; pinnae up to 130 per side, irregularly arranged and spreading in different planes, to 50 × 4 cm, linear, sharp- and stiff-pointed. Inflorescences interfoliar, staminate and pistillate dissimilar; staminate to 65 cm long, erect, rachillae up to 30, to 10 cm long; pistillate to 2 m long, orange, spreading (Fig. 29), rachillae up to 40, to 40 cm long. Fruit to 1.8 × 0.9 cm, ellipsoid, dark purple to black.

Distribution and Ecology: *Phoenix loureiroi* occurs throughout nearly all of Taiwan and inhabits a variety of sites, including grassy areas, sand dunes, steep slopes, mixed forests, *Pinus* forests, and open, disturbed, often dry forests and places subject to burning, up to 1700 m elevation (Fig. 30). It often occurs in harsh sites, such as steep rocky slopes and windswept coastal areas. It is the only palm found in the dry western one-third of Taiwan. It also occurs in mainland China, Southeast Asia and the Philippines, India, Bhutan, Nepal and Pakistan.

Conservation Status: Because *Phoenix loureiroi* is widespread in Taiwan and adaptable to a variety of sites, it is likely not threatened, although it has yet to be assessed officially.

Notes: *Phoenix loureiroi* is a highly variable species across its wide range resulting historically in numerous synonyms. For a complete list of synonyms consult the World Checklist of Selected Plant Families (*http://apps.kew.org/wcsp/synonomy.do?name_id=152690*). Two varieties are accepted: var. *loureiroi*, which occurs in Taiwan and has newly opened pinnae with brown filament along the margins and var. *pedunculata*, which is restricted to the Indian subcontinent and lacks the brown filament. *Phoenix loureiroi* is an overlooked or undeservedly rare palm horticulturally and, because of its ornamental nature, small size and tolerance of adverse, harsh conditions, deserves wider use in the landscape.

Pinanga tashiroi Hayata – *lanyu shan bin lang*.

Pseudopinanga tashiroi (Hayata) Burret

Moderate, solitary, understory tree palm to 5 m tall (Figs. 32 & 33). Stem smooth, green, conspicuously ringed, aging gray to brown, to 10 cm diam. Leaves 10–12, pinnate, ascending to spreading, eventually drooping; leaf bases to 1 m long, tubular, forming a well-developed, dark green, sometimes swollen crownshaft with reddish brown scale-like hairs; petiole to 60 cm long; rachis to 2 m long; pinnae to 50 per side, to 60 × 2.5 cm, linear, close-set, regularly arranged, primary nerves abaxially with brownish scale-like hairs (Fig. 34); apical ones with truncate, jaggedly toothed tips. Inflorescences 3–5, infrafoliar, to 50 cm long, pendulous, 1-branched (Fig. 35); peduncle short, to 8 cm long; rachis to 40 cm long; rachillae up to 30, to 25 cm long, slender, flexuous, stiff, drooping in flower and fruit. Fruit to 1.8 × 1.2 cm, ovoid to globose, red (Figs. 36 & 37).

Distribution and Ecology: *Pinanga tashiroi* is endemic to Lanyu Island, where it occurs in moist to wet forest up to 500 m elevation.

Conservation Status: Because *Pinanga tashiroi* is known only from a small island just several kilometers across and unusually small population numbers, it is considered Critically Endangered (IUCN 2014). It is cultivated in the Taichung Botanical Garden and Taipei Botanical Garden.

Notes: Seeds of *Pinanga tashiroi* are chewed as a substitute for betel nut (*Areca catechu*), with which it can be confused, especially when juvenile or non-flowering. Indeed, wild, naturalized plants of *A. catechu* are frequently sympatric with *P. tashiroi*, especially at the latter's lower elevational range. However, non-flowering plants can be distinguished by the primary nerves on the abaxial surface, which in *P. tashiroi* have brownish scales while in *A. catechu* are glabrous.

Although Henderson (2009) and Pei et al. (2014) stated that *Pinanga tashiroi* can be solitary or clustered, we saw only solitary plants. Careful comparison of *P. tashiroi* with some of its Philippine counterparts might show it not to be distinct.

That *Pinanga tashiroi* grows well in the relatively cooler climate, especially in the winter, in Taipei in the northern part of Taiwan seems significant. It is likely one of the few cool-tolerant species of *Pinanga* and is worthy of trial in marginal palm-growing areas with subtropical or Mediterranean climates.

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36 (left). These fruits of *Pinanga tashiroi* are about full size but unripe (D.R. Hodel). 37 (right). Fruits of *Pinanga tashiroi* are red when mature (A.C. Hsu).

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