

***Guihaia grossifibrosa*, the Dragon Scale Palm – An Endangered Species from Limestone Mountains in Northern Vietnam and China**

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Guihaia grossifibrosa is a poorly known dwarf fan palm, a typical element of the indigenous vegetation of ancient karst limestone hills and low ridges, widespread in northern Vietnam and China. In this article the authors give more information about the habit of this species and describe the natural conditions of its habitats in Vietnam.

Guihaia J. Dransf., Lee & Wei is genus of Coryphoid palms comprising two species distributed in karst-limestone areas of southern China and northern Vietnam (Dransfield et al. 1985). While the type species of the genus, *G. argyrata* (Lee & Wei) Lee, Wei & J. Dransf., is a common plant in southern China and is quite well studied, the second species – *G. grossifibrosa* – is much less well known and is represented by only a few collections. A detailed description of this plant and its ecology is provided below, based on recently collected material from the territory of northern Vietnam.

Guihaia grossifibrosa (Gagnep.) J. Dransf., Lee & Wei, *Principes*, 29, 1: 12, Fig. 8. 1985. *Rhapis grossifibrosa* Gagnep. in *Notulae System.* 6: 159. 1937 and in Humbert, *Fl. Gen. Indochine* 6: 994. 1937. Type: ANNAM: massif de Lin-ca, prov. de Vinh, *Poilane 16383* (P).

Unbranched dioecious fan palm, solitary or in clumps of 2–5 individual stems of different height, rarely forming ± dense groups with more than 5 trunks, each terminated by a very open crown. Trunk rigid, erect, 0.5–2.5 m tall (female samples usually more compact and smaller, up to 2 m high) in upper part densely



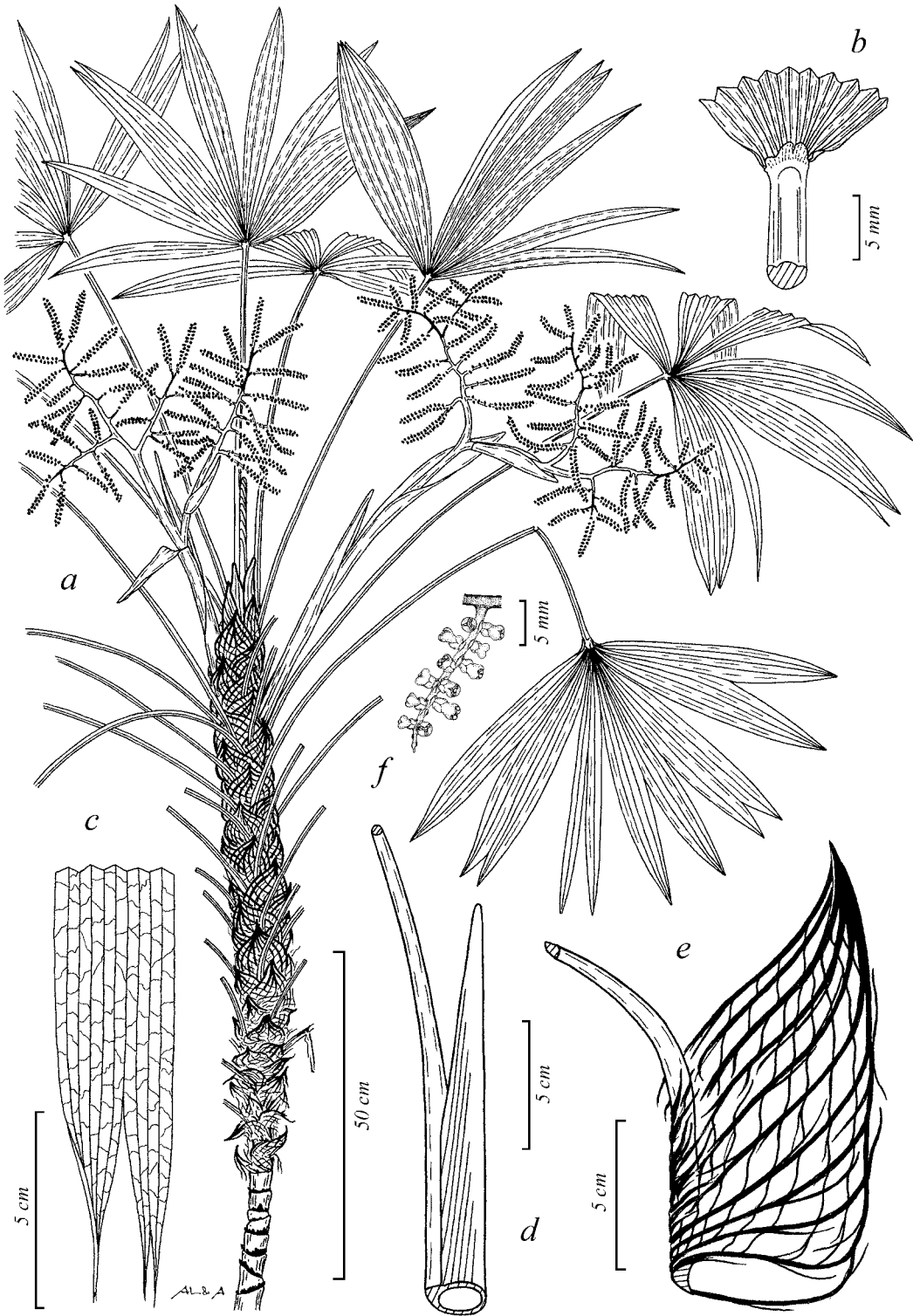
1. *Guihaia grossifibrosa* in its natural habitat.

covered with persistent leaf sheaths, 4–8 cm in diam., bare near the ground, 1.5–2.5 cm diam., with internodes 1–1.5 cm long. Leaves 6–12(14) in crown; sheaths, when young narrow, cylindrical, hardly splitting, 18–12 cm long, 1–1.5 cm wide, dull brown, with dull gray-brown papyraceous hairs; sheaths of old leaves widening to 6–8 cm, deep brown to black, glabrous, shortly cylindrical to broad ovate, inflated, split into linear, very rigid, coarse, woody, wire-like anastomosing segments, often disintegrating into free, more or less reflexed spike-like tips, surrounding stem with wire-like rigid netlike covering; ligule-like tip deep brown to black, glabrous, erect, 6–15 cm long, with very rigid and hard, beak-like apex, at the base dissected into network of numerous anastomosing linear rigid segments; petiole narrow, slender, rigid, 0.5–1 m long, 2–3 mm broad, subterete, broadening and flattened to the base up to 5–6 mm wide, slightly curved in basal portion (strongly curved in old leaves), ± straight toward the leaf blade, glabrous, smooth along margin, green or dull brown near trunk;

adaxial hastula semi-circular, erect, 2–2.5 mm high, sometimes irregularly dissected into two unequal lobes, hairy when young with dull gray-brown papyraceous caducous hairs, on old leaves glabrous; leaf blade leathery, dark green above, light green (sometime whitish) below, broadly fan shaped in outline, 40–45 cm long from hastula, palmately segmented from near the base into 6–10(12) unequal segments, each segment linear to elliptic, (0.8)1–3(6) cm wide, broadest segments commonly partially dissected from periphery, smooth (in male samples) to sparsely, very finely denticulate along margin (in female samples) with 1 to 6(10) prominent longitudinal veins, longitudinally folded, sometimes slightly narrowing to acute apex, hairy above (in young leaves) at the base with sparse short papyraceous dull gray-brown hairs. Inflorescence 1–2(3), branched to 3(4) order, situated in leaf axils near the apex of the trunk, 40–70 cm long, with light dull brownish to deep brown, rigid, narrowly lanceolate smooth laterally compressed basal bracts; basal bracts 2(3), 15–30 cm long, 1–2 cm wide,

2 (left). Steep inaccessible slopes and cliffs of ancient limestone ridges and hills composed of marble-like crystalline highly eroded limestone at elevations 500–900 m a.s.l., the home of *Guihia grossifibrosa*. 3 (right). Open primary dry coniferous forests with *Pinus fenzeliana* and *Pseudotsuga sinensis* on rocky ancient limestone are typical habitats of *Guihia grossifibrosa*.



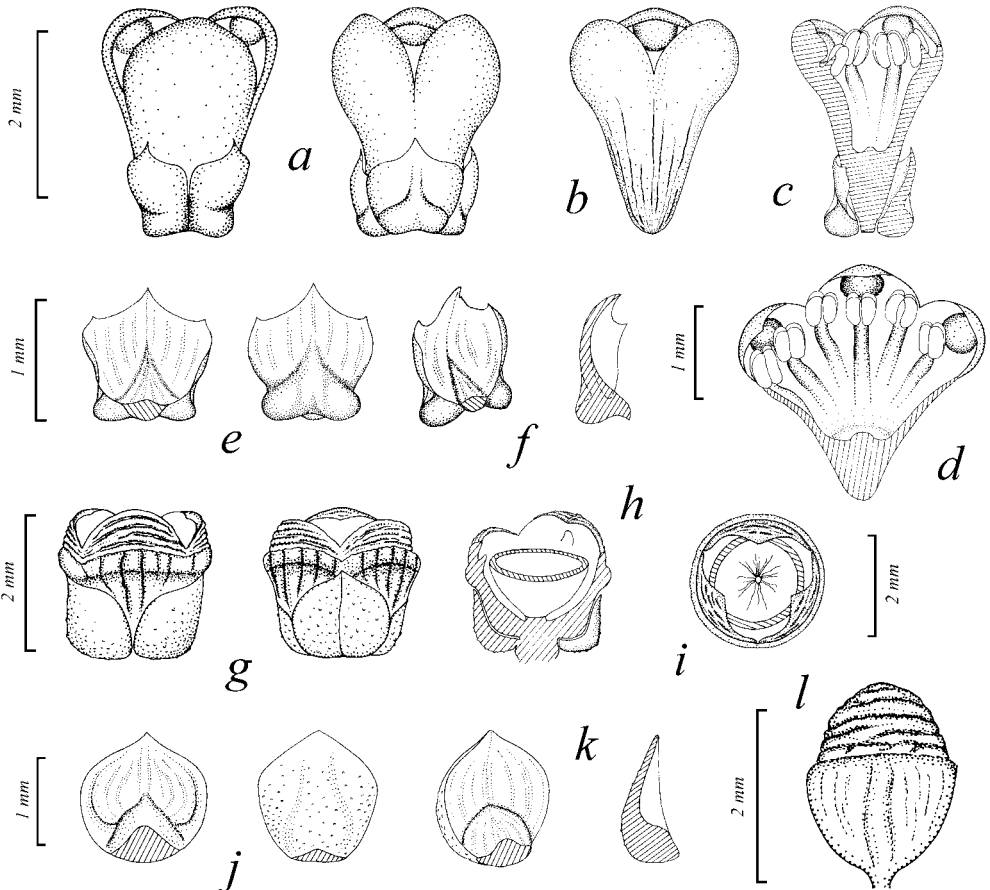


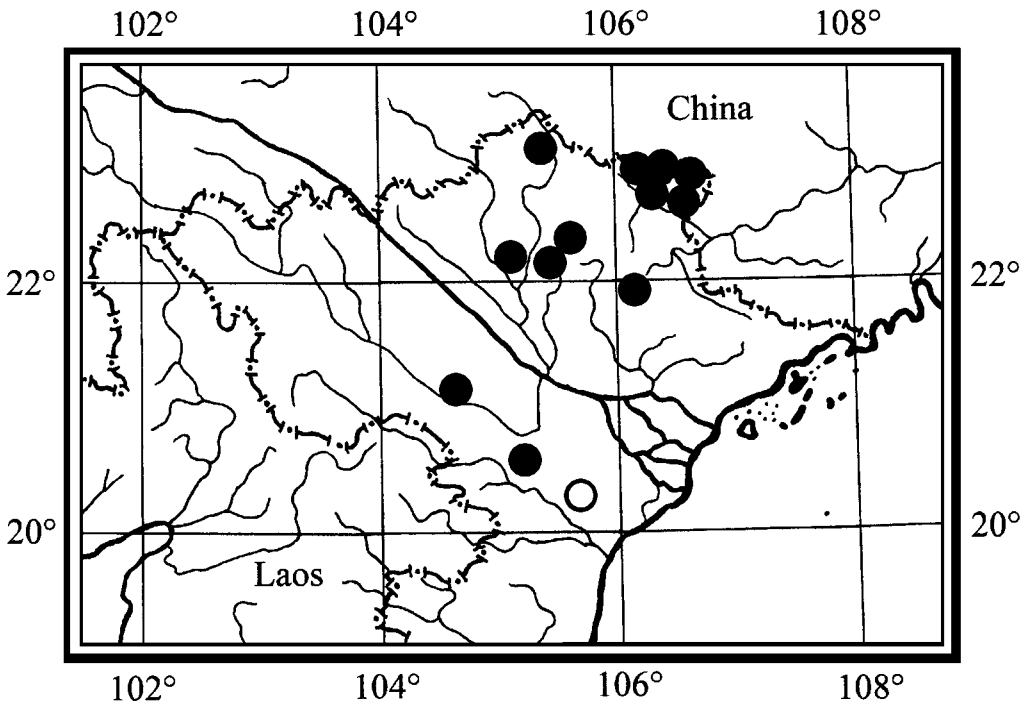
4. *Guihia grossifibrosa*. a. habit; b. base of leaf lamina with ligula (hastula); c. apical part of leaf segments; d. base of young leaf with leaf sheath; e. base of adult leaf with leaf sheath; f. rachilla with male flowers. All drawn from male sample - HAL 4741 by Leonid Averyanov and Anna Averyanova.

densely hairy with dull gray-brown short papyraceous hairs (when young) or glabrous (when old), tubular in basal portion, acuminate at the apex; peduncle erect, very rigid, 20–30 cm long, 5–7 mm broad, oval in cross section, enveloped by basal bracts; rachis very rigid, 20–25 cm long, 3–4 mm wide, slightly flexuous, with 2–3 main branches, with 1 rigid brown bract similar to basal inflorescence bracts, hairy (when young), 6–9 cm long, 4–8 mm broad; rachillae numerous, (0.5)1.5–8(10) cm long, rather straight, rigid, with numerous, sessile, densely spirally arranged, yellowish to yellow-green flowers, each flower with very small insignificant triangular bracteole. *Flowers* unisexual, sessile, radially symmetrical; male flowers shortly cylindrical or broadly shortly conical, 2.4–2.6 mm long, about 2 mm wide, campanulate;

sepals 3, free, scale-like, ovate to subquadrate, 2–2.2 mm long, 2–2.4 mm broad, indistinctly trilobed or broadly tridentate at apex, thickening into broad inflated broadly triangular woody base; petals 3, narrowly triangular, 2.4–2.6 mm long, 1.5–1.8 mm wide, with orbicular apex, three times longer than sepals, inside at the apex with prominent hemispherical cushion, connate from the base to 3/4 their length into conical fleshy tube, finely longitudinally wrinkled; stamens 6, \pm similar, in two whorls, not exceeding the petals, filaments adnate to the perianth, anthers subsessile oblong reniform, 0.3–0.4 mm long, 0.2–0.3 mm broad, dehiscent longitudinally along lateral margin; pistillodes absent; female flowers shortly cylindrical to subglobose, 2–2.2 mm long and broad; sepals 3, free, scale-like, broadly ovate to

5. *Guihia grossifibrosa*. a. male flower, side view; b. corolla of male flower, side view; c. male flower, longitudinal section; d. male flower, half-dissected and flattened; e. sepals of male flower, view from adaxial and abaxial side; f. sepal of male flower, side view and longitudinal section; g. female flower, side view; h. female flower, longitudinal section with half developed ovary; i. female flower, with transverse section of half developed ovary, view from the top; j. sepals of female flower, view from adaxial and abaxial side; k. sepal of female flower, side view and longitudinal section; l. petal, view from abaxial side. All drawn from HAL 4741 (male sample) and NTH 3543 (female sample) by Leonid Averyanov and Anna Averyanova.





6. *Guihia grossifibrosa*. Map of distribution in Vietnam. Studied populations confirmed with herbarium collections are marked with dots; the open circle designates a locality based on observations not confirmed with voucher herbarium specimens.

suborbiculate, 1.4–1.6 mm long and broad, thickened at the base, finely verrucose outside; petals 3, ovate, about 2 mm long, 1.8 mm wide, outside in upper part with transverse low inflated band, at basal half smooth or indistinctly longitudinally wrinkled, in apical portion with irregular transverse rough wrinkles, deeply connate into rigid woody cupule with only free roundish apices of petals; staminodes 3 (rudiments of stamen of inner whorl), small, tooth-like; gynoeceum unknown. Fruit 1-seeded; young fruit briefly stalked, ovoid, with thin exocarp and with few weak fibers in mesocarp; old ripe fruits (fallen on ground) black, spherical, about 1 cm in diameter; seed unknown. Fig. 1, 4, 5, 7–10.

Flowering Period. April–June.

Ecology. Lithophytic and terrestrial erect unbranched fan palm 0.5–2(2.5) m tall. Primary rather open and dry evergreen seasonal lowland and submontane coniferous (particularly with *Pinus fenzeliana* and *Pseudotsuga sinensis*) and broad-leaved forests on rocky tops and cliffs of remnant ridges and hills composed of marble-like crystalline highly eroded limestone at elevations 500–900 (1100) m a.s.l.

Distribution. Vietnam. Bac Kan prov. (districts: Ba Be, Cho Don, Na Ri), Cao Bang prov.

(districts: Ha Lang, Tra Linh, Trung Khanh), Ha Giang prov. (Dong Van district), Ninh Binh prov. Nho Quan district, Cuc Phuong national park [sight record on steep, inaccessible cliffs], Son La prov. (Moc Chau district), Thanh Hoa prov. (Ba Thuoc district). Fig. 6.

Specimens Examined. Vietnam, Bac Kan prov., Cho Don distr., Nam Mau Municipality, Ba Be national park around point 22°23'22"N 105°37'09"E, 500 m, 23.12.2002, J. Regalado, N.T. Hiep, L. Averyanov et al., HLF 609 (HN); Phia Khao village, Cau Muc locality, 22°17'32"N 105°31'27"E, 900–1000 m, 26.12.2002, P.K. Loc, L. Averyanov, T.V. Thao et al., HLF 807 (HN); same locality, around point 22°15'52"N, 105°32'01"E, 800–900 m, 21.5.2004, L. Averyanov, N.T. Hiep, P.V. The, N.T. Vinh, HAL 4741 (HN, LE); Na Ri distr., Liem Thuy Municipality, village Lung Vai, around point 21°57'18"N, 106°06'12"E, 500–700 m, 28.5.2004, L. Averyanov, N.T. Hiep, P.V. The, N.T. Vinh, HAL 4982 (HN); Cao Bang prov., Ha Lang distr., municipality Thang Loi, vicinities of Ban Hao (22°43'N 106°40'E), about 43 km to E from Cao Bang town, 700 m, 26.11.1998, L. Averyanov, P.K. Loc, N.X. Tam, CBL 681 (HN); Tra Linh distr., municipality Quang Vinh (22°51'N 106°14'E), about 21 km from Cao Bang town to the N, 800–850 m, 9.12.1998, L.

Averyanov, N.T. Hiep et al., CBL 997 (HN); Quoc Toan municipality, near Thang Heng lake in environs of Thang Heng and Lung Tao villages, 800–900 m, 4.1.1996, *L. Averyanov, N.T. Hiep et al., VH 2466* (HN); vicinities of Lung Tao village (22°45'N 106°19'E), about 12 km from Cao Bang town to the NNE, 600–800 m, 14.12.1998, *N.T. Hiep, P.K. Loc, L. Averyanov et al., CBL 1238* (HN); Trung Khanh distr., Ngoc Khe Municipality, Pac Nga village, around point 22°54'59"N, 106°31'44"E, 750–850 m, 12.6.2004, *L. Averyanov, P.K. Loc, P.V. The et al., HAL 5655* (HN); Ha Giang prov., Dong Van distr., Tu Tinh municipality (23°05'N 105°15'E) 40.7 km to 43° of Ha Giang city, 600–750 m, 10.10.1999, *N.T. Hiep, L. Averyanov, P. Cribb et al., NTH 3543* (HN, LE); Son La prov., Moc

Chau distr., municipality Chieng Hac, vicinities of Co Liu village (20°51'N 104°38'E), 900–1100 m, 29.5.1999, *N.T. Hiep, P.H. Hoang, L. Averyanov, NTH 2951* (HN); Thanh Hoa prov., Ba Thuoc distr., Co Lung municipality, territory of Pu Luong protected area, near Pu Luong village (20°27'01"N, 105°11'03"E), 500–550 m, 13.4.2001, *N.T. Hiep, L. Averyanov, D.T. Doan et al., HAL 929* (HN).

Notes. This palm was first described by Gagnepain based on collections made by Poilane in the Massif de Lin-ca, province of Vinh, in Vietnam. The geographical origin of the type may be questionable, as it is reported from an area of southern Vietnam with mainly siliceous rocks. *Guihaia grossifibrosa* is an



7. *Guihaia grossifibrosa*, adult flowering male samples in natural habitat.

8. *Guihia grossifibrosa*, inflorescences and leaves (adaxial and abaxial sides) of male samples.



obligate calcium dependent species and typically inhabits rocky karst limestone in northern Vietnam. Its occurrence in southern Vietnam has not yet been confirmed by recent field investigations. It is also known from southern China (Dransfield et al. 1985).

The first time we became aware of this unusual dwarf palm in northern Vietnam was during initial exploratory expeditions in the karst limestone areas of northern Vietnam supported by U.S. National Geographic Society and American Orchid Society. Dr. N.T. Hiep

and Prof. L. Averyanov found it in 1996 with a number of other calcium dependent endemic plants, some new to science, most famous of which was *Paphiopedilum helenae* Aver. The discovery of numerous new species emphasized how important the floristic complex of karst limestone area in northern Vietnam is as a center of plant diversity.

During detailed explorations of Cao Bang province two years later *Guihia grossifibrosa* was collected and observed many times, and we recognized this palm as a typical shrubby

element of the rocky and cliff habitats on tops of remnant, highly eroded, limestone ridges. Extensive field investigations of limestone regions of northern Vietnam during the next few years detailed the distribution area of this species as widespread throughout the northwest of the South Chinese and the northeast of the North Indochinese floristic Provinces of the Indochinese floristic Region of the Indomalaysian Subkingdom of the Paleotropic Realm (Averyanov et al. 2003a, b; Averyanov 2004). Up to now it has been found in most administrative provinces of northern Vietnam where primary vegetation on rocky karst limestone still survives. The plant was recorded from Ha Giang, Cao Bang, Bac Kan, Son La, Ninh Binh and Thanh Hoa provinces (Fig. 6). In some cases, however, it is found on rocky vertical cliffs inaccessible for collecting and such records are not confirmed by voucher herbarium samples. In the last few years *G. grossifibrosa* was collected in the extreme north of Cao Bang province very near to the Chinese border. Identical landscapes on both sides of the border gives clear evidence that the palm may also be common on the Chinese side of the border if it has not become extinct due to more widespread deforestation.

Natural conditions observed throughout the range of distribution of *Guihaia grossifibrosa* were described in detail in a number of our previous publications (Averyanov et al. 2000, 2002, 2003a, b, in press; Averyanov 2004). The climate here is classified as monsoon tropical climate with a cool winter and summer rains (Nguyen Khanh Van et al. 2000). Commonly, annual rain precipitation averages around 1500–1700 mm, with mean annual temperatures 20–22°C. A hot damp summer with an abundance of torrential heavy rain from May–June until September–October is typical for the area. The winters are dry and rather cool from October up to April. Average summer temperatures usually vary between 23–28°C, the usual winter temperatures (at elevation 174–520 m a.s.l.) hover around 11–16°C. On the coldest winter nights, at elevations 520 m in open places the temperatures may approach -3.5°C. Night cloud and fog are common in the mountains and mountain valleys at elevations higher than 500 m a.s.l.

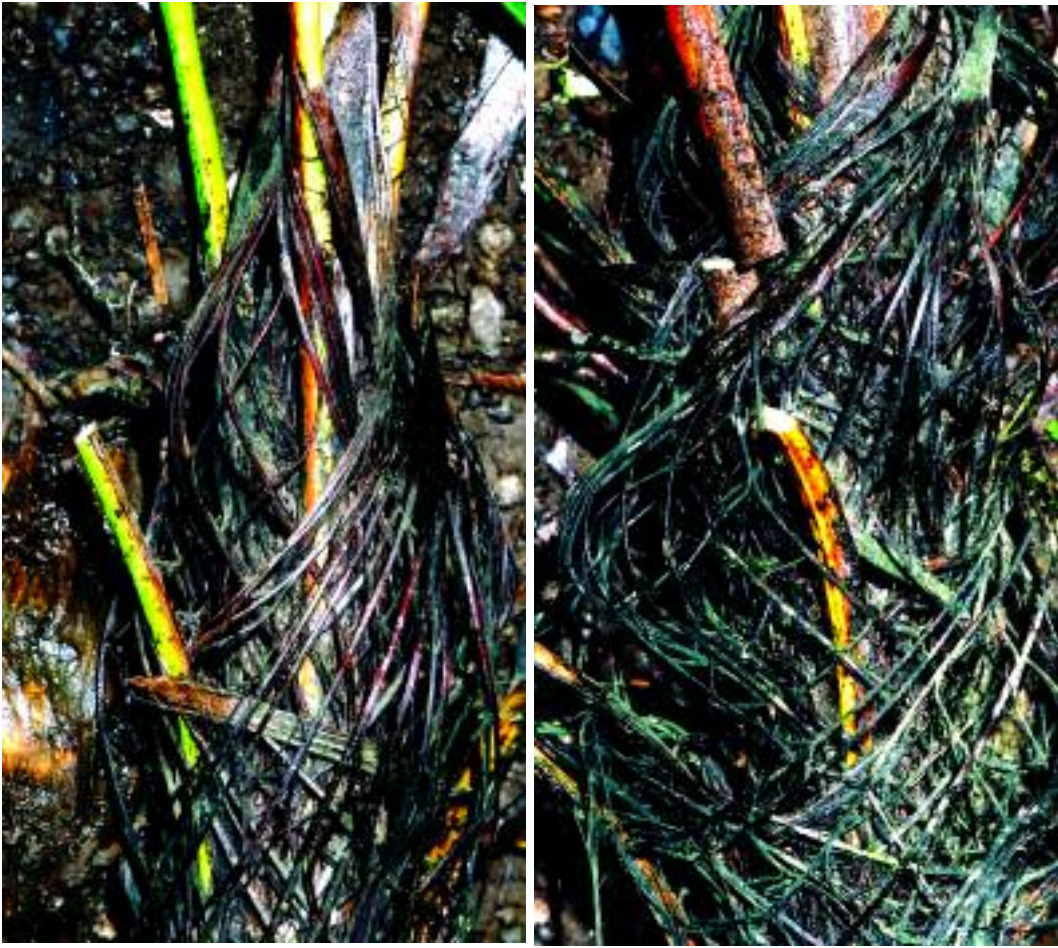
Guihaia grossifibrosa was found as an integral floristic element of the shrubby understory in primary open evergreen, more or less seasonal, tropical lowland and submontane coniferous and broad-leaved forests on rocky limestone

mountains. It grows predominantly at elevations 500–900 m a.s.l. (Fig. 2.). The species is a typical inhabitant of open limestone outcrops, steep rocky slopes and ledges of vertical cliffs. It is particularly common in light coniferous forests with *Pinus fenzeliana* and *Pseudotsuga sinensis* (Fig. 3). Fragments of these forests cover isolated rocky tops of highly eroded remnant limestone formations, which appear as numerous hills or small mesa-like mountains with very steep slopes and numerous vertical cliffs (Fig. 2). Mountains at the localities of *Guihaia grossifibrosa* are composed of solid crystalline white to deep gray marble-like limestone, which represents a relictual geologic formation derived from marine deposits of late Paleozoic and early Mesozoic age (Dovzikov et al. 1965a, b). Deep erosion of the ancient highly metamorphosed marble-like limestone formed a spectacular landscape.

Other conifers occasionally appearing as canopy dominants of limestone forest are *Calocedrus rupestris*, *Dacrycarpus imbricatus*, *Fokienia hodginsii* and *Keteleeria davidiana*. This forest stratum on tops of mountains reaches 15–20 m tall, but can reach up to 25–30 m on slopes protected from wind. Some broad-leaved trees, such as *Platycarya strobilacea* (Juglandaceae) and several tropical oaks (*Quercus* spp.) occur sometimes in this stratum with the conifers. Projected plant cover of the first stratum is not too high and averages about as 15–25% only.

The second forest stratum includes many species of trees commonly 6–15 m tall with total projected cover of their canopies up to 40%. Among the most common species here are *Acer tonkinense* (Aceraceae), *Aglaia* sp. (Meliaceae), *Apodytes dimidiata* (Icacinaceae), *Boniodendron parviflorum*, *Nephelium* sp. (Sapindaceae), *Carpinus* sp. (Betulaceae), *Celtis* sp. (Ulmaceae), *Ficus* sp. (Moraceae), *Lysidice rhodostegia* (Fabaceae), *Pistacia weinmannifolia* (Anacardiaceae), *Radermachera boniana* (Bignoniaceae), *Reevesia* sp. (Sterculiaceae), *Sapium rotundifolium* (Euphorbiaceae), *Schefflera pes-avis* (Araliaceae), *Sinosideroxylon racemosum* and *S. wightianum* (Sapotaceae). Some gymnosperm trees, such as *Nageia fleuryi* and *Podocarpus neriifolius*, are also regular components in this stratum.

The next stratum of the forest includes small trees and shrubs commonly 1.5–5 m tall. They develop more or less dense cover composed of a great number of species. Main co-dominants



9–10. *Guihia grossifibrosa*, leaf sheaths in male (9, left) and female sample (10, right).

here are species such as *Alstonia guangxiensis*, *Tabernaemontana* sp. (Apocynaceae), *Ardisia* sp., *Myrsine kwangsiensis* (Myrsinaceae), *Bischofia* sp., *Mallotus* sp., *Phyllanthus* sp. (Euphorbiaceae), *Cryptocarya chinensis*, *Litsea* sp. (Lauraceae), *Callicarpa* sp., *Premna* sp. (Verbenaceae), *Calophyllum balansae*, *Calophyllum* sp., *Garcinia fagraeoides*, *Garcinia* sp. (Clusiaceae), *Campylotropis bonii*, *C. henryi*, *Sophora tonkinense* (Fabaceae), *Carallia* sp. (Rhizophoraceae), *Decaspermum parviflorum*, *Rhodamnia dumetorum*, *R. trinervia* (Myrtaceae), *Diospyros kerrii*, *D. rufogemmata* (Ebenaceae), *Eriobotrya bengalensis*, *E. cavaleriei*, *Sorbus* sp. (Rosaceae), *Euonymus* sp., *Glyptopetalum thorelii* (Celastraceae), *Ficus* sp. (Moraceae), *Glycosmis puberula*. (Rutaceae), *Homalium petelotii* (Flacourtiaceae), *Illicium difengpii* (Illiciaceae), *Ixora* sp., *Psychotria* sp., *Tarenna collinsae* (Rubiaceae), *Ligustrum* sp., *Osmanthus* sp. (Oleaceae), *Lithocarpus* sp., *Quercus* spp. (Fagaceae), *Mahonia nepalensis* (Berberidaceae), *Mangifera flava*, *Mangifera* sp., *Pistacia*

weinmannifolia, *P. cucphuongensis* (Anacardiaceae), *Melientha suavis* (Opiliaceae), *Memecylon edule* (Melastomataceae), *Pittosporum* sp. (Pittosporaceae), *Polyalthia* sp. (Annonaceae), *Rhapis divaricata* (Arecaceae), *Strobilanthes* sp. (Acanthaceae), *Tirpitzia sinensis* (Linaceae), *Viburnum cinnamomifolium* (Caprifoliaceae) and *Xerospermum noronhianum* (Sapindaceae). Dwarf cycads, *Cycas dolichophylla*, may be observed on steep open slopes and cliffs. Projected cover of this forest stratum often reaches 40%, but on rocky outcrops and cliffs the shrub cover may be less than 10%.

The herbaceous species composition in habitats of *Guihia grossifibrosa* is extraordinarily rich and includes a great number of species among which most common are *Aglaonema* sp., *Amorphophallus* sp., *Arisaema* sp., *Typhonium* sp. (Araceae), *Alpinia* sp., *Hedychium* sp. (Zingiberaceae), *Ardisia maclurei*, *A. silvestris* (Myrsinaceae), *Aspidistra* sp., *Disporum cantoniense*.

Ophiopogon peliosanthoides, *Peliosanthes teta*, *Polygonatum punctatum*, *Tupistra* sp. (Convallariaceae), *Carex* sp. (Cyperaceae), *Elatostema* sp., *Procris* sp. (Urticaceae), *Impatiens* sp. (Balsaminaceae), *Lysimachia* aff. *microcarpa*, *L. insignis* (Primulaceae) and *Ophiorrhiza* sp. (Rubiaceae). Shady vertical cliffs represent the typical habitat of numerous obligate lithophytes, such as *Begonia aptera*, *B. cavaleriei*, *Begonia* spp. (Begoniaceae), *Chirita* spp. (Gesneriaceae), *Peperomia blanda* (Piperaceae) and numerous ferns.

Among the most common fern species observed in habitats of *Guihaia grossifibrosa* are *Adiantum caudatum*, *A. gravesii*, *Amphineuron tonkinense*, *Antrophyum* sp., *Asplenium griffithianum*, *Asplenium* sp., *Colysis bonii*, *C. elliptica*, *C. pothifolia*, *Ctenitopsis austrosinensis*, *Cyclosorus* sp., *Cyrtomium fortunei*, *Drymoglossum* sp., *Lemmaphyllum microphyllum*, *Neocheiropteris ensata*, *Polystichum* sp., *Pteridrys* sp., *Pteris* sp., *Pyrrosia porosa*, *Tectaria polymorpha* and *Tectaria* sp.

The orchids reach extraordinarily high diversity in habitats of *Guihaia grossifibrosa*. Like this palm most of them are very rare, calcium-dependent, endemic species such as *Bulbophyllum ambrosia*, *B. longibrachiatum*, *Calanthe argenteo-striata*, *Habenaria ciliolaris*, *Liparis averyanoviana*, *Luisia appressifolia*, *Paphiopedilum emersonii*, *P. hangianum*, *P. helenae*, *P. hirsutissimum* var. *esquirolei*, *P. malipoense*, *Pholidota roseans*, *Renanthera citrina*, *R. vietnamensis*, *Rhomboda petelotii* and *Vanda fuscoviridis*.

Guihaia grossifibrosa is a common element of the shrub stratum in primary limestone forests. However, this palm never forms large dense populations and occurs commonly as scattered individuals or loose groups including usually not more than 3–5 growths of different heights. Male plants are usually a little bit taller, while female ones are shorter, more compact and robust. The plants are commonly rooted in deep vertical pockets in eroded limestone filled with rich deep brown well structured friable soil covered with leaf litter. Drainage of the karst limestone ground is very sharp, and rain water never accumulates in soils even during heavy rains.

Guihaia grossifibrosa has a dwarf habit with trunk 1–2 m tall (rarely up to 2.5 m) covered with unusual rigid scale-like leaf sheaths rather reminiscent of dragon scales. This unusual "dragon scale palm" obviously has potential

for ornamental horticulture but is not yet widely known in culture. Cultivation of this palm may be an important factor for its protection. *Guihaia grossifibrosa*, like many other indigenous endemic plants of the primary limestone floristic complex, is a highly endangered species, which could become extinct very quickly after logging of the forest and successive progressive deforestation. Effective regeneration of its populations in degraded secondary forests has never been observed in the studied areas. Without any doubt this rare Vietnamese endemic needs effective protection in all its discovered localities.

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