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Betula hainanensis (*Betulaster*, Betulaceae), a new species from Hainan Island, China

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Betula hainanensis J. Zeng, B.Q. Ren, J.Y. Zhu & Z.D. Chen (Betulaceae), a new species from Hainan Island, China, is described and illustrated. It is distributed in tropical, montane rain forests and evergreen broad-leaved forests at elevations above 700 m a.s.l., mostly as scattered individuals and occasionally as small populations. *Betula hainanensis* belongs to the section *Betulaster* and differs notably from the related species *B. alnoides*, *B. luminifera* and *B. fujianensis* in its morphology and phenology. A key is presented that distinguishes the species in the section *Betulaster* of *Betula*.

Introduction

Since the 1980s, specimens of *Betula* have been collected on Hainan Island and considered representing *B. alnoides* according to records in some herbaria compiled in *Flora of China* (Li & Skvortsov 1999). In 1996 and 2004, the research group of the first author adopted that name, investigated genetic resources and collected seeds of the species on Hainan Island (Zeng *et al*. 1999). A seedling growth trial was conducted in 2006 using seeds of 30 *B. alnoides* provenances. As a result, the seedlings of the Hainan Island provenance were found to be quite distinct from those of other provenances. Since then, additional specimens were collected for closer examination.

We collected specimens bearing fruit in April and male inflorescences in December from Jianfengling, Ledong County, Hainan Province. We also observed the phenology during the flowering period. Completely developed leaves, male inflorescences and fruits were measured routinely, and their bracts and nutlets were observed under a stereomicroscope (SZ-CTV, Olympus, Japan). The bark of this and its morphologically-related species were photographed with a digital camera from trees whose diameter at breast height was more than 30 cm. The specimens were compared with those of other species in the section *Betulaster*. It was concluded that we had an undescribed species at hand.

Betula hainanensis J. Zeng, B.Q. Ren, J.Y. Zhu & Z.D. Chen, *sp. nova* (Figs. 1 and 2D)

Type: China. Hainan, Ledong County, Jianfengling Reserve,

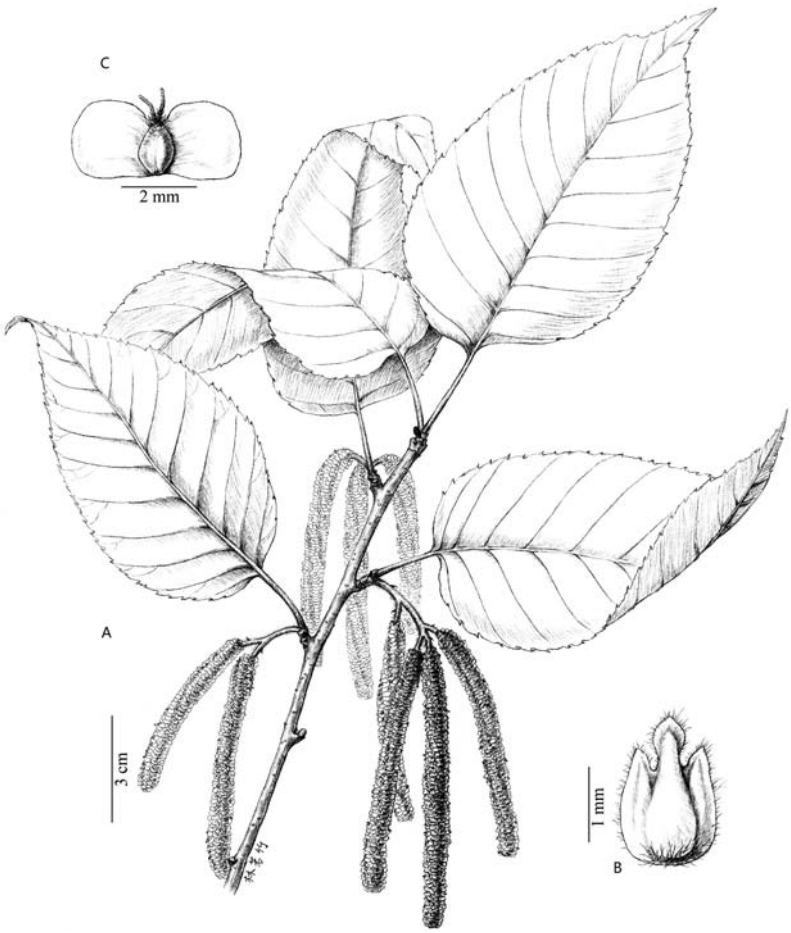

Fig. 1. *Betula hainanensis* (from the holotype). — **A**: Fruiting branch. — **B**: Bract. — **C**: Nutlet.

tropical montane rain forest, 850 m, *Zeng 2008042201* (holotype PE). — PARATYPE: China. Hainan, Ledong County, Jianfengling Reserve, tropical montane rain forest, 800 m, *Huangquan 84018* (RITF).

ETYMOLOGY: The specific epithet is derived from the type locality and known distribution of the species.

Trees up to 20 m tall with diameter at breast height up to 35 cm. Bark dark grey or grey-brown, smooth. Branchlets grey-brown or red-brown, densely pubescent and resinous glandular. Leaves on dwarf shoots and on long branches; petiole 1.5–2.5 cm, white villous and resinous punctuate; leaf blade ovate or oval, 7.5–10.5 × 3.5–5.5 cm, papery, abaxially densely glandular punctuate, bearded on main and secondary veins, apex acuminate caudate, base rounded or subcordate, sometimes asymmetric, secondary veins 10–14 on each side of midvein, margin irregularly incurved setiform serrate. Male inflorescences (3)4–5 arranged on top of branches or 1–3 axillary on upper part of branches. Female inflorescences (1)2–4 in a raceme, pendulous, narrowly cylindric, approx. 3.0–8.5 cm × 5 mm when mature, peduncle 2–10 mm, densely white pubescent. Bracts subcordate, sparsely white pubescent and ciliate, spongy at base, 3-lobed, lateral lobes rounded or triangular, approx. 1/4–1/2 as long as middle lobe. Nutlet ovate, approx. 0.9–1.5 × 0.7–1.0 mm, densely pubescent at apex, with membranous wings 3–4 times as wide as nutlets. Stigmas 2, persistent.

DISTRIBUTION AND HABITAT. *Betula hainanensis* is distributed in the central, southern, and southwestern parts of the Hainan Island, China. It was seen in forest areas such as Diaoluoshan, Jianfengling, Bawangling, Wuzhishan, and Lim-

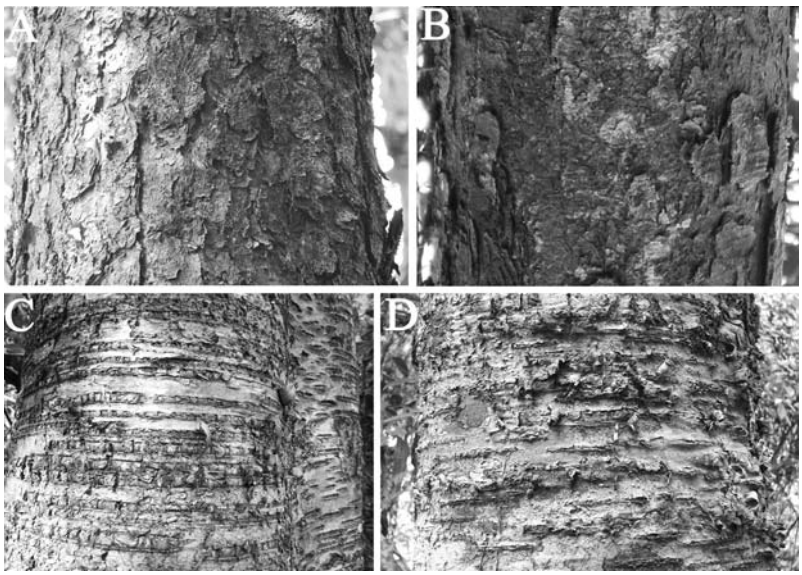

Fig. 2. Bark illustrations. — **A**: *Betula alnoides*. — **B**: *B. fujianensis*. — **C**: *B. luminifera*. — **D**: *B. hainanensis*.

uling, where there are many mountains higher than 1000 m a.s.l. Based on our investigation, the minimum elevations at which this species grows naturally are generally above 700 m a.s.l, and the majority of the plants grow between 800 and 1000 m a.s.l. There were fewer plants of this species above 1000 m a.s.l. in the well-protected natural forests.

Betula hainanensis is a pioneer tree species in the mountain rain forest and evergreen broad-leaved forest areas of Hainan Island. It was mainly observed in secondary forests. In well-preserved natural forests, few trees of this species were found and those were growing only in gaps. The Hainan ITTO Research Group found at least one tree of this species growing in four out of 48 plots in Bawangling; at that time it was however recognized as *B. alnoides* (Chen Y. F. pers. comm.). On the western slope of Daidongling in the Wuzhishan mountain area, fallow shifting agriculture sites have naturally regenerated into small fragments of pure stands of *Betula hainanensis* since the 1960s or 1970s. The tree has also migrated into the nearby plantations of *Pinus kesiya* var. *langbianensis*, *Dacrydium pierrei* and *Cunninghamia lanceolata*.

Betula hainanensis has racemes of two to four female inflorescences, which are narrowly elongate, cylindrical and pendulous; the wings of its nutlet are much wider than the nutlet itself and are partly exserted in mature infructescences. Therefore, it can be recognized as a species of the section *Betulaster* (Skvortsov 1997). *Betula hainanensis* differs from *B. alnoides*, *B. fujianensis*, and *B. luminifera* of that section by its bark or phenology (Table 1). The bark of *B. hainanensis* is similar to that of *B. luminifera*, typically smooth even on trees with a diameter at breast height over 30 cm, whereas old bark of *B. alnoides* and *B. fujianensis* exfoliate on large-sized trees (Fig. 2). The infructescences of *Betula hainanensis* normally become mature in late March and April, one to two months later than those of *B. alnoides* in the southern part of Yunnan and Guangxi, one-half to one month earlier than those of *B. luminifera* in the southern parts of Guangdong and Guangxi, and approximately half a month earlier than those of *B. fujianensis* in Fujian. The length of the leafless period of *B. hainanensis* is more than two months, similar to *B. luminifera* and *B. fujianensis*, though quite different from that of *B. alnoides* whose new leaves develop seven to ten days after defoliation (Table 1).

Betula hainanensis can also be distinguished from the species mentioned above by the leaf vein indumentum, bracts, and nutlets (Table 1). First, *B. hainanensis*, similar to *B. alnoides* and *B. luminifera*, is bearded on the main and secondary veins on the abaxial leaf blade, whereas

Table 1. A comparison of morphological and phenological characteristics between *Betula hainanensis, B. alnoides, B. fujianensis* and *B. luminifera*. Information on *B. alnoides*, *B. fujianensis* and *B. luminifera* is partly from Zeng *et al.* (2008).

Character	*B. hainanensis*	*B. alnoides*	*B. fujianensis*	*B. luminifera*
Leaf vein indumentum	bearded	bearded	beardless	bearded
Length ratio of lateral and middle lobes of bracts	1/4–1/2	< 1/3	1/3–1/2	< 1/3 or reduced
Old bark of large-sized trees	smooth	exfoliate	exfoliate	smooth
Leaf fall period	two months	7–10 days	two months	two months
Number of female catkins in a raceme	2–4	2–5	3–4	mainly single
Pubescence of bracts	sparse	dense	sparse	sparse
Pubescence at apex of nutlet	dense	dense	intermediate	intermediate
Width ratio of wing and nutlet	3–4	2–3	3–4	2.5–3.5
Fruiting period	late March and April	generally January–March	April–May	May–August

B. fujianensis is beardless on its secondary vein axils. Second, *B. hainanensis* normally has two to four female inflorescences in a raceme, whereas *B. luminifera* has mainly a single inflorescence. Third, the nutlet apex of *B. hainanensis* is much more densely pubescent than that of *B. luminifera* or *B. fujianensis*.

Key to species in section *Betulaster* of *Betula* (information on *B. luminifera*, *B. cylindrostachya* and *B. rhombibracteata* from Zeng *et al.* 2008).

1. Female inflorescences 2–5 in a raceme 2
1. Female inflorescences 1 or 2 5
2. Fruiting period September to October .... *B. maximowicziana*
2. Fruiting period January to May 3
3. Bract sparsely white pubescent, wing of nutlet three to four times as wide as nutlet 4
3. Bract densely white pubescent, wing of nutlet two to three times as wide as nutlet ..... *B. alnoides*
4. Leaf vein indumentum bearded; old bark of large-sized tree smooth ..... *B. hainanensis*
4. Leaf vein indumentum beardless; old bark of large-sized tree exfoliate ..... *B. fujianensis*
5. Female inflorescence 1 (or 2) ..... *B. luminifera*
5. Female inflorescences always 2 6
6. Scales of buds glabrous; petiole glabrous except villous in furrow; bracts rhombic, glabrous; nutlet 3–5 × 1.5–3 mm ..... *B. rhombibracteata*
6. Scales of buds villous; petiole densely yellow villous; bracts oblong-lanceolate, pubescent at base; nutlet ca. 2 × 1–1.5 mm ..... *B. cylindrostachya*

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