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A new distribution record for *Trigonobalanus verticillata* (*Fagaceae*) from Hainan Island, South China

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Summary. *Trigonobalanus verticillata* Forman was found in central Hainan Island, South China, during a survey in 2005. The taxon was previously only recorded from Malaysia and Indonesia. It is characterised by having leaves arranged in whorls of three and trigonous cupules that are opposite or in whorls. The importance of this discovery is briefly discussed.

Key Words. China, Hainan, Mayuling, new record, *Trigonobalanus verticillata*, Yinggeling.

Introduction

During a biodiversity survey of the Mayuling and Yinggeling areas in central Hainan Island, South China between May and Dec. 2005 for the proposed upgrade of the Yinggeling Nature Reserve to a National Nature Reserve, the survey team found three populations of *Trigonobalanus verticillata*, a species previously recorded only from Malaysia and Indonesia (Soepadmo 1972; Nixon & Crepet 1989).

Trigonobalanus verticillata *Forman* (1962: 139 & 1964: 382, f. 1 – 3); Soepadmo (1972: 368, f. 35 – 38); Nixon & Crepet (1989: 828). Type: Mt Kinabalu, Liwagu R., Kundasang, 4 Sept. 1961, *RSNB* 2732a (holotype K; isotypes L, LE, US).

The Hainan populations of this species are described below:

Tree up to 10 – 20 m tall, 30 – 70 cm dbh; bark pale grey-brown, smooth to shallowly fissured (Fig. 1A). Branchlets trigonous, covered in sparse stellate hairs. Leaves in whorls of three (Fig. 1B), coriaceous, 5.0 – 9.2 × 1.8 – 4.2 cm, obscurely and bluntly crenate in the distal half to entire, apex acuminate to obtuse or emarginate. Stipules in whorls of three, ovate lanceolate 3.8 – 5.1 × 1.2 – 2.8 mm, caducous. Inflorescences and infructescences in axils of upper leaves or terminal, erect, clustered into terminal or sub-terminal paniculate clusters, sparsely covered with stellate hairs. Androgynous inflorescences not seen. Staminate inflorescence 2.5 – 5 cm (Fig. 1B), unbranched or with up to three more or less equal branches towards base, male flowers in groups of 3 – 5, perianth 6-lobed, margin fimbriate, centre of adaxial side with pilose hairs. Infructescences 5 – 6.5 cm (Fig. 1C), unbranched; ripe cupules sessile, opposite to whorled on rachis, occasionally single, enclosing 3 – 5 fruits, open, (3 –) 5 lobes, triangular, acute, adaxial side fulvous tomentose by appressed simple hairs, abaxial side fulvous stellate hairy and with 5 – 6 transverse rows of acutely dentate lamellae; fruit sharply trigonous, 5.8 – 6.4 mm long × 3.4 – 4.9 mm wide, sparsely stellate hairy; base truncate; scar flat triangular; apex acute.

DISTRIBUTION. South China (Hainan Island) (present study), Malaysia (Malay Peninsula, Borneo), Indonesia (Sulawesi, Sumatra) (Nixon & Crepet 1989).

ADDITIONAL SPECIMENS. CHINA: Hainan, Wuzhishan County (City), Fangyang Township, Nan-le-shan, *S. C. Ng* 5091 (HKU); Fangyang Township, Po-chun-ling, 27 Nov. 2005, *S. C. Ng* 5561 (IBSC, HKU); same locality, 28 Nov. 2005, *S. C. Ng* 5575 (IBSC, HK) and *Lin J. Y. & Mo L. J.* 050474 (CANT); Baisha County, Yuanmun Township, Yinggeling, 22 May 2006, *S. C. Ng* 5670 (IBSC, HK).

HABITAT & ECOLOGY. Two of the three populations were found on the southern slopes of the Mayuling Mountain

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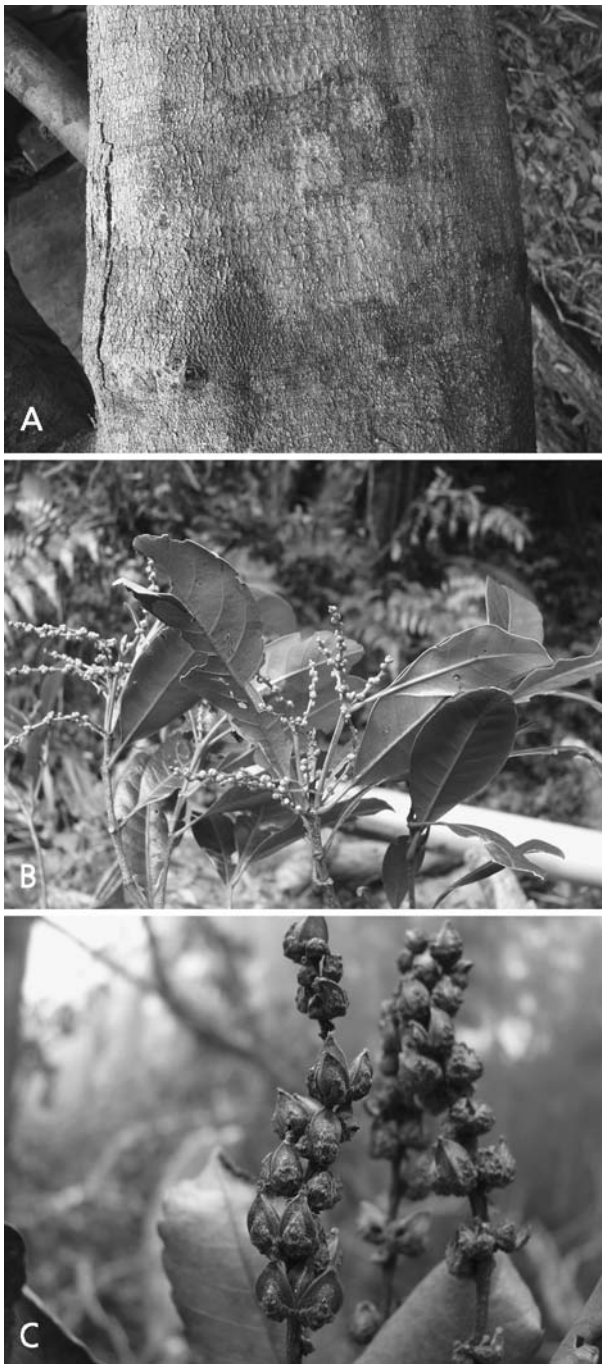

Fig. 1. A trunk of *Trigonobalanus verticillata* from Hainan; B branch with leaves and staminate inflorescences; C dried infructescence from a fallen tree, with ripe cupules and fruits. PHOTOGRAPHS BY SAI-CHIT NG, NOV. 2005.

which is continuous with Yinggeling Mountain, the second highest mountain on Hainan Island. *S. C. Ng* 5091 was found at a place locally called Nan-le-shan in montane tropical broadleaved forest at 1100 m, whereas *S.C. Ng* 5561 & 5575 and *Lin & Mo* 050474 were found in similar vegetation type at Po-chun-ling, 1200 m and 900 m respectively, about 7 km from the former site. The third population where *S. C. Ng* 5670 was collected was on the ridge (1400 – 1600 m) of Yinggeling Mountain about 18 km from the two previous sites. The species is locally common in tropical montane rainforest and evergreen broadleaf forest at the three sites. Major accompanying tree species included *Castanopsis tonkinensis*, *Lithocarpus fenzelianus*, *Altingia obovata* and *Dacrydium pectinatum*. It is occasionally abundant enough to become codominant with the above species.

PHENOLOGY. The specimen *S. C. Ng* 5561 was found to have staminate inflorescences with flowers just beginning to open during the survey in late Nov. 2005. A specimen with unripe infructescences (*S. C. Ng* 5670) was subsequently collected in May 2006. The fruiting specimens *S. C. Ng* 5575 and *Lin & Mo* 050474 were collected from a fallen tree which was probably blown down by a typhoon two months earlier, in Oct. 2005.

CONSERVATION STATUS. The global conservation status of *Trigonobalanus verticillata* has not been assessed (IUCN 2006). It was described as growing "gregariously" in montane forest in Peninsula Malaysia and Borneo (Soepadmo 1972) and was "commonly found" in some areas there (Kamiya *et al.* 2002, citing personal communications with K. C. Nixon & M. Hotta). Without first hand data on the global distribution and populations of the species, we can only assess its regional conservation status in China. Since Hainan Island is over 1,600 km from any previously known locality of the species, and the species shows very limited gene flow via seed (Kamiya *et al.* 2002), the Hainan population can be considered an effectively isolated breeding population. The regional conservation status in China can, therefore, be assessed with the IUCN Red List Criteria (IUCN 2001) without any downgrade (IUCN 2003). So far only three populations have been confirmed in China and the area of occupancy of these populations is less than 20 km^2, so the regional conservation status in China should be 'Vulnerable' (VU D2).

NOTES. The species is a distinctive member of *Fagaceae* with leaves arranged in whorls of three and trigonous fruits and cupules arranged oppositely or in whorls. The specimens collected more-or-less conformed to the description in the above-cited literature. The authors have also compared the above specimens to flowering material from Sulawesi kept in the South China Botanic Garden, Guangzhou, (IBSC *herb. no.* 249616, *coll.* s.n.), and found no obvious differences in vegetative parts, except for the slightly denser and longer stellate hair cover on the rachis of the staminate inflorescence of the Sulawesi specimen. Such a difference is within the range mentioned in Forman (1964) & Soepadmo (1972). The present discovery greatly expands the distribution range of this species, which was previously only known in the wet tropical montane rainforest between about 7°N (Sabah & Fraser's Hill) and 0° (Sulawesi) (Nixon & Crepet 1989), to 18°N on Hainan

Island, which has a tropical moist monsoon climate with distinct dry and cool seasons.

Trigonobalanus verticillata differs from the related *Formanodendron doichangensis* (Nixon & Crepet 1989) which has spirally alternate leaves and cupules on the inflorescence. The latter species was recorded from S and SW Yunnan in China as well as N Thailand and used to be included in the genus *Trigonobalanus* Forman as *T. doichangensis* Forman (Forman 1964; Hsu *et al.* 1981; Hsu & Jen 1998; also see Huang *et al.* 1999). Various morphological and palynological differences among the three species in *Trigonobalanus sensu* Forman suggested them to be in different genera (Nixon & Crepet 1989; Wang *et al.* 1998). This is further supported by substantial DNA sequence divergence among the three species compared to other genera of *Fagaceae* (Manos & Standford 2001), suggesting that they had diverged since ancient times. As a result, the discovery of *T. verticillata* in Hainan represents a new generic record (*Trigonobalanus* Forman *sensu* Nixon & Crepet (1989)) for China.

Trigonobalanus sensu Forman shows a disjunct continental distribution. It has been shown to be sister to all other genera in the *Fagaceae* except *Fagus* and probably diverged and spread throughout the world before other *Fagaceae* genera (Manos & Standford 2001; Li *et al.* 2004). Although fossil and molecular evidence suggest that *Trigonobalanus sensu lato* may have been continuously distributed in Asia, Europe and N America, there is no fossil record in S China (Zhou 1999; Manos & Standford 2001). Zhou (1999) attributed the present scattered distribution of *Trigonobalanus sensu* Forman to differential local extinction of a once continuous distribution. Kamiya *et al.* (2002) and Sun *et al.* (2006) also showed exceptionally high genetic differentiation among populations of *T. verticillata* in Malaysia and *F. doichangensis* compared to other *Fagaceae* species, suggesting that members of *Trigonobalanus sensu lato* are generally poor at dispersal. Nearby, isolated populations of *T. verticillata* in Borneo had differentiated at least 2 million years ago (Kamiya *et al.* 2002). The populations of *T. verticillata* on Hainan may, therefore, be relicts of a once continuous distribution, rather than the result of population establishment by recent dispersal events. Genetic comparison with Malesian populations will shed light on the origin of the Hainan populations and also the biogeography of the ancient relict species.

Given its biogeographical importance and restricted distribution in China and Hainan, immediate action to step up its *in situ* conservation, by setting up the proposed Yinggeling National Nature Reserve which includes the three known populations in Hainan, seems essential. The species should also be included into the National Protected Plant List of China.

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