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## The identity of *Cryptocoryne crispata* var. *tonkinensis* (Araceae)

### Abstract

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A renewed study of the type material of *Cryptocoryne tonkinensis* Gagnep. has been compared to recently collected live material from northeastern Vietnam and southeastern China. This has revealed that plants from these regions hitherto referred to *Cryptocoryne crispata* var. *tonkinensis* (Gagnep.) N. Jacobsen are different from material found in Thailand and southern Vietnam, also previously referred to var. *tonkinensis*. A taxonomic description of *Cryptocoryne crispata* var. *tonkinensis* s.str. is provided.

Additional key words: aroids, taxonomy, typification, relationships

### Introduction

Over the years the complex around *Cryptocoryne crispata* Engl. s.l. has been the subject of different interpretations regarding relationships and taxonomy, i.e. perceiving the complex as consisting of different species, subspecies, or varieties, based mainly on differences in leaf morphology (De Wit 1968, 1971, 1983, 1990; Rataj 1975; Jacobsen 1980, 1991; Mühlberg & Hertel 2007; Jacobsen & al. 2012). The shape and colours of the spathe, especially the limb of the spathe, have to some extent been correlated with the leaf form, but without supporting or clarifying the classification and recognition of species, subspecies or varieties within the complex.

The distributional area for the complex ranges from Assam in northeastern India, through Myanmar, southern China from Yunnan Province in the west to Guangxi Province in the east, all except the most southern part of peninsular Thailand, Lao P. D. R., Cambodia and Vietnam. Given this vast area of distribution, it is not surprising to find a wide morphological variation as plants have adapted to different ecological conditions, e.g., annual precipitation rhythms, temperature, and soil conditions. Topography and water supply in streams and river systems are highly variable, ranging from the main course of the Mekong to the smallest tributary streamlets near their headwaters.

At the time of the description of the taxa (species/varieties) within the *Cryptocoryne crispata* group, the

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then known accessions came from restricted areas of the presently known distribution. Only in later years has it been possible to observe the many different leaf forms growing in their natural habitats. To obtain a thorough and comprehensive picture of *Cryptocoryne* species, it is preferable to bring the wild-collected material into cultivation and then make observations over some time.

During our studies of the *Cryptocoryne crispata* group, it has become clear that the spathe length in the different *C. crispata* forms is correlated to the variation in water-bearing of the habitats throughout the year, which is correlated to emergent versus submerged leaves. This means that genotypes that generally have leaves emergent during the flowering season have short spathes, whereas plants that to a greater extent have submerged leaves in the flowering season have longer spathe tubes.

One of the taxa about which there has been some taxonomic uncertainty is *Cryptocoryne tonkinensis* Gagnep. (*C. retrospiralis* var. *tonkinensis* (Gagnep.) De Wit; *C. crispata* var. *tonkinensis* (Gagnep.) N. Jacobsen); in the following text referred to as “var. *tonkinensis*”. The present treatment will only deal with aspects concerning var. *tonkinensis*, i.e. it does not include *C. retrospiralis* (Roxb.) Kunth from India or other non-relevant *C. crispata* varieties. We do need to repeat some of the considerations dealt with by others.

A general problem in this context is that herbarium specimens of *Cryptocoryne* only provide a rather poor picture of the wild-growing material, e.g. when especially the somewhat leathery and fleshy textured leaves are dried they often become slightly rugose with the leaf margins curved. Also colours preserve very badly. So, ideally, identification and naming should be based on

live material brought into cultivation and observed for some time (years!) there (see, e.g., Mühlberg & Hertel 2007).

### History

Several people have dealt with the identity of var. *tonkinensis* over the years. Mühlberg & Hertel (2007) dealt with all the classical collections from Vietnam in a detailed morphological, phenological and nomenclatural study.



Fig. 1. *Cryptocoryne crispata* var. *tonkinensis* – A: habitat showing stream running in granite bedrock in gully; B: descent to water shown in A; C: pool with large patch of submerged plants. – Vietnam, Quang Ninh Province, W of Hai Ha, Cau Khe Heo, 130 m, 15 Dec 2013, photographs by M. Ørgaard.





Fig. 2. *Cryptocoryne crispatula* var. *tonkinensis* – A: pool shown in Fig. 1C with large patch of submerged plants being sampled; B: extracted plant lying beside pool; C: spathe showing spirally coiled limb with purple line-like markings; D: sampled plant showing long flaccid leaves and long spathe exceeding leaves in length. – Photographed on 15 Dec 2013 by M. Ørgaard.

The original description of *Cryptocoryne tonkinensis* by Gagnepain (1941) is based on three herbarium gatherings from Vietnam: “Rive droite de la rivière Noire, en aval de Ben-heu”, 29 Nov 1887, *Balansa* 2043 (L0041882, L0041883, P00461144, P00461145, P00461146, P00461147); “Vallée de Baa-tai, à la base du Mont Bavi” [present-day Mt Ba Vi], 8 Feb 1887, *Balansa* 2044 (L0041884, L0041885, P00461140, P00461141, P00461142, P00461143); and “Vallée de Baa-tai (Mont-Bavi)”, Aug 1887, *Balansa* 2045 (P00509483). The specimens in L can be seen at <http://vstbol.leidenuniv.nl/NHN/Explore> and those in P can be seen at <https://science.mnhn.fr/institution/mnhn/collection/p/item/search/form>.

The specimens of *Balansa* 2043 have inflorescences with a rather short spathe tube, and relatively short broad emergent leaves, while the specimens of *Balansa* 2044 and *Balansa* 2045 have long submerged leaves; *Balansa* 2044 has spathes with a c. 30 cm-long tube (*Balansa* 2044 is pictured in Gagnepain (1942: 1194, fig. 113, 3), and *Balansa* 2045 is fruiting. Gagnepain (1941) noted: “The leaves of *Balansa* 2045 are very interesting, some with a flat margin like *Balansa* 2044 while others are undulate-crispate in a very significant way, which makes one think that they are in a more developed stage” (translated from French).

One specimen of *Balansa* 2043 has filiform-terete lower leaves, which is a characteristic for *Cryptocoryne crispatula* plants growing in the main courses of larger rivers, where the plants in the rainy season may be submerged under several metres of water (Jacobsen 1980, 1991; Jacobsen & al. 2012; Mühlberg & Hertel 2007).

Gagnepain (1941, 1942) did not indicate which of the mentioned three gatherings should be regarded as the type. Rataj (1975) selected *Balansa* 2045 (P) from Ba Vi as the lectotype.

The combination *Cryptocoryne retrospiralis* var. *tonkinensis* was made by De Wit (1968) and retained in De Wit (1971). Rataj (1975) maintained *C. tonkinensis* as a species, whereas Jacobsen (1980), as De Wit (1983, 1990), lumped it into *C. crispatula* without distinguishing any varieties. However, in Jacobsen (1991) five varieties within *C. crispatula* were recognized, among them var. *tonkinensis*. Later treatments for the Flora of China (Li & Jacobsen 2010) recorded four varieties, whereas the treatment for the Flora of Thailand (Jacobsen & al. 2012) recorded six varieties of *C. crispatula*.

We consider the accessions *Balansa* 2044 and *Balansa* 2045 to be different from *Balansa* 2043; the latter we consider to belong to *Cryptocoryne crispatula* var.

*crispata* (in agreement with Mühlberg & Hertel 2007). This taxon is short-tubed, fully emergent during flowering and without submerged leaves except for the filiform-terete “monsoon leaves”. In Vietnam, this variety is relatively well known from more southern localities (Mühlberg & Hertel 2007; Hertel & Mühlberg 2009).

## Results

The type locality for var. *tonkinensis* is “Vallée de Baatai, à la base du Mont Bavi” (situated some 65 km W of Hanoi). Field observations in December 2013 revealed that this no longer exists as a *Cryptocoryne* locality. The streams in the valley and nearby seem to be too influenced by cultivation and recreational park activities. However, it cannot be totally ruled out that var. *tonkinensis* may still be found in other streams in the area of Mt Ba Vi.

During our stay in Vietnam in December 2013, we visited a locality in Quang Ninh Province in the north-eastern part, close to the Chinese border, on the main road QL 18, c. 10 km before Hai Ha, by the bridge “Cau Khe Heo” at km 242+500. Khe Heo is a stream c. 10 m wide running in granite bedrock in a gully (Fig. 1A, B). At some places cascades and natural dams are formed by larger protruding rocks resulting in pools with stagnant to calm currents and a sandy gravelly-stony bottom. In such a pool (Fig. 1C, 2A), which was 30–60 cm deep, we found a rather large patch of *Cryptocoryne* with long (40–50 cm), narrow ((0.3–)0.5–1.3 cm) leaves, smooth or with an undulate margin. The plants had easily extractable rhizomes up to more than 40 cm long, hardly any stolons, and besides normal roots there were also fine, multi-branched roots protruding from the soil up into the water, a feature also observable in the old herbarium specimens from Ba Vi. We refer this gathering (ØJV 13-4 [= Bogner 3015]) to var. *tonkinensis*.

## Discussion

Previously Zhou (2005) reported *Cryptocoryne crispata* var. *flaccidifolia* N. Jacobsen from Guangxi Province in southeastern China, in a tributary to the Beilun River near the village of Na Liang. The river was about 10 m wide with a bottom of quartz sand and pebbles of granite origin. Based on our present observations we would now refer this accession to var. *tonkinensis* (H. Zhou 05-04-3; Fig. 3).

Zhou & al. (2010) also found another form of *Cryptocoryne crispata* with long narrow undulate-crispate leaves occurring in a small stream north of Dongxing, also in Guangxi Province, which was then also referred to var. *flaccidifolia*. Based on our present observations we would now also refer this gathering to var. *tonkinensis* (Na Suo River, 30 Jan 2010, H. Zhou ZH2010-2 [= B 1353],



Fig. 3. *Cryptocoryne crispata* var. *tonkinensis* – China, Guangxi Province, tributary of Beilun River near village of Na Liang, H. Zhou 05-04-3 (L). – Photograph by J. D. Bastmeijer.

C). In cultivation, these plants maintain their 0.3–0.6 cm-wide leaves with an undulate-crispate margin.

Having re-analysed and updated our present knowledge, we have now come to the conclusion that the three populations from northeastern Vietnam and southeastern China, i.e., the new population from Quang Ninh, the one from Na Liang, and the one from north of Dongxing in southeastern China all belong to var. *tonkinensis* in a strict sense. This means that the taxonomic position of var. *flaccidifolia* (Jacobsen & al. 2012), known from peninsular Thailand, and what has previously been referred to var. *tonkinensis* from eastern Thailand (Khao Yai and



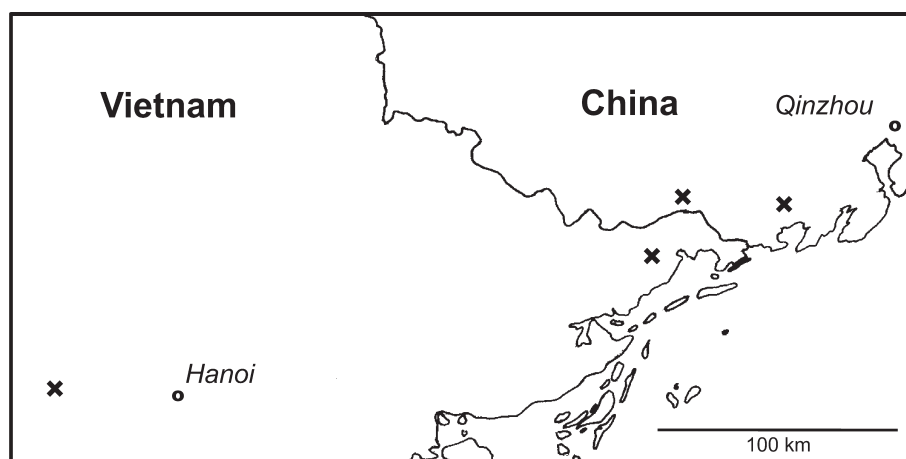


Fig. 4. Map showing the documented accessions of *Cryptocoryne crispata* var. *tonkinensis* in northeastern Vietnam (x): Mount Ba Vi and Khe Heo; and southeastern China: Beilun River and north of Dongxing.

tube slightly to somewhat twisted, 25–30 cm long; limb cream to greyish, with  $\pm$  densely dispersed purple elongated markings,  $\pm$  spirally twisted, 4–8 cm long. Spadix with 4–6 rather short and stubby female flowers; stigmas vertical, ovate. Olfactory bodies yellow,  $\pm$  irregularly lobed with protruding cells. Male flowers 80–100, with surface of thecae rough from protruding cells. Infructescence elongate ovoid, c. 1.5 cm long. Seeds: no material was available for study.

Ubon Ratchathani) now have to be reconsidered. In an AFLP study of the *C. crispata* complex, Jacobsen & al. (2015) showed that var. *flaccidifolia* from peninsular Thailand, the plants from Khao Yai and from Ubon Ratchathani are not closely related to each other nor to var. *tonkinensis* from the Vietnam-China border area.

Mühlberg & Hertel (2007) and Hertel & Mühlberg (2009) reported var. *tonkinensis* from Da Rang River, Phu Yen Province (population Vi 04). Here it was growing in the broad river bed with many rapids. We have not seen this accession live, but judging from the photographs we do not consider it to be var. *tonkinensis* s.str. However, Mühlberg & Hertel (2007) did refer population Vi 04 to var. *tonkinensis* s.l. indicating that it resembled var. *tonkinensis* s.str. but some characters were mis-matching and not 100 % similar to the Ba Vi gatherings. We find that Vi 04 rather shows resemblance to some plants in cultivation from Thailand, e.g., Khao Yai (Jacobsen & al. in press).

***Cryptocoryne crispata* var. *tonkinensis*** (Gagnep.) N. Jacobsen in Aqua Pl. 16(1): 29. 1991  $\equiv$  *Cryptocoryne tonkinensis* Gagnep. in Notul. Syst. (Paris) 9: 133. 1941  $\equiv$  *Cryptocoryne retrospiralis* var. *tonkinensis* (Gagnep.) De Wit in Aquariumplanten, ed. 3: 182. 1968. – Lectotype (designated by Rataj 1975: 50): Vietnam, “Vallée de Baa-tai (Mont-Bavi)”, Aug 1887, Balansa 2045 (P00509483).

**Description** — Rhizomes with short or long internodes. Leaves 20–50(–60) cm long, 0.3–0.6(–0.8) cm wide; blade varying from green to brownish and appearing almost reddish, varying from smooth to somewhat undulate to having a finely undulate-crispate margin. Spathe outside greenish to brownish, (20–)30–40 cm long; kettle c. 2 cm long, inside  $\pm$  red (especially in upper part), constricted below male flowers, with alveolae in upper part; flap closing entrance to kettle  $\pm$  purple-spotted;

Chromosome number —  $2n = 36$ , reported here for ØJV 13-4.

**Distribution** — Southeastern China and northeastern Vietnam, based on the following specimens. CHINA: SE China, without precise locality, Windeløv s.n. (C); Guangxi Province, tributary of Beilun River near village of Na Liang, H. Zhou 05-04-3 (L) (Fig. 3); Guangxi Province, N of Dongxing, Na Suo River, 30 Jan 2010, H. Zhou ZH2010-2 [= B 1353] (C) (Zhou & al. 2010). — VIETNAM: Mt Ba Vi, 8 Feb 1887, Balansa 2044 (L, P) & Aug 1887, Balansa 2045 (P), not recollected, see above under History for further specimen details; Quang Ninh Province, W of Hai Ha, Cau Khe Heo, 130 m, flowering 15 Dec 2013, Ørgaard & Jacobsen ØJV 13-4 (C) [= Bogner 3015 (M)].

**Ecology** — Var. *tonkinensis* is a plant of smaller or larger streams with more or less quickly running water (season dependent) and a depth of up to 1 m during the rainy season. The bottom consists of granite and quartz sand and gravel in between larger stones; in some places where the bedrock is protruding, pools may be found and the plants may find a sheltered habitat; a scenario that we also saw at Ba Vi, where the habitats no longer hosted var. *tonkinensis* but, e.g., *Vallisneria* cf. *natans* (Lour.) H. Hara instead.

**Conservation status** — Var. *tonkinensis* is presently known only from three localities in northeastern Vietnam and southeastern China. A former locality west of Hanoi indicates that at least previously the distribution areas had been larger. However, the regions in northeastern Vietnam and southeastern China have in no way been surveyed sufficiently to provide a status to the total occurrence in the area. A guess could be that var. *tonkinensis* is also found other places in the region, but we are not aware of reliable data. However, the regions are being

rapidly developed (forest cutting), and it is likely that the presently known localities and any other existing habitats in the region are under stress and perhaps leaving the populations in the region somewhat vulnerable.

**Remarks** — The leaves of var. *tonkinensis* are adapted to being submerged throughout the year, and when they occasionally become emergent they become shorter and somewhat deformed compared to the submerged leaves (a characteristic also found in var. *balansae* (Gagnep.) N. Jacobsen and var. *flaccidifolia*).

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