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Authors: Jacobsen, Niels, Bastmeijer, Jan D., Jensen, Karen R., and Ørgaard, Marian

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NIELS JACOBSEN[1*], JAN D. BASTMEIJER[2], KAREN R. JENSEN[1] & MARIAN ØRGAARD[1]

A new tetraploid variety of *Cryptocoryne ciliata* (*Araceae*) from Sarawak

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Abstract: A new, tetraploid variety of *Cryptocoryne ciliata* (Roxb.) Fisch. ex Schott from Sarawak, Malaysia, is described and illustrated: *C. ciliata* var. *bogneri* N. Jabobsen. The ecology, morphology and chromosome numbers of *C. ciliata* are discussed. The new variety is compared with the other two varieties of the species, *C. ciliata* var. *ciliata* and *C. ciliata* var. *latifolia* Rataj, and an identification key is provided.

Key words: *Araceae*, Borneo, chromosome number, *Cryptocoryne*, identification key, Malaysia, new variety, Sarawak

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Introduction

Cryptocoryne ciliata (Roxb.) Schott is widespread in the mangroves of SE Asia from the eastern part of India, Bangladesh, Myanmar, Thailand, Cambodia, Vietnam, Philippines (Palawan), Malaysia, and Indonesia to Papua New Guinea. It is the second largest known species of *Cryptocoryne*, described by Roxburgh as *Ambrosina ciliata* Roxb. in his monumental work *Plants of the coast of Coromandel* (Roxburgh 1820, as "*Ambrosinia*"). It grows in the inner tidal zones up to the freshwater tidal zone, where it sometimes grows just below other taxa of *Cryptocoryne* that may tolerate some level of salt, such as *C. crispatula* var. *balansae* (Gagnep.) N. Jacobsen (SW Thailand; Randal 2009), *C. ferruginea* Engl. and *C. lingua* Engl. (Sarawak; Jacobsen 1980), *C. moehlmannii* De Wit and *C. pontederiifolia* Schott (Sumatera; Jacobsen 1980) and *C. versteegii* Engl. var. *versteegii* (New Guinea; Hansen 1995). In most other instances the upper limits of occurrence represent the lower survival limits of freshwater-requiring taxa: *C. cordata* Griff. var. *cordata* and *C. griffithii* Schott (Peninsular Malaysia) and *C. bullosa* Engl. and *C. longicauda* Engl. (Sarawak) (Jacobsen 1980).

Cryptocoryne ciliata is an eye-catching, well-known element because of its size, up to almost one metre tall, with bright green leaves. Also, when building roads along the coastline, the bridges crossing the rivers are often built in areas where the saltwater influence is still prominent, and stands of *C. ciliata* are easily seen from these bridges.

Ecology

Cryptocoryne ciliata grows on mudflats in larger or smaller rivers, ditches and canals, in tidal zones with brackish water, sometimes just entering what appears to be the freshwater tidal zone. It is one of the outposts along the rivers, often associated with mangrove trees, e.g. *Bruguiera* Savigny and *Rhizophora* L., as well as

1 Section of Organismal Biology, Department of Plant and Environmental Sciences, University of Copenhagen, Thorvaldsensvej 40, DK-1871 Frederiksberg C, Denmark; *e-mail: nika@plen.ku.dk (author for correspondence).
2 Oude Roswinkelerweg 72, NL-7822 AG Emmen, The Netherlands.

the palm *Nypa* Steck. *Cryptocoryne ciliata* plants often grow in more or less open sun and the leaves are usually covered with a distinct layer of silt stemming from the tides. Simon & al. (2008) made a thorough study of the occurrence and distribution of *C. ciliata* var. *ciliata* from the Sungai Sarawak near Kuching. One of the conclusions was that salinity as such was not a primary factor for the distribution and growth of *C. ciliata*, but the plants were able to adapt to different environmental conditions such as varying temperature, pH, light and nutrient availability. The tide system also affects the distribution of the plants because strong currents will wash away the soil. Trees and other larger plants play a role in giving shade and in stabilizing the soil. During low tide, *C. ciliata* usually becomes emergent and is noticeable with its mud-covered leaves. In S Thailand at the Tha Pom Klong Som Nam (which translates as "The river with two waters"), *C. ciliata* occurs in its typical habitat, but also totally submerged in what is the freshwater stream bed when all the muddy tidal water has been washed out (Jacobsen 2005, 2006).

Flowering in *Cryptocoryne ciliata* is associated with the two monthly periods of low tidal amplitude oscillations occurring after a new moon and after a full moon, where the river/stream banks are above water for four to five (to eight) days at a given location (Jacobsen 1980).

Morphology

Cryptocoryne ciliata is distinguished from all other *Cryptocoryne* species by its spathe limb with numerous 0.5–1.5 cm long, simple and branched, red-purple cilia along the margin. It has been known for a number of years that there is variation in the leaf size and shape, the length of the epigeal stolons and in the shape and size of the spathe limb.

Two forms of stolons have been recognized: long, horizontal, rooting stolons (50 cm or more) and more upright, fasciculate and fragile to shattering "stolons". These two stolon types are to some extent correlated with the leaf shape. Plants with long stolons generally have relatively long and narrow leaf blades, while the plants with short stolons have relatively short and broad leaf blades. The two different leaf-blade and stolon-type morphs also have different chromosome numbers: long-stolon plants have a chromosome number of $2n = 22$, whereas the short-stolon plants have $2n = 33$ (triploid). The short-stolon plants with the broad leaf blades have been described as a separate variety: *Cryptocoryne ciliata* var. *latifolia* Rataj (1975).

In 1994, another somewhat deviating plant of *Cryptocoryne ciliata* was found by Josef Bogner in the tidal zone at Saratok, Betong Division, in Sarawak. It had relatively shorter and broader leaf blades than var. *latifolia* but longer, rooting stolons. An investigation of its chromosome number showed that it had $2n = 44$ (tetraploid), a number hitherto not reported in *C. ciliata*. We here describe this tetraploid plant as a new variety of *C. ciliata*.

Material and methods

The live material used represented clone material of the type collection obtained from the Botanic Garden München-Nymphenburg (Germany) and cultivated in the greenhouses of the Department of Plant and Environmental Sciences, University of Copenhagen. The DAPI stained chromosome preparations were made according to the protocol used by Wongso & al. (2016). The pollen was stained in a mixture of Cotton Blue (Aniline Blue) 0.5 g, phenol 10 g, glycerol 10 ml, lactic acid 10 ml and distilled water 10 ml.

Results and Discussion

Cryptocoryne ciliata (Roxb.) Fisch. ex Schott, Melet. Bot.: 16. 1832 ≡ *Ambrosina ciliata* Roxb., Pl. Coromandel 3: 90. 1820.

= *Cryptocoryne elata* Griff., Not. Pl. Asiat. 3: 134. 1851; Icon. Pl. Asiat.: t. 170, 171. 1851.

– "*Cryptocoryne drymorrhiza* Zipp." (Schott in Ann. Mus. Lugduno-Batavi 1: 122. 1863), nom. inval. (Turland & al. 2018: Art. 36.1).

Cryptocoryne ciliata (Roxb.) Fisch. ex Schott var. ***ciliata*** – Fig. 1.

Description — *Rhizome* 5–20 cm long, 1–3 cm thick, stout. *Stolons* epigeal, horizontal, to more than 50 cm long with internodes 2–10 cm long, rooting at nodes, firmly attached to plant, each node with a cataphyll to 4 cm long. *Leaves* green, somewhat spongy; *petiole* 10–50 cm long; *blade* almost linear to ovate, 15–50 cm long, 2–20 cm wide, surface smooth, base truncate to almost cordate, margin entire, apex mucronate. *Spathe* 15–50 cm long; *kettle* white inside, generally constricted in middle, 1.5–2 cm long, inner surface rough; *tube* whitish, 4–40 cm long, with fused margins somewhat bulging; *limb* narrowly ovate to ovate, 3–10 cm long, 2–3 cm wide, surface rough, margin with numerous simple and branched, red-purple, 0.5–1 cm long cilia; limb colour purple-reddish to greenish, changing to yellow toward collar and throat, throat yellow, sprinkled with small or larger red spots; *collar* ± conspicuous, narrow to broad. *Female flowers* 4–8; stigmas ± narrowly ovate, sometimes emarginate. *Olfactory bodies* white, rounded or ± irregular, small. *Male flowers* 30–50. *Syncarp* globular; *seeds* smooth, with a thin, whitish testa; embryo with numerous cilia-like plumulary processes folded within testa; endosperm absent in mature seeds.

Chromosome number — $2n = 22$ (Jacobsen 1977; Arends & al. 1982).

Distribution — E India, Bangladesh, Myanmar, Thailand, Vietnam, Malaysia, Indonesia and Papua New Guinea

Fig. 1. *Cryptocoryne ciliata* var. *ciliata* – A: flowering plant in cultivation showing long, rooting stolons; B: spathe limb with a distinct, red-spotted tube opening. – Source: S Thailand, Tha Pom Klong Song Nam, 21 Dec 2003, *NJT 03-15A*. – Photographs by N. Jacobsen.

(Bastmeijer 2018; Ipor & al. 2009; Jacobsen 1985; Jacobsen & al. 2012; Othman & al. 2009).

Remarks — The seeds of *Cryptocoryne ciliata* differ, like those of *C. versteegii* Engl. and *C. dewitii* N. Jacobsen, from the rest of the genus by having numerous, folded, cilia-like plumulary processes on the embryo and by lacking endosperm (Wit 1990). The seeds have a thin, white testa, which breaks soon after dehiscence of the seed, releasing a fully developed embryo that unfolds its cilia and forms an immediately growing seedling resembling the hair of the Greek Gorgon Medusa.

Cryptocoryne longicauda Engl. also has several plumulary processes, but has an endosperm. In recent descriptions of new *Cryptocoryne* species from Kalimantan, Borneo (Wongso & al. 2016, 2017), several species proved to have seeds rather similar to *C. longicauda* with the germinating embryo emerging c. ⅓ from the distal end and with c. 5 plumulary processes.

Cryptocoryne ciliata var. ***latifolia*** Rataj in Stud. Ceskoslov. Akad. Ved. 3 [Rev. Gen. Cryptocoryne]: 38. 1975. – Fig. 2.

Description — *Stolons* epigeal, vertical, short, 2–15 cm long, initially non-rooting, branching at nodes and quite fragile, breaking off at nodes and rooting later. *Petiole* 10–20 cm long; *blade* ovate, 10–30 cm long, 4–10 cm wide, base cordate, apex mucronate. *Spathe* 15–25 cm long, *limb* c. 5 cm long, with a broad *collar* and throat opening, usually with small, red spots. *Flowers* sterile with no fruit development.

Chromosome number — $2n = 33$ (Jacobsen 1977; Arends & al. 1982).

Distribution — Triploids have been found in Thailand (Bangkok), Cambodia, Malaysia (Peninsular and Sarawak) and the Philippines (Palawan).

Remarks — Plants with $2n = 33$ are here regarded as a triploid cytotype and may be accepted at the variety level. Only few chromosome counts have been made, so the exact distribution of diploids and triploids is not known. The triploids are sterile and their only mode of propagation is by their short, fragile stolons. Whether the triploids occurring in the different locations originate from the same triploidization event or from separate events is not known.

In some cases, plants of *Cryptocoryne ciliata* from Borneo and New Guinea, with large, narrow or broad leaves, have long stolons and are fertile; therefore the association of broad leaves with triploids and narrow leaves with diploids is not absolute.

Fig. 2. *Cryptocoryne ciliata* var. *latifolia* – A: flowering plant in cultivation showing a few vertical, short, fragile stolons; B: base of plant with numerous vertical, short, fragile stolons; C: spathe limb with a faintly red-spotted tube opening; D: ± branched cilia along margin of spathe limb. – Source: Thailand, Bangkok, 24 Feb 2002, *NJT 02-27*. – Photographs by J. D. Bastmeijer.

Fig. 3. *Cryptocoryne ciliata* var. *bogneri* – A: cultivated plant; B: spathe limb showing whitish tube opening, somewhat rough purplish limb surface and mostly unbranched marginal cilia; C: stolons. – Source: *J. Bogner 3025*. – Photographs: A & B by G. Gerlach; C by N. Jacobsen.

Cryptocoryne ciliata var. ***bogneri*** N. Jacobsen, **var. nov.** – Fig. 3 & 4.

Holotype: Malaysia, Sarawak, Betong Division, Seblak River, Saratok, *J. Bogner 3025* (M). Originally collected in March 1994 and cultivated in the Botanic Garden München-Nymphenburg (Germany), where it flowered and the holotype was prepared in March 2014.

Diagnosis — *Cryptocoryne ciliata* var. *bogneri* differs from var. *ciliata* by shorter and relatively broader leaves,

and from var. *latifolia* by even broader but shorter leaves, long, rooting stolons, and from both varieties by being tetraploid, $2n = 44$.

Description — *Stolons* epigeal, horizontal, to more than 40 cm long, rooting at nodes, firmly attached to plant for a long time. *Petiole* 6–15(–25) cm long; *blade* ovate, 13–15 cm long, 5–7 cm wide, base cordate, margin sometimes somewhat crenulate and faintly brownish, apex mucronate. *Spathe* 15–25 cm long; *limb* narrowly ovate, 5–6 cm long, c. 2 cm wide (excluding cilia), surface somewhat rough, reddish, greenish toward whitish *collar*, throat whitish without spots. *Pollen* indicated as fertile by stainability (Cotton Blue). *Syncarp* not observed.

Chromosome number — $2n = 44$, reported here for *J. Bogner 3025* (Fig. 4B).

Distribution — So far known only from the type locality.

Remarks — *Cryptocoryne ciliata* var. *bogneri*, with $2n = 44$, is here regarded as a tetraploid cytotype of *C. ciliata*.

Conservation status — As *Cryptocoryne ciliata* var. *bogneri* is known only from one locality, it is difficult to ascertain the conservation status according to IUCN (2017) categories and criteria, except that it is Data Deficient (DD). The habitat type and the usual way that the other two varieties of *C. ciliata* are dispersed suggest that it may occur quite abundantly in the Seblak River, but more observations are needed in order to outline a conservation assessment.

Key to the varieties of *Cryptocoryne ciliata*

1. Stolons vertical, short, initially non-rooting, breaking off at nodes and rooting later . . . . . var. ***latifolia***
– Stolons horizontal, long, rooting at nodes, firmly attached to plant **2**
2. Leaf blade almost linear to ovate, 15–50 cm long, 2–20 cm wide . . . . . var. ***ciliata***
– Leaf blade ovate, 13–15 cm long, 5–7 cm wide . . . . . var. ***bogneri***

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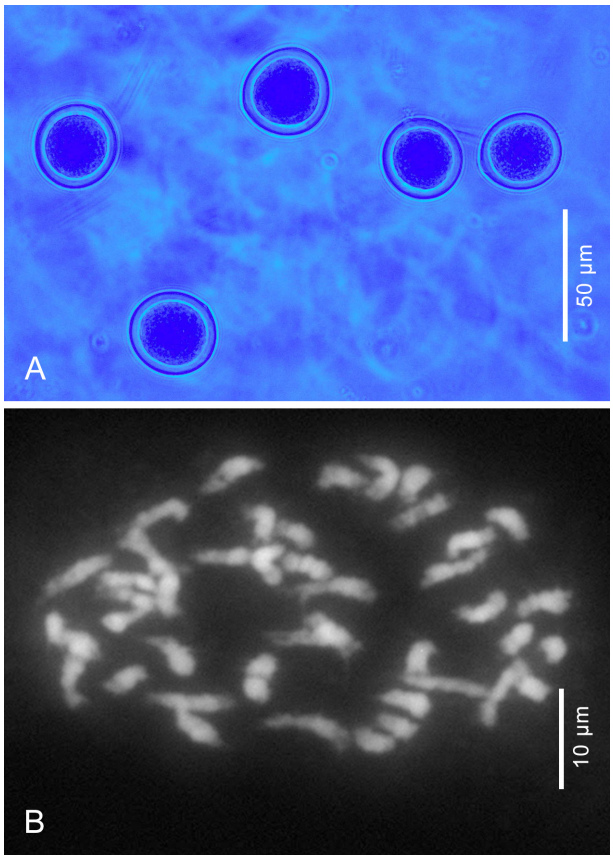

Fig. 4. *Cryptocoryne ciliata* var. *bogneri* – A: fertile pollen indicated by Cotton Blue; B: DAPI staining of somatic chromosomes, $2n = 44$. – Source: *J. Bogner 3025*. – Photographs by K. R. Jensen.

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