New *Cryptocoryne* (Araceae) from West Kalimantan, Indonesia: a new species and a new interspecific natural hybrid

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ABSTRACT

A new species, *Cryptocoryne verrucosa* and an interspecific hybrid, *C.* ×*nakamotoi* from the Kapuas Hulu Regency, West Kalimantan Province of Indonesia are described and illustrated. The hybrid is sterile but propagates vegetatively, forming large stands.

KEY WORDS

Araceae, chromosome number, *Cryptocoryne*, Borneo, sterile pollen, interspecific hybrids

INTRODUCTION

Cryptocoryne is an aquatic to amphibious plant belonging to the largest genus of aquatic aroids (Mansor et al. 2012). Several are popular as ornamental plants for aquascaping and tropical aquaria (Jacobsen 1976; Rusly 2016); some species have potential as medicine for microorganism infections (Wadkar et al. 2017). The original distribution of *Cryptocoryne* is from west India, the island of Sri Lanka to south China, the Malay Peninsula, Sumatra, Borneo, Java, Sulawesi, the Philippines, and Papua New Guinea (Othman 1997).

Borneo, including Natuna and Anambas islands, is one of the hot spots of

Cryptocoryne species diversity amounting to 26 named species, six additional varieties and six interspecific hybrids including the present described two taxa (Bastmeijer 2020; Ipor et al. 2009, 2016; Jacobsen et al. 2016; Wongso et al. 2017). Jacobsen (1985) reported that *Cryptocoryne* on Borneo are found in three major habitats and almost all localities are in deep shade on banks of smaller rivers and streams (rheophyte type), slow to fast running rivers and streams (aquatic type) or the inner tidal zones some of which are in more sunny locations (amphibious type).

The *Cryptocoryne* of Kalimantan have been studied intensively in recent years (Wongso & Bastmeijer 2005; Bastmeijer et al. 2013; Wongso et al. 2016; Wongso et al. 2017, 2019, 2020 a, b & c), and it has become clear that hybridization among species occurs quite commonly in localities where two or more species inhabit the same river system. Furthermore, the hybrids, which often are sterile may spread vegetatively throughout the river systems by means of their proliferous stolons (Jacobsen et al. 2016; Jacobsen & Ørgaard 2019; Wongso et al. 2019, 2020 a & b).

This study presents the results of our investigations of two *Cryptocoryne* taxa from the upper part of the Kapuas River in the Kapuas Hulu Regency. This fieldwork was conducted during 2009 – 2019 (SW of Putussibau) during which one new species and an interspecific natural hybrid were discovered growing in small rivers and streams with flowering specimens found along the banks. This study confirms that more studies and fieldwork are still needed in Kalimantan.

RESULTS

Cryptocoryne verrucosa **Wongso & Asih, sp. nov. – Figure 1 – 5**

Type: Indonesia, W Kalimantan Province, Kapuas Hulu Regency, SW of Putussibau, 08 May 2018, *SW 1835*, (BO holotype; isotype C).

Diagnosis**:** *Leaves* cordate, upper surface distinctly verrucose, lower surface and margins distinctly pubescent. *Spathe* outside purplish in the upper part; limb c. 2 cm long, obliquely forward bent, surface red purple, rough with rounded protuberances, collar zone distinct, black purple.

Description**:** *Amphibious herb* with a slender and stout *rhizome*, and with long, stout subterranean stolons. *Leaves* 5 – 9 in a rosette, 5 – 15 cm long, *lamina* 2 – 5 × 1.5 – 4 cm, cordate, submerged or emergent, evenly green to dark green to brown, upper surface distinctly verrucose (sometimes slightly bullate), lower surface and margins distinctly pubescent. Peduncle 1 – 3 cm long. *Spathe* 3 – 5 cm long, outside purplish in the upper part; *kettle* c. 1.5 cm long, inside purple, appearing a bit inflated, with a slight contraction above the female flowers, *flap* white to reddish, *tube* about 1 cm long; limb 3 – 4 cm long, obliquely forward bent, surface red purple, rough with rounded,

Figure 1. *Cryptocoryne verrucosa*, type locality SW of Putussibau, Kapuas Hulu Regency, W Kalimantan Province *SW 1835*. **A.** habitat with a stand of *C. verrucosa* by the tree log in the water; **B.** stand along stream bank. Photographs by S. Wongso, 8 May 2018.

Figure 2. *Cryptocoryne verrucosa*, plants from the type locality, *SW 1835*. **A.** extracted flowering plants of the type collection; **B.** specimen with infructescence; **C.** close up of spathe with the short tube and the short spathe limb. Photographs by S. Wongso, 8 May 2018.

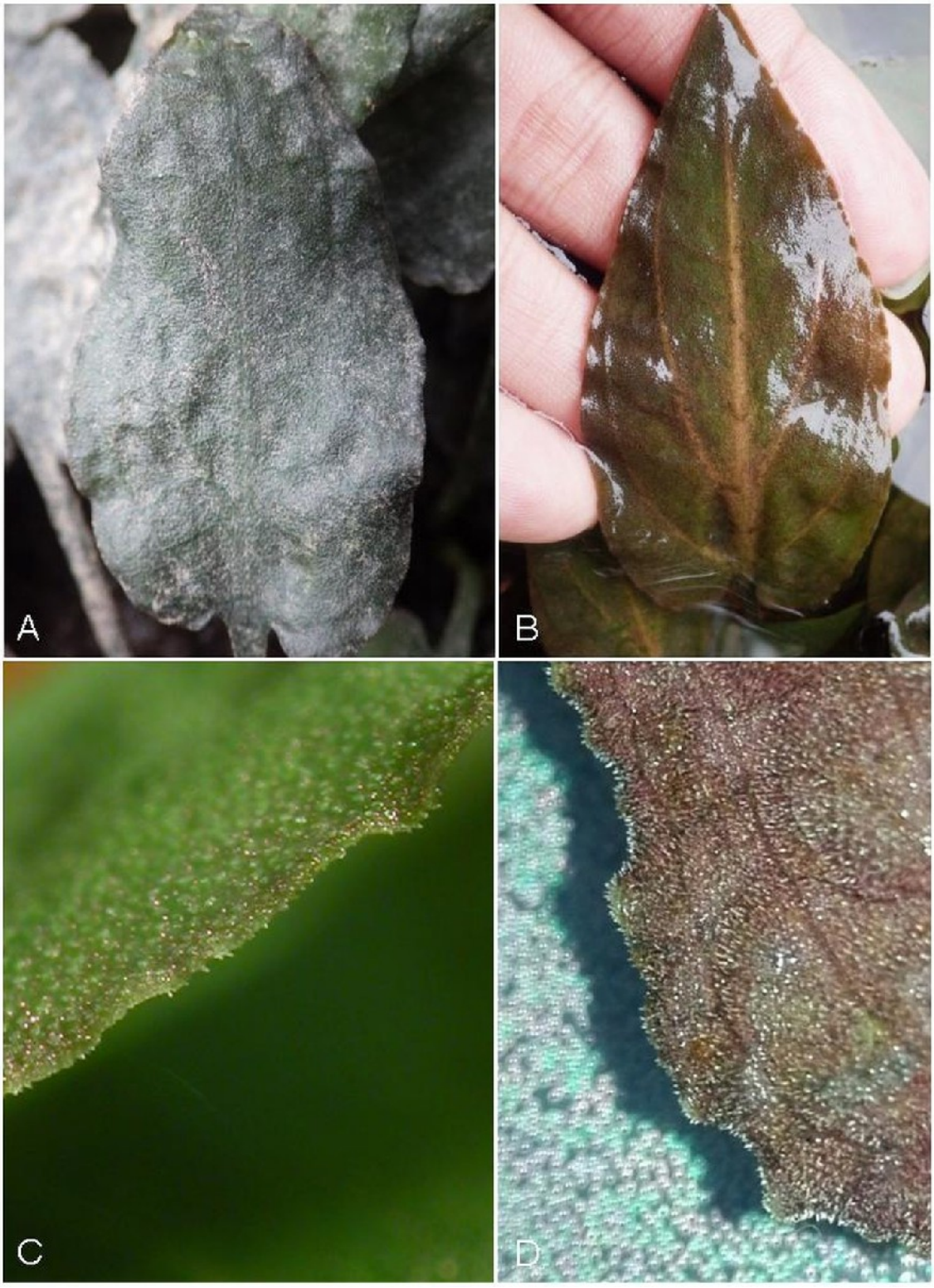

Figure 3. *Cryptocoryne verrucosa*, leaf structures *SW 1835*. **A.** emergent leaf showing the verrucose upper surface; **B.** submerged leaf with a more smooth surface; **C.** margin of leaf showing the verrucose surface and hairs along the margin; **D.** lower surface of leaf covered with short hairs. Photographs A-B by S. Wongso, C by J. D. Bastmeijer and D by H. Budianto.

Figure 4. *Cryptocoryne verrucosa*, *NT200126–1*, SE of Putussibau. **A.** cultivated, emergent plant showing the brown, bullate, rugose leaves; **B.** spathe showing the forward, obliquely twisted spathe limb; **C.** kettle cut open showing the female flowers at the base, the sterile interstice part of the spadix, the male flowers partly hidden by the flap. Photographs by S. Wongso.

Figure 5. *Cryptocoryne verrucosa*, *SW 1630*, near Putussibau. **A.** spathe seen from the opening into the tube; **B.** longitudinally cut open spathe showing the kettle with female flowers and male flowers partly covered by the flap; **C.** longitudinally cut open spathe showing the transition between the "smooth" tube and collar zone and the limb surface with rounded protuberances ["smooth" – the apparently smooth surface consists of numerous cells with downwards pointed trichomes]; **D.** closeup of the kettle showing a slight constriction above the female flowers (change in cell wall structure and colour). Photographs by J.D. Bastmeijer.

Figure 6. *Cryptocoryne ×nakamotoi*, type locality, SW of Putussibau, Kapuas Hulu Regency, W Kalimantan Province, *B 1584*. **A.** habitat on stream bank below gallery trees; **B.** stand along stream bank showing the elongate, bullate leaves. Photographs by K. Nakamoto, June 2014.

Figure 7. *Cryptocoryne ×nakamotoi*, *B 1584*. **A.** on the bank showing the carpet of plants formed by the subterranean stolons; **B.** flowering plants at type locality showing the characteristic half twisted, red spathe limb with protuberances and the black-purple collar zone. Photographs by K. Nakamoto, June 2014.

Figure 8. *Cryptocoryne ×nakamotoi*, *B 1584*, cultivated plants from the type collection. **A.** a 5 l tank with plants having the bullate, elongate leaves becoming emergent; **B-C.** cut off spathes showing the 1.5 cm long kettle and tube, the spathe limb has a characteristic forward bent limb and a broad, dark purple collar zone into the throat. Photographs by N. Jacobsen.

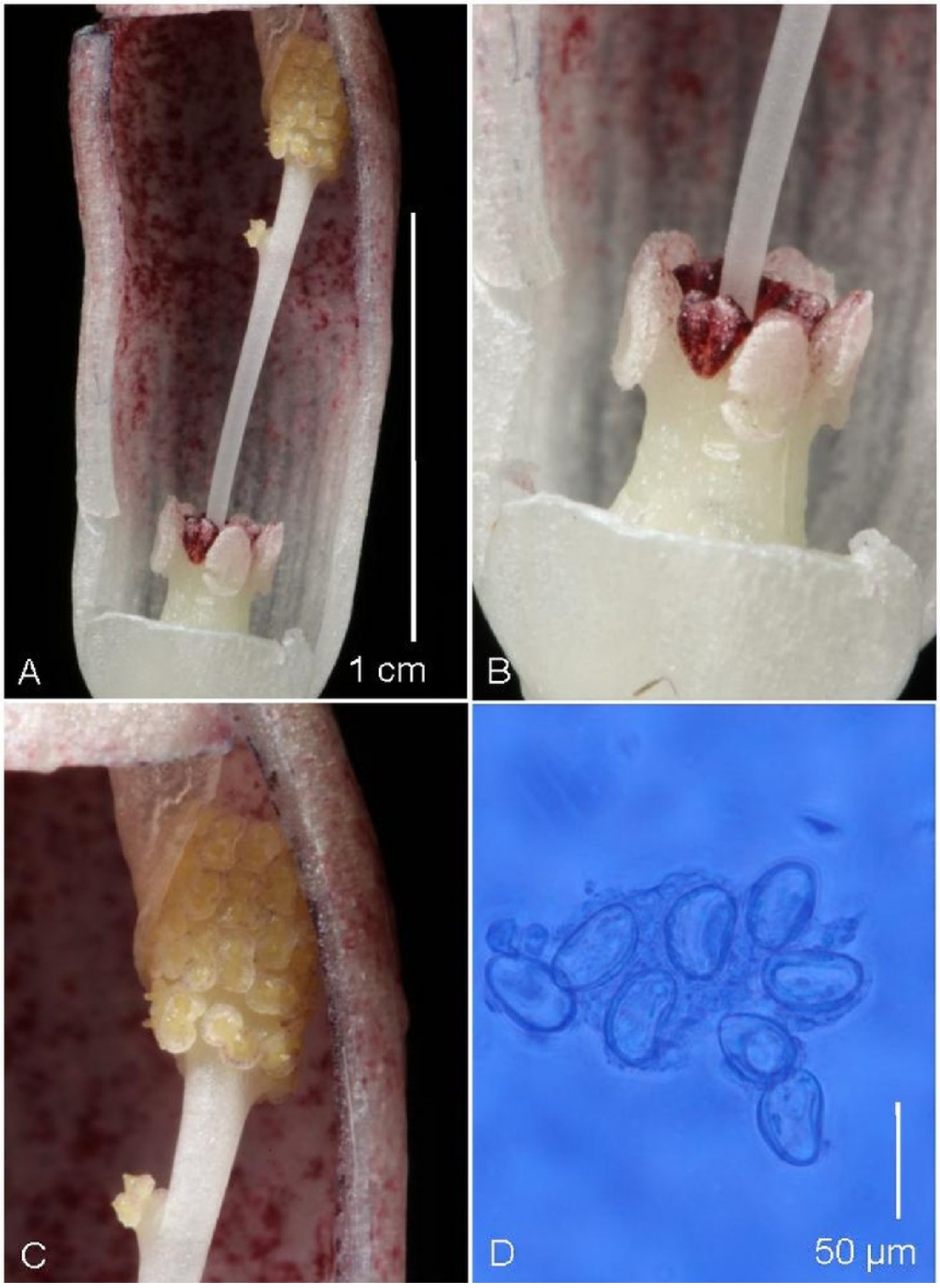

Figure 9. *Cryptocoryne ×nakamotoi*, *B 1584*, cut open kettle. **A.** full kettle showing female flowers with ovate stigma, and between them the dark purple olfactory bodies are seen, male flowers and the flap; **B.** female flowers with the dark purple olfactory bodies clearly seen between the stigma; **C.** male flowers partly behind the flap and one male flower dislocated below the others; **D.** pollen stained with cotton blue, showing they are empty and therefor sterile. Photographs A-C by S. Reitel and D by K.R. Jensen.

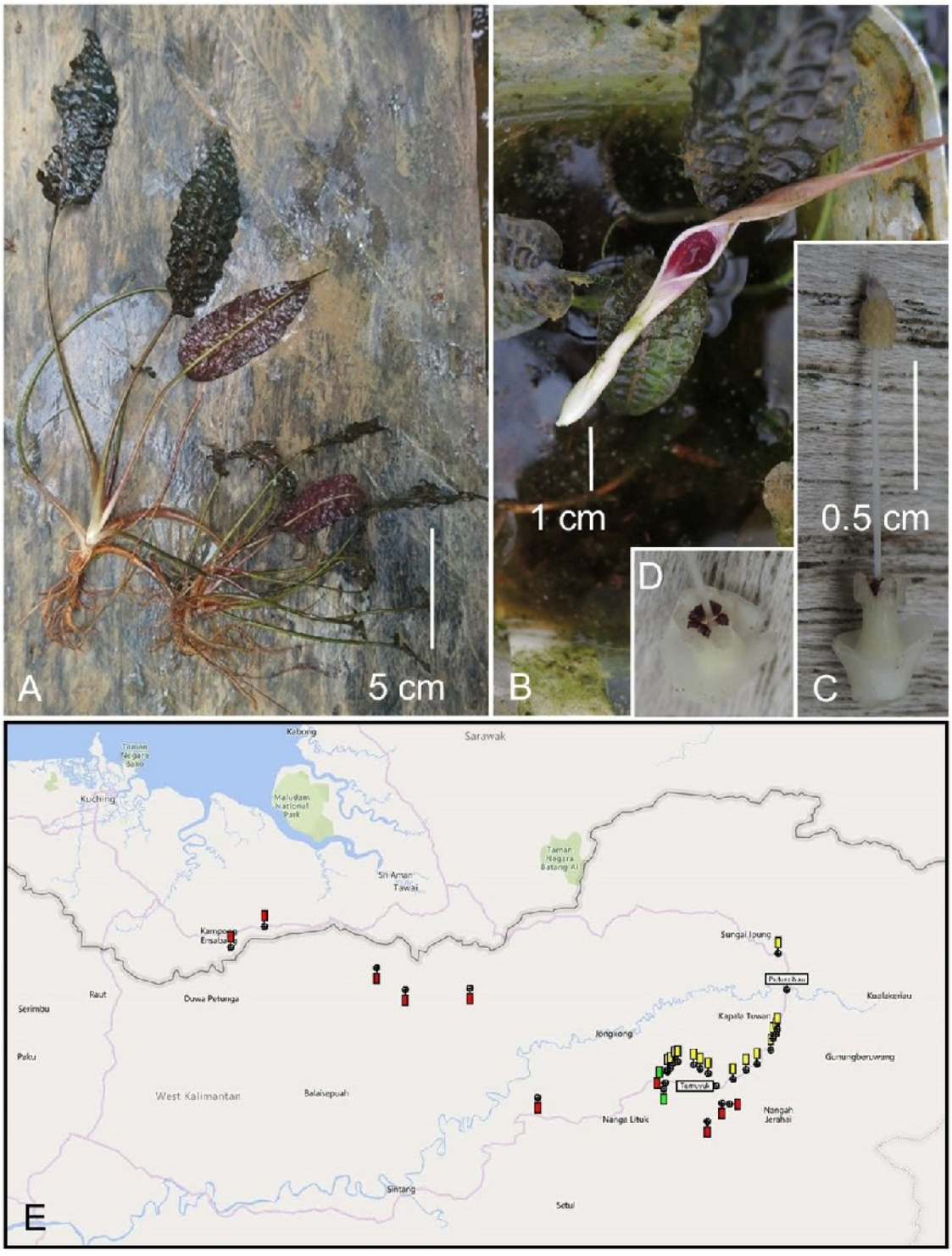

Figure 10. *Cryptocoryne uenoi* Yuji Sasaki, *SW 1834*, S of Nanga Litau, SW of Putussibau, Kapuas Hulu Regency, 8 May 2018; **A.** whole plants from the river; **B.** cultivated specimen showing open spathe limb; **C.** spadix showing female flowers, purple olfactory bodies, naked axis, male flowers and sterile appendix; **D.** spadix seen from above with the purple olfactory bodies around the naked axis. **E.** distribution map of *Cryptocoryne ×nakamotoi* (green), *C. uenoi* (red) and *C. verrucosa* (yellow). Photographs A by S. Wongso and B-D by N. Jacobsen.

irregular protuberances, collar zone distinct, black-purple. *Spadix* c. 1.5 cm long, with about 6 (-8) white to purplish *female flowers* with round to broadly ellipsoid to emarginate stigmas; *olfactory bodies* whitish to yellowish with some purple spots; *male flowers* 30 – 40, yellowish, sometimes with a purplish rim around the thecae; *appendix* white or with purple spots. *Syncarp* broadly ovoid. *Seeds* not studied.

***Chromosome number*:** $2n = 34$, reported here for *SW 1835*.

***Distribution*:** Endemic to Indonesia, W Kalimantan, from the Kapuas Hulu Regency, where it has been observed at a number of locations (**Figure 10E**).

***Additional collections*:** *SW 1930*, Nanga Litau to Nanga Bojan, SW of Putussibau, Kapuas Hulu Regency, 30 July 2019.

***Habitat*:** On the banks of small rivers and streams with a muddy bottom. Larger specimens grow in deeper water, and flowering specimens cover the banks during the dry season. The present habitat is a secondary habitat. The original has probably been in a stream in the previous rainforest. Water pH 4.1 and conductivity 35 µS/cm.

***Conservation status*:** As *Cryptocoryne verrucosa* has been observed at a number of localities (**Figure 10E**), and with the region not thoroughly investigated, there are indications that it is data deficient (DD) or of least concern (LC) according to IUCN (2019).

***Etymology*:** Referring to the verrucose leaves.

***Remarks*:** *Cryptocoryne verrucosa* resembles *C.* ×*nakamotoi* but differs by the more cordate, verrucose leaf blades and pubescent on the lower surface and leaf margins, and it has fertile pollen. It also resembles *C. fusca* De Wit, but it has a shorter spathe limb, and the kettle is more rounded, appearing a bit inflated, while the kettle in *C. fusca* is more tubular, and it has a verrucose leaf blade surface.

***Cultivation*:** *Cryptocoryne verrucosa* is easily cultivated submerged or halfway emergent in an acidic layer of leaf litter soil or mulched bamboo leaves.

***Cryptocoryne* ×*nakamotoi* Bastm., nothosp. nov. – Figure 6 – 9**

Type: Indonesia, W Kalimantan, *B 1584*, 20 May 2013, conveyed by K. Nakamoto (BO holotype; C, L isotypes).

***Diagnosis*:** *Cryptocoryne* ×*nakamotoi* is characterized by its brownish ± bullate leaves, a spathe with a long, broad, narrowly ovate, obliquely forward twisted limb with a long tail-like prolongation, surface purple, with rough irregular protuberances, a broad purple tube opening and a distinct collar zone. Chromosome number $2n = 34$.

Interspecific hybrid between *C. uenoi* Yuji Sasaki and *C. verrucosa* Wongso & Asih.

***Description*:** *Amphibious herb* with long, subterranean stolons. *Leaves* 5 – 14, 12 – 16 cm long, *lamina* up to 8 × 3 cm, ovate with a slightly cordate base, somewhat bullate, spreading more or less upright, brownish on the upper surface, lighter on the lower surface. *Spathe* about 6 – 8 cm long, outside whitish; *kettle* c. 1.5 cm long, inside white in the lower half, upper part with a purple zone continuing into the tube, *flap* whitish; *tube* c. 1.5 cm long; limb c. 5 cm long and c. 1 cm broad at the opening, narrowly ovate, obliquely forward twisted into a long tail-like prolongation, purple with a rough surface of irregular protuberances, a broad purple tube opening and a distinct collar zone. *Spadix* c. 1.5 cm long, with about 5 white *female flowers*, ovate to emarginate stigmas; *olfactory bodies* irregularly rounded, purple; *male flowers* 35 – 45, yellow, pollen fertility 0%; *appendix* white. *Syncarp* not known.

***Chromosome number*:** $2n = 34$, is reported here for *B 1584*.

***Distribution*:** Endemic to Indonesia, W Kalimantan, Kapuas Hulu Regency, W of Temuyuk (**Figure 10E**).

***Additional collections*:** *SW 1929*, S of Nanga Litau, SW of Putussibau, Kapuas Hulu Regency, 30 July 2019; *SW 1931*, Nanga Litau to Limbang, SW of Putussibau, Kapuas Hulu Regency, 30 July 2019.

***Habitat*:** On the banks of small rivers and streams with a muddy bottom. Larger specimens grow in deeper water, and flowering specimens are found covering the banks during the dry season. The present habitats are secondary habitats. The original has probably been in a stream in the previous rainforest. Water pH 5.5 and conductivity 28 µS/cm was reported for *SW 1931* and water pH 5.7 and conductivity 21 µS/cm for *SW 1929*.

***Conservation status*:** As *Cryptocoryne* ×*nakamotoi* is known only from a few localities, it is difficult to ascertain the conservation status according to IUCN (2019) categories and criteria, except that it is Data Deficient (DD); more observations are needed in order to outline a conservation assessment.

***Eponymy*:** Named after Mr. Kazuya Nakamoto who kindly provided the first samples and photographs from the habitat.

***Remarks*:** C. ×*nakamotoi*, has now been found at two localities in a region from where *C. verrucosa* has been reported several times. *C. uenoi*, also has been found several times in the area e.g., *SW 1834* and these are generally a bit larger than those from the type locality of *C. uenoi* some 150 km towards the northwest in Sarawak near Simunjan and they have purple olfactory bodies, a trait inherited in the hybrid

(**Figure 10)**. The leaves of *C. verrucosa* are ± cordate, and the surface is verrucose and pubescent on the lower surface, while *C. uenoi* has lanceolate leaves distinctly bullate and not pubescent. The spathe in the hybrid is intermediate between the two suggested parents regarding morphology. The hybrid is broader at the spathe tube opening than any of the two parental species.

***Cultivation*:** *Cryptocoryne* ×*nakamotoi* is easily cultivated submerged or halfway emergent in an acidic layer of leaf litter soil or mulched bamboo leaves.

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