## *Thysananthus ciliaris* (Lejeuneaceae, Marchantiophyta), a rare species new to Singapore from the Singapore Botanic Gardens

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ABSTRACT. *Thysananthus ciliaris*, a rare and poorly known species from Southeast Asia, is newly discovered in Singapore in the Singapore Botanic Gardens. Its oil bodies are here reported for the first time for the species. The geographical distribution of all published occurrences of the species is briefly discussed. Provisional conservation assessments are given at the global and Singapore national levels based on current knowledge. A lectotype is designated in a second step lectotypification.

*Keywords.* Conservation assessments, distribution, lectotype, liverwort, *Mastigolejeunea*, oil bodies, Ptychanthoideae

## Introduction

During a survey of bryophytes in the Singapore Botanic Gardens by the first author, several species of bryophytes were collected on the buttress of a 47 m tall *Terminalia subspathulata* King. Among them was an interesting liverwort specimen belonging to Lejeuneaceae subfam. Ptychanthoideae. The specimen does not belong to any species already recorded for Singapore (Piippo et al., 2002; Zhu et al., 2018). Recognising that it is a species of *Thysananthus* Lindenb., the second author, who recently revised the genus (Sukkharak & Gradstein, 2014; Sukkharak, 2015), determined it as *Thysananthus ciliaris* (Sande Lac.) Sukkharak, a rare species new to Singapore upon reviewing all known specimens of this species to date, global and Singapore national conservation assessments are given following the guidelines in IUCN Standards and Petitions Committee (2019) and Davison (2008). Herbarium codes follow Thiers (continuously updated). The photographs and illustrations below are based on the cited Singaporean specimen.

## New species record for Singapore

*Thysananthus ciliaris* (Sande Lac.) Sukkharak in Sukkharak & Gradstein, Nova Hedwigia 99: 339 (2014); Sukkharak, Phytotaxa 193: 25, f. 12 (2015); Chantanaorrapint

et al., Telopea 21: 154, f. 1 (2018). – *Phragmicoma ciliaris* Sande Lac., Ann. Mus. Bot. Lugduno-Batavi 1 (fasc. 10): 307 (1864 ['1863–1864']). – *Lopholejeunea ciliaris* (Sande Lac.) Schiffn., Consp. Hepat. Arch. Ind. 291 (1898). – *Ptychocoleus ciliaris* (Sande Lac.) Steph., Sp. Hepat. 5: 39 (1912 ['1912–1917']); Stephani, Icon. Hepat. pl. 8309 (1985). – *Mastigolejeunea ciliaris* (Sande Lac.) Verd., Ann. Bryol. 6: 79, 78 [unnumbered fig.] (1933); Verdoorn, Ann. Bryol., Suppl. 4: 110 (1934). – TYPE: [Indonesia], Banca [Bangka], Baroe prope Batoe-Roesak [Baru near Batu Rusak], *S. Kurz [as 'J. Amand'] s.n. '181'*, 14 August 1858 (lectotype L [L.3979175], first step designated by Verdoorn (1934: 110), second step designated here). (Fig. 1–3)

*Thysananthus comosus* auct. non Lindenb.: Wilson et al., Molec. Phylogen. Evol. 43: App. 1 (2007); Sukkharak et al., Taxon 60: 1618, p.p. [sample 4] (2011) [based on *Gradstein et al. 10366*, GOET, see Sukkharak (2015: 26) and Sukkharak & Gradstein (2017: 95)].

*Morphology*. A full species description is not presented here since it has recently been provided twice (Sukkharak, 2015; Chantanaorrapint et al., 2018) and will be given again in the treatment for the *Flora of Singapore*. The Singaporean specimen does not show any variance to other specimens of *Thysananthus ciliaris* and fits comfortably into the species concept as circumscribed by Sukkharak (2015). Distinguishing characters of the species include 1) enlarged dorsal epidermal cells (Fig. 1N); 2) apiculate leaf apex (Fig. 1I, 3A); 3) elongate lobule tooth, 4–6 cells long (Fig. 1M, 2B, 3D–F); and 4) laciniate involucres and perianths (Fig. 1E–H, 2C) as shown in the Singaporean specimen.

Of the 30 accepted species of *Thysananthus*, oil bodies have been reported for 12 of them, viz. *T. aculeatus* Herzog, *T. amazonicus* (Spruce) Schiffn., *T. auriculatus* (Wilson & Hook.) Sukkharak & Gradst., *T. comosus* Lindenb., *T. convolutus* Lindenb., *T. discretus* Sukkharak & Gradst., *T. nigrus* (Steph.) Sukkharak & Gradst., *T. reconditus* (Steph.) Sukkharak & Gradst., *T. reconditus* (Steph.) Sukkharak & Gradst., *T. repletus* (Taylor) Sukkharak & Gradst., *T. retusus* (Reinw., Blume & Nees) B.M.Thiers & Gradst., *T. spathulistipus* (Reinw., Blume & Nees) Lindenb. and *T. virens* Ångstr. Oil bodies in *Thysananthus* are generally ellipsoidal to subglobose and their number varies from 2 to 6 in the marginal and median leaf cells, reaching to 8 in the vittate cells. They are coarsely segmented globules (*Calypogeia*-type) except in *Thysananthus repletus* in which finely segmented globules (*Jungermannia*-type) to rather coarsely segmented ones are observed (Sukkharak & Gradstein, 2014; Sukkharak, 2015). The oil bodies of *Thysananthus ciliaris*, not reported in previous studies, are here described, illustrated and photographed for the first time (Fig. 10, 3B). They are ellipsoidal and coarsely segmented globules, 2–3 per marginal and median cells, reaching to 6 per basal cell.

Because of its small size, *Thysananthus ciliaris* could be overlooked in the field. In addition, the species has often been misidentified in the past, especially as *Thysananthus comosus* with which it shares a similar morphology (Sukkharak, 2015). With its elongate lobule tooth, *Thysananthus ciliaris* may also be confused with *T. retusus*. The differences between these species of *Thysananthus* are discussed in Sukkharak (2015).



Fig. 1. *Thysananthus ciliaris* (Sande Lac.) Sukkharak A. Portion of female plant with young gynoecia, ventral view. B. Portion of male plant with androecia, ventral view. C. Lateral leaves, ventral view. D. Underleaves, ventral view. E. Female bracts, ventral view. F. Female bracteole, ventral view. G. Perianth, dorsal view. H. Perianth, ventral view. I. Apical cells of leaf lobe. J. Marginal cells of leaf lobe. K. Median cells of leaf lobe. L. Basal cells of leaf lobe. M. Leaf lobule apices. N. Cross section of stem. O. Oil bodies. All from *Ho RF20-15*. Drawn by P. Sukkharak.



Fig. 2. *Thysananthus ciliaris* (Sande Lac.) Sukkharak A. Shoots of dried plants with laciniate bracts and bracteoles. B. Leaf lobule, ventral view. C. Female bract, ventral view. D, E. Underleaves, ventral view. All from *Ho RF20-15*. (Photos: B.C. Ho)

*Thysananthus ciliaris* was formerly assigned to four other genera, viz. *Lopholejeunea* (Spruce) Steph., *Mastigolejeunea* (Spruce) Steph., *Phragmicoma* Dumort., nom. illeg. and *Ptychocoleus* Trevis., nom. illeg. The last two names have been (mis)applied to the current concept of *Acrolejeunea* (Spruce) Schiffn. (see



**Fig. 3.** *Thysananthus ciliaris* (Sande Lac.) Sukkharak **A.** Apical cells of leaf lobe. **B.** Median cells of leaf lobe with oil bodies. **C.** Basal cells of leaf lobe. **D–F.** Leaf lobule apices. Scale bars: 20 μm. All from *Ho RF20-15*. (Photos: B.C. Ho)

Gradstein, 1974). *Thysananthus ciliaris* does not belong to either *Acrolejeunea* or *Phragmicoma* because its enlarged epidermal cells are limited to the dorsal part of the stem (all epidermal cells are enlarged in *Acrolejeunea* and *Phragmicoma*), the presence of innovations (absent in both *Acrolejeunea* and *Phragmicoma*), and sharply 3-keeled perianths (6–10-keeled in *Acrolejeunea* and 2–5-keeled in *Lopholejeunea*). The elongate-hexagonal leaf cells in *Thysananthus ciliaris* further excludes it from

*Lopholejeunea* which has isodiametric leaf cells. The type of oil bodies in *Thysananthus ciliaris*, newly reported in this study, further supports its removal from *Acrolejeunea* and *Lopholejeunea* in which their oil bodies are of the homogenous type.

Recently, the genus *Mastigolejeunea* has been reduced to *Thysananthus* subg. *Mastigolejeunea* (Spruce) Sukkharak & Gradst. while *T. ciliaris* belongs to *Thysananthus* subg. *Thysananthus* (Sukkharak & Gradstein, 2017).

*Thysananthus* is most easily confused with *Schiffneriolejeunea* Verd. as they are morphologically very similar. However, with stiffly suberect leaves when dry, the lack of microphyllous branches, the presence of two or more lobule teeth, the absence of innovations, and a perianth with two short, rounded ventral keels in the latter set them apart (Thiers & Gradstein, 1989; Gradstein, 1994). Thiers & Gradstein (1989) considered *Thysananthus ciliaris* to be a synonym of *Schiffneriolejeunea pulopenangensis* (Gottsche) Gradst. However, the former is distinguished from the latter by its single elongate lobule tooth (two sharp teeth, each tooth 2–3 cells long in *Schiffneriolejeunea pulopenangensis*), upper 2/3 of bracts with laciniate margins (entire margins, finely denticulate at the apex in *S. pulopenangensis*), and upper 1/3 of 3-keeled perianth with laciniate margins (3-keeled perianth becoming 5-keeled above with entire margins in *S. pulopenangensis*).

*Distribution.* Peninsular Thailand (Songkhla), Peninsular Malaysia (Perak), Riau Islands (Bangka) and Borneo (East Kalimantan). New to Singapore. All associated specimens from the abovementioned localities, except the last, have been seen and verified by the second author in her previous works (Sukkharak, 2015; Chantanaorrapint et al., 2018). The Bornean record stemmed from a report from Meijer (1954: 267) in sharing his collecting experience, where he mentioned the species as *Mastigolejeunea ciliaris* from Beoul, East Kalimantan, Indonesia. A specimen matching this information has been found in BO (*W. Meijer B1601d3*, 6 Jul 1952, BO [BO-9803]). We have confirmed its determination from photographs of selected parts taken under a compound microscope. No specimen of this species collected by Meijer has been located in L. Verdoorn (1937: 211) also reported a collection of the species as *Mastigolejeunea ciliaris* from Tayabas, Luzon in the Philippines (*M.D. Pastrana s.n.*, 1935, FH [FH00955621]), but, from photographs of the specimen taken with a microscope, the identification is incorrect. However, we are unsure of its true identity. Thus, Luzon is excluded from the distribution of *Thysananthus ciliaris*.

*Habitat and ecology.* From reported occurrences and also the new collection, the species appears to favour the lowlands, tolerates some level of direct bright sunlight, and a high but fluctuating daily humidity.

*Provisional IUCN conservation assessment.* Globally Endangered (EN B2ab(iii, iv), D) with four of the five known localities (deduced from known specimens) situated in almost a straight line about 1200 km apart, across the Equator and over discontinuous heterogenous habitats including open sea. Each locality is assumed to be less than 4

km<sup>2</sup>, considering that bryophytes are generally sensitive to microhabitats. It is also uncertain if the species still exists on Bangka since it was first collected more than 160 years ago. In Singapore, it is assessed here as Critically Endangered (CR/D) as it is currently known from a single population in the country. The Singapore collection was made on an old tree within the Singapore Botanic Gardens, a UNESCO World Heritage Site. The Singapore Botanic Gardens is an area designated as a national park where plants therein are protected under the legislation of the Parks and Trees Act (revised 2006; http://sso.agc.gov.sg/Act/PTA2005).

*Specimen examined.* SINGAPORE: **Singapore Botanic Gardens:** edge of the Rainforest at the beginning of Maranta Avenue, growing on buttress of tree (*Terminalia subspatulata*), 5 Oct 2020, *B.C. Ho RF20-15* (SING [SING0298415]).

Notes. Verdoorn (1934: 110) mentioned having seen a specimen or specimens in the herbarium of Van der Sande Lacoste and cited the type as "Bangka: bei Batoe Roesak (Kurz 1858, Typus!)". This is taken as an effective lectotypification where the specimens of Van der Sande Lacoste are now incorporated in L (Stafleu & Cowan, 1985: 28). Sukkharak (2015: 25) cited a "Kurz s.n." specimen in L as the holotype. However, there are four specimens in L (i.e., L.3979172, L.3979173, L.3979174 and L.3979175) bearing the basionym name Phragmicoma ciliaris and with information that matches the protologue. Two duplicate specimens are also located in FH (i.e., FH00955622 n.v. and FH00955623 n.v.). They are variously indicated as collected by Amand, Amann or Kurz in 1858, when a date is indicated. It is known that (Wilhelm) Sulpiz Kurz (1834–1878) often used the pseudonym Johann Amann; also, bryophyte specimens from Bangka said to be collected in 1858 by J. Amand should be corrected to J. Amann (Van Steenis-Kruseman & Van Steenis, 1950: 13, 305). None of the aforementioned specimens are at variance with the protologue and they are considered to be syntypes of *Phragmicoma ciliaris*. Three specimens in L are indicated as previously from "Herb. v.d. Sande Lacoste" and, among them, the specimen that has the most abundant material and bears hand-written descriptions, likely from Van der Sande Lacoste, is selected here as the lectotype in a second-step lectotypification (Turland et al., 2018, Art. 9.17).

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