

## The moss family Octoblepharaceae A.Eddy ex M.Menzel in Australia

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### Abstract

This is the first treatment of the family Octoblepharaceae for Australia. The only known Australian species, *Octoblepharum albidum* Hedw., is described and illustrated, and a map of its known and potential distribution in Australia is included. *Octoblepharum exiguum* Müll.Hal. is here treated as a new synonym of *O. albidum*.

### Introduction

The moss family Octoblepharaceae consists of a single genus, *Octoblepharum*, known from subtropical and tropical regions worldwide. Salazar Allen and Chantanaorrapint (2018) listed 18 species of *Octoblepharum* in their summary of the global distribution of the genus and added one more. Salazar Allen and Gudiño (2020) added an additional species, bringing the total number of accepted species to 20. *Octoblepharum albidum* has by far the widest distribution of any species in the genus (Salazar and Chantanaorrapint 2018).

The taxonomic position of *Octoblepharum* Hedw. has long been in dispute (Santos and Stech 2017). It was originally included in Leucobryaceae (Schimper 1856). Cardot (1899) separated the Leucobryaceae into tribes, placing *Octoblepharum* in tribe Octoblephareae Cardot on the basis that the costa has no stereid band and the chlorocysts (green cells containing chloroplasts) are triangular in cross-section and in a single layer throughout the length of the costa. Fleischer (1904) later placed *Octoblepharum* with *Leucophanes*, *Arthrocormus* and *Exodictyon* in family Leucophanaceae.

Andrews (1947) suggested, on the basis of peristome structure, that *Octoblepharum* should be placed in Calymperaceae, along with *Arthrocormus* and *Leucophanes*. However, Edwards (1979) noted that, on peristome characters alone, the relationships of *Octoblepharum* were less clear.

Eddy (1990) included the genus in its own family, Octoblepharaceae, noting that ‘The combination of gametophyte features, monoecious (autoecious) reproductive system and peculiar peristome structure appears to set *Octoblepharum* apart from the Leucobryaceae on the one hand and Calymperaceae on the other, although the genus would seem to approach, for example, the Calymperaceous genus *Arthrocormus* much more closely than it does *Leucobryum* or *Schistomitrium*.’ The family was validated by Menzel (1991).

Recent molecular phylogenetic studies have clarified the relationships of *Octoblepharum*. Using two chloroplast markers, La Farge *et al.* (2000) found *Arthrocormus*, *Exostratum* and *Leucophanes* to be nested within *Syrrhopodon*, *Leucobryum* to be distantly related to that clade, and *Octoblepharum* to be the sister group to the Calymperaceae, supporting Eddy's (1990) establishment of the monogeneric family Octoblepharaceae. A phylogenetic analysis by Fisher *et al.* (2007) investigating the monophyly of *Syrrhopodon*, and a detailed analysis of haplolepidous mosses by Stech *et al.* (2012), supported this finding.

This position was further reinforced by the comprehensive study of Santos and Stech (2017), who analysed 21 *Octoblepharum* samples representing four putative species: *O. albidum* (pantropical), *O. arthrocormoides* Mitt. (tropical Asia), *O. cocuiense* Mitt. (Central America) and *O. pulvinatum* (Dozy & Molk.) Mitt. (Central America), together with an extensive molecular dataset (Stech *et al.* 2012) and an additional 12 Calymperaceae samples. They found strong divergence between Calymperaceae and *Octoblepharum* and recommended that *Octoblepharum* should be separated in Octoblepharaceae because of significant morphological synapomorphies of leaf shape and leaf anatomy. Inferences on evolutionary relationships between *Octoblepharum* species are complicated by variation in the number and ornamentation of peristome teeth; eight species have eight peristome teeth as described in the protologue (Salazar Allen and Gudiño, 2020); the remaining species have 16, or, as with *O. arthrocormoides*, sporophytes not seen (Salazar Allen 1991; Salazar Allen and Tan 2010). Santos and Stech (2017) recommended further studies on peristome structure and ornamentation.

Based on morphological characters and molecular analyses identified by Santos and Stech (2017), family Octoblepharaceae is now recognised by the online Classification of Extant Moss Genera (Goffinet and Buck 2020; *pers. comm.* B. Goffinet, Sept. 2020), and by the online Australian Moss Name Index (AusMoss 2020).

*Octoblepharum* is often described as a leucobryoid genus because of the *Leucobryum*-like leaf cross-section, in which chlorocysts (green cells containing chloroplasts) are sandwiched between layers of larger, thin-walled cells lacking chloroplasts (hyalocysts), so that the overall colour is often glaucous or pale green.

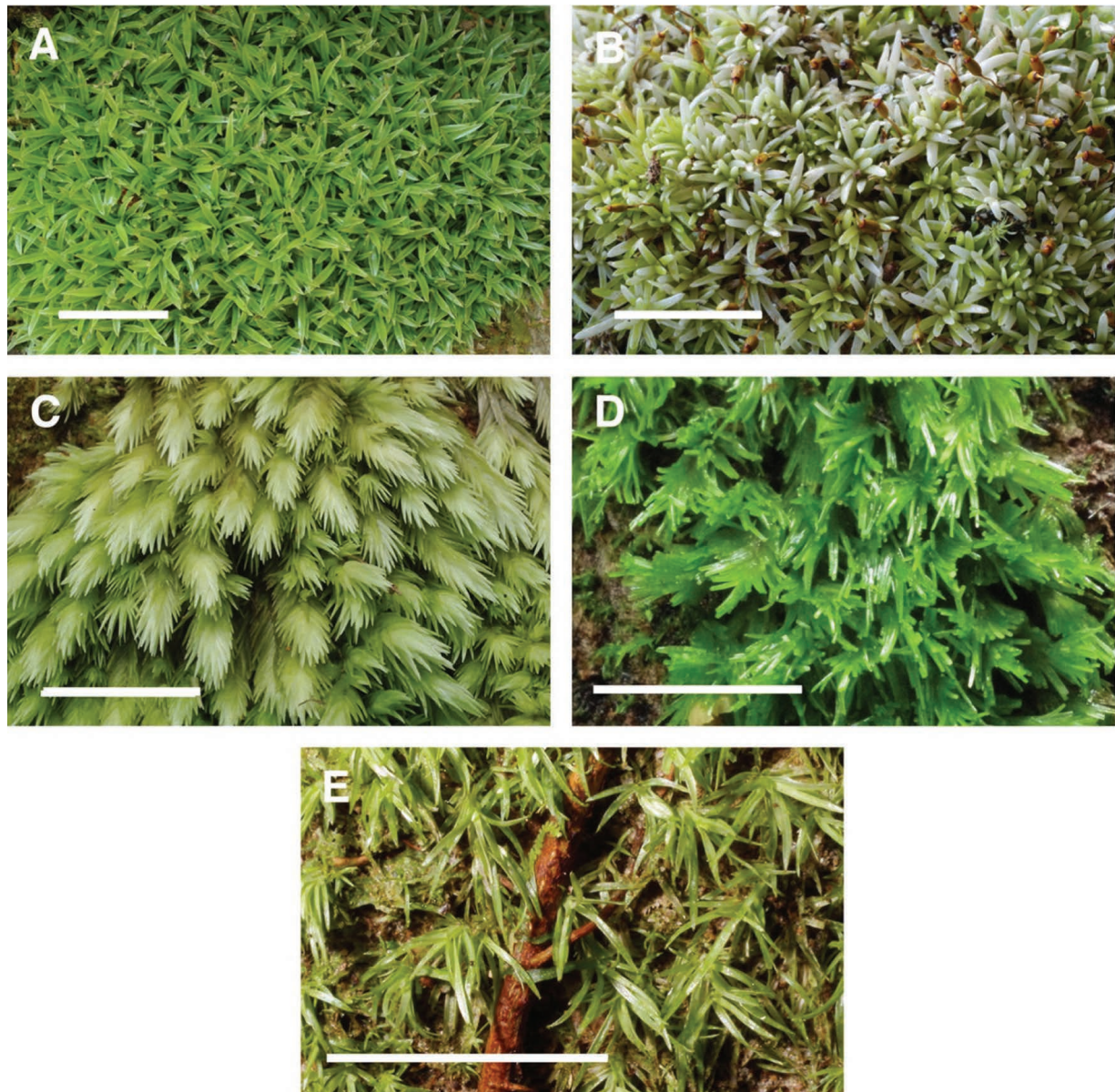
Leaf structure in *Octoblepharum* is quite different from *Arthrocormus* and *Exostratum* in having a single, centrally-located layer of mostly triangular chlorocysts surrounded by two or more layers of porose hyalocysts. Each chlorocyst is surrounded by 3 or 4 hyalocysts and, like *Exostratum* (described by Ellis 1985) but unlike *Leucophanes*, the leaf lacks a stereid band. *Octoblepharum* shares with *Leucophanes* a single central layer of chlorocysts surrounded by layers of porose hyalocysts.

The following key can be used to separate the five leucobryoid genera known from Australia. Figure 1 illustrates the typical habit of these genera.

### Key to the leucobryoid genera in Australia

- 1 In section, costal chlorocysts arranged in a single medial layer ..... 2
- 1: In section, costal chlorocysts arranged in three layers (adaxial, medial and abaxial) ..... 4
- 2 Costa including a narrow longitudinal band of stereids..... *Leucophanes*
- 2: Costa lacking stereids ..... 3
- 3 Leaves oblong-linear, spreading widely; chlorocysts  $\pm$  3-sided in cross-section;  
peristome of 8 teeth ..... *Octoblepharum*
- 3: Leaves ovate-lanceolate to linear-lanceolate, imbricate to somewhat spreading;  
chlorocysts  $\pm$  4-sided in cross-section; peristome of 16 teeth ..... *Leucobryum*
- 4 Leaves very fragile, commonly missing the apical portion ..... *Arthrocormus*
- 4: Leaves not fragile..... *Exostratum*

The Santos and Stech (2017) study also identified a considerable intraspecific variability in *O. albidum*, 'which may correspond to morphologically distinguishable groups within a species complex'. Worldwide, *Octoblepharum albidum* shows little variation in gametophytic morphology. However, distinctive differences in peristome structure and ornamentation within specimens previously identified as *O. albidum* suggest there exists 'a complex of cryptic species' (Salazar and Chantanaoapint 2018), warranting a review of herbarium specimens.



**Fig. 1.** **A** *Leucophanes glaucum* (Schwägr.) Mitt. **B** *Octoblepharum albidum* Hedw. **C** *Leucobryum aduncum* Dozy & Molk. var. *aduncum*. **D** *Arthrocormus schimperi* (Dozy & Molk.) Dozy & Molk. **E**: *Exostratum blumei* (Nees ex Hampe) L.T.Ellis. Scale bars are 10 mm. (Photos: D.A. Meagher)

Only *Octoblepharum albidum* Hedw. has been accepted for Australia. A second species, *O. exiguum* was reported in 1881 from Goods Island, near Thursday Island, close to the northern tip of Cape York. The type of this species has been lost, although Catcheside (unpublished manuscript, cited in Salazar Allen and Tan 2010) considered it likely to be a small form of *O. albidum*. Another collection from Goods Island made by Powell in 1883 has been identified as *O. albidum* (MEL-1000988A).

*Octoblepharum benitotanii* N.Salazar & Chantanaorr., recently described from Thailand and Indonesia, has long, narrow, tumid leaves with long-acuminate apices (Salazar Allen and Chantanaorr. 2018). Although its gametophyte characters are close to those of *O. albidum*, the peristome ornamentation is closer to the neotropical *O. cylindricum* Schimp. ex Mont. (Salazar Allen and Chantanaorr. 2018). Because of the proximity of Australia to Indonesia and the occurrence of numerous bryophyte species in both Thailand and tropical Australia, *O. benitotanii* might occur in northern Australia. However, in the absence of a comprehensive review of Australian collections, we treat all Australian records here as *Octoblepharum albidum*.

## Taxonomic Treatment

(Note: !d following a herbarium catalogue number means a digital image of the type has been seen.)

OCTOBLEPHARACEAE A.Eddy ex M.Menzel

Type: *Octoblepharum*

Whitish green or brown-tinged mosses forming compact tufts on the bark of trees, occasionally on rock or soil; stems lacking a central strand. Leaves erecto-patent to spreading, with a cuspidate to mucronate to long-acuminate apex, an obovate sheathing hyaline base and rigid ligulate limb composed of several layers of quadrate to rectangular leucocysts above and below a medial band of triangular chlorocysts; leucocysts of parenchymatous appearance, cells arranged in alternate positions within layers, corresponding to triangular chlorocysts (in costa cross-section). True lamina a single layer of hyaline cells, broad at the base, tapering up margins of limb. Monoicous. Perichaetia terminal on main shoots; perigonia inconspicuous, in axils of upper leaves. Calyptra small, cucullate. Setae terminal. Capsules erect, ovoid to cylindrical. Peristome variable, of 8 single teeth with a median dividing line, or 16 in 8 pairs, rigid, flattened, inner and outer layers appearing multicellular; preperistome hyaline, to 1/3–1/2 length of teeth.

*Octoblepharum* Hedw., Sp. Musc. Frond. 50. 1801

Type: *Octoblepharum albidum* Hedw.

Description as for the family.

A predominantly pan-tropical genus of about 20 species, the centre of maximum diversity being Central America.

Etymology: *oktos* (eight) + *blepharon* (eyelid), alluding to the eight-toothed peristome in the type species. The name was first coined, as *Octoblepharis*, in the 8th edition of Linnaeus's *Genera Plantarum* (Schreber 1791: 758), before the starting date for non-*Sphagnum* mosses. Hedwig (1801) preferred the root *blepharon* over *blepharis* (eyelash).

*Octoblepharum albidum* Hedw., Sp. Musc. Frond. 50. 1801

**Original material:** 'E Providentiae insula acceperat Dillenius, Swartz in Jamaica; procul dubio terrestre.'

**Syntypes:** Colombia, Isla de Providencia [Providence Island colony], *s.coll.*, *s.n.*, *s.d.*; Jamaica, Swartz *s.n.*, 1783–1786 (BM-000729628!d LD-1734098!d LD-1738316!d SBT-10417!d)

Note: Although appearing to relate to a single gathering, the type citation in fact refers to two gatherings, specimens derived from which are thus syntypes, as indicated above. BM-000729628!d is a duplicate of the second syntype, from Jamaica (det. Noris Salazaar Allen 1990), as are LD-1734098!d, LD-1738316!d and SBT-10417!d (det. E. Nyholm 1974). No lectotype has been designated.

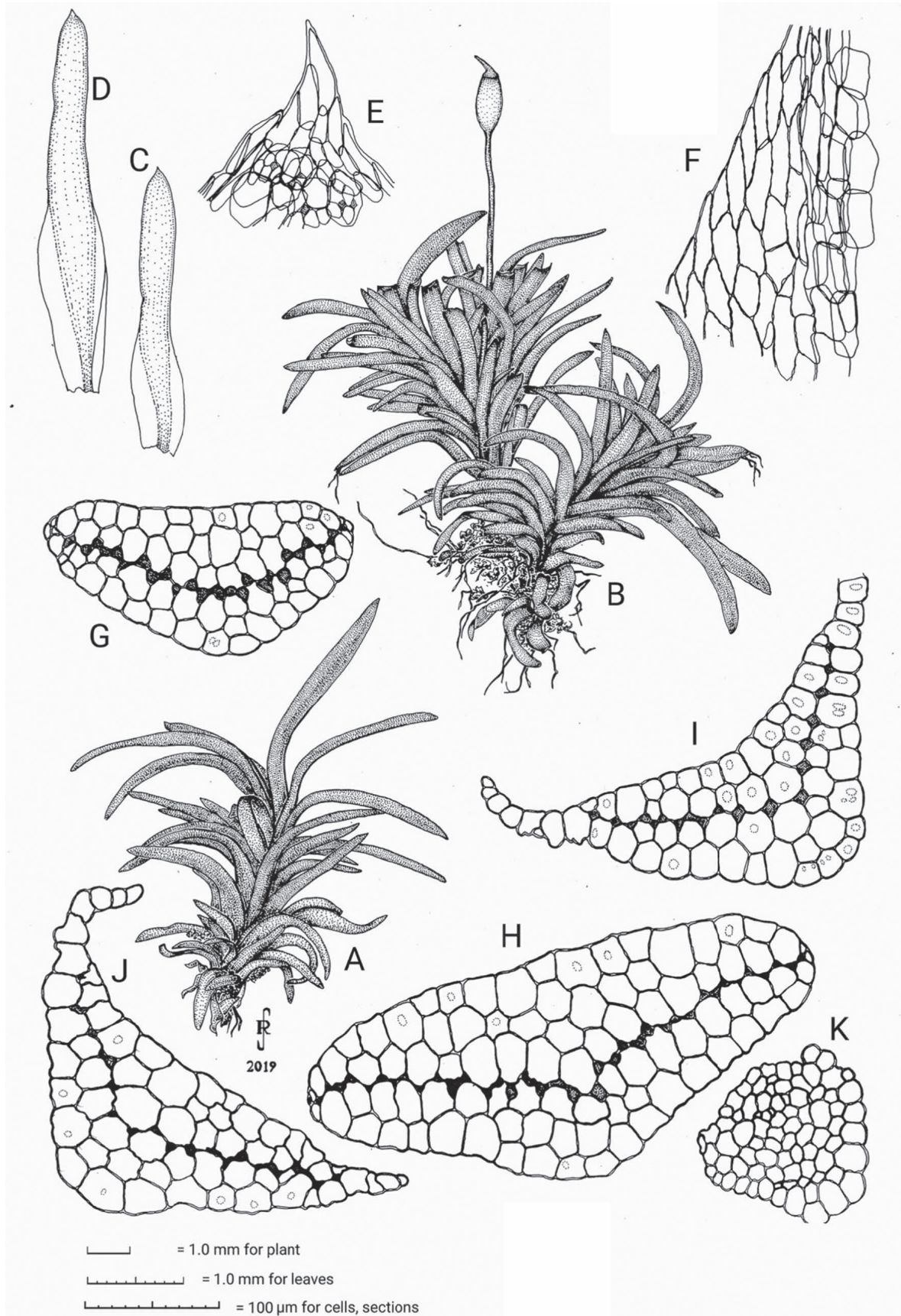
= *Octoblepharum exiguum* Müll.Hal., Gen. Musc. Frond. 88. 1901, **syn. nov.**

**Original material:** 'Torres-strasse nimmt auf Goode-Inland, wo es W. Powell 1881.'

**Type:** Australia: Torres Strait, Goods Island, *W.Powell s.n.*, 1881; holotype B (destroyed); isotype PC-0695017!d

Goode Island is now known as Goods Island. Walter Powell was on Goods Island from about 1878 to 1887, initially as a signalman and later the lighthouse keeper (Wikipedia 2020). A possible additional isotype (MEL-1000988A!d) is dated 1883, which disagrees with both the protologue and the isotype in PC. We have therefore assumed that this material is a later collection and not part of the original gathering. The isotype in PC consists of a single stem with a sporophyte. The holotype was almost certainly in Müller's herbarium in B and destroyed by fire after being bombed on the night of 1–2 March 1943. Although PC-0695017 could be selected as lectotype, the specimen is so paltry that we hesitate to do so until a thorough search is made for other original material.

**Illustrations:** Figure 1. Also Magill (1981, p. 162, f.44, 1–9), Eddy (1990, p. 32, f.186), Reese (2007, p. 664).

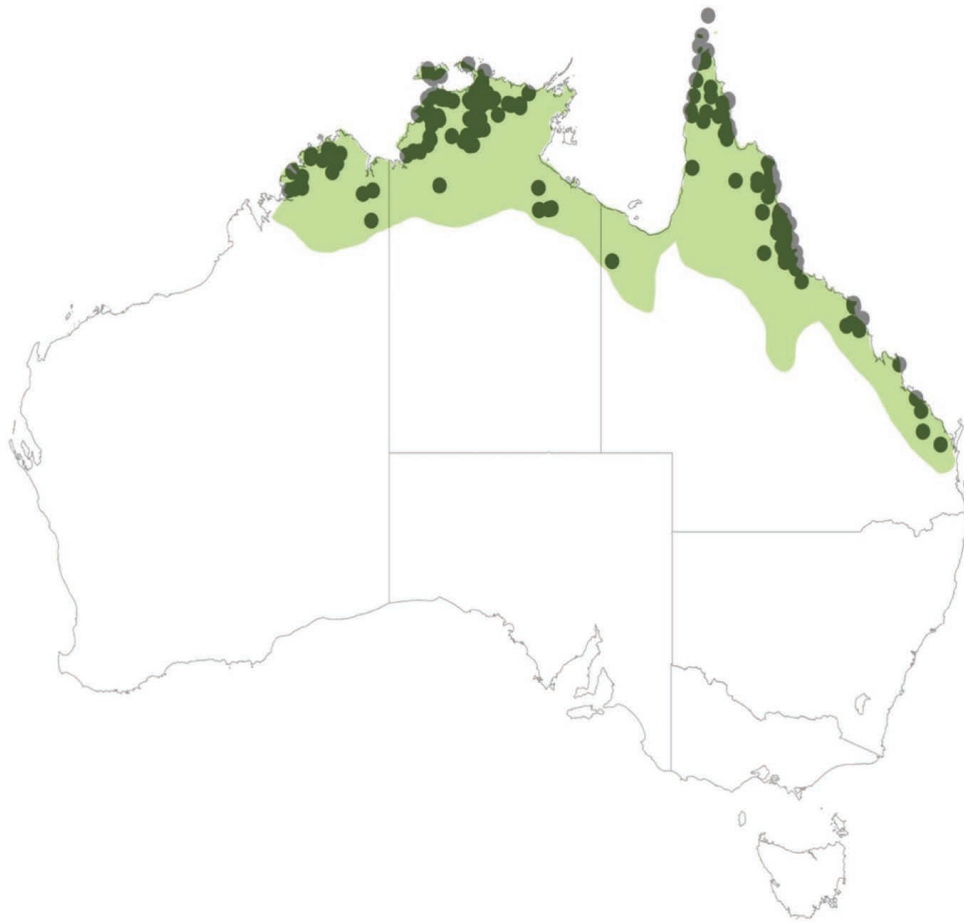


**Fig. 2.** *Octoblepharum albidum* Hedw. **A, B:** Habit of plants, drawn moist. **C, D:** Stem leaves. **E:** Cells of leaf apex. **F:** Cells of hyaline lamina. **G, H:** Sections of leaf limb. **I, J:** Sections of leaf base. **K:** Stem section. Drawn from: Queensland: North Kennedy District; Track to Cochable Creek camp site from Cardstone Road, south of Tully, A.Cairns and D.A.Meagher WT-603, 27 May 2015, 83 m a.s.l. Scales: = 1.0 mm for plants; = 1.0 mm for leaves; = 100 µm for cells, sections. (Illustration by R.D.Seppelt)

Plants forming low tufts, whitish or tinged with brown. Stems densely foliate, simple or irregularly branched, lacking a central strand, 1–2 cm tall; rhizoids dark reddish-brown. Leaves 4–7 mm long, 0.4 mm wide, ligulate, of solid texture, parallel-sided, typically recurved-spreading from an oblong or obtuse, slightly broadened sheathing base, and then abruptly narrowed to a subacute, obtuse, or shortly mucronate apex; margins smooth; costa occupying entire strap-shaped portion of leaf, surface slightly planoconvex in mid-leaf, composed of 2–3 layers of adaxial and abaxial hyalocysts on either side of a medial layer of chlorocysts, the chlorocysts narrow, mostly  $\pm$  triangular in section; hyaline lamina a single layer of hyaline cells forming broad wings of the sheathing base, narrowing upwards and disappearing about 1/3–1/2 leaf length, lacking a differentiated border. Autoicous. Perigonia bud-like in axils of upper leaves; perichaetia inconspicuous. Seta 4–7 mm long. Capsule ovoid, urn brown, 1.0–1.5 mm long, c. 0.5 mm wide, widest just below middle; operculum long-rostrate, c. 0.8 mm long, the beak straight in young capsules but becoming strongly oblique before dehiscence. Peristome teeth 8, narrowly triangular, smooth below, and papillose distally; outer surface reticulate; preperistome translucent, reaching 1/3–1/2 height of teeth.

**Distribution:** In Australia, *Octoblepharum albidum* is known from the Kimberley region of Western Australia, the tropical north of the Northern Territory, and in Queensland from Torres Strait islands and Cape York, as far south as Maryborough, about 260 km north of Brisbane (Fig. 3). Elsewhere it is widespread and pantropical in distribution, including southern United States of America, Caribbean, Central America, South America, west Africa, Central Africa, South Africa, Madagascar, Seychelles, Thailand, southern China (Hainan Island), Malesia, the Philippines, Hawaii.

**Habitat:** Epiphytic on the trunks of trees, palms and *Pandanus*, and on tree stumps and occasionally on rock and soil, in tropical and subtropical woodland and forest.



**Fig. 3.** Distribution of *Octoblepharum albidum* in Australia. Dots indicate locations of specimens held in Australian herbaria (data from AVH 2020). Green shading indicates the inferred maximum range according to the extent of known habitat (based on Scarth *et al.* 2019, Fig. 11).

**Recognition:** The characters in the key to Australian leucobryoid genera (above), together with Fig. 2, may be used to separate *Octoblepharum* from similar Australian genera.

*Octoblepharum* is easily distinguished in the field by its pale colour, oblong-linear leaves, and the star-like shoots when viewed from above. When fertile, the eight-toothed peristome is a further distinguishing character.

Although somewhat similar in appearance to *Octoblepharum*, *Arthrocnemum* is readily distinguished by its green and very fragile leaves. *Leucophanes octoblepharoides* has leaves that are green, linear-lanceolate, and V-shaped in cross-section, with a distinctly acute apex. *Leucobryum* has ovate to linear-lanceolate leaves that also have an acute apex, and the colour when moist is often green or bluish-green. *Exostratum* has green leaves that taper to a very narrowly acute apex.

In leaf cross-section it is readily distinguished by its triangular chlorocysts. *Leucophanes* has a stereid band in the costa, and *Arthrocnemum* and *Exostratum* have three chlorocyst layers. *Leucobryum* has a true medial costa.

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## References

- Andrews AL (1947) Taxonomic notes VI. The Leucobryaceae. *The Bryologist* 50: 319–326. [https://doi.org/10.1639/0007-2745\(1947\)50\[319:TNVTL\]2.0.CO;2](https://doi.org/10.1639/0007-2745(1947)50[319:TNVTL]2.0.CO;2)
- AusMoss (2020) *Australian Moss Name Index*. (<https://moss.biodiversity.org.au/nsl/services/AusMoss>) (Accessed 7 Sept 2020)
- AVH (2020) *The Australasian Virtual Herbarium*. ([www.avh.ala.org.au](http://www.avh.ala.org.au)) (Accessed 23 September 2020)
- Cardot J (1899) Nouvelle classification des Leucobryacées. *Revue Bryologique* 26: 1–8
- Eddy A (1990) *A Handbook of Malesian Mosses*. Vol. 2. *Leucobryaceae to Buxbaumiaceae*. (Natural History Museum Publications: London) (pp. 30–149)
- Edwards SR (1979) Taxonomic implications of cell patterns in haplolepidous moss peristomes. Pp. 317–346 in Clarke GCS, Duckett JG (eds) *Bryophyte Systematics*. Systematics Association Special Volume 14. (Academic Press: London)
- Ellis LT (1985) A taxonomic revision of *Exodictyon* Card. (Musci: Calymperaceae). *Lindbergia* 11: 9–37
- Fisher KM, Wall DP, Yip KL, Mishler BD (2007) Phylogeny of the Calymperaceae with a rank-free systematic treatment. *The Bryologist* 110(1): 46–73. [https://doi.org/10.1639/0007-2745\(2007\)110\[46:POTCWA\]2.0.CO;2](https://doi.org/10.1639/0007-2745(2007)110[46:POTCWA]2.0.CO;2)
- Fleischer, M. (1904). *Die Musci der Flora von Buitenzorg (Zugleich Laubmoosflora von Java)*. (E J Brill: Leiden)
- Goffinet B, Buck WR (2020) *Classification of extant moss genera*. (<https://bryology.uconn.edu/classification/>) (Accessed 16 September 2020)
- Hedwig J (1801) *Species muscorum frondosorum*. (JA Barth: Leipzig)
- La Farge C, Mishler BD, Wheeler JA, Wall DP, Johannes K, Schaffer S, Shaw AJ (2000) Phylogenetic relationships within the haplolepidous mosses. *The Bryologist* 103(2): 257–276
- Magill RE (1981) *Flora of southern Africa. Bryophyta. Part 1, Fascicle 1. Mosses. Sphagnaceae – Grimmiaceae*. Botanical Research Institute, Department of Agriculture and Fisheries, Pretoria, South Africa
- Menzel M (1991) Listado básico de la flora Salvadorensis: Bryophyta. Sphagnopsida, Andreopsida, Bryopsida. In Berendsohn WG (ed.) *Cuscatlania* 1(5): 1–24
- Reese WD (2007) *Octoblepharum*. In Flora of North America Editorial Committee (Eds.) *Flora of North America North of Mexico* [Online], Vol. 27: Bryophyta: Mosses, part 1. New York and Oxford <http://beta.floranorthamerica.org/Octoblepharum> (Accessed 26 November 2020)
- Salazar Allen N (1991) A preliminary treatment of the Central American species of *Octoblepharum* (Musci: Calymperaceae). *Tropical Bryology* 4: 85–97. <https://doi.org/10.11646/bde.4.1.10>
- Salazar Allen N, Chantanaorrapint S (2018) *Octoblepharum benitotanii* (Octoblepharaceae) a new species from the Old World Tropics. *Philippine Journal of Systematic Biology* 12(1): 58–66. <https://doi.org/10.26757/pjsb.2018a12005>
- Salazar Allen N, Gudiño JA (2020) *Octoblepharum peristomiruptum* (Octoblepharaceae) a new species from the Neotropics. *PhytoKeys* 164: 1–9. <https://doi.org/10.3897/phytokeys.164.51783>

- Salazar Allen N, Tan BC (2010) *Octoblepharum arthrocormoides* (Calymperaceae) N.Salazar Allen & B.C.Tan, sp. nov., a new species from Tropical Asia. *Botany* (Ottawa) 88: 439–442. <https://doi.org/10.1139/B10-022>
- Santos MB, Stech M (2017) Tackling relationships and species circumscriptions of *Octoblepharum*, an enigmatic genus of haplolepideous mosses (Dicranidae, Bryophyta). *Systematics and Biodiversity* 15(1): 16–24. <https://doi.org/10.1080/14772000.2016.1213325>
- Scarth P, Armston J, Lucas R, Bunting P (2019) A structural classification of Australian vegetation using ICESat/GLAS, ALOS PALSAR and Landsat sensor data. *Remote Sensing* 11: 147. <https://doi.org/10.3390/rs11020147>
- Schimper WP (1856). *Bryologia Europaea, conspectum diagnosticum familiarum, generum et specierum*. (Sumptibus Librariae E Schweizerbart: Stuttgart)
- Schreber JCD (ed.) (1791) *Genera Plantarum, 8th edition, Volume 2*. (Varrentrapp & Wenner: Frankfurt)
- Stech M, McDaniel SF, Hernández-Maqueda R, Ros-Espín RM, Werner O, Muñoz J, and Quandt D (2012) Phylogeny of haplolepideous mosses – challenges and perspectives. *Journal of Bryology* 34: 173–186. <https://doi.org/10.1179/1743282012Y.0000000014>
- Wikipedia (2020) Walter David Taylor Powell. ([https://en.wikipedia.org/wiki/Walter\\_David\\_Taylor\\_Powell](https://en.wikipedia.org/wiki/Walter_David_Taylor_Powell)) (Accessed 28 October 2020)

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