

## WARBURGIELLA

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*Warburgiella* Müll.Hal. ex Broth., *Monsunia* 1: 176 (1900); named after the botanist Otto Warburg (1859–1938).

Type: *W. cupressinoides* Müll.Hal. ex Broth.

Autoicous or polycious. Plants small, in dense glossy yellowish green to yellowish brown mats. Stems creeping, elongate, irregularly pinnate to bipinnately branched. Branches short or long, with short erect-divergent cuspidate tips. Stem and branch leaves similar. Pseudoparaphyllia foliose. Leaves strongly falcate-secund to circinate, lanceolate to ovate-lanceolate, ecostate, with an expanded sheathing base, in some species abruptly long-acuminate, the acumen occasionally twisted, the acumen occasionally twisted; margins sharply serrate to ±entire above, entire below, plane but occasionally appearing involute due to the strong concavity. Laminal cells elongate to narrowly linear, prorulose or smooth, occasionally unipapillose; alar region often coloured, with a single basal row of 2–4 large swollen thick-walled elongate cells; supra-alar cells subquadrate in a single row of 1–3.

Perigonia and perichaetia on separate branches; inner perichaetial leaves large, with an expanded base clasping the branch and vaginula, often abruptly cuspidate, lacking alar cells. Calyptra large, campanulate (mitrate), sheathing the whole capsule, or cucullate, smooth; base deeply lacinate to entire. Seta slender, elongate, curved distally, smooth or papillose above. Capsule horizontal to inclined, cylindrical; neck with stomata; constricted under the mouth when dry, smooth; exothecial cells rectangular, with thickened longitudinal walls, occasionally semi-collenchymatous; operculum obliquely long-rostrate, Peristome double; exostome of 16 lanceolate teeth, subulate, densely cross-striolate below, coarsely papillose above with a deep median furrow, with well-developed trabeculae on the inner surface; endostome segments 16, the same length as the exostome teeth, keeled, slit and perforate, hyaline, smooth, from a high basal membrane; cilia 1 or 2, well developed, nodose. Spores finely papillose. Chromosome numbers of Australian species not known.

A genus of 30 species in South America, India, Sri Lanka, Malesia, New Caledonia, New Zealand and Oceania. Three species are recognised here from Australia. Two taxa erroneously listed by Streimann & Klazenga (2002) have since been removed by Ramsay *et.al.* (2004), viz. *W. leptorrhyncha* (A.Jaeger) Broth. and *W. cupressinoides* Müll.Hal. ex Broth. The Australian species grow on tree trunks in closed, subtropical and tropical forests.

The mitrate to campanulate calyptra, traditionally diagnostic for *Warburgiella*, is an unreliable character as it can sometimes split on one side and appear to be cucullate. Buck & Tan (1989) circumscribed the genus by its strongly circinate leaves with abruptly narrowed to long-toothed apices and somewhat thick-walled alar cells. It is further characterised by the semi-collenchymatous exothecial cells and the occasionally prorulose to unipapillose laminal cells. Although sometimes unipapillose, *Warburgiella* can be distinguished from *Trichosteleum* by the calyptra, semi-collenchymatous exothecial cells and filiform-pointed, falcate-secund leaves with a serrate acumen. *Warburgiella* can be separated from circinate-leaved species of *Rhaphidorrhynchium* by the exothecial cells, and the sheathing inner perichaetial leaves with a somewhat abruptly acuminate or constricted cuspidate apex.

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<sup>1</sup> c/- National Herbarium of New South Wales, Mrs Macquaries Road, Sydney, New South Wales 2000.

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## Key

- 1 Most stem and branch leaves abruptly cuspidate or long-acuminate to filiform, with an expanded and involute leaf base ..... **1. W. leptorhynchoides**
- 1: Stem and branch leaves gradually, but not abruptly long-acuminate, lacking an expanded involute leaf base ..... 2
- 2 Leaves strongly falcate due to the long, slender and curved apices; perichaetial leaves with an abruptly long-cuspidate and strongly serrate apex; capsules horizontal or pendulous; spores 10–15 µm diam. .... **2. W. leucocytus**
- 2: Leaves less markedly falcate, with acuminate and flexuose apices; perichaetial leaves with a gradually elongate apex that is only slightly serrulate; capsules erect; spores 15–30 µm diam. .... **3. W. macrospora**

### 1. *Warburgiella leptorhynchoides* (Mitt.) M.Fleisch., *Musc. Buitenzorg* 4: 1253 (1923)

*Stereodon leptorhynchoides* Mitt., *J. Linn. Soc., Bot.*, Suppl. 1: 103 (1859). T: Nilghiri, India, *Perotet* s.n.; holo: NY.

*Rhaphidostegium subleptorrhynchoides* M.Fleisch., *Hedwigia* 44: 327 (1905); *Warburgiella subleptorrhynchoides* (M.Fleisch.) M.Fleisch., *Musc. Buitenzorg* 4: 1250 (1923). T: West Java, [Indonesia], *M.Fleischer s.n.*; holo: L.

[*Warburgiella cupressinoides* auct. non Müll.Hal. ex Broth.: E.B.Bartram, *Farlowia* 4: 235–247 (1952)]

Illustration: H.P.Ramsay, W.B.Schofield & B.C.Tan, *op. cit.* 61, fig. 26.

Polyoicous. Plants greenish to yellow-green. Stems to 20 mm long; branches erect to spreading, 4–5 mm long. Leaves falcate or falcate-secund, narrowly oblong to lanceolate, 0.5–1.0 mm long, c. 0.3 mm wide, abruptly narrowed to a long serrulate acumen. Laminal cells narrowly oblong to linear, 45–72 × 5–6 µm, often low-unipapillose over the lumen; apical cells elongate; alar region with a basal row of 2 or 3 large cells, orange, elliptical, thick-walled, > 100 µm long and c. 15 µm wide; supra-alar cells few, thick-walled.

Perichaetial leaves long and narrow, acuminate, with a serrulate apex. Seta orange, 15–20 mm long, smooth. Capsule ovoid, c. 1.3 mm long, constricted below the mouth; exothecial cells semi-collenchymatous. Peristome with exostome teeth cross-striolate below, median groove, with a median groove, papillose on both surfaces; endostome segments with scattered papillae; basal membrane high; cilium 1, shorter than the teeth and segments. Spores 11–15 µm diam.

Known from southern India, Sri Lanka, Thailand, Indonesia, New Guinea, eastern Qld and eastern N.S.W.; grows on tree stems and branches in rainforest.

Qld: South Peak, Mt Bellenden Ker, *H.Streimann 27339, 27416* (CANB, H, L, NICH, NY); Josephine Falls, Mt Bartle Frere, *W.B.Schofield 79747 & M.I.Schofield* (NSW, UBC); Plane Track, Mt Bellenden Ker,

*I.G.Stone 16869* (MEL); Atherton Forest Reserve No 194, *B. de Winter 988* (NSW). N.S.W.: Gibbergunyah, NNE of Lismore, *H.Streimann 315* (CANB).

Tan (in Touw, 1992) regarded *W. subleptorrhynchoides* as being conspecific with *W. leptorrhynchoides*.

*Warburgiella leptorrhynchoides* has often been confused with *W. cupressinoides* Müll.Hal. ex Broth. However, the latter has a mitrate or campanulate calyptra and strongly toothed, falcate leaf acumens.

## 2. *Warburgiella leucocythus* (Müll.Hal.) B.C.Tan, W.B.Schofield & H.P.Ramsay, *Nova Hedwigia* 67: 221 (1998), as *leucocyta*

*Hypnum leucocythus* Müll.Hal., *Syn. Musc. Frond.* 2: 314 (1851); *Rhaphidostegium leucocythus* (Müll.Hal.) A.Jaeger, *Ber. Thätigk. St. Gallischen Naturwiss. Ges.* 1876–77: 403 (1878) [Ad. 2:469]; *Rhaphidorrhynchium leucocythus* (Müll.Hal.) Broth., *Nat. Pflanzenfam.*, 2nd edn, 11: 427 (1925). T: Auckland, New Zealand, *J.D.Hooker*; holo: BM.

*Hypnum cerviculatum* Hook.f. & A.Wilson, *Fl. Nov.-Zel.* 2: 113 (1854); *Rhaphidorrhynchium cerviculatum* (Hook.f. & A.Wilson) M.Fleisch., *Musc. Buitenzorg* 4: 1249 (1923). T: Port Nicholson, New Zealand, *Sinclair*; lecto: BM (Herb. Wilson), fide A.Fife (1992, unpubl.)

*Hypnum tuloferum* Hampe, *Linnaea* 30: 644 (1860); *Rhaphidostegium tuloferum* (Hampe) A.Jaeger, *Ber. Thätigk. St. Gallischen Naturwiss. Ges.* 1876–77: 403 (1878) [Ad. 2:469]; *Rhynchostegium tuloferum* (Hampe) Paris, *Index. Bryol.* 1: 1139 (1898); *Rhaphidorrhynchium tuloferum* (Hampe) Broth., *Nat. Pflanzenfam.*, 2nd edn, 11: 427 (1925). T: Sealers Cove, Vic., *F.Mueller*; holo: MEL.

*Hypnum trachychaeton* F.Muell., *Austral. Mosses* 1: pl. 15 (1864); *Rhaphidorrhynchium trachychaeton* (F.Muell.) Broth., *Nat. Pflanzenfam.* I, 3: 1110 (1908); *Rhaphidostegium trachychaeton* (F.Muell.) Broth., *Nat. Pflanzenfam.*, 2nd edn, 11: 427 (1925). T: "Eastern Australia", *F.Mueller*; holo: MEL.

Illustrations: J.Beever, K.Allison & J.Child, *Mosses of New Zealand* 65, fig. 53 (1992), as *Sematophyllum leucocythus*; H.P.Ramsay, W.B.Schofield & B.C.Tan, *op. cit.* 56, fig. 24.

Autoicous. Plants pale green to pale yellow-brown. Stems to 4 cm long, interwoven, subpinnately and densely branched; branches to 20 mm long, almost straight, ±cuspidate from the penicillate apical leaves. Leaves narrow, long and tapering, strongly falcate-secund, 1.0–1.4 mm long, 0.2–0.3 mm wide; margins plane or narrowly recurved in the middle, entire or slightly denticulate in the acumen. Laminal cells narrow, 50–75 × 4–5 µm, weakly unipapillose; apical cells elongate-linear, 30–35 × 2.0–2.5 µm; alar region with single row 3 or 4 inflated cells; supra-alar cells 1 or 2.

Perichaetial leaves ovate-oblong, acuminate to abruptly short-cuspidate; apices strongly toothed. Seta 10–20 mm long, rather stout if short, slightly rugulose distally, red, twisted to the right. Capsule oblong or elliptic, 1.25–1.50 mm long, horizontal or pendulous, with an angular ridge around the base; annulus lacking; exothecial cells semi-collenchymatous, with strongly incrassate longitudinal walls giving the capsule a striped appearance; operculum with the rostrum filiform, as long as the capsule. Peristome double; exostome teeth to 250 µm long, ovate-lanceolate, broad at the base, with an acuminate papillose apex; endostome segments ovate-lanceolate, arising from a broad low basal membrane; cilium 1, shorter than the segments and teeth. Spores 10–15 µm diam.

Known from South America, New Zealand and Australia (Qld, N.S.W., Vic., Tas.). Occurs on tree trunks and on fallen logs in fern gullies and in rainforest. Rather rare in Qld and N.S.W.; most common in cool-temperate habitats.

Qld: Mt Bellenden Ker, *W.B.Schofield 90249* (NSW); Damper Ck, Cardwell, *I.G.Stone 1554* (MEL). N.S.W.: Pretty Pt, Mt Kosciuszko, *J.H.Maiden & W.Forsyth 208* (NSW); Mt Wilson, *W.W.Watts 10369* (NSW). Vic.: Masons Falls, Kingslake Natl Park, *A.W.Thies FN1565Y* (MEL); Mt Baw Baw, 1892, *C.French s.n.* (MEL); Otway Ra., *A.C.Beauglehole 9080* (MEL). Tas.: Mt Wellington, *R.A.Bastow 360* (NSW); Fern Tree, *D.A. & A.V.Ratkowsky B319* (MEL); Wellards Track, Upper Meander, *W.A.Weymouth 1213* (HO).

G.O.K.Sainsbury (*A Handbook of New Zealand Mosses. Bull. Roy. Soc. New Zealand* 5: 463–464, 1955) observed that vegetative plants of *W. leucocythus* (as *Sematophyllum leucocythus*) were often difficult to distinguish from those of *Rhaphidorrhynchium amoenum* (as *Sematophyllum amoenum*). However, the exothecial cells of the former are semi-

collenchymatous with extremely thickened longitudinal walls and thin transverse walls (G.A.M.Scott & I.G.Stone, *Mosses of Southern Australia* 442–444, 1976).

### 3. *Warburgiella macrospora* (Dixon & Sainsbury) B.C.Tan, W.B.Schofield & H.P.Ramsay, *Nova Hedwigia* 67: 222 (1998)

*Sematophyllum macrosporum* Dixon & Sainsbury, *Trans. Roy. Soc. New Zealand* 75: 183 (1945). T: Mt Ngauruhoe, Mangatepopo Valley, Tongariro Natl Park, New Zealand, 31 Dec. 1926, *G.O.K.Sainsbury* 695; holotype: BM (Dixon).

*Rhaphidorrhynchium sydneyense* Dixon, *nom. nud.* Based on: Sydney, N.S.W., *R.Collie* (BM, NSW, NY); *Rhaphidorrhynchium sydneyense* Dixon ex H.P.Ramsay, W.B.Schofield & B.C.Tan, *J. Hattori Bot. Lab.* 95: 58 (2004), *nom. inval.* (no description & in synonym.), *fide AUSMOSS* (August 2011).

[*Sematophyllum subcylindricum* auct. non (Broth. ex M.Fleisch.) Sainsbury: G.A.M.Scott & I.G.Stone, *Mosses of Southern Australia* 443 (1976)]

Illustrations: W.R.Buck, D.H.Vitt & W.M.Malcolm, *Key to the Genera of Australian Mosses* 16 (2001); H.P.Ramsay, W.B.Schofield & B.C.Tan, *op. cit.* 59, fig. 25.

Autoicous. Plants slender, forming dense flat glossy mats, yellow-brown, bronze or yellow-green. Stems creeping, irregularly pinnately branched; branches erect, 2–3 mm long, the apex straight, curved or weakly falcate. Leaves falcate-secund, narrowly ovate-lanceolate, acuminate, tapering towards the narrow apex, c. 1 mm long and 0.25 mm wide; margins slightly recurved on one or both sides, serrate above. Laminal cells narrow and elongate, 50–70 × 2–3 μm, with a single low papilla; apical cells narrowly oblong, 20–30 × 2–3 μm; alar region with 2–4 slightly enlarged basal cells, thin-walled ± coloured; supra-alar cells few, quadrate to irregular. Flagelliferous shoots occasionally on the tips of branches.

Perichaetia on stems; outer perichaetial leaves narrow, short-cuspidate; inner leaves long-acuminate, apex smooth to slightly serrulate. Seta less than 10 mm long, smooth. Capsule erect, 1.0–1.5 mm long, subcylindrical, elliptic or ovoid, tapered towards mouth when dry; operculum conical; rostrum curved; exothecial cells semi-collenchymatous. Peristome double; exostome teeth 16, 250–300 μm long, narrow, lanceolate; apex subpiliform, papillose, hyaline; border trabeculae projecting laterally, with long trabeculae on the inner face and cross-striolate on dorsal surface, with a median groove; endostome segments 16, lightly papillose; basal membrane of medium height; cilia absent or rudimentary. Spores 15–30 μm diam.

Occurs on trees and on fallen logs in tropical-montane and temperate forest in eastern Qld, N.S.W., Vic. and Tas. Also in New Zealand.

Qld: Mt Bellenden Ker, *I.G.Stone* 16936 (MEL). N.S.W.: Deep Ck, Batlow, *W.W.Watts* 7976 (NSW). Vic.: Mt Donna Buang, 4.5 km NNW of Warburton, *H.Streimann* 36252, 36233 (CANB, UBC); Mt Cope, Bogong Natl Park, *A.C.Beauaglehole* 15560 (MEL). Tas.: junction of Florentine Rd and Robinson Rd, *S.J.Jarman* 1284 (HO); Willards Rivulet, Tasman Penin., *W.A.Weymouth* 1967B (HO).

Sainsbury (1952) synonymised *Sematophyllum macrosporum* with *S. subcylindricum* (Broth. ex M.Fleisch.) Sainsb. from Java based on their recurved leaf margins and comparatively large spores. Subsequently, Clifford & Willis (*Victorian Naturalist* 68: 151–158, 1952) and Scott & Stone (*op. cit.* 443, 1976) reported *S. subcylindricum* from Victoria and Tasmania. However, Tan *et al.* (1998) and Ramsay *et al.* (2004) studied the type specimens of both taxa and concluded that they were not conspecific. The type specimen of *S. subcylindricum* (FH) has larger plants with longer and more slender leaf acumens. In addition, the exothecial cells of are strongly collenchymatous, while those of *S. macrosporum* are semi-collenchymatous, i.e. with areas of thickening not confined to the corners of cells but also found on longitudinal walls. Ramsay *et al.* (2004) concluded that all Australian records of *Rhaphidorrhynchium subcylindricum* or *Sematophyllum subcylindricum* examined by them were referable to *W. macrocarpa*.

*Warburgiella macrospora* differs from *W. leucocytus* in having oblong to elongate apical leaf cells, shorter setae, more erect capsules, larger and strongly papillose spores (15–30 μm diam.) and, more significantly, narrowed, short-cuspidate or acuminate and serrulate perichaetial leaf apices. The apical leaf cells of *W. leucocytus* are elongate-linear, and the perichaetial leaves have an abruptly long-cuspidate and strongly toothed apex. The capsules

are horizontal and the spores are considerably smaller (10–15  $\mu\text{m}$  diam.) than those of *W. macrospora*.