

THUIDIACEAE

(P. Martin)

Plants small to large and rather robust, forming loose to somewhat dense mats or wefts, dull light to dark green, yellowish-green to brown, or golden. **Stems** 1-3 pinnately branched, often rather densely tomentose; central strand present (except in *Hylocomiopsis*); paraphyllia scattered or dense, simple to branched, smooth to papillose. **Leaves** usually weakly to strongly dimorphic. **Stem leaves** appressed to erect-spreading, ovate or cordate (triangular) - lanceolate or subulate, apex short to long acuminate; margins plane distally, recurved or reflexed below, entire to serrulate- or crenulate-papillose; costa single, usually strong and projecting on back, percurrent to excurrent; median cells oval to isodiametric, uni- or pluripapillose on back or both surfaces, papillae low or long and often curved. **Branch leaves** broadly to somewhat narrowly ovate or ovate-short lanceolate, apex acute to obtuse, costa often ending below apex. **Asexual structures** apparently absent. **Autoicous** or dioicous. **Perigonia** lateral, leaves ovate to short ovate-lanceolate. **Perichaetia** lateral, leaves usually differentiated, long ovate-lanceolate to lanceolate, margins ciliate or not. **Seta** elongate, smooth to papillose or hispid. **Capsule** sub-erect to pendulous, urn cylindrical, usually curved. **Operculum** short to long rostrate, oblique. **Peristome** double, exostome teeth 16, cross-striate below, distally papillose; endostome lightly papillose, basal membrane low to high, segments 16, keeled, endostome cilia in groups of 1-3. **Calyptra** cucullate, naked and smooth (hispid in *Pelekium velatum* Mitt.). **Spores** spherical, smooth to more commonly papillose.

DISCUSSION. The Thuidiaceae contain sixteen genera, as defined here (Touw 2001a), and 150 or more species widely distributed in temperate and tropical regions; in sub-Saharan Africa seven genera and 22 species. There is an extensive literature discussing the delimitation of this family, and its relationship with other pleurocarpous families, some of which is listed below; the current scope of the family is as recognised by Touw (2001a). Any reference that is of value for identification is mentioned under the individual genera; Touw (1976) will be the most useful, but doesn't cover all the genera now included in the family.

Study guide: Attention must be given to branching patterns, i.e., 1-, 2-, 3-pinnately branched. Paraphyllia need to be observed, both on stems with some of the leaves removed and separated from the stem in order to examine the surface ornamentation. Stem and branch leaves are required with particular attention paid to papillae, which, together with paraphyllia allow many of the sub-Saharan African species to be identified without sporophytes. In a few cases, seta ornamentation and the inclination of the capsule are required.

LITERATURE. **Buck, W.R. & Crum, H. 1990.** An evaluation of familial limits among the genera traditionally aligned with the Thuidiaceae and Leskeaceae. *Contributions to the University of Michigan Herbarium* 17: 55-69. **Fang, Y. M., Koponen, T., 2001.** A review of *Thuidium*, *Haplocladium* and *Claopodium* (Musci, Thuidiaceae) in China. *Bryobrothera* 6:1-82. **Hedenäs, L. 1997.** An evaluation of phylogenetic relationships among the Thuidiaceae, the Amblystegiaceae and the temperate members of the Hypnaceae. *Lindbergia* 22: 101-133. **O'Brien, T.J. and Horton, D. 2000.** *Bryochenea* (Musci: Thuidiaceae) is *Cyrto-hypnum* (Thuidiaceae), but *B. sachaliensis* is *Echinophyllum* (Thuidiaceae), a new genus from the Pacific rim. *Bryologist* 103: 509-517. **Spence, J. R. 1997.** A gametophytic evaluation of the Leskeaceae and related families. *Journal of the Hattori Botanical Laboratory* 82: 261-270. **Touw, A. 1976.** A taxonomic revision of *Thuidium*, *Pelekium*, and *Rauyiella* (Musci: Thuidiaceae) in Africa south of the Sahara. *Lindbergia* 3: 135-195. **Touw, A. 1993.** Notes on tropical Asian Thuidiaceae, with two new Malesian species of *Thuidium* s.l. *Journal of the Hattori Botanical Laboratory* 74: 193-204. **Touw, A. 2001a.** A review of the Thuidiaceae (Musci) and a realignment of taxa traditionally accommodated in *Thuidium* sensu amplo (*Thuidium* Schimp., *Thuidiopsis* (Broth.) M. Fleisch and *Pelekium* Mitt.),

including *Aequatoriella* gen. nov. and *Indothuidium* gen. nov. Journal of the Hattori Botanical Laboratory 90: 167-209. **Touw, A., 2001b.** A taxonomic review of the Thuidiaceae (Musci) of tropical Asia, the western Pacific rim and Hawaii. Journal of the Hattori Botanical Laboratory 91:1-136. **Touw, A. & Falter-Van den Haak, L. 1989.** A revision of the Australasian Thuidiaceae (Musci), with notes on species from adjacent regions. Journal of the Hattori Botanical Laboratory 67: 1-57. **Watanabe, R. 1972.** A revision of the family Thuidiaceae in Japan and adjacent areas. Journal of the Hattori Botanical Laboratory 36: 171-320.

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Abietinella (Fig. XX)

One species in sub-Saharan Africa, *A. abietina* Hedw., reported only from Lesotho and Natal.

Plants medium to large forming stiff yellow green to brownish mats. **Stems** erect – ascending, unipinnately branched. Branches short and varying in length, central strand present; paraphyllia abundant on stems and branches, simple or branched, often lanceolate, papillose. **Leaves** of stem and branch differentiated. **Stem leaves** ovate to triangular, plicate, 1.1-1.8 mm long, apex acuminate, margin plane to broadly recurved. Costa strong, ending below apex, cells rhombic, thick walled and strongly unipapillose dorsally, less so ventrally, sometimes curved. **Branch leaves** oval 0.6-0.7mm long, cells rhombic, terminal cell with 2 or more papillae. Costa ending below the apex. **Dioicous.** **Perichaetial** leaves up to 4mm, serrate in upper leaf, longly lanceolate, apex drawn out, plicate with smooth cells **Seta** 25mm red. **Capsule** 2-3mm, cylindrical, curved and inclined, annulus of large cells. **Operculum** conic to short rostrate. **Peristome** endostome with nodulose cilia and high basal membrane; cilia 2-3, **Calyptra** naked. **Spores** smooth to finely roughened 9-16µm

HABITAT. Xerotolerant, found in open exposed areas.

DISCUSSION. Although intermediates occur, *Abietinella* is distinct in the fronds forming turfs as opposed to the more common wefts in the Thuidiaceae. Differs from *Thuidium* in having once-pinnate ramification, more weakly ornamented paraphyllia, leaf cells ornamented on both faces and differentiated alar cells. These characters prevent a merging of *Abietinella* and *Thuidiopsis*.

LITERATURE. **Touw, A. 2001a.** - see general refs.

Haplocladium (Fig. XX)

Two species for sub-Saharan Africa, *H. angustifolium* Hampe & Muell.Hal., known from eastern and Southern Africa, and *H. jacquemontii* Muell.Hal. recorded only from Ethiopia.

Plants small to medium forming loose mats green to yellow-brown. **Stems** creeping, 1-pinnate, central strand present; paraphyllia dense on stems, sparse on branches, unbranched and not papillose. **Leaves** on stem and branch differentiated. **Stem leaves** cordate to ovate with long drawn out apex 0.5 – 0.8 mm long, nerve excurrent, margin serrulate in upper leaf. Cells oval to rectangular, prorulose on upper side. **Branch leaves** smaller than stem leaves, 0.3-0.5mm long, lanceolate, margin serrulate above. Costa ending in apex, cells oval to rectangular, prorulose on upper adaxial side. **Autoicous. Perichaetial** leaves lanceolate 1-1.5mm long, costa ending in apex, margin plane and serrulate **Seta** 1.2-1.8cm, smooth, red. **Capsule** 1.5-2 mm long, inclined asymmetric, annulus in 2-3 rows. **Operculum** high. **Peristome** endostome high, segments keeled, perforate in groups of 1-2; exostome teeth yellow to yellow-brown papillose distally. **Calyptra** cucullate and smooth. **Spores** spherical, slightly roughened.

HABITAT. Grows in the bottom layer of forests as well as more open situations, on rocks, soil, logs or tree bases.

DISCUSSION. *Haplocladium* has previously been placed in the Leskeaceae due to its smooth paraphyllia and terminal leaf cells. In both phenetic analysis of gametophyte morphology and cladistic analysis it has been shown to be close to the Thuidiaceae (Hedenäs 1997; Spence 1997). The most frequently found species, *H. angustifolium*, is found for instance in Mexico and India and is described in the bryophyte floras of those countries, as well as in Fang & Koponen (2001).

LITERATURE. **Fang, Y. M., Koponen, T., 2001.** - see family refs. **Hedenäs, L. 1997** - see family refs. **Spence, J. R. 1997.** - see family refs.

Hylocomiopsis (Fig. XX)

One species in sub-Saharan Africa: *H. cylindricarpa* Thér., recorded from Cameroon and more widely in eastern Africa.

Plants medium sized forming intricate wefts, green to yellow, brown or blackish below. **Stems** creeping or occasionally erect and covered with brown tomentum, irregularly pinnate, sometimes bi-pinnate. Branches often julaceous and pointed at apex. Central strand absent. Stem paraphyllia multibranched and numerous, shorter on branches. **Leaves** of stem and branches similar, branch leaves having shorter acumens. **Stem leaves** large, ovoid with long acumens, 1.4-2 mm, deeply plicate to undulate; margin plane or recurved; entire or sinuose, occasionally denticulate above. Costa reaching base of acumens. Cells variously shaped, elongated, especially in upper part of leaf. Basal cells longer and porose, smooth or papillose. **Branch leaves** smaller, oval-triangular to oval round, straight or curved, 0.75-1.2 x 0.5-0.75mm, plicate, margin plane or recurved in middle part. Cells papillose with one large central papilla **Autoicous. Perichaetial** leaves 7-8mm long, nerved entire, plicate, cells 100 x 5-6µm. **Seta**. 2.3-3.5mm **Capsule** usually erect, rarely inclined 3-4 x 1.5 mm, brown or red-brown; annulus in 1-3 rows. **Operculum** conical. **Peristome** with exostome striate, pale yellow and papillose; endostome membrane high to low, cilia absent. **Calyptra** naked and smooth. **Spores** papillose and verruculose, green, large to 40-50µm and multicellular in the closed capsule

HABITAT. Montane forests, 2250-2500m, mostly on bark.

DISCUSSION. Has unusually large spores, becoming multicellular in closed capsules. *Hylocomiopsis* has a homogenous central stand, unique in the Thuidiaceae. Previously included in the Leskeaceae due to its specialised sporophyte, and in the Hylocomiaceae because of axillary hairs, paraphyllia, leaf cell ornamentation and ramification. More recent

weight of opinion had accommodated *Hylocomiopsis* in the Thuidiaceae since the specialised sporophytes are similar to other epiphytic Thuidiaceae.

LITERATURE. **De Sloover, J.L. 1976.** Note de bryologie Africaine VI. – *Hylocomiopsis*. Bulletin du Jardin Botanique National de Belgique 46: 379-385.

Pelekium (Fig. XX)

Eleven species for sub-Saharan Africa.

Plants small to medium forming intricate, often delicate mats. **Stems** prostrate to arching, pinnate to bi-pinnate rarely weakly tri-pinnate, central strand present; paraphyllia mostly simple and unbranched with weak to strong intermediate cells, apical cell mostly rounded or truncate, occasionally acute. Paraphyllia absent or sparse on ultimate branches. **Leaves** Stem leaves and branch leaves usually differentiated in shape. **Stem leaves** usually triangular, occasionally ovate, 0.25-1mm, apex shortly acuminate, often incurved when dry. Margin weakly to strongly recurved. Costa strong, ending below apex. Mid-leaf cells isodiametric to slightly longer than wide, quadrate to irregular, mamilllose and uni- to pluri-papillose on both leaf faces. **Branch leaves** smaller than stem leaves, usually ovate 0.3-0.9mm long, mid-leaf cells usually isodiametric, mamilllose and uni- to pluri- papillose on both leaf faces. Leaf margin plane or recurved in lower leaf. Costa single, ceasing below apex. **Autoicous.** **Perichaetial** leaves lanceolate with elongate apex. Costa single, leaf margin notched to longly ciliate. **Seta** (4) 10-20 (27)mm, smooth, occasionally papillose or hispid. **Capsule** 0.6-2 mm long, ovoid to elliptical, inclined to pendulous, reddish brown to orange. **Operculum** conic to long rostrate, 0.5-1mm. **Peristome** exostome with mostly high ventral lamellae, apically papillose. Endostome basal membrane low to high, cilia in groups of 1-3 **Calyptra** 1.4-3.2 mm, cucullate and smooth though hispid and campanulate in *P. velatum* Mitt.. **Spores** 8-20 (30) μm , spherical to sub-spherical, smooth to finely papillose.

HABITAT. Tree trunks, logs and rocks in rain forest, 300-2500 m.

DISCUSSION. In recent years the separation within *Thuidium* of the small monoicous from the large dioicous species has stimulated much discussion and nomenclatural changes. After the transfer of several species out of the genus (Touw 2001a) a sensible group remains which sees the merging of *Pelekium* (sensu lato) and *Cyrto-hypnum* to form *Pelekium* (Touw 2001a). *Pelekium* is distinguished from *Thuidium* and *Thuidiopsis* by its small size and autoicous breeding system.

LITERATURE. **Touw, A. 1976.** - see family refs. **Touw, A. 2001a.** - see family refs.

Rauarella (Fig. XX)

One species, *R. subfilamentosa* (Besch.)Wijk & Margad., recorded from Kenya, Tanzania, Malawi, Zimbabwe, South Africa and Madagascar.

Plants small, forming coarse thin to dense mats, dull olive green, yellowish, or golden to reddish-brown. **Stems** creeping and spreading, pinnately branched; central strand weak; rhizoids often produced on terminal branch tips; paraphyllia abundant on stems, few to absent on branches, simple or weakly branched, papillose with oblate cells. **Leaves** erect when dry, spreading when wet, stem and branch leaves dimorphic. **Stem leaves** short to long lanceolate from an ovate base, 0.4-0.8 (0.9) mm long to 0.6 mm wide, plicate, apex usually abruptly long acuminate, base weakly decurrent; margins reflexed, crenulate; costa strong, percurrent to short excurrent; laminal cells similar throughout, oval to quadrate-rounded, strongly bulging, uni- or pluripapillose. **Branch leaves** ovate, to 0.65 mm long, apex acute to bluntly short acuminate. **Autoicous.** **Perichaetial** leaves glossy pale yellow, setaceous from an ovate base, to 3.5 mm long. **Seta** (5)8-15 mm or more long, slightly twisted, smooth. **Capsule** inclined, urn ovoid-short cylindrical, (0.4) 0.9-1.5 mm long; annulus present. **Operculum** rostrate, oblique. **Peristome** with exostome teeth finely cross-striate below, distally papillose; endostome basal membrane high, cilia 1-2. **Calyptra** cucullate, naked and smooth. **Spores** spherical, lightly papillose.

HABITAT. In montane forests on tree bases, rocks and occasionally terrestrial, 1200-1800m.

DISCUSSION. Previously included in *Thuidium* and *Haplocladium*. Distinct from *Pelekium* by bulging leaf cells on both sides of leaf and larger paraphyllia which have oblate cells.

LITERATURE: **Touw, A. 1976.** - see family refs. **Touw, A. 2001a.** - see family refs.

Thuidiopsis (Fig. XX)

One species for sub-Saharan Africa, *T. sparsa* Hook.f. & Wilson, reported for the Comoros islands.

Plants Medium sized plants, pale to yellow-green. **Stems** spreading or ascending, mostly bi-pinnate, central strand present, paraphyllia unbranched and numerous on stem and lower part of branches, papillose. **Leaves** of stem and branch differentiated. **Stem leaves** triangular to cordate, 1-1.5mm long, apically contracted to form acute acumen. Leaf margin recurved below, plane above, usually entire. Costa strong, ceasing below apex. Median leaf cells mostly isodiametric, abaxially unipapillose to mostly pluripapillose, adaxially mamilllose and mostly smooth. **Branch leaves** ovate to ovate-oblong, to 0.3mm long, median cells pluripapillose to smooth. Costa reaching $\frac{3}{4}$ way up leaf. **Dioicous. Perichaetial** leaves to 2mm, acuminate apex, margin mostly ciliate; costa usually weak, sometimes strong and excurrent, cells smooth. **Capsule** to 2.5mm long, inclined to sub-pendulous. **Operculum** to 2mm conical to rostrate. **Peristome** with yellowish to orange-brown exostome with high ventral lamellae. Endostome yellowish, brownish or orange, well developed, basal membrane high, cilia in groups of 2-4 **Calyptra** cucullate, smooth and fringed at base. **Spores** 8-16 μm , smooth or minutely papillose.

HABITAT. Distributed in a variety of habitats from open forest communities, on boulders, base of trees or dead wood.

DISCUSSION. Differs from *Thuidium* by having simple paraphyllia and leaf cells ornamented on both leaf faces. Has characteristic long paraphysal hairs fringing base of calyptra and strongly incurved stem leaves.

LITERATURE. **Touw, A. 2001a.** - see family refs.

Thuidium (Fig. XX)

5 species in sub-Saharan Africa, mainly in eastern and southern Africa and the Indian Ocean islands; only one recorded also for west Africa (*T. involvens* ssp. *thomeanum*).

Plants medium to large forming loose to dense coarse mats, pale yellow-green to brownish green. **Stems** and branches spreading to loosely spreading, 1-3 pinnately branched; central strand present and sometimes well developed; paraphyllia mostly large and branched; weakly to strongly papillose and varying from numerous along stem and branches to few or scattered along stems and often absent on branches. **Leaves** of stems and branches differentiated, sometimes strongly dimorphic. **Stem leaves** broadly ovate/cordate or triangular, short to long lanceolate, 0.4-1.7 mm long; bi-plicate and sometimes short decurrent, apex broadly to narrowly short to long acuminate, occasionally ending in a long hyaline capillary hair point. Margins often strongly incurved or recurved to reflexed at base, partially inflexed or erect above, serrate or serrulate in distal $\frac{2}{3}$; costa strong ending below acumen or long excurrent; median cells oval-rhombic to \pm elongate or subhexagonal to subquadrate-rounded; uni-papillose or pluri-papillose, papillae projecting on dorsal lamina or both sides, somewhat erect to curved; basal cells \pm elongate. **Branch leaves** smaller, ovate-short lanceolate, up to 0.75 mm long, margins plane to erect, entire, costa mostly ending below the acumen. **Dioicous. Perichaetial** leaves elongate, ovate-triangular, lanceolate to oblong-lanceolate; apex short or more commonly gradually to abruptly long acuminate. Costa single, margins entire to ciliate **Seta** 7-40 mm long, papillose or smooth, reddish orange to brown **Capsule** 0.6-3 mm inclined to pendant, urn cylindrical or short to \pm long ovoid or ovoid cylindrical; annulus in 2-3 rows .

Operculum conic to conic- short to long rostrate, oblique. **Peristome** with exostome teeth cross-striate, papillose distally; endostome basal membrane high, segments keeled, cilia 1-3(-4). **Calyptra** cucullate, naked and smooth **Spores** spherical, smooth to lightly papillose or papillose

HABITAT. Although found also in grassland and scrub, predominantly in mountain forest between 450-2000 m. Overall range from sea level to 3500 m. Mostly on tree trunks and decaying wood, but also found on soil, rocks, low branches and litter.

DISCUSSION . This genus is now restricted to the large dioicous species. *Thuidium* has distinct bi- or tri-pinnate fronds and large paraphyllia. The genus presents difficulties in differentiation of the species which have slight, but consistent, differences.

LITERATURE: **Fang, Y. M., Koponen, T., 2001.** - see family refs. **Touw, A. 1976.** - see family refs. **Touw, A. 2001a.** - see general refs.