

The moss family Calymperaceae (Bryophyta) in Australia Part 1: Introduction and key to genera

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Abstract

This paper is the first of five constituting a synopsis of the family Calymperaceae for Australia. An expanded concept of the family is followed, including *Arthrocormus*, *Exostratum* and *Leucophanes* as well as the traditional genera *Calymperes*, *Mitthyridium* and *Syrrhopodon*. A key to genera is provided.

Introduction

In its traditional sense, the moss family Calymperaceae Kindb. includes the genera *Calymperes* Sw., *Mitthyridium* (Mitt.) Robinson and *Syrrhopodon* Schwägr. (Reese and Stone 1995, 2012). A concise historical outline of the generic concepts of the traditional family with these three genera was provided by Reese *et al.* (1986a), and taxonomic relationships were later confirmed by molecular studies (Fisher *et al.* 2007; Stech *et al.* 2012).

In their treatment of Australian Calymperaceae, Reese and Stone (1995, 2012) noted that earlier authors, for example, Andrews (1947), had recommended that genera then assigned to Leucophanaceae: *Arthrocormus* Dozy & Molk., *Leucophanes* Brid. and *Octoblepharum* Hedw. should be included in the Calymperaceae. However, Reese and Stone (1995, 2012) preferred to maintain the traditional view. An expanded concept of the family, recognised by the Australian Moss Name Index (AusMoss 2020) based on Goffinet and Buck (2020), is followed in this updated treatment. This includes *Exostratum* L.T.Ellis, (1985) but excludes *Octoblepharum* Hedw., which is placed in its own family, Octoblepharaceae (Cairns *et al.* 2020), following Santos and Stech (2017a).

Calymperaceae as circumscribed here is a largely tropical and pantropical family. The family in Australia includes 50 species in six genera: *Arthrocormus* (1 sp.), *Calymperes* (15 spp.), *Exostratum* (1 sp.), *Leucophanes* (4 spp.), *Mitthyridium* (9 spp.), and *Syrrhopodon* (20 spp.).

As with other groups of organisms, Calymperaceae carries its own suite of descriptive terms for unique gametophyte characteristics. Terms used in this synopsis are based on their usage by earlier authors as cited, and in bryophyte glossaries (Buck 1990; Ramsay 2006; Malcolm and Malcolm 2006; Glime and Chavoutier 2017). These include:

hyaline lamina (Fig. 1A): A region of transparent, lattice-like groups of **hyalocysts** in a single layer on each side of the costa, occupying the sheathing leaf base to variable extent. In older publications these groups of cells are often referred to as **cancellinae**.

hyalocysts (Fig. 1B): Large, empty, thin-walled, porose, usually colourless water-storage cells. Hyalocysts are dead at maturity, in contrast to **hyaline cells** which may retain their cell contents but are colourless due to the absence of chloroplasts. The term **leucocyst** (as occur in the Leucobryaceae) is considered to be a synonym but molecular analyses (e.g., Santos and Stech 2017b, Fisher *et al.* 2007) showed the leucobryoid genera in Calymperaceae (and Octoblepharaceae) to not be closely related to those in the Leucobryaceae; cells are morphologically similar but not homologous. We have chosen to use **hyalocyst** in descriptions of Calymperaceae taxa throughout this series. Hyalocysts in the hyaline lamina are occasionally called **endohyalocysts**, a term we consider unnecessary.

chlorocysts (chlorophyllose cells): Cells containing chlorophyll, green in fresh material. At least for *Arthrocormus* and *Exodictyon*, the arrangement of the chlorophyllous cells, both in section and in surface view of the leaf limb, is important in generic identification.

intramarginal cells (Fig. 1C): Many *Calymperes* species have leaves with a narrow strip of elongate, often thick-walled, hyaline **intramarginal cells** in 1–4(–6) rows, widest at shoulders, and generally 1–2(–4) cells thick. These may be weak, obscure, or lacking in some leaves. In older publications these thickenings are often referred to as **teniolae**. A unistratose extension of the intramarginal cells into the sheathing leaf base, referred to in older publications as a **parateniola**, may also be present in some *Calymperes* species, for example, *C. erosum* (Edwards 1980a). Recent publications simplify terminology and include all intramarginal cells in the ‘intramarginal rib’ (Ellis 2018, 2020).

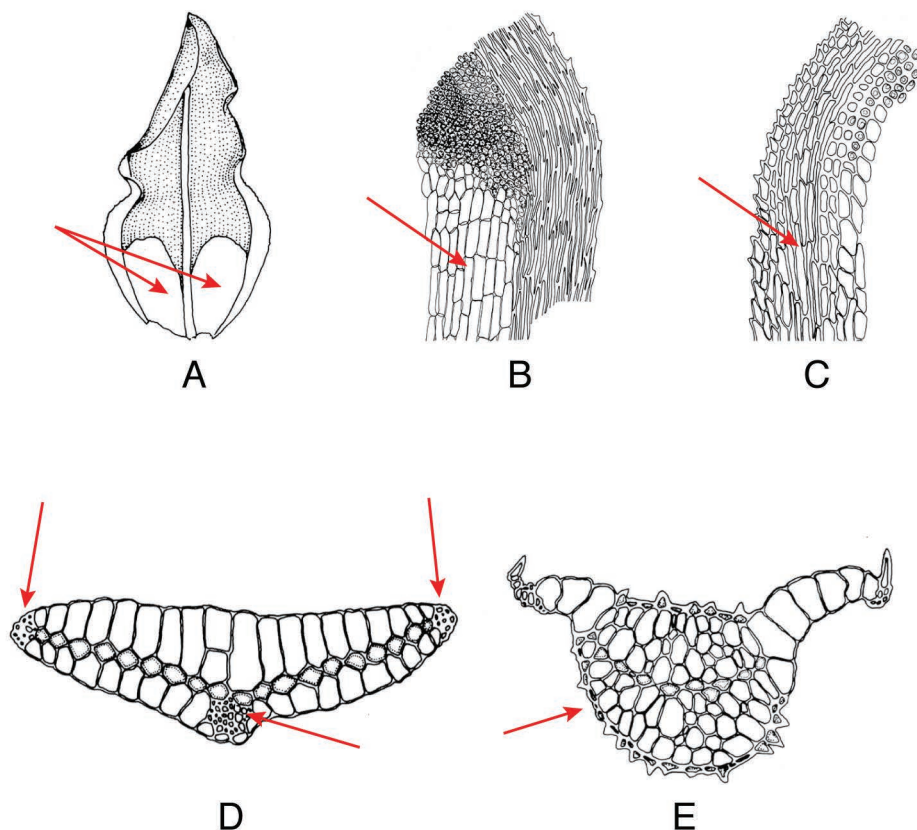


Fig. 1. Characteristics of the gametophyte of Calymperaceae. **A** hyaline lamina (*Mitthyridium repens*). **B** hyalocysts (*Mitthyridium repens*). **C** intramarginal cells (*Calymperes moluccense*). **D** marginal stereomes and medial stereome (*Leucophanes octoblepharoides*). **E** leucobryoid costa (*Exostratum blumei*). Illustrations by R.D. Seppelt.

stereome (Fig. 1D): Supporting or strengthening tissue; for example, the thickened marginal border of some taxa, which may include narrow elongate and thick-walled cells surrounded by the lamina cells of the border (**marginal stereome**). In *Leucophanes* a **medial stereome** comprised of stereids is a significant character of the genus, variously termed ‘median strand’, ‘median stereome’ or ‘pseudonerve’ by Eddy (1990), ‘central stereid

band' by Enroth (1990), and 'pseudocosta' by Catcheside (2012). Descriptions of *Leucophanes* species in Part 2 of this synopsis will refer only to the **medial stereome**.

leucobryoid costa (Fig. 1E): The leaf structure of the leucobryoid genera *Arthrocnemum*, *Exodictyon* (not yet reported from Australia), *Exostratum*, and *Leucophanes*, has been interpreted in various ways, beginning with Cardot (1900). Termed 'pseudolamina' (Eddy 1990; Catcheside 2012), leaves of these genera 'consist mainly of a very wide costa composed of two to several layers of large hyaline cells (leucocysts or hyalocysts) surrounding one (or up to three) layer(s) of chlorophyllose cells (chlorocysts)' (Santos and Stech 2017b), with a 'hyaline lamina restricted to the lowest parts of the leaves' (Eddy 1990). This is the structure most commonly recognised in descriptions of the leucobryoid genera.

CALYMPERACEAE Kindb., *Gen. Eur. N.-Amer. Bryin.*: 11 (1897)

Type genus: Calymperes Sw. ex F.Weber

Plants acrocarpous, tufted, with erect simple or branched stems (in *Mitthyridium*, primary stems are creeping), mainly small and less than 4 cm tall, occasionally robust to 6 cm or more and with leaves over 1 cm long. Stems without a central strand; rhizoids usually reddish or brown. Leaves diverse in form, costate, most commonly with a differentiated row of cells forming a border or (in *Calymperes*) intramarginal, with a conspicuously differentiated and usually abruptly delineated hyaline lamina; leaf outline typically linear but commonly ligulate or spatulate; leaf apex variable, sometimes expanded and modified to form a receptacle enclosing a gemmiferous zone, gemmiferous leaves often differing morphologically from stem leaves. Costa usually strong, typically of 2–6 median guide cells in a single row (sometimes with additional guide cells not in a row), adaxial and abaxial stereid bands, and a differentiated epidermal layer; strongly modified and composed largely of hyalocysts and superficial chlorocysts (in *Arthrocnemum*, *Exostratum*, *Leucophanes*); costa variously excurrent, percurrent, or ending below leaf apex, often with scattered or localised regions bearing fusiform, multicellular gemmae. Dioicous. Perigonia and perigynia terminal on unmodified shoots; perichaetia usually inconspicuous, perichaetial leaves similar to normal leaves or the innermost reduced. Sporophytes relatively small; capsules cylindrical or ovoid-cylindrical; setae of variable length. Calyptra variable, small or large, sometimes conspicuously plicate. Peristome simple, of 16 narrow, papillose segments (lacking in *Calymperes*).

The above description is modified from Eddy (1990) and differs from the family description of Reese and Stone (2012), taking into consideration the broader family concept followed here.

Of the non-leucobryoid genera now included in the family, the genus *Calymperes* is most closely related to *Syrrhopodon*. A critical distinguishing feature is the presence in *Calymperes* of a persistent calyptra which may play a peristome-like role in regulating spore dispersal (Edwards 1980b). In *Syrrhopodon* the calyptra is shed prior to spore dispersal. The differentiated leaf margin found in many species of Calymperaceae is also often useful in separating *Calymperes* from *Syrrhopodon*. In *Syrrhopodon*, when present the sheathing base is often marginally bordered and only rarely is the extension of this intramarginal.

Mitthyridium is the only genus present having prostrate primary stems with erect branches.

Regional floras and specific generic or family treatments which provide much useful additional information relevant to the Calymperaceae recorded from Australia and neighbouring regions include:

Australia — Ellis (2003); Reese (1989, 1992); Reese and Stone (1987, 1995, 2012);

India — Ellis (1989, 2016a);

Malaysia — Ellis (2016b); Reese *et al.* (1986b); Reese and Mohamed (1985); Tixier (1978);

Malesia (including the Philippines, Papua New Guinea): Akiyama and Reese (1992); Eddy (1990); Ellis (1991, 2020), Ellis and Tan (1999); Menzel and Schultze-Motel (1990); Mohamed and Reese (1985);

Oceania — Nowak (1980);

Thailand — Promma and Chantanaorrapint (2013);

World-wide (*Calymperes*) — Reese (1987).

In the following key to genera of Australian Calymperaceae, *Exodictyon* Card. (although not yet reported from Australia) is included for completeness and to enable ready differentiation from the one species of the genus *Exostratum* that is known from Queensland.

Key to the genera of Calymperaceae in Australia

- 1 Leaves whitish green, consisting almost entirely of costa composed of hyalocysts, and 1–3 strata of green chlorocysts; true lamina composed only of hyaline cells with a narrow border of elongate, thick-walled cells 2
- 1: Leaves yellow-green, green, brownish-green, not whitish, consisting of a well-defined lamina and costa; hyalocysts confined to the hyaline lamina 5
- 2 In section, costal chlorocysts arranged in a single medial layer *Leucophanes*
- 2: In section, costal chlorocysts arranged in three layers, adaxial, medial and abaxial 3
- 3 Leaves very fragile, the distal portions commonly missing; in section, peripheral chlorophyllous layers covered by one layer of hyalocysts *Arthrocormus*
- 3: Leaves not or hardly fragile, the distal portions mostly intact; in section, costal chlorocysts somewhat exposed at surface 4
- 4 In section, costal surface composed of a continuous layer of chlorocysts, many with spinulose or coronate-papillose projections; in surface view most chlorocysts quadrate to shortly rectangular or elliptical *Exostratum*
- 4: In section, costa surface composed of hyalocysts and a reticulate network of chlorocysts; chlorocysts smooth or with low papillae, rarely with conspicuous projections, mostly with 4–6 sides in surface view *Exodictyon*
- 5 Plants bearing sporophytes 6
- 5: Plants lacking sporophytes 8
- 6 Calyptra persistent, spirally furrowed when dry, twisted round the seta below the capsule, opening above by slit-like apertures; peristome lacking *Calymperes*
- 6: Calyptra cucullate, deciduous; peristome present or absent; or calyptra not present 7
- 7 Stems usually creeping, often rhizome-like, with ascending-erect branches; leaves bordered (often broadly so) by elongate hyaline cells, the border unistratose *Mitthyridium*
- 7: Stems erect, neither creeping nor rhizome-like, simple or forked; border of elongate hyaline cells present or absent, if present then narrow and bi- to multistratose *Syrrhopodon*
- 8 Leaves bordered entirely or in part by elongate hyaline cells (border weak, incomplete or \pm lacking on some leaves of some specimens) 9
- 8: Leaves lacking elongate hyaline marginal cells 11
- 9 Stems usually creeping, often rhizome-like, with spreading erect branches; border of hyaline cells on leaves often broad, always unistratose *Mitthyridium*
- 9: Stems mostly erect, neither repent nor rhizome-like, simple or forked; border of hyaline cells narrow, mostly bi- to multistratose 10
- 10 Plants very small; leaves strongly dimorphic; gemmiferous leaves narrow, stiffly erect, almost elaminate; border of hyaline cells incomplete, unistratose, often present only near leaf shoulders *Calymperes (subintegrum)*
- 10: Plants small to robust; leaves \pm monomorphic; border of hyaline cells mostly well-developed, usually bi- to multistratose *Syrrhopodon*
- 11 Leaves bearing intramarginal rows of differentiated elongate mostly hyaline cells; intramarginal cells sometimes indistinct or obscured or \pm lacking in some leaves of some specimens *Calymperes*
- 11: Leaves lacking intramarginal rows of elongate hyaline cells 12
- 12 Plants very small to medium-sized, commonly bearing abundant fusiform uniseriate-multicellular gemmae on modified tips of gemmiferous leaves; gemmiferous leaves often strongly differentiated from vegetative leaves and almost always present even though gemmae may have been lost 13
- 12: Plants medium-sized to robust; gemmae mostly lacking or inconspicuous; gemmiferous leaves, if present, not markedly different from vegetative leaves 14

- 13 Rhizoids dark red *Syrrhopodon (stoneae)*
 13: Rhizoids brown to reddish-brown *Calymperes*
 14 Cells of leaf limb \pm transversely elongate, at least in part *Calymperes*
 14: Cells of leaf limb isodiametric to somewhat vertically elongate *Syrrhopodon*

Acknowledgments

We acknowledge the Traditional Owners of lands on which collections were made, and recognise their Elders, past, present, and emerging. Our gratitude goes to the late Bill Reese and the late Ilma Stone for their pioneering studies on Australian Calymperaceae. We also thank Len Ellis (Natural History Museum, London) for useful discussions on terminology. We acknowledge the Royal Botanic Gardens and National Herbarium of Victoria (MEL), the University of Melbourne Herbarium (MELU) and the Australian National Herbarium (CANB) for loans of material, and the Queensland Herbarium (BRI) for access to collections. We also thank Sarah Xu for digitising the figures and the two anonymous referees for their insightful comments and suggestions.

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