



## Taxonomic novelties resulting from recent reclassification of the Lophoziaceae/Scapaniaceae clade

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### Abstract

A new family, Anastrophyllaceae, is segregated from Lophoziaceae, two new genera, *Neoorthocaulis* and *Oleolophozia* are described and the following new combinations are made: *Neoorthocaulis attenuatus*, *N. binsteadii*, *N. floerkei*, *N. hyperboreus*, *Barbilophozia* subgen. *Sudeticae*, *Barbilophozia sudetica* and *Oleolophozia perssonii*.

**Key words:** Anastrophyllaceae, liverworts, *Neoorthocaulis*, *Oleolophozia*, *Barbilophozia*

### Introduction

The Lophoziaceae has previously been either recognized as a separate family (e.g. Grolle & Long 2000) or placed in the synonymy of Jungermanniaceae (e.g. Damsholt 2002). Recent molecular work (De Roo *et al.* 2007) has shown that the two are not particularly closely related and that Lophoziaceae should be retained as a separate family. However, molecular data (Schill *et al.* 2004) also show that the family Scapaniaceae is nested within Lophoziaceae, a pattern confirmed by, *inter alia*, Yatsentyuk *et al.* (2004), Davis (2004) and De Roo *et al.* (2007). Those studies also exclude two elements frequently included in Lophoziaceae in the past—the family Jamesoniellaceae and the genus *Leiocolea* (Müller 1913: 711) Buch (1933: 288). However, some recent studies (De Roo *et al.* 2007 and unpublished results by R. De Roo, L. Söderström & T. Hedderson) have shown that even after removing those elements, the ‘Lophoziaceae clade’ still includes many other taxa, e.g. Cephaloziellaceae, and that the generic position of many taxa remains to be re-evaluated. More detailed morphological and molecular studies are needed to provide further insight in the taxonomy of the complex. However, some well supported relationships have emerged that warrant nomenclatural changes that are made here.

### Results and Discussion

Within the Lophoziaceae/Scapaniaceae/Cephaloziellaceae clade there is one strongly supported lineage (De Roo *et al.* 2007) that we consider should be recognized at family level. This clade includes most of the species of *Anastrophyllum* (Spruce 1876: 235) Stephani (1893: 139) and *Barbilophozia* Loeske (1907: 37) *s. lat.* together with various other elements. It is therefore described below as the new family Anastrophyllaceae.

Although this new family is strongly supported, the relationships within the clade remain largely unresolved. In particular the type genus *Anastrophyllum* may prove to be polyphyletic. However, it is clear

that the genus *Sphenolobus* (Lindberg 1874: 369) Berggren (1898: 22), in the past synonymized under *Anastrophyllum*, should be reinstated as a well-supported genus.

*Barbilophozia*, another genus of Anastrophyllaceae to which many species have been ascribed (e.g. Grolle & Long 2000), is shown to be polyphyletic (Yatsentyuk *et al.* 2004, De Roo *et al.* 2007) and should be separated into at least five genera, *Barbilophozia s. str.*, *Orthocaulis* Buch (1933: 293), *Schljakovia* Konstantinova & Vilnet (2009: 66), *Schljakovianthus* Konstantinova & Vilnet (2009: 66) and *Neoorthocaulis* L.Söderstr., De Roo & Hedd., the latter proposed here.

The remaining elements of the *Barbilophozia/Orthocaulis* complex we propose to retain in the following way. The genus *Barbilophozia s.str.* includes *B. barbata* (Schmidel ex Schreber 1771: 107) Loeske (1907: 37; type of the genus), *B. hatcheri* (Evans 1898: 417) Loeske (1907: 37), *B. lycopodioides* (Wallr. in Bluff & Fingerhuth 1831: 76) Loeske (1907: 37) and *B. rubescens* (Schuster & Damsholt 1987: 325) Kartt. & L.Söderstr. in Söderström *et al.* (1992: 120). Two recently described genera of Anastrophyllaceae include one species each, *Schljakovia* with *S. kunzeana* (Hübener 1834: 115) Konstantinova & Vilnet (2009: 66) and *Schljakovianthus* with *S. quadrilobus* (Lindb. in Lindberg & Arnell 1889: 55) Konstantinova & Vilnet (2009: 66). In addition, another species formerly placed in *Lophozia s. lat.* must be transferred to *Barbilophozia*, *B. sudetica* (Nees ex Hübener 1834: 142) *comb. nov.* in the new subgenus *Barbilophozia subg. Sudeticae* (Schljakov 1980: 113) *comb. et stat. nov.* Konstantinova & Vilnet (2009) treat this as a separate genus, *Pseudolophozia* Konstantinova & Vilnet (2009:65), however, in our opinion the genetic distance is insufficient to warrant generic recognition. The genus *Orthocaulis* includes *O. atlanticus* (Kaalaas 1898: 11) Buch (1933: 294), *O. cavifolius* H.Buch & S.W.Arnell in Buch (1951) and *O. longiflorus* Herzog (1954: 32).

Within the remaining Scapaniaceae/Lophoziaceae/Cephaloziellaceae clade, the genus *Lophozia* (Dumortier 1831: 53) Dumortier (1835: 17) *sensu* Schuster (1969) is still heterogeneous as has recently been pointed out (e.g. Konstantinova *et al.* 1992, 2009). One segregate genus, *Leiocolea*, is shown to belong to a completely different order, Jungermanniales (Yatsentyuk *et al.* 2004, De Roo *et al.* 2007), and some other segregate genera belong to Anastrophyllaceae. Of the remaining elements placed in *Lophozia* by e.g. Schuster (1969), we agree with the genera *Hypolophozia* (Schuster 1966: 276) Bakalin (2005: 38), *Obtusifolium* Arnell (1956: 133) and *Schistochilopsis* Konstant. in Konstantinova & Vasiljev (1994: 125). We retain them in the paraphyletic family Scapaniaceae (incl. Lophoziaceae) for the time being. One other species, *Lophozia perssonii* H.Buch & S.W.Arnell in Buch (1944: 382), is shown to be very different from the rest and is therefore transferred below to a new genus, *Oleolophozia*. Finally, several species previously placed in *Lophozia* subgen. *Protolophozia* Schuster (1968: 474) undoubtedly belong elsewhere, but as this group is heterogeneous, more studies are needed before their placement can be clarified.

## Taxonomy and nomenclature

### Anastrophyllaceae L. Söderstr., De Roo & Hedd., *fam. nov.*

*Familiae* Lophoziaceae *affinis*, *ob sequencias ITS, rps4, trnG et rpoC1 ab eo removendum. Folia bilobatae, trilobatae vel quadrilobatae.*

**Type:**—*Anastrophyllum donnianum* (Hooker 1813: tab. 39) Stephani (1893: 140)

Shoots prostrate to ascending or erect, simple or with lateral or terminal branches. Stems in cross section with small thick-walled cortical cells and large, thin-walled medullary cells (not in *Sphenolobopsis*). Leaves alternate, 2–4-lobed, succubous to transverse. Underleaves lacking, simple or large and bilobed. Cells small to medium sized with indistinct to bulging trigones, sometimes thick-walled. Oil bodies variable. Gemmae lacking, or ovoid to polygonal, 1–2-celled, yellow-green to orange brown to vinaceous red. Dioicous, rarely paroicous. Androecia at apex or intercalary, composed of several pairs of bracts. Gynoecia at apex of main shoot with single subgynoecial innovation. Perianths large, inflated, long exerted, ovoid-cylindrical

(ellipsoidal to subclavate in *Gymnocolea*, obovoid-clavate in *Sphenolobopsis*), deeply multi-plicate to plicate only at distal part (smooth in *Gymnocolea*); mouth slightly contracted, entire or with teeth 3–6 cells long or weakly dentate.

**Notes:**—The family, as here defined, includes the following genera: *Anastrepta* (Lindb. in Lindberg & Arnell 1889: 40) Schiffner (1893: 85), *Anastrophyllum* (Spruce) Steph., *Barbilophozia* Loeske, *Biantheridion* (Grolle 1964: 662) Konstantinova & Vilnet (2009: 67), *Chandonanthus* Mitten (1867: 750), *Crossocalyx* Meylan (1939: 266), *Gymnocolea* (Dumortier 1831: 52) Dumortier (1835: 17), *Hamatostrepta* Váňa & Long (2008: 134), *Isopaches* Buch (1933: 287), *Neoorthocaulis* L.Söderstr., De Roo & Hedd. *comb. nov.*, *Orthocaulis* H.Buch, *Plicanthus* Schuster (2002: 484), *Schljakovia* Konstant. & Vilnet, *Schljakovianthus* Konstant. & Vilnet, *Sphenolobopsis* R.M.Schust. & N.Kitag. in Schuster (1972: 152), *Sphenolobus* (Lindb.) Berggr. and *Tetralophozia* (Schuster 1961: 206) Schljakov (1976: 227). The family is genetically and phylogenetically very distinct from the rest of the Scapaniaceae/Lophoziaace/Cephaloziellaceae clade but the morphological characters that single out the family are not yet clear.

***Neoorthocaulis* L.Söderstr., De Roo & Hedd., *gen. nov.***

*Folia plerumque trilobatae, usque ad 0.3-0.4 laminiis partitis. A Orthocauli affinis sed amphigatriis grandis et bilobatis vel nullis et sequenciis ITS, rps4, trnG et rpoC1 differt.*

**Type:**—*Neoorthocaulis attenuatus* (Mart.) L.Söderstr., De Roo & Hedd., *comb. nov.*

**Synonym:**—*Lophozia* sect. *Attenuatae* Schuster (1969: 306). Type: *Lophozia attenuata* (Martius 1817: 177) Dumortier (1835:17), *nom. illeg.*

Shoots 1–5 cm long. *Leaves* (2-)3(–4) lobed, lobes mostly acute, lacking cilia on the postical margin (*N. attenuata*, *N. binsteadii*) or with 1–3 cilia (*N. floerkei*, *N. hyperboreus*). Trigones small to bulging. Underleaves lacking or large and bifid (in *Orthocaulis* small and unlobed). Gemmae absent or green to red. Dioicous. Perianth longly exerted, cylindrical, plicate.

**Etymology:**—This genus consists of most species that Buch (1933) included in his genus *Orthocaulis* except the species lectotypifying that genus.

**Note:**—*Lophozia* sect. *Attenuatae* R.M.Schust. is described as belonging to subgenus *Orthocaulis*. The genus/subgenus *Orthocaulis* is typified by Kitagawa (1963) with *O. atlanticus* but this apparently escaped Schuster who typified it with *O. kunzeana*. Schuster then included *Lophozia (Orthocaulis) atlantica* (H.Buch) Schiffner (1901: 46) in his new section *Attenuatae* making it an illegitimate name according to Art. 22.1 in ICBN (McNeill *et al.* 2006).

***Neoorthocaulis attenuatus* (Mart.) L.Söderstr., De Roo & Hedd., *comb. nov.***

Basionym: *Jungermannia quinquedentata*  $\delta$  *attenuata* Martius (1817: 177). Type: Ad Cataracta pone Bodenmais sylvae bohemicae in truncis putridis (Martius 1817). Holotype: GERMANY: Böhmerwald, "ad cataractam pone Bodenmais" (BR, isotype STR, cf. Grolle 1976).

***Neoorthocaulis binsteadii* (Kaal.) L.Söderstr., De Roo & Hedd., *comb. nov.***

Basionym: *Jungermannia binsteadii* Kaalaas (1898: 9). Type: NORWAY: Bei Kongsvold auf Dovre am 10. Juli 1892, von ... C. H. Binstead, von mir selbst 18 Juli 1893 an Vaarstien auf der Nordseite der Alpe Knudshö bei 1150 m.

***Neoorthocaulis floerkei* (F.Weber et D.Mohr) L.Söderstr., De Roo & Hedd., *comb. nov.***

Basionym: *Jungermannia floerkei* Weber & Mohr (1807: 410). Type: E Salisb. Flörke (sub n. 27). Holotype: AUSTRIA: Tirol: Zillertal, Grasbergalpe, 1798, *Floerke s.n.* (W, isotypes JE, ROST, S, UPS, cf. Grolle 1976).

***Neoorthocaulis hyperboreus* (R.M.Schust.) L.Söderstr., De Roo & Hedd., *comb. nov.***

Basionym: *Lophozia floerkei* var. *hyperborea* R.M.Schust. in Schuster *et al.* (1959: 21). Holotype: CANADA: Nunavut: Mt. Pullen, near Alert, ca. 82°25'N, northeast coast of Ellesmere I., on shale substrate. *R. Schuster RMS-35101* (Herb. Schuster).

***Barbilophozia* subgen. *Sudeticae* (Schljakov) L.Söderstr., De Roo & Hedd., *stat & comb. nov.***

Basionym: *Lophozia* sect. *Sudeticae* Schljakov (1980: 113). Type: *Jungermannia sudetica* Hübener (1834: 142).

**Synonym:**—*Pseudolophozia* Konstantinova & Vilnet (2009: 65).

**Note:**—This clade includes, as here defined, only a single species, *B. sudetica* and is the sister clade to the rest of *Barbilophozia*. It is treated as a separate genus (recognizing two species) by Vilnet *et al.* (2009) but we do not think the genetic distance is large enough to warrant recognition at the genus level.

***Barbilophozia sudetica* (Nees ex Huebener) L.Söderstr., De Roo et Hedd., *comb. nov.***

Basionym: *Jungermannia sudetica* Nees ex Huebener (1834: 142). Type: in den Sudeten im Metzgergrund. Lectotype (designated by Grolle 1971: 262): POLAND: "Sudeten", Riesengebirge, Melzergrund ("Metzgergrund"), Nees s.n. (STR, sub *Jung. alpestris*)

**Synonyms:**—*Lophozia debiliformis* Schuster & Damsholt (1987: 326). Holotype: GREENLAND: Kangikitoq Fjord, *R. Schuster & K. Damsholt RMS & KD 82-1798* (herb. Schuster), *syn. nov.*

*Lophozia debiliformis* var. *concolor* Schuster & Damsholt (1987: 326). Holotype: GREENLAND, Christian IV's Ø, Tasiussaq, *R. Schuster & K. Damsholt RMS & KD 82-1645* (herb. Schuster), *syn. nov.*

**Note:**—*Barbilophozia sudetica* is a very variable species. *Lophozia debiliformis* is an expression with unusually large underleaves, and due to this it has sometimes been placed in *Protolophozia* (Schuster 1968: 474) Schljakov (1979: 204). *Lophozia debiliformis* seems to be a common expression of the species both in the Alps and in Scandinavia, probably also elsewhere. However, as there exist many intermediate forms we here synonymize them.

***Oleolophozia* L.Söderstr., De Roo & Hedd., *gen. nov.***

*Lophoziae primo adspectu maxime simile, sed gemmis rubellis usque ad aurantiacis et guttis olei flavis, permanentis.*

**Type:**—*Oleolophozia perssonii* (H.Buch & S.W.Arnell) L.Söderstr., De Roo & Hedd., *comb. nov.*

Small, up to 5 mm long. Stem dorsiventrally differentiated into a ventral brownish and mycorrhizal, and a dorsal, hyaline region. Leaves bifid for 1/4-1/3. Lobes sharply pointed. Cells thin-walled with distinct trigones and 3-8(10) oil bodies per cell. Gemmae in reddish to orange masses, 2-celled with 1-2 large, yellowish, persistent oil-bodies. Dioicous.

**Etymology:**—The name refers to a *Lophozia* with the characteristic, persistent oil-bodies in the gemmae.

**Note:**—The genus is monotypic and the description of *Lophozia perssonii* in e.g. Damsholt (2002) can serve as a full description of the genus. The family placement is somewhat unclear but we retain it in Lophoziaceae for now.

***Oleolophozia perssonii* (H.Buch & S.W.Arnell) L.Söderstr., De Roo & Hedd., *comb. nov.***

Basionym: *Lophozia perssonii* H.Buch & S.W.Arnell in Buch (1944: 282). Type: Specimina originalia in Suecia, prov. Dalecarlia, Sörvik (in vicinitate oppidi Brunnsvik) in terra nuda calcarea aug. 1940 ab H. Buch et S. Arnell lecta sunt. Isotype: SWEDEN: Dalarna: Ludvika, Sörvik, *H. Buch & S. Arnell s.n.* (UPS, *vide* Grolle 1976). No type material was found in S (L. Hedenäs, pers. comm.) or H (Grolle 1976).

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