

## Diversity of Grimmiaceae subfam. Racomitrioideae in sub-Saharan Africa, including an addition of *Bucklandiella striatipila* to the moss flora of the continent

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**Abstract** – Diversity of the Grimmiaceae subfam. Racomitrioideae in sub-Saharan Africa is briefly outlined. This subfamily is represented by two genera in this region, namely *Racomitrium* Brid. s. str. and *Bucklandiella* Roiv. which, until recently, consisted altogether of one and four species, respectively. *Bucklandiella striatipila* (Cardot) Bednarek-Ochyra et Ochyra, a species described from Chile, is here added as the fourth species of *Bucklandiella* to the moss flora of mainland Africa where it occurs in the Western Cape in South Africa. The species is briefly taxonomically assessed and its diagnostic characters are described and illustrated. The global range of *B. striatipila* is briefly reviewed and mapped. The error in the citation of the avowed substitute of *Grimmia austropatens* Müll.Hal. 1899, *hom. illeg.*, in *Schistidium* Bruch et Schimp. is corrected for *S. austropatens* (Broth.) Ochyra et Bednarek-Ochyra.

**Bryophyta / *Bucklandiella* / Capensis / distribution / Grimmiaceae / *Racomitrium* / South Africa / taxonomy**

### INTRODUCTION

The traditionally conceived genus *Racomitrium* Brid. of the Grimmiaceae subfam. Racomitrioideae is not well represented in tropical sub-Saharan Africa, both in terms of the number of species as well as their frequency and cover. Like elsewhere in the tropics, the species of this genus are restricted in their distribution to montane areas where they occur at high elevations above the timber line in the alpine belt.

All African racomitrialean species belong to *Racomitrium* s. str. and *Bucklandiella* Roiv., the largest segregate of the broadly interpreted genus *Racomitrium* (Bednarek-Ochyra, 1995a; Ochyra et al., 2003). *Codriophorus acicularis* (Hedw.) P.Beauv., the representative of the genus *Codriophorus* P.Beauv. which is another segregate of *Racomitrium* (Bednarek-Ochyra et al., 2001), was reported from South Africa but this species and genus does not occur in this region at all. This report was based on the wrong interpretation of the type material of *Grimmia pseudoacicularis* Müll.Hal. [= *Racomitrium pseudoaciculare*

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(Müll.Hal.) Paris], a species described from the Cape (Müller, 1899), which was considered by Sim (1926) as identical to *Racomitrium aciculare* (Hedw.) Brid. Actually, this species is conspecific with *Bucklandiella lamprocarpa* (Müll.Hal.) Bednarek-Ochyra et Ochyra (Ochyra *et al.*, 1988; Bednarek-Ochyra 2004, 2006; Bednarek-Ochyra & Ochyra, 2012a).

*Racomitrium s. l.* was first surveyed by De Sloover (1977) in sub-Saharan Africa and East African islands in the Indian Ocean. Three species were recognised, of which two, *R. alare* (Broth.) Paris and *R. nigroviride* (Müll.Hal.) Paris, were found to occur on the mainland. Magill (1981) revised the genus for southern Africa and also distinguished three species in the genus. In both treatments the genus was treated in the local scope, without consideration of the affinities of the species concerned to the extra-African ones. Ochyra *et al.* (1988) subsequently found that the rheophytic *R. nigroviride* was conspecific with the South American *R. lamprocarpum* (Müll.Hal.) A.Jaeger, which was established as an amphiatlantic south-temperate species, with the highly isolated occurrence in the Iberian Peninsula. Finally, Ochyra (1993) found that the African endemic *R. alare* was identical to the pantropical *R. subsecundum* (Harv.) Mitt. and, additionally, he reported *R. crispipilum* (Taylor) A.Jaeger for the first time from Africa.

## **RACOMITRIUM AND BUCKLANDIELLA IN SUB-SAHARAN AFRICA**

Like elsewhere in the tropics, *Racomitrium s. str.* is represented in sub-Saharan Africa by a single species, *R. lanuginosum* (Hedw.) Brid., which is locally abundant only in coastal mountain regions in the southern and south-western Cape in South Africa (Magill, 1981). Actually, it was the first racomitrialean moss reported from sub-Saharan Africa (Thunberg, 1800 as *Trichostomum hypnoides* Willd. ex P.Beauv.). This species was also described by Müller (1869) from the Cape as *R. incanum* Müll.Hal. but this name is a synonym of *R. lanuginosum* (Vitt & Marsh, 1988). The report of *R. lanuginosum* from the Ruwenzori Mountains in the Democratic Republic of Congo (Demaret, 1940; Born *et al.*, 1993; O'Shea, 2006) is based upon the misidentified material which correctly belongs to *Bucklandiella crispipila* (Taylor) Bednarek-Ochyra et Ochyra.

There have been eight species and one variety described from sub-Saharan Africa under *Grimmia* Hedw. and *Racomitrium* which correctly represent the genus *Bucklandiella*. However, all these taxa proved to be identical to species which were originally described from South America and Asia. Thus, *Grimmia alaris* Broth. (= *Racomitrium alare*) from the Ruwenzori Mountains and *Grimmia dura* Broth. [= *Racomitrium durum* (Broth.) Paris] from Mt. Cameroon are conspecific with *Bucklandiella subsecunda* (Harv.) Bednarek-Ochyra et Ochyra (Ochyra, 1993), whereas *Racomitrium capense* Lorentz, *Grimmia pseudoacicularis*, *G. nigroviridis* Müll.Hal. (≡ *Racomitrium nigroviride*) and *G. nigroviridis* var. *robusticula* Müll.Hal. [= *R. nigroviride* var. *robusticulum* (Müll.Hal.) Paris] are all identical to *Bucklandiella lamprocarpa* (Bednarek-Ochyra & Ochyra, 2012a). To this species belongs also *Racomitrium defoliatum* Dixon from Mt. Kenya (De Sloover, 1977; Ochyra *et al.*, 1988).

In addition to the aforementioned species, the two other species from South Africa were given names under *Racomitrium*, namely *R. austropatens* Broth. and *R. drakenbergense* Sim. The first of these was originally described as

*Grimmia austropatens* Müll.Hal. (Müller, 1899) and later Dixon (1920) reported another specimen of this species from the Cape. However, this name is a younger homonym of *G. austropatens* Müll.Hal. (Müller, 1890) and Brotherus (1902) legitimised this epithet when transferring this species to *Racomitrium*. The type material of this species has nothing to do with this genus and correctly represents the genus *Schistidium* Bruch et Schimp. and Ochyra & Bednarek-Ochyra (2011) shifted it to this genus. Unfortunately, they overlooked the earlier legitimisation of *Grimmia austropatens* of 1899 by Brotherus (1902) as *Racomitrium austropatens* Broth. and established the new name *Schistidium austropatens* Bednarek-Ochyra et Ochyra. However, the error in the citation of the replaced synonym does not affect valid publication of this name according to Art. 33.7(a) of the Vienna Code (McNeill et al., 2006) which correctly should be cited as *S. austropatens* (Broth.) Ochyra et Bednarek-Ochyra, Polish Bot. J. 56: 97. 2011 (Typonym: *Racomitrium austropatens* Broth. in Engl. et Prantl, Nat. Pflanzenfam. 1(3): 454. 1902).

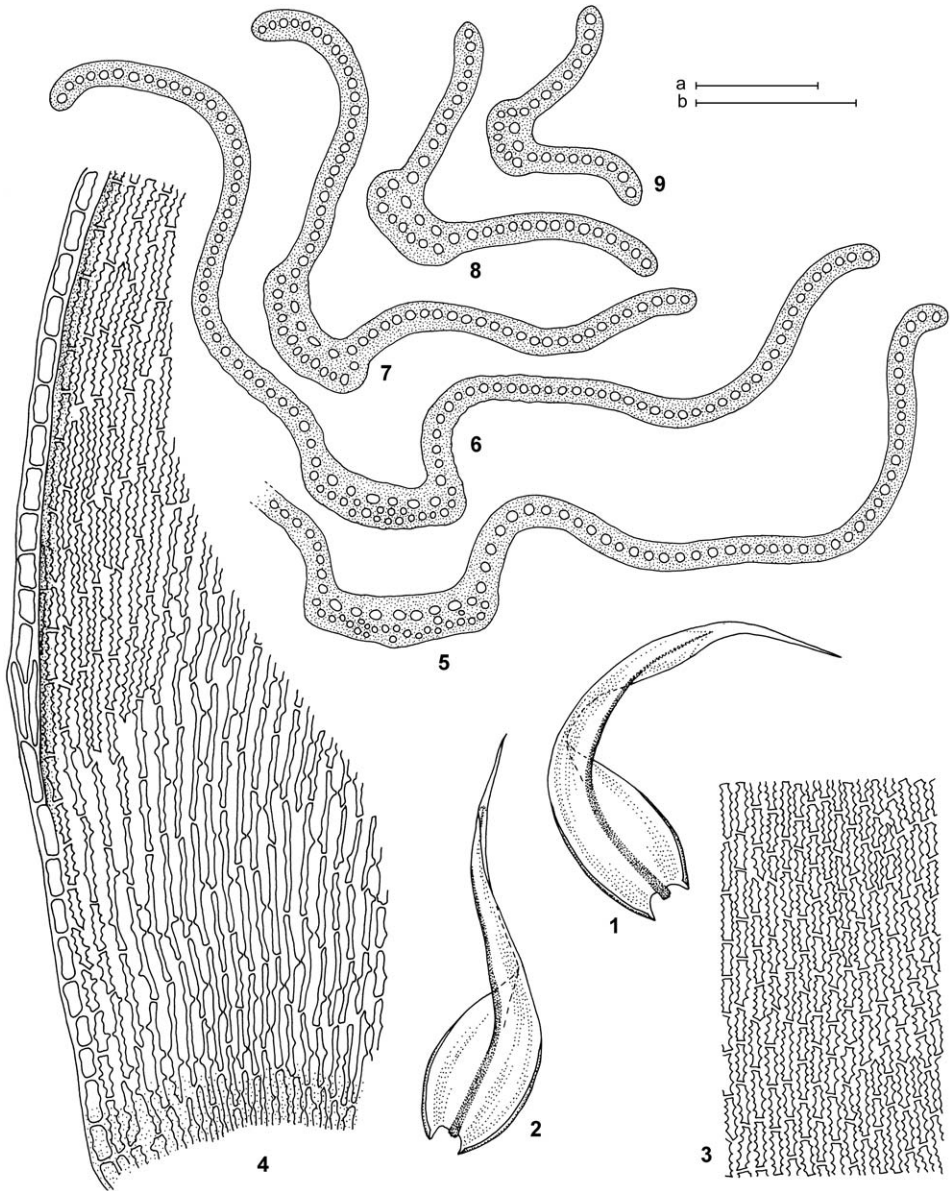
*Racomitrium drakenbergense* was described as a new species by Sim (1926) from material collected in KwaZulu-Natal which was earlier named by Dixon (1920) as *R. symphyodontum* (Müll.Hal.) Paris. Magill (1981) reduced *R. drakenbergense* to synonymy with *R. crispulum* (Hook.f. et Wilson) Hook.f. et Wilson [≡ *Bucklandiella crispula* (Hook.f. et Wilson) Bednarek-Ochyra et Ochyra] but this taxonomic conclusion cannot be accepted. Although *R. crispulum* is a well known and widely used name, for a very long time it was misinterpreted and applied to the broadly interpreted catch-all species with which were lumped almost all species of *Racomitrium* described from the Southern Hemisphere (Dixon, 1926; Clifford, 1955; Lawton, 1973). In fact, this collective species consists of many distinct, unrelated species as have been shown by studies of various authors (e.g. Bell, 1974; Frisvoll, 1984; Deguchi, 1984; Bednarek-Ochyra & Ochyra, 1994, 1998, 2010a, b, 2011, 2012a, b, c; Bednarek-Ochyra et al., 1996, 1999; Larrain et al., 2011a, b; Ellis et al., 2011a, b).

*Bucklandiella crispula* itself is actually a narrow endemic of the Auckland and Campbell Islands lying south of the South Island of New Zealand in the south-cool-temperate zone (Ochyra et al., 2008a, b). *Racomitrium drakenbergense* has no close affinity to this species and it is apparently identical to *Bucklandiella subsecunda*.

Most specimens named *Racomitrium crispulum* in South Africa belong actually to *Bucklandiella crispipila*. However, during the course of the ongoing monographic studies of this genus two specimens from the Western Cape were found to represent *B. striatipila* (Cardot) Bednarek-Ochyra et Ochyra, a south-temperate cool-adapted species which has not hitherto been recorded from Africa. Thus, the African continental moss flora increased by one distinct species and considering this discovery *Bucklandiella* consists of four species in mainland Africa.

## AFRICAN REPRESENTATION

The African material of *Bucklandiella striatipila* (Figs 1-9) matches plants from other parts of its wide geographical range perfectly in all critical characters. The plants are fairly large, hoary because of long hyaline hair-points and grow in large, fairly dense tufts, brown inside, olive- to yellow-green in the uppermost



Figs 1-9. **1.** *Bucklandiella striatipila* (Cardot) Bednarek-Ochyra *et* Ochyra. **1-2.** Leaves. **3.** Mid-leaf cells. **4.** Alar cells. **5-9.** Transverse sections of leaves. [All from *Esterhuysen 15774*, BM.] Scale bars: a – 1 mm (1-2); b – 100  $\mu$ m (5,9).

part. The stems are ascending to suberect, rigid and stiff, 4-6 cm long, irregularly branched and bear numerous short lateral branchlets which are usually pinnately branched. The leaves are erect-appressed when dry, becoming erect-spreading on wetting, straight to somewhat curved and folded in the distal portion, 2.9-3.2 mm long (without a hair-point), 0.8-1.0 mm wide, ovate- to

oblong-lanceolate, gradually long-acuminate and sharply acute. They are terminated with a hyaline, capillaceous, flat hair-point, 1.0-1.3 mm long which is entire to obscurely serrulate, straight to flexuose. The leaf margins are entire, flat on one side throughout and reflexed to broadly recurved to the middle or two third of the leaf length on the other side. The costa is single, vanishing in the hyaline hair-point and situated on the bottom of a fairly deep furrow. It is strongly flattened, 90-110  $\mu\text{m}$  wide and consists of 6-9 enlarged ventral cells and bistratose dorsal stereid band in the proximal part. The laminal cells are unistratose throughout, with strongly thickened and sinuose lateral walls, smooth. They are rectangular throughout the leaf, 30-45  $\mu\text{m}$  long and only on the apical part they are shorter, 15-20  $\mu\text{m}$ , but intermixed with longer ones. The basal and suprabaasal cells are long-rectangular to linear-rectangular, 50-80  $\mu\text{m}$  long, 4-5  $\mu\text{m}$  wide and are strongly incrassate and nodose lateral walls. The basal marginal cells are strongly differentiated and form a uniseriate border composed of 15-20 hyaline, transparent, rectangular cells with moderately thickened and mostly straight walls. The alar cells are not differentiated.

The African plants of *Bucklandiella striatipila* are entirely sterile but actually the species only seldom produces sporophytes in South America where it has the main centre of its occurrence. So far, no fertile plants have been found on subantarctic islands (Blockeel *et al.*, 2009; Ellis *et al.*, 2010) as well as on the South Atlantic islands in the cool-temperate zone (Ellis *et al.*, 2011b, 2012) where the species is consistently sterile.

*Bucklandiella striatipila* was described by Cardot (1905, 1908) as *Racomitrium striatipilum* Cardot from material collected from Tierra del Fuego and southern Chile. The species was subsequently accepted by most authors, for example Cardot & Brotherus (1923), Roivainen (1955), Bell (1974), and Greene (1986). Although it is a very handsome and distinct species, its specific distinctness has been questioned by some authors. Robinson (1975) reduced *Racomitrium striatipilum* to synonymy with *R. crispipilum*, a pantropical oreophyte occurring in the Neotropics (Frisvoll, 1988), Africa (Ochyra, 1993) and Papua New Guinea (Blockeel *et al.*, 2007). This taxonomic conclusion has been adopted by Deguchi (1984, 1987). However, Frisvoll (1988), Bednarek-Ochyra (1995b) and Bednarek-Ochyra & Ochyra (2010a) demonstrated the essential and indisputable differences between *Bucklandiella striatipila* and *B. crispipila*, thus rejecting the conspecificity of these two species.

*Bucklandiella striatipila* and *B. crispipila* share a similar habit, hyaline hair-point, overall appearance, as well as the leaf shape and areolation. However, *B. crispipila* has a much narrower costa which is bistratose throughout, with mostly three enlarged ventral cells towards the base and a single layer of dorsal stereid cells, only occasionally with a second incomplete layer consisting of a few stereids. Moreover, *B. crispipila* often has a well developed group of yellow or orange alar cells, whereas in *B. striatipila* angular leaf cells are not differentiated.

The two species are doubtless closely related but in South America their geographical ranges do not overlap and the species are clearly vicariant on this continent. *Bucklandiella crispipila* is a widely distributed montane species, ranging in the Neotropics along the Cordillera from Mexico (Frisvoll, 1988) to Bolivia (Churchill *et al.*, 2000, 2009). In contrast *B. striatipila* is a temperate species occurring in southern South America, south of lat. ca 37°S and extends to the subantarctic islands in the Southern Ocean. However, in South Africa the two species occur in the same area and may be confused in the field, but the careful examination of the costal anatomy should exclude any possibility of confusion.

**Specimens examined:** SOUTH AFRICA. **Western Cape Province. Drakenstein Local Municipality:** Paarl Division, Seven Sisters (Hawekwa) Mountains, lat. 33°40'52"S, long. 19°05'10"E, alt. 4500 ft (= ca 1375 m), grid div. 3319 CA, moist rock ledge on south side near summit, 29 September 1949, *Esterhuysen 15774* (BM, PRE, S). **City of Cape Town Metropolitan Municipality:** Sommerset West, Hottentots-Holland Mountains, Helderberg above Loursensford, lat. 34°02'S, long. 18°52'E, alt. ca 580 m, grid div. 3418 BB, 10 September 1925, *Pillans 13417* (PRE).

## ECOLOGICAL AND PHYTOGEOGRAPHICAL REMARKS

For a long time *Bucklandiella striatipila* was considered to be an amphipacific cool-south-temperate species, with the main centre of distribution in southern South America. It is widely distributed in the *Nothofagus* zone on the western coast of this continent, ranging from the Valdivian region in central Chile to Tierra del Fuego and the Falkland Islands (Cardot & Brotherus, 1923), with an isolated station in the Juan Fernandez Islands (Robinson, 1975) and, additionally, extending to subantarctic South Georgia (Bell, 1974). The report of this species from Bolivia (Churchill *et al.*, 2000) is apparently based upon a misidentification and the material actually represents *B. crispipila*.

On the opposite side of the Pacific Ocean, *Bucklandiella striatipila* was reported from the South Island of New Zealand (Sainsbury, 1945), but Bednarek-Ochyra & Ochyra (2010a) showed that actually this material represent a different species, *B. allanfifei* Bednarek-Ochyra *et* Ochyra. It is a closely related species, though definitely distinct from *B. striatipila*, endemic to New Zealand.

In recent years *Bucklandiella striatipila* has been discovered in the archipelagoes of Îles Crozet (Blockeel *et al.*, 2009) and Îles Kerguelen (Ellis *et al.*, 2010) in the Subantarctic, as well as in Tristan da Cunha (Ellis *et al.*, 2011b) and on Gough Island (Ellis *et al.*, 2012) in the middle of the South Atlantic Ocean in the temperate zone. These discoveries, along with the present record of the species in South Africa, have firmly established *B. striatipila* as an amphiatlantic south-cool-temperate species (Fig. 10).

A characteristic feature of the moss flora of South and East Africa is the penetration of considerable number austral cool-adapted mosses (Seki, 1986). Many of them have the main occurrence centre in South America but they occur also on subantarctic islands in the Tristan da Cunha group in the temperate zone. They apparently reached these islands via long-distance dispersal thanks to prevailing westerlies (Schuster, 1983). However, it cannot be excluded that the occurrence of some species in the Cape Floral Region may have an ancient historical foundation and date to the time of the fragmentation of the supercontinent Gondwana. The same distribution pattern shown by *Bucklandiella striatipila* is exhibited by a number of species, for example *Vittia pachyloma* (Mont.) Ochyra (Ochyra 1987; Ochyra & Lightowlers, 1988), *Platyneuron praealtum* (Mitt.) Ochyra *et* Bednarek-Ochyra (Ochyra & Bednarek-Ochyra 1997), *Bucklandiella lamprocarpa* (Ochyra *et al.*, 1988; Bednarek-Ochyra & Ochyra, 2012a), and *Philonotis vagans* (Hook.f. *et* Wilson) Mitt. (Magill, 1981).

*Bucklandiella striatipila* is a saxicolous moss, which occurs in dry and often exposed rocks, but it thrives also on soil in various types of tundra vegetation. Although the South African specimens lack any ecological data on the labels, one may assume that it was collected on rocky ground and this is confirmed by the admixture of *Racomitrium lanuginosum* in the specimen from the Seven Sisters Mountains.

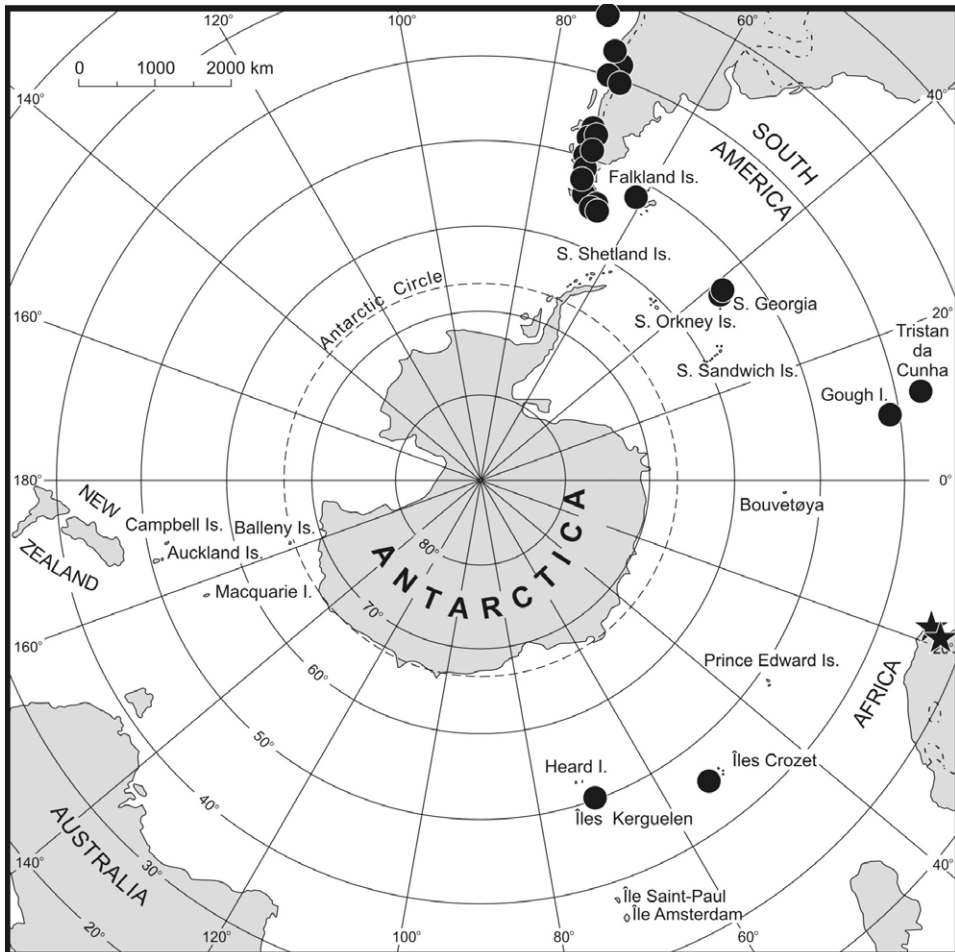


Fig. 10. Global distribution of *Bucklandiella striatipila* (Cardot) Bednarek-Ochyra *et* Ochyra. New localities in South Africa marked with stars.

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