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Distribution of *Bucklandiella lamprocarpa* (Grimmiaceae, Musci) in South Africa

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Abstract — *Bucklandiella lamprocarpa* (Müll.Hal.) Bednarek-Ochyra & Ochyra is the only rheophytic representative of the genus in South Africa. Although this distinct and almost unmistakable species is bipolar in distribution, it is mostly an austral cool-temperate species ranging northwards along the alpine belts of South America and Africa. Examples are given of pan-Holantarctic mosses in the Cape Floristic Region and hypotheses put forward to explain this distribution pattern. The South African distribution of *B. lamprocarpa* is mapped and described in detail.

Bryophyta / Cape Floristic Region / distribution / phytogeography / rheophytic mosses / South Africa

INTRODUCTION

As traditionally understood, the genus *Racomitrium* Brid. is a heterogeneous assemblage which was split into four smaller natural genera (Ochyra *et al*., 2003). Of these, only two are represented in South Africa, namely *Racomitrium s.str.* and *Bucklandiella* Roiv. *Codriophorus acicularis* (Hedw.) P.Beauv., representative of the third segregate (Bednarek-Ochyra *et al*., 2001), was also reported from this area (Sim 1926) but this record was based upon misinterpretation of the type material of *Grimmia pseudoacicularis* Müll.Hal. [≡ *Racomitrium pseudoaciculare* (Müll.Hal.) Paris] which in fact is identical to *Bucklandiella lamprocarpa* (Müll.Hal.) Bednarek-Ochyra *et* Ochyra (Bednarek-Ochyra, 2004; Bednarek-Ochyra & Ochyra, 2012a). Actually, all species of racomitrialean mosses in South Africa belong within the genus *Bucklandiella*, except for *Racomitrium lanuginosum* (Hedw.) Brid. which was the first species of the complex to be recorded in this region (Thunberg, 1800).

Magill (1981) recognised only three species of the broadly conceived *Racomitrium*, namely *R. lanuginosum*, *R. nigroviride* (Müll.Hal.) Paris and *R. crispulum* (Hook.f. *et* Wilson) Hook.f. *et* Wilson, of which the latter two are currently placed in *Bucklandiella*. Of these, the most problematic is the latter species because of its long history of misinterpretation and convenient repository of a number of distinct austral species. They were uncritically lumped with *Bucklandiella crispula* (Hook.f. *et* Wilson) Bednarek-Ochyra *et* Ochyra, making it

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a catch-all collective species which actually comprises many distinct and unrelated species (Bednarek-Ochyra *et al*., 1998; Bednarek-Ochyra & Ochyra, 2010, 2011, 2012a, b, c). Two of them, *B. crispipila* (Taylor) Bednarek-Ochyra *et* Ochyra (Hodgetts *et al*., 1999) and *B. striatipila* (Cardot) Bednarek-Ochyra *et* Ochyra (Bednarek-Ochyra & Ochyra, 2013) have been reported from South Africa. However, further species are expected with progress in critical revisionary studies of the complex in the Southern Hemisphere which should provide a sound taxonomic framework for African material.

Like elsewhere in the tropics, *Bucklandiella* is not well represented in southern Africa, both in terms of the number of species as well as their frequency and cover. In the Southern Hemisphere the genus exhibits the greatest diversity on islands in the Southern Ocean situated in the subantarctic and cool-temperate zones and only some species extend northwards to the continental masses where they occur primarily at high elevation in the alpine belts. One such species is *Bucklandiella lamprocarpa* which may serve as a model of this distribution pattern.

SOUTH AFRICAN REPRESENTATION OF *BUCKLANDIELLA LAMPROCARPA*

Bucklandiella lamprocarpa is a distinct and almost unmistakable species. It is a rheophytic moss growing mostly on rocks in fast flowing streams and brooks or in otherwise wet sites on stream banks and in waterfalls. This is a large, mostly coarse and rigid moss, dark olive-green above and blackish below or sometimes blackish throughout. The stems are usually 3-4 or occasionally to 10 cm long and the leaves are epilose, straight to falcate, 2.5-3.5 × 0.9-1.1 mm.

The most characteristic feature of *B. lamprocarpa* is its multistratose leaf laminae. They are entirely 2-4-stratose distally, with 2-5-layered marginal borders of many rows of cells which form fleshy limbidia extending from the base to the apex and merging imperceptibly with the laminal cells in the distal part. The leaves have a salient costa which is strongly convex on the abaxial side and reniform on the adaxial side in the proximal part. The alar groups are composed of large and moderately thick-walled cells and usually form pronounced, orange-brownish, pellucid decurrencies. The basal marginal cells are not differentiated as a border. The capsules are obloid, 1.8-3.0 mm long, lustrous and blackish-brown, and the spores are coarsely papillose and large, 20-28 μm in diameter. The species, under the name *Racomitrium nigroviride*, is well illustrated in the moss *Flora of Southern Africa* (Magill, 1981).

GLOBAL DISTRIBUTION OF *BUCKLANDIELLA LAMPROCARPA*

Bucklandiella lamprocarpa is a pan-Holantarctic species in the Southern Hemisphere which has maximum occurrence in the *Nothofagus* zone on the western fringes of southern South America. It ranges from the Cape Horn area and the Falkland Islands to lat. *ca* 39°S in the Valdivian province on the mainland, with isolated stations in the Sierra de la Ventana in the eastern part of the

continent and on the Juan Fernandez Islands (Ochyra *et al*., 1988; Bednarek-Ochyra *et al*., 1996). It is also known from scattered localities in the Andes of Bolivia (Blockeel *et al*., 2009), Ecuador (Blockeel *et al*., 2002), and Colombia and Venezuela (Churchill *et al*., 2000). Outside South America the species occurs on some islands in the Southern Ocean, including Gough Island in the South Atlantic (Ochyra *et al*., 1988), Marion Island in the Prince Edward Islands archipelago (Ellis *et al.,* 2011), Îles Kerguelen (Bednarek-Ochyra & Ochyra, 1998) and Heard Island (Ellis *et al*., 2010) in the Kerguelen biogeographical province of the Subantarctic and on Macquarie Island in the Australasian sector of Subantarctica (Blockeel *et al*., 2007). In addition, the species is known from the Cape Floristic Region of South Africa and from isolated stations on East and Central African mountains of Kenya, Tanzania, Uganda, Rwanda and the Democratic Republic of Congo (Ochyra *et al*., 1988).

It is worth noting that although *Bucklandiella lamprocarpa* was described from material collected in 1840 in the Falkland Islands by J.D. Hooker, the species was actually collected for the first time in the Cape of Good Hope area by J.F. Drège between 1823 and 1827 and this material was much later described as *Grimmia pseudacicularis* Müll.Hal. (Bednarek-Ochyra & Ochyra, 2012a). In general phytogeographical terms, *Bucklandiella lamprocarpa* is a bipolar species which, outside the Southern Hemisphere, has a narrow geographical range on the Iberian Peninsula (Casas *et al*., 1992).

A REVIEW OF SOUTH AFRICAN DISTRIBUTION OF *BUCKLANDIELLA LAMPROCARPA*

The Cape Floristic Region (Van Wyk & Smith, 2001) is home to a good number of austral, cool-adapted mosses. Most of them are amphiatlantic species that have the main centre of their occurrence in southern South America, for example *Bucklandiella striatipila* (Bednarek-Ochyra & Ochyra, 2013), *Vittia pachyloma (*Mont.) Ochyra (Ochyra, 1987; Ochyra & Lightowlers, 1988), *Platyneurum praealtum* (Mitt.) Ochyra *et* Bednarek-Ochyra (Ochyra & Bednarek-Ochyra, 1997), *Philonotis vagans* (Hook.f. *et* Wilson) Mitt. (Magill, 1981) and *Cratoneuropsis chilensis* (Lorentz) Ochyra (Ochyra *et al*., 2008).

There are two generally accepted contrasting hypotheses which try to explain this distribution pattern. Some taxa of this group show a typical palaeoaustral distribution pattern (sensu Frey *et al*., 2010) which covers distant temperate landmasses including southern South America, south-eastern Australia, Tasmania, New Zealand and southernmost Africa as well as some Gondwanan islands such as the Falkland Islands, Îles Kerguelen, the Auckland Islands and the Campbell Islands in the Southern Ocean, for example *Leptotheca gaudichaudii* Schwägr. (Churchill & Buck, 1982) and *Blindia magellanica* Müll.Hal. (Bartlett & Vitt, 1986). They are remnants of an ancient moss flora which existed on the large expanses of the supercontinent Gondwana before its fragmentation (Schuster, 1976, 1983). More than sixty species of moss show a wide distribution in holantarctic regions, especially in areas with temperate, humid climates.

The opposite hypothesis assumes that many, if not most, moss species having widespread antipodal distribution may have reached the south-western tip of Africa and subantarctic islands in the Kerguelen biogeographical province via

long-distance dispersal of propagules and spores thanks to prevailing westerlies (Muñoz *et al*., 2004). They are usually well suited for long-range transoceanic dispersal by leaf fragmentation as well as by spores and this may support their capacity for long-distance dispersal and colonisation of relatively recent islands of volcanic origin in the Southern Ocean such as Gough Island, Tristan da Cunha, the Prince Edward Islands, Îles Crozet, Île Amsterdam and Île Saint-Paul.

Bucklandiella lamprocarpa apparently belongs to this group of species. It has optimum occurrence in southern South America which may suggest that this is the centre of its origin, although not necessarily so. On the other hand, the species is exceedingly rare on relatively young subantarctic islands such as Marion Island (Ellis *et al*., 2011) and Macquarie Island (Blockeel *et al*., 2007), but it is absent from Australia, Tasmania and New Zealand. One cannot exclude the possibility that *B. lamprocarpa* has been able to secondarily extend its range to eastern subantarctic islands from a South African refugium. As is the case with vascular plants (Van der Putten *et al*., 2010) the species can be considered as a pre-glacial survivor in local refugia rather than a post late-Glacial Maximum immigrant from South Africa or more distant temperate landmasses in the Southern Hemisphere.

In the Cape Floristic Region, *Bucklandiella lamprocarpa* is widely distributed but scattered (Fig. 1). The vast majority of its localities are found in the western part of the region, along the north-south axis of the Cape Fold Mountains. Localities are particularly concentrated on Table Mountain and the Boland Mountain Complex, at the centre of the Cape Floristic Region. Here the species often occurs at relatively low elevations, mostly well below 1000 m a.s.l. Along the more northerly mountain ranges of the Great Winterhoek, Cederberg and Hex River, the localities gradually increase in elevation towards the interior where the species often occurs above 1200 m a.s.l. The highest record of the species is from the Matroosberg in the Hex River Mountains, where it was found at 2200 m a.s.l. The northernmost stations are from the Cold Bokkeveld Mountains and the southern Cederberge, at elevations of 1520 and 1219 m a.s.l. respectively. The species is rarely collected along the east-west axis of the Cape Fold Mountains and only known from a few localities in the Swartberge. Here it occurs in mountain fynbos at elevations of 1585-1981 m a.s.l. A single collection came from Wilderness near George at the foot of the Outeniqua Mountains in the eastern part of the Western Cape Province where the species was found near sea level (92 m a.s.l.).

Bryofloristically, the Cape fynbos area is rather less distinctive and classified as the Cape Domain, a subdivision of the Afromontane Region (Van Rooy & Van Wyk, 2010). The moss flora of the Cape Domain, which includes *Bucklandiella lamprocarpa*, represents 57% of all moss species in southern Africa. The TWINSPAN classification of van Rooy & van Wyk (2010) also included *B. lamprocarpa* in the moss flora of the Western Cape Domain, a subdivision of the Karoo-Namib Region, but this was probably a result of the course grain of the study. The species can therefore be regarded as restricted to, and one of the diagnostic species for the Cape Domain.

Bucklandiella lamprocarpa belongs to the Boland Subelement, a subdivision of the Cape distribution Element of Van Rooy & Van Wyk (2011). The families Wardiaceae (endemic to the Cape Domain) and Aulacomniaceae (southern temperate areas of the world) are restricted to this subelement in southern Africa. The Boland Subelement is mainly distributed in the southwestern corner of the Cape but ranges north as far as the Cederberge near Clanwilliam, and east to the Groot Swartberge and Outeniqua mountain ranges of the Klein Karoo, and occasionally to the southern KwaZulu-Natal

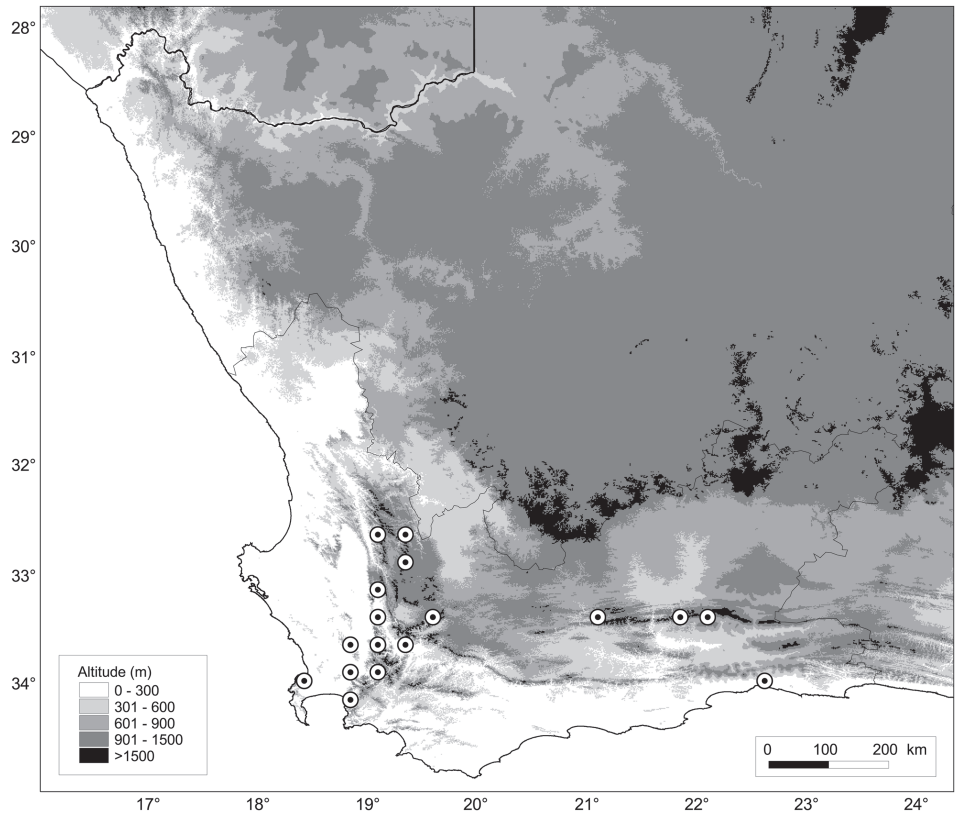

Fig. 1. Known distribution of *Bucklandiella lamprocarpa* (Müll.Hal.) Bednarek-Ochyra *et* Ochyra in the Cape Floristic Region.

Drakensberg. *Bucklandiella lamprocarpa* is largely restricted to the core area of distribution for the Boland Subelement, which is Table Mountain and the Cape Fold Mountains of the Boland.

Specimens examined[1]**: SOUTH AFRICA.** WESTERN CAPE. — **3219** (Worcester): Clanwilliam Div., Cold Bokkeveld Mountains, Heksberg, alt. 1520 m, (–CA), 24 Mar. 1951, *Esterhuysen 18474* (BM, BR, PRE, S); Ceres Div., Sandfontein, S. Cederberge, alt. 1210 m, (–CB), 6 Apr. 1953, *Esterhuysen 21326* (PRE); Bokkeveld, Tafelberg, alt. 1220-1525 m, (–CD), 14 Aug. 1955, *Esterhuysen 24423* (PRE). — **3318** (Cape Town): Table Mountain, (–CD), *Rehmann 139* (BM, H, KRAM, PRE, S - syntype of *Grimmia nigroviridis*); Slangolie, alt. 610 m, (–CD), Jan. 1919, *Sim 9193* (PRE); saddle between Devil's Peak and Table Mountain, 500 m, (–CD), 27 Jan. 1973, *Crosby & Crosby 8179* (MO, PRE); Blinkwater Ravine, above Camps Bay, alt. 457-914 m, (–CD), Feb. 1917, *Bews (Sim) 8633* (PRE); Devil's Peak, (–CD), *Rehmann 139c* (BM, H, KRAM, PRE - type of *Grimmia nigroviridis* var. *robusticula*); same locality, Aug. 1883, *Wilms 2575* (BM, H, S); Cape of Good Hope, (–CD), *Ecklon s.n.* (PC, W - type of *Racomitrium capense*) and *Drège s.n.* (BM, H, W - type of *Grimmia pseudoacicularis*); Paarl, Groot-Drakenstein Mountains, alt. 914 m,

1 Specimens cited according to the quarter-degree reference system of Edwards & Leistner (1971).

(–DB), 26 Apr. 1953, *Esterhuysen 21358* (PRE); Paarl Rock, alt. 452 m, (–DD), Jan. 1919, *Sim 9631* (PRE); Stellenbosch, Banghoek Kloof, (–DD), 13 Jan. 1952, *Esterhuysen 19914* (BM, BR, PRE, S); Simonsberg, SW slopes, alt. 800-1000 m, (–DD), 11 Mar. 1956, *Esterhuysen 25437* (BM, BR). — **3319** (Worcester): Great Winterhoek, alt. 1524 m, (–AA), 31 Dec. 1951, *Esterhuysen 19870a* (PRE); 27 Jan. 1957, *Esterhuysen 27049* (PRE); Sneeugat Valley, (–AA), Oct. 1932 (PRE), *Thorne SAMH50357* (PRE); same locality, alt. 1065-1220 m, (–AA), *Thorne 51131 & 51133* (PRE); Ceres Div., Roodeberg, Hex River Mountains, alt. 1981 m, (–BC), 27 Dec. 1952, *Esterhuysen 20965* (PRE); Ceres - De Doorns Area, Matroosberg Nature Reserve, above Spekrivier Kloof, NW facing mountain slopes, alt. 1300-1500 m, (–BC), 8 Dec. 2003, *Hedderson 15399* (PRE); same locality, summit, alt. 2200 m, (–BC), 9 Dec. 2003, *Hedderson 15443* (PRE); Worcester Div., Witteberg, Slanghoek Mountains, alt. 914 m, (–CA), 5 Nov. 1957, *Esterhuysen 22265* (PRE); Bain's Kloof, Kromrivier, alt. 549 m, (–CA), 16 Jan. 1982, *Viviers 60* (PRE); Krom River Kloof, off Du Toit's Kloof, (–CA), 4 Mar. 1956, *Esterhuysen 25420 & 25425* (BM, BR, S); mountains above Worcester, (–CB), *Rehmann 139b* (BM, KRAM, PRE - lectotype of *Grimmia nigriviridis*); Waaihoek Mountains, Goudini, (–CB), Apr. 1928, *Barnard 45721 & CH5451* (PRE); Groot-Drakenstein Mountains, (–CC), Mar. 1925, *Primos CH9697* (PRE); Du Toit's Kloof Mountains, (–CC), 28 Aug. 1949, *Esterhuysen 15660* (PRE). — **3321** (Ladismith): Swartberg near Ladismith, Towerkop, alt. 1981 m, (–AC), 23 Apr. 1951, *Esterhuysen 18573* (PRE); 16 Dec. 1956, *Esterhuysen 26840* (BM, BR, PRE, S); Prince Albert Div., Swartberg, (–BD), Jan. 1947, *Stokoe CH13167* (BM, PRE, S). — **3322** (Oudtshoorn): Oudtshoorn, Swartberg, (–AC), Dec. 1946, *Stokoe 9334* (BM, PRE, S); Swartberg Pass, at summit, S slope, alt. 1585 m, (–AC), 19 Jan. 1979, *Magill 6128 & 6131* (PRE); Wilderness, George, alt. 92 m, (–DC), *Taylor CH5450* (PRE).— **3418** (Simonstown): Helderberg above Lourensford, near Sommerset West, alt. ± 580 m, (–BB), 1 Apr. 1925, *Pillans 11925 & CH13442* (PRE).

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