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Antipodal mosses: XVIII. *Syntrichia christophei* (Pottiaceae), a new species from subantarctic Îles Kerguelen

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Abstract – *Syntrichia christophei* Ochyra *et* R.H. Zander is new to science from Îles Kerguelen in the Subantarctic. The species is described and illustrated and its affinities are discussed. It is closely related to *S. saxicola* (Cardot) R.H. Zander but it is easily distinguished by its larger leaf size, larger distal laminal cells, longer awn at the leaf apex, and larger capsules and spores. *Syntrichia christophei* is endemic to Îles Kerguelen, a highly isolated archipelago in the Southern Ocean, and evolutionary interpretation of its origin is presented.

Bryophyta / endemism / gigantism / Musci / Southern Ocean / Subantarctica / taxonomy

INTRODUCTION

Îles Kerguelen is the largest subantarctic archipelago situated in the South Indian Ocean sector of this biome at latitude 48°35'-49°44'S and longitude 68°43'-70°35'E. It comprises one major island, Grande Terre, and about 300 minor islands, islets, rocks and outliers which occupy in total 7215 sq. km. The archipelago was discovered in 1772 by Yves-Joseph de Kerguelen-Trémarec and François Alesno but the first collection of bryophytes from this small speck of land was made only in the austral autumn and winter of 1840 by Joseph D. Hooker during the British Antarctic voyage in 1839-1843 under the command of Captain James C. Ross on the ships *Terror* and *Erebus*.

The first collection of mosses from Îles Kerguelen comprised 25 species, six of which were described as new (Hooker & Wilson, 1844; Wilson & Hooker, 1847). A small moss collection from this archipelago was subsequently made in 1874 by H.N. Moseley, the naturalist to the British *Challenger* expedition which circumnavigated the globe between 1872 and 1876, who collected 28 species, four of which were new (Mitten, 1876a, 1884).

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At the turn of 1874-1875 the archipelago was visited by the British, American and German Transit-of-Venus expeditions. The mosses collected by A. E. Eaton, naturalist to the British expedition consisted of 38 species, including one new (Mitten, 1876b, 1879) and the specimens gathered by J.H. Kidder, naturalist to the United States expedition, comprised in total 28 species, two of which were described as new (James, 1875, 1876). Bryologically, the most successful was the German Expedition on the ship *Gazelle* commanded by Captain Georg F. von Schleinitz. The naval surgeon Dr Friedrich C. Naumann made a rich moss collection that consisted of 93 species, 80 of which were described as new (Müller, 1883, 1889).

In the first quarter of the twentieth century the important contributions to the moss flora of Îles Kerguelen we made by Brotherus (1906) who reported 51 species (including nine new) from the collection made in 1902-1903 the German South Polar Expedition under the leadership of Erich von Drygalski. Later Cardot (1916a, b) reported 48 species from this archipelago, including seven new, on the basis of the collections made by French explorers M. Rallier du Baty in 1907-1908 and 1913-1914 and M. Bossière in 1913-1914, while Thériot (1924, 1925) reported 14 species, including one new, which had been collected by M. Etienne Peau in 1923-1924. No new records of moss were made from Îles Kerguelen in subsequent nearly half a century until Hébrard (1970a, b) and Desplanques & Hébrard (1972) published a contribution based on material collected by the latter author in the 1969 campaigne, but no new species were discovered. It is worth mentioning that J.-P. Hébrard was the first professional bryologist to carry out fieldwork in this archipelago. Later some additional five species of mosses were recorded by Bednarek-Ochyra & Ochyra (1998) and Ochyra & Poulsen (2003).

In all the aforementioned contributions no less than 115 species of moss were described from Îles Kerguelen and about the same number of other species have been reported from the archipelago. However, the real number of moss species is much lower because the great number of species described from this archipelago have proven to be conspecific with species known from other regions of the south-cool-temperate and austral polar regions. Thus, by the beginning of the present century the moss flora of Îles Kerguelen consisted of about 125 species.

In 2006-2007 the first and third authors made a large collection of bryophytes on Îles Kerguelen which yielded no fewer than 15 of phytogeographically and taxonomically important additional species of moss (Blockeel *et al.*, 2009b, c, 2010; Ochyra, 2010; Ellis *et al*., 2010, 2011, 2012a, b) and four taxa of liverworts (Blockeel *et al.*, 2009a), including the discovery of a new species, *Sematophyllum lebouvieri* Ochyra (Ochyra, 2010).

This is not the final number of new moss records to Îles Kerguelen. A good number of specimens still need detailed investigations and careful comparison with taxa known from oceanically nearly territories, including southern South America, Australasia and islands in the Southern Ocean, in order to eliminate a superfluous description of new species. However, herein we describe a new species of the genus *Syntrichia* Brid. that evidently does not fit any known species of this genus. It is with pleasure that we name it *S. christophei* in honour of Christophe Brumbt who actively helped us in field work during the 2006-2007 campaign.

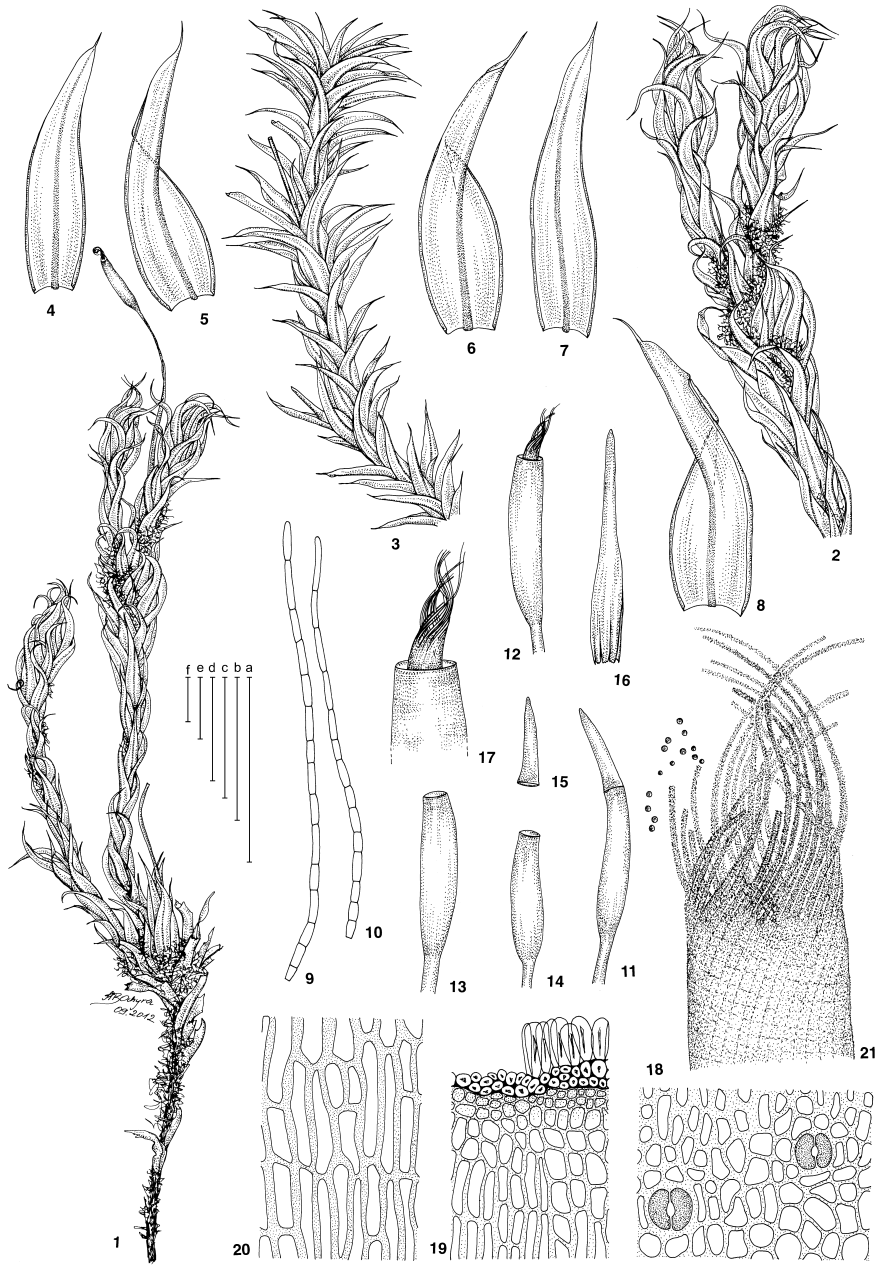
DESCRIPTION

Syntrichia christophei Ochyra *et* R.H. Zander, *sp. nov.* **Figs 1-31**

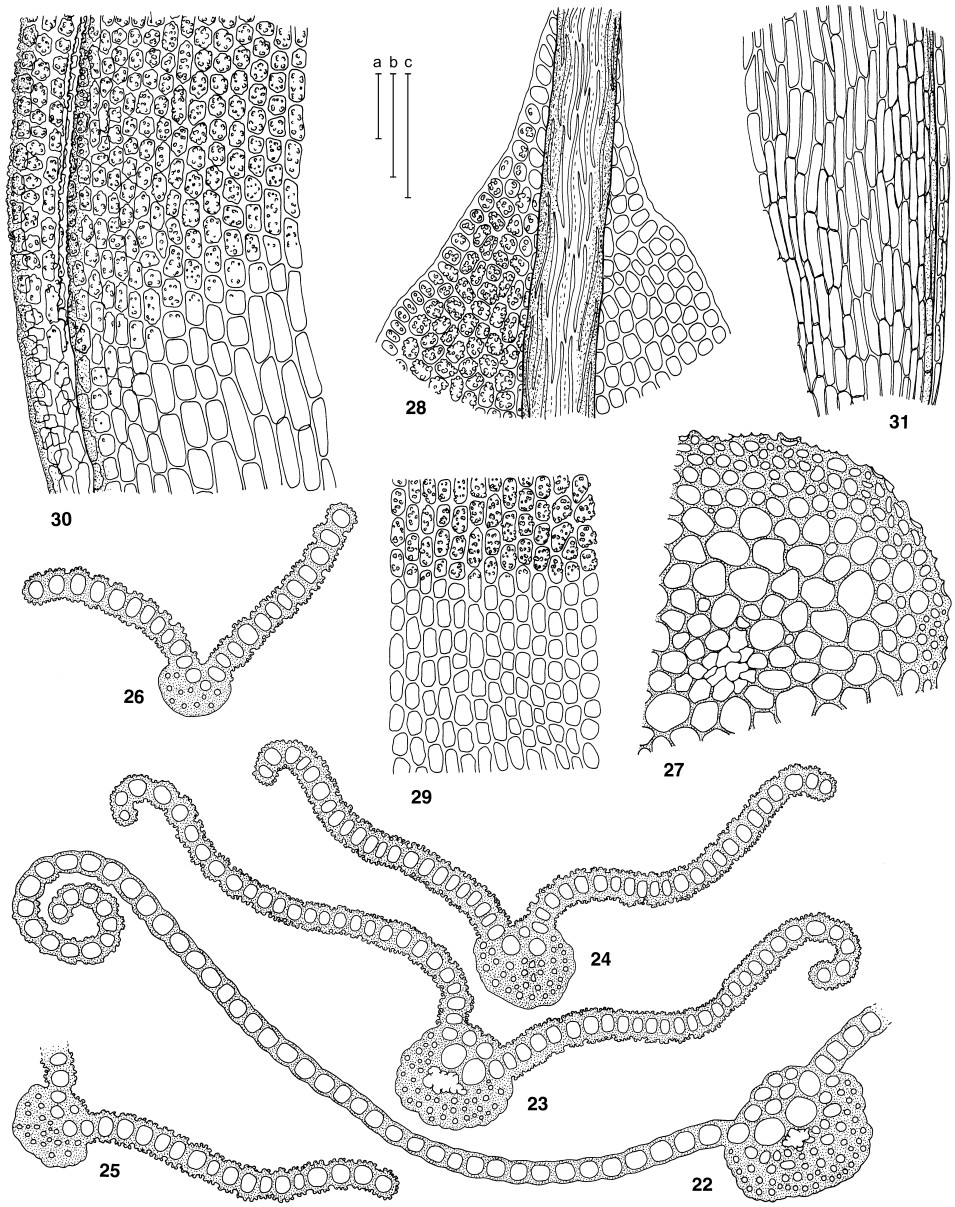
Diagnosis – *Plantae caespites magnos formantes, supra virides, infra rubro-brunneae. Caules saepe ramosantes, hyalodermide in serie unica distincta, filo centrali debili praesenti. Folia appresso-incurva, in statu sicco conduplicata, madido erecto-patentia vel squarroso-recurva, brevi- vel oblongo-lanceolata; margines ubique recurvae vel semel revolutae tenus prope apicem integrae; apex late acutus subobtusus; costa robusta, in mucronem leniter serrulata basaliter complanatam rubescentem angustam, vel in aristam brevem e cellulis hyalinis paucis producta; cellulae ad basem parum abrupte distinctae maiores rectangulares laeves hyalinae, parietibus incrassatiusculis subporosae, ad laminas supernas 13-20 µm, rotundo-quadratae papillis per lumen 4-6 ellipticis vel bifidis, marginales parietibus in seriebus 8-10 incrassatioribus. Status sexualis ut videtur dioicus. Seta ca 1 cm. Urna capsulae cylindrica 2.5-2.7 mm longa; operculum conicum strictum ca 1.5 mm longum; peristomium e divisionibus rubrescentibus papillosis dextrorsim paene semel tortis supra membranam basalem tessellatam in 1/3 parte inferna longitudinis peristomalis. Calyptra ca 3.5 mm longa, anguste cucullata. Sporae 12-15 µm diametro, leniter papillosae. Color laminalis in KOH ruber vel aurantiacus reagens.*

Type – SUBANTARCTICA. **ÎLES KERGUELEN.** GOLFE DU MORBIHAN, ÎLE AUSTRALIA: north-eastern coast of the southern part of the island, south of Anse des Macrocystis, opposite Île Stoll over Passe de l'Aventure, on gentle slope at the foot of the highest cliff of the southern plateau in its northeastern part, lat. 49°27'48.6'' S, long. 69°52'33.8'' E; alt. 126 m; forming large extensive monospecific tufts on detritus and soil in *Acaena magellanica* community in dry, open and exposed situation; 20 December 2006, *Ochyra 3066/06* (with Christophe Brumbt) (Holotype: KRAM; isotypes: BM, H, KRAM, MO, NY, PC, S).

Description – **Plants** robust, in large fairly but easily disintegrating tufts, dull or somewhat lustrous, stiff and rigid, green above, red-brown below. **Stems** erect, 4-7 cm tall, commonly branching, moderately radiculose at base with clusters of reddish-brown, lustrous, branched rhizoids, in transverse section obtusely rounded-pentagonal, consisting of a distinct unistratose hyalodermis of larger, thin-walled cells, usually with collapsed outer walls, 2-3-stratose cortex of smaller, substereid, brown cells grading into 4-6-stratose medulla of large, hyaline or yellowish-hyaline cells and weak central strand; **axillary hairs** long, filiform, hyaline throughout, consisting of 14-18 cells, usually somewhat shorter at base but otherwise similar to distal cells. **Leaves** densely set, closely appressed-incurved to somewhat twisted and infolded when dry, erect-spreading to squarrose-revolute on wetting, lanceolate to oblong-lanceolate from an oblong, hyaline base, sheathing the stem for a quarter to a third of the leaf length, gradually long-acuminate to broadly acute weakly obtuse apex, 4.5-5.2 mm long (without awn), 0.9-1.3 mm wide, non-decurrent, broadly to narrowly keeled; **margins** entire throughout, recurved to once-revolute to near apex; **costa** single, sharply demarcated from the laminal cells, strong, excurrent as a weakly serrulate or entire, basally flattened, reddish narrow mucro or short awn, 0.5-0.7 mm long, ending in a few hyaline cells, reddish-brown, 80-100 µm wide, strongly convex and smooth or scabrous below with simple verrucate papillae on the dorsal side, flat or convex on the ventral side, in transverse section semiterete, at mid-leaf showing a single median layer of 4 guide cells, 1-2 layers of smaller adaxial cells, a strong abaxial stereid band of 4-6 rows of small, sclerenchymatous cells lacking epidermis, hydroid strand differentiated but sometimes represented by a void, adaxial epidermis composed of



Figs 1-21. *Syntrichia christophei* Ochyra *et* R.H.Zander. – **1.** Habit, dry. **2.** Portion of branch, dry. **3.** Portion of branch, wet. **4-8.** Leaves. **9-10.** Axillary hairs. **11.** Operculate capsule. **12.** Deoperculate capsule with peristome. **13-14.** Urns with removed peristomes. **15.** Operculum. **16.** Calyptra. **17.** Upper part of urn with peristome. **18.** Basal exothecial cells and stomata. **19.** Exothecial cells at orifice and annulus. **20.** Mid-urn exothecial cells. **21.** Peristome and spores. [1-10, 13, 16-21 from *Ochyra 3066/06*, holotype, KRAM; 11-12, 14-15 from *Ochyra 3355A/06*, paratype, KRAM]. Scale bars: a - 0.5 cm (2); b - 1 mm (17); c - 0.5 cm (1, 3); d - 100 µm (18-20) and 200 µm (9-10); e - 1 mm (4-8, 11-16); f - 100 µm (21).



Figs 22-31. *Syntrichia christophei* Ochyra *et* R.H.Zander. – **22-26.** Cross-sections of leaves, sequentially from base to apex. **27.** Portion of stem cross-section. **28.** Apical leaf cells (papillae partly removed). **29.** Mid-leaf cells (papillae partly removed). **30.** Laminal cells in transition zone to basal hyaline cells. **31.** Basal leaf cells. [All from *Ochyra 3066/06*, holotype, KRAM]. Scale bars: a - 100 μm (31); b - 100 μm (27, 30); c - 100 μm (22-26, 28-29).

large papillose cells; **laminal cells** unistratose throughout, red to orange in KOH reaction; **upper cells** strongly chlorophyllose, irregularly rounded-quadrate to rounded-hexagonal, occasionally rounded-elliptical, 6-14 μm wide, densely papillose on both ventral and dorsal faces with 4-6 elliptical or bifid papillae per lumen, markedly obscuring the lamina and making it opaque, spreading down the margins of the upper basal part, separated from the basal cells along the sharp junction line; **basal cells** rather abruptly differentiated, larger, rectangular to linear, 40-120 μm long, 8-20 μm wide, smooth, hyaline, lax and inflated in the inner part of the base, becoming sturdier towards the margins and forming a ± distinct border of 8-10 rows. **Specialised asexual reproduction** not seen. **Sexual condition** apparently dioicous. **Perigonia** bud-like, to 1.3 mm long, with many antheridia and yellowish paraphyses, slightly exceeding the antheridia. **Perichaetia** terminal; **perichaetial bracts** very weakly sheathing the seta, larger but otherwise similar to vegetative stem leaves. **Seta** erect, straight, *ca* 1 cm, orange, smooth, dextrorse when dry. **Capsule** long-exserted, erect, slightly curved, orange; **urn** obloid to cylindrical, 2.5-2.7 mm, with weakly differentiated neck, smooth, somewhat lustrous; **annulus** persistent, 3-4-seriate, composed of large, vesiculose cells with strongly incrassate walls; **operculum** conic-rostrate, straight, *ca* 1.5 mm, about half the length of the urn; **exothecial cells** thick-walled, rectangular, 35-85 μm × 15-20 μm, becoming shorter and deeper brown in 3-4 tiers below the orifice; **stomata** at the base of the urn in a single row, bicellular, superficial, with oval openings; **peristome** of 32 filiform, reddish, papillose divisions twisted dextrorse almost once above a tessellated basal membrane 1/3 the total length of the peristome. **Spores** 12-15 μm in diameter, yellowish to brownish, finely papillose. **Calyptra** *ca* 3.5 mm long, narrowly cucullate, brown, smooth, naked.

Additional specimen seen (Paratype) – SUBANTARCTICA. **ÎLES KERGUELEN**. GOLFE DU MORBIHAN, ÎLE AUSTRALIA: north-eastern coast of the southern part of the island, south of Anse des Macrocystis, opposite Île Stoll over Passe de l'Aventure, on gentle slope at the foot of the highest cliff of the southern plateau in its central part part, lat. 49°27'49.1'' S, long. 69°52'34.5'' E; alt. 120 m; on soil in *Acaena magellanica* community, in dry, insolated and exposed situation, associated with *Hypnum cupressiforme*, *Streptopogon australis* and *Cratoneuropsis chilensis*; 20 December 2006, *Ochyra 3055A/06* (with Christophe Brumbt) (BM, H, KRAM, MO, NY, PC, S).

DISCUSSION

Syntrichia christophei is a distinct and unmistakable species which is readily known in the field by its robust, red-brown plants, lanceolate, finely long-acuminate leaves with entire margins, and long-excurrent costa as a brown awn ending in a few hyaline cells. The lanceolate leaves are very seldom found in the genus *Syntrichia* although *S. christophei* shares this leaf shape with *S. saxicola* (Cardot) R.H.Zander, a widely distributed amphiatlantic subantarctic species. The latter species has maximum occurrence in the northern maritime Antarctic (Lightowlers, 1986a; Ochyra, 1998) and on subantarctic South Georgia (Lightowlers, 1985), extending northwards to the Falkland Islands, Tierra del Fuego and the Valdivian province in Chile (Ochyra *et al*., 2008), then recurring at highly disjunct stations in Îles Kerguelen (Lightowlers, 1986b; Ochyra, 1997).

Syntrichia christophei is closely related to *S. saxicola* but differs significantly in the larger leaf size (4.5-5.2 mm *versus* 2.2-3.3 mm), larger upper laminal

cells (13-20 µm *versus* 6-14 µm), longer excurrent awn (0.5-0.7 mm *versus* 0.1-0.3 mm), as well as longer (2.5-2.7 mm) and curved capsule versus shorter (1.9-2.3 mm) and straight one. In addition, the spores of *S. christophei* are somewhat larger, 12-15 µm in diameter, versus 10-13 µm in diameter in *S. saxicola*. The latter is relatively frequent in Îles Kerguelen (Ochyra, personal observations) and does not intergrade.

One biological explanation for the large size of *Syntrichia christophei* is selection for size and heaviness on islands because lighter species or variants in small environmental patches have fewer progeny because diaspores (in this case leaf fragments or whole plants) land in unfavorable sites (e.g. the sea). This is termed precinctiveness (Carlquist, 1966) or atelochory (van der Pijl, 1972).

Certain species of Pottiaceae evince gigantism in hyperoceanic areas. These include *Didymodon maximus* (Syed *et* Crundwell) M.O.Hill, *D. giganteus* (Funck) Jur., *Trichostomum hibernicum* (Mitt.) Dixon*, T. recurvifolium* (Taylor) R.H.Zander), or on margins of the geographic range in the case of *Tortella humilis* (Hedw.) Jenn. (Eckel, 1998). Gigantism occurs on islands and also in hyperoceanic areas and mountainous regions, in other taxa, for instance, *Hymenostylium recurvirostrum* (Hedw.) Dixon var. *cylindricum* (E.B.Bartram) R.H. Zander occurs throughout the West Indies and Himalayas, *Anoectangium aestivum* (Hedw.) Mitt. demonstrates a variant with much thickened costa in Hawaii (Zander, 1977), *Weissia jamaicensis* (Mitt.) Grout and species of *Pseudosymblepharis* Mont. have thickened costae and are restricted to mountainous tropical areas but also islands, while *Leptodontium gemmascens* (Mitt.) Braithw. has a gigantic variant on subantarctic Marion Island in the South Indian Ocean (Zander, 1972).

It may be that montane and hyperoceanic areas have, as far as mosses are concerned, a patchy landscape similar to that of islands that encourages selection for large size of diaspores. The spores of *Syntrichia christophei* are not particularly large, so it may be that this species is evolutionarily neutral in regard to reproduction by spores, while one might argue that possible but presently undemonstrated polyploidy and associated gigas traits also explain the large gametophyte size. Because a comparative biology is the ultimate goal of taxonomy, it is important to consider various hypotheses of evolutionary ecology.

Syntrichia christophei is an epigean moss. It grows on bare soil or on detritus in dry, exposed and insolated sites in *Acaena magellanica* community. It forms large, extensive, mostly monospecific patches, sometimes with infrequent admixture of *Hypnum cupressiforme* Hedw., *Cratoneuropsis chilensis* (Lorentz) Ochyra and *Streptopogon australis* Mitt. In both populations the plants produce sporophytes in profusion.

The genus *Syntrichia* is well represented in the Subantarctic. Lightowlers (1985, 1986b) recorded eight species and two varieties from this biome (under the genus *Tortula* Hedw.). However, one of these, *Tortula arenae* (Besch.) Broth. was transferred to the genus *Hennediella* Paris (Zander, 1993; Cano, 2008) but this loss is now compensated by the newly described *S. christophei*. Only one species, *S. andersonii* (Ångstr.) R.H. Zander has a pan-Holantarctic geographical range, whereas *S. rubra* (Mitt.) R.H. Zander occurs only on Macquarie Island in the Australasian sector of Subantarctica (Seppelt, 2004), and *S. robusta* (Hook. *et* Grev.) R.H. Zander and *S. fontana* (Müll. Hal.) R.H. Zander are known only from South Georgia in the American sector of this biome. The other four species, namely *S. filaris* (Müll. Hal.) R.H. Zander, *S. geheebiopsis* (Müll. Hal.) R.H. Zander, *S. magellanica* (Mont.) R.H. Zander and *S. saxicola* (Cardot) R.H. Zander are amphiatlantic species occurring disjunctively in southern South America, on subantarctic South Georgia and in the northern maritime Antarctic

in the American sector of the Subantarctic and then appear in the Kerguelen biogeographical province in the African sector of this biome. All of them are known from Îles Kerguelen themselves and with the discovery of *S. christophei* the number of the species in this largest subantarctic archipelago increased to five species.

Syntrichia christophei is endemic to Îles Kerguelen. So far, it has been found only in a narrow area on Île Australia in Golfe du Morbihan, but it is likely that it can be found elsewhere in this large archipelago with progress with field studies. Although no less than 115 species of moss were described as new from this archipelago, the real number of species endemic to it is very small. It is because very many species names were reduced to synonymy with species described from elsewhere or a number of initially endemic species has subsequently been discovered on other subantarctic islands, for example *Hennediella marginata* (Hook.f. *et* Wilson) R.H. Zander in Îles Crozet (Cano, 2008), *Hymenoloma dryptodontoides* (Müll. Hal.) Ochyra in the Prince Edward Islands (Ellis *et al.*, 2011), *H. tortifolia* (Hook.f. *et* Wilson) Ochyra in Îles Crozet (Ellis *et al.*, 2013). At present only four species may be considered endemic to Îles Kerguelen, including *Muelleriella atrata* (Mitt.) Vitt, *Schistidium chrysoneuron* (Müll. Hal.) Ochyra, *Bucklandiella ochracea* (Müll. Hal.) Bednarek-Ochyra *et* Ochyra and *B. fuscolutea* (Cardot) Bednarek-Ochyra, although the taxonomic status of the last two species needs a careful taxonomic assessment.

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