

Racomitrium norrisii sp. nova (Grimmiaceae, Bryopsida), endemic of western North America

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Racomitrium norrisii Bedn.-Ochyra & Ochyra (Grimmiaceae, Bryopsida) is described as a new species of subgen. *Cataracta* Vilh. and sect. *Stenotrichum* (Chev.) Bedn.-Ochyra, and its diagnostic features are illustrated. It is closely related to the European *R. hespericum* Sérgio, Muñoz & Ochyra from the Iberian Peninsula from which it differs in its leaves with bistratose marginal border of (1–)2–10(–13) rows of cells extending from the base to the apex; unistratose laminae in the upper part; shorter, 9–12-celled axillary hairs; and lacking or inconspicuous papillae over the cell walls. *Racomitrium norrisii* is a hydrophytic moss endemic to western North America where it occurs in California and Idaho.

Key words: Bryophyta, California, Grimmiaceae, Idaho, Musci, new species, North America, *Racomitrium*, taxonomy

INTRODUCTION

The moss genus *Racomitrium* Brid. is well represented in North America north of Mexico and so far 24 species have been recorded from this area (Anderson *et al.* 1990). The number of species recognized for this continent has markedly increased in the last two decades and the checklist of the North American mosses of 1973 provided only ten species and five varieties of *Racomitrium* (Crum *et al.* 1973). The rapid increase of the specific richness of *Racomitrium* in North America is primarily a result of the careful taxonomic studies of the *R. canescens* (Hedw.) Brid.

and *R. heterostichum* (Hedw.) Brid. complexes (Frisvoll 1983, 1988), yielding a good number of distinct and well defined species.

This does not seem to be the final number and the taxonomic revision of the third large complex of species centered around *Racomitrium aciculare* (Hedw.) Brid. and *R. fasciculare* (Hedw.) Brid., which are classified into subgen. *Cataracta* Vilh. (Bednarek-Ochyra 1995), should result in the discovery of additional new species. Hitherto, one new species, *R. aduncooides* Bedn.-Ochyra, was discovered in the Appalachian region in the eastern part of the continent (Bednarek-Ochyra 1999) and the present paper provides description of an-

other new species from the west coast of North America.

It is a great pleasure to us to name this new species *Racomitrium norrisii* in honour of Dr. Daniel H. Norris. It is a tribute to his great collecting activity in California and adjacent territories, which yielded many important moss records to the bryoflora of the Pacific coast of North America. He also drew our attention to this peculiar moss noting its similarity to the European *R. hespericum* Sérgio, Muñoz & Ochyra.

DESCRIPTION

Racomitrium norrisii Bedn.-Ochyra & Ochyra, *sp. nova* (Figs. 1–3)

Species Racomitrio hesperico valde similis, a quo laminis versus apicem unistratosis, cellulis laminae laevibus vel infirme papillois supra parietes, pilis axillaribus 9–12 cellularum compositis et foliis limbatis, limbis bistratosis, 2–10-seriatis facile dignoscenda.

TYPE: U.S.A. California, El Dorado Co.: along South Fork of the American River at Carpenter Creek, 1 300 m, 7 April 1981, Norris 58449 (holotype UC, isotype KRAM).

Plants small to medium-sized, dull, stiff and rigid, forming loose or rarely compact tufts, light to dark olive-green above, blackish-brown below, occasionally dark green above and blackish below or blackish throughout. *Stems* ascending, (1.5–)2.0–3.0(–3.5) cm long, sparsely to repeatedly irregularly branched, densely foliate, but with leaves often heavily eroded at base, in cross-section rounded, without central strand, consisting of 1–3 layers of small, sclerenchymatous cortical cells with moderately incrassate walls and small lumina surrounding 5–6-layered medulla composed of large, hyaline to yellowish-hyaline cells with thin to slightly thickened walls. *Rhizoids* sparse to abundant, mostly scattered in clusters in the lower part of stems, smooth, long, branched, reddish-brown. *Axillary hairs* infrequent in the apical parts of stems and branches, filiform, hyaline throughout, consisting of 9–12 relatively short, barrel-shaped cells below and more elongate above. *Stem and branch leaves* similar in size and shape, evenly set and crowded, appressed,

closely imbricate and erect when dry, erect-spreading when wet, lingulate to oblong-lanceolate, (1.7–)2.0–2.5(–3.0) mm long, 0.7–0.8(–0.9) mm wide, obtusely keeled below, concave above, not plicate, usually distinctly auriculate and decurrent at base, without hair-point, rounded-obtuse at the apex, occasionally long acuminate; *margins* bistratose throughout, broadly recurved on one side and flat to narrowly recurved on the other side from the base to mid-leaf or sometimes higher, plane above, entire below, distantly, bluntly erose-dentate at the extreme apex or sometimes down the margin in the upper one-fourth, sometimes nearly entire, especially on older leaves, bordered from nearly the base by (1–)2–10(–13) rows of cells in 2 or very rarely 3–4 layers; *costa* single, almost concolorous and weakly demarcated from the laminal cells to dark yellow or brownish on older leaves, almost of the same width throughout or somewhat tapering above, 70–90(–120) μm wide, extending almost to the apex but not sharply delimited above and imperceptibly merging into laminal cells, in cross-section plano-convex throughout or occasionally somewhat biconvex above, bistratose and crescent-shaped dorsally at the apex with 3–4 larger ventral cells, becoming gradually 3(–4)-stratose in the upper half, mostly with 3–4 larger cells in the central row and imperfectly developed row of ventral cells and somewhat wider in mid-leaf, plano-convex and flattened-lunate dorsally, with 6–8 rows of larger cells across ventrally, below lying in a shallow groove, strong, flattened-reniform dorsally, 4–5-stratose with 6–8 large ventral cells; *laminal cells* unistratose throughout except for bistratose marginal thickenings, without or with inconspicuous papillae over the cell walls, with moderately to strongly sinuose or nodulose, firm to thick walls; *upper cells* irregularly rounded-quadrate, oval, short-rectangular to transversely short-rectangular, 6–12(–14) μm long, 6–8(–10) μm wide, becoming short-rectangular to irregularly quadrate in mid-leaf, (8–)12–22(–25) μm long, (7–)8–10(–12) μm wide, and longer rectangular, to 50 μm long, 8–10 μm wide below; *cells at the insertion* rectangular only slightly different from the adjacent laminal cells, weakly sinuose and somewhat porose, moderately thick-walled, forming a distinct yellow to intensively yellow strip of 1–2 rows of cells; *alar cells*

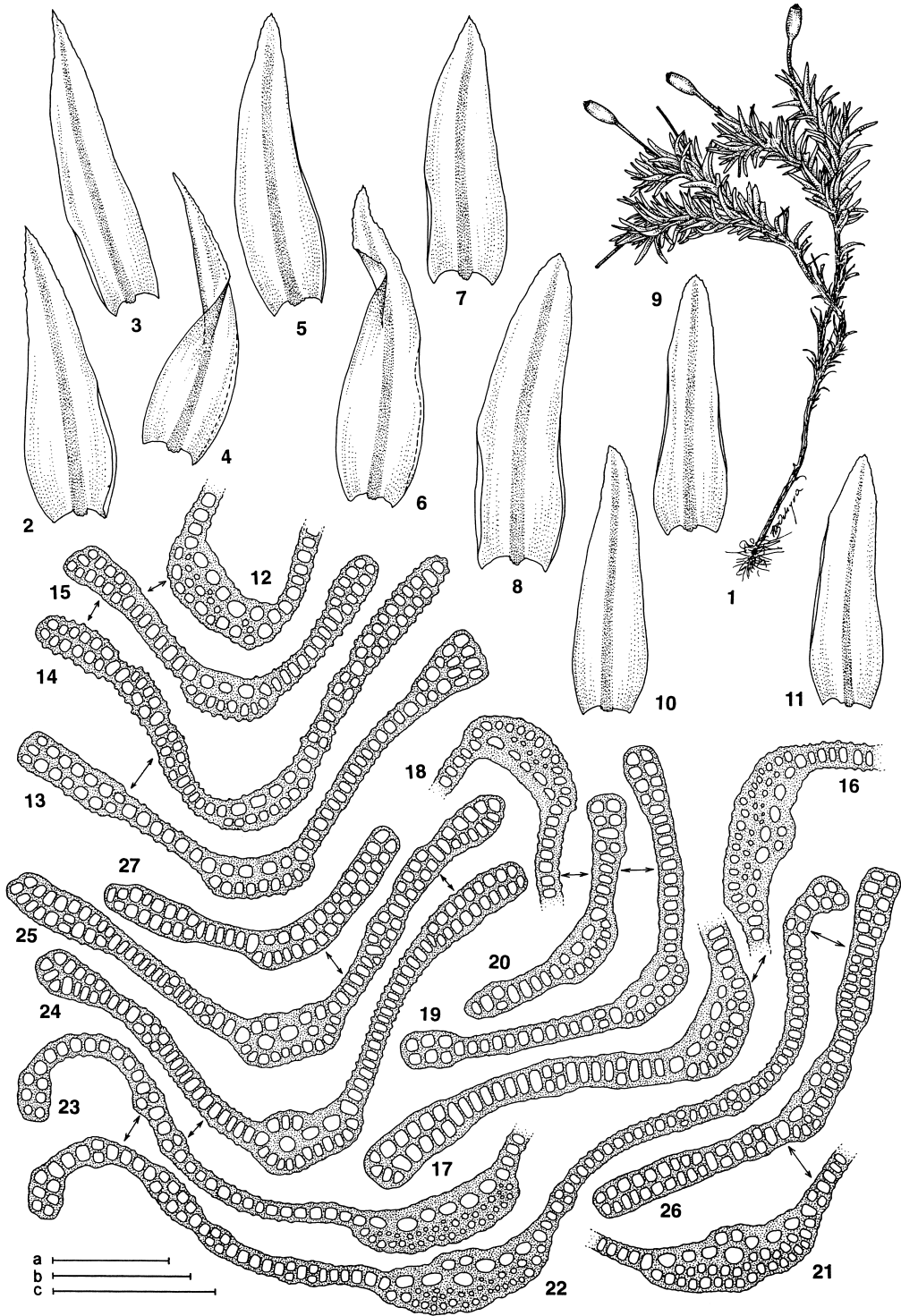


Fig. 1. *Racomitrium norrisii* Bedn.-Ochyra & Ochyra. — 1: Habit. — 2–11: Leaves. — 12–27: Transverse sections of leaves from four various plants, a sequence from base to apex [drawn from *Norris 58449* (isotype) (1, 9–11, 21–27); *Flowers 6507* (2–4, 18–20); *Shevock & York 14499* (5–6, 12–15); *Wagner 810* (7–8, 16–17); all in KRAM]. Scale bars: a = 1 mm (2–11), b = 100 μ m (12–27), c = 1 mm (1).

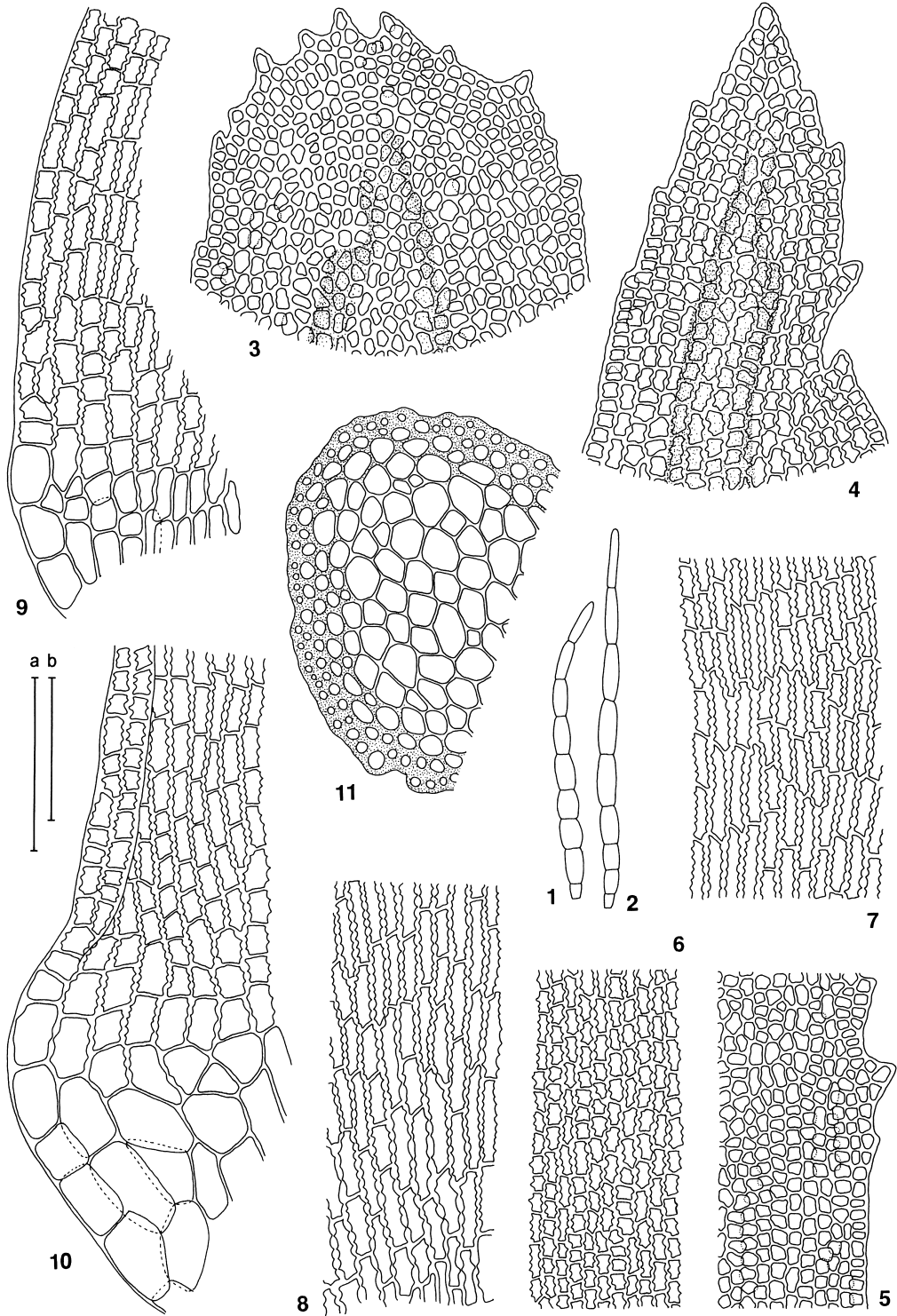


Fig. 2. *Racomitrium norrisii* Bedn.-Ochyra & Ochyra. — 1 and 2: Axillary hairs. — 3 and 4: Leaf apices. — 5: Upper leaf cells at margin. — 6: Upper cells. — 7: Mid-leaf cells. — 8: Basal juxtacostal cells. — 9 and 10: Alar and supra-alar cells. — 11: Portion of stem section [drawn from *Norris 58449* (isotype) (1–2, 9–11); *Shevock & York 14499* (3, 5–8); *Flowers 6507* (4); all in KRAM]. Scale bars: a = 100 μ m (3–11), b = 100 μ m (1 and 2).

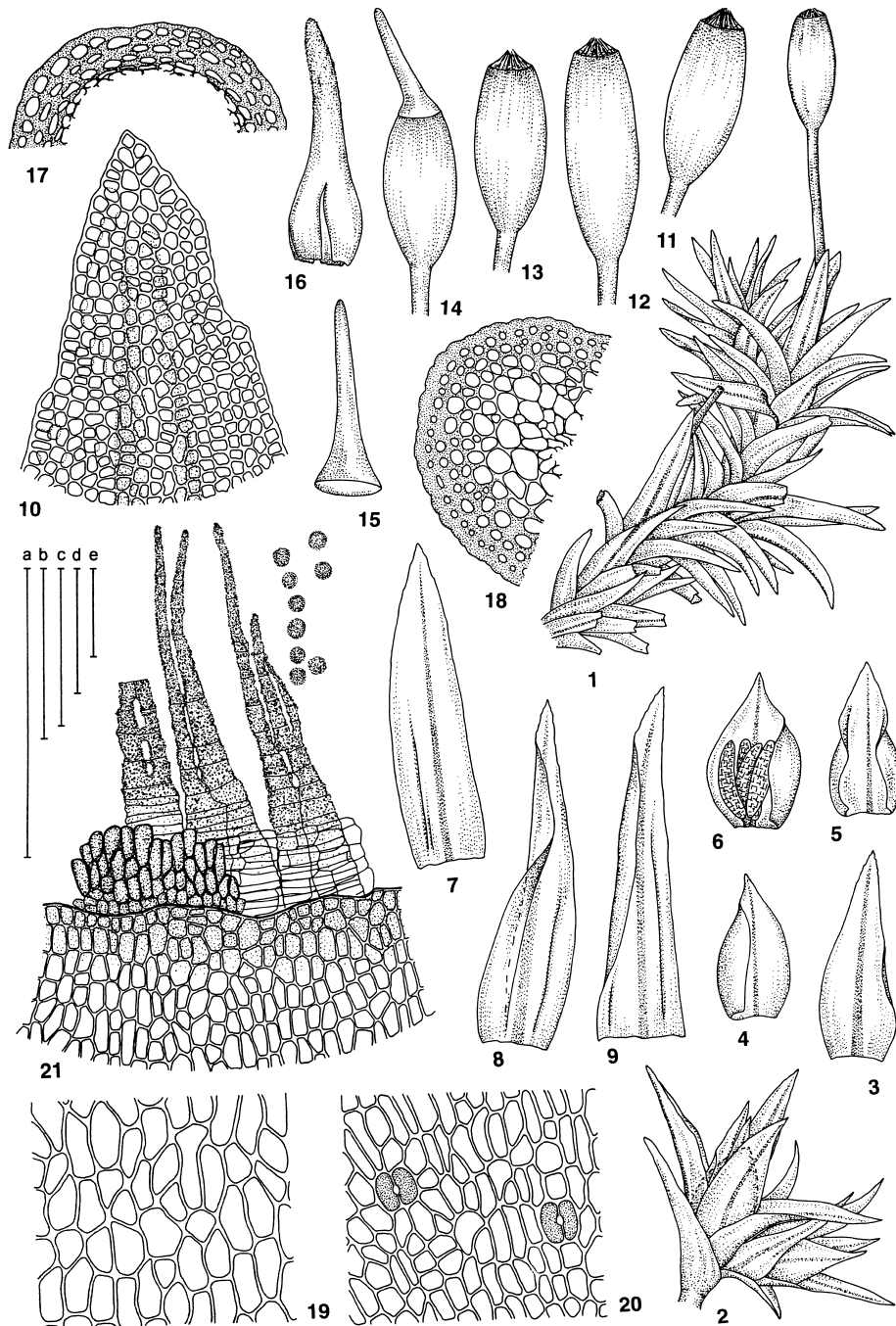


Fig. 3. *Racomitrium norrisii* Bedn.-Ochyra & Ochyra. — 1: Habit of the plant with sporophyte, wet. — 2: Perigonium. — 3: Outer perigonial bract. — 4 and 5: Inner perigonial bracts. — 6: The innermost perigonial bract with antheridia. — 7–9: The innermost perichaetial leaves. — 10: Apex of the innermost perichaetial leaf. — 11–13: Deoperculate capsules. — 14: Operculate capsule. — 15: Operculum. — 16: Calyptra. — 17: Transverse section of calyptra. — 18: Portion of the transverse section of seta. — 19: Exothelial cells in the middle of urn. — 20: Exothelial cells and stomata at urn base. — 21: Exothelial cells at the orifice, annulus, peristome and spores [drawn from *Norris 58468* (1, 11–14) & *58449* (isotype) (7–10, 15–21); *Wagner 810* (2–6); all in KRAM]. Scale bars: a = 0.5 cm (1), b = 100 μ m (10, 17–18), c = 1 mm (6), d = 1 mm (2–5) and 100 μ m (7–9, 15 and 16, 19 and 20), e = 1 mm (11–14) and 100 μ m (21).

subquadrate to short-rectangular, larger than other basal cells, 20–30(–60) μm long, 14–25 μm wide, with thin to moderately thick, smooth to sinuose walls, usually forming distinct, yellow-green to brown, flat or swollen, pellucid, shortly decurrent auricles, or sometimes almost undifferentiated and not forming distinct auricles; *basal marginal cells* quadrate to short rectangular, 9–11 μm wide, 10–16 μm long, thick-walled, sinuose, not pellucid, not particularly different from the adjacent laminal cells and not forming a distinct border.

Dioecious. *Perigonia* bud-like, 0.8–1.1 mm long, rather infrequent; *outer perigonial bracts* similar to vegetative leaves, only smaller; *inner perigonial bracts* yellow-brown, ovate, broadly and shortly acute, 0.9–1.0 mm long, strongly concave, with a rather firm costa ending well below the apex; *antheridia* 5–7 per perigonium, club-shaped, pale, short-stalked; *paraphyses* lacking. *Outer perichaetial leaves* lanceolate to oblong-lanceolate, gradually narrowly acuminate, 2.2–2.5 mm long, 0.7–0.8 mm wide, with narrowly obtuse or acute apex, entire to weakly erose-dentate, with upper laminal cells thick-walled and sinuose, generally similar to those in the vegetative leaves, and lower cells rectangular, rather thin-walled and weakly sinuose; *inner perichaetial leaves* oblong-ovate to lingulate, rounded-obtuse to obtusely acute at the apex, 2.8–3.0 mm long, 0.8–0.9 mm wide, entire or indistinctly erose, strongly concave, sheathing below, yellowish-brown to hyaline, composed of thin-walled cells below, chlorophyllose in the upper one-third and composed of cells similar to those in the vegetative leaves. *Setae* single in perichaetium, short, 4.0–4.2 mm long, light brown above, dark brown below, becoming dark brown throughout with age, smooth, dextrorsely twisted when dry; *vaginula* dark brown, 0.7–1.0 mm long, with rectangular, sinuose epidermal cells. *Capsule* erect, straight, obloid to shortly cylindrical, gradually narrowed towards the seta and the mouth, 1.5–2.0 mm long, 0.9–1.0 mm wide, smooth, dull to somewhat lustrous, light brown becoming dark brown with age, pachydermous; *operculum* erect, long-rostrate, with a straight rostrum to 1.0 mm long; *exothecial cells* isodiametric to elongate, irregularly hexagonal, subquadrate to short-rectangular, 20–70 μm long, 15–25 μm wide, firm-walled, becoming rounded to oval below the mouth and forming

distinct, 5–7-seriate yellow-brown rim; *stomata* quite few near the base of the urn in 1–2 rows, superficial, bicellular with rounded pores, variously oriented; *annulus* separating, 3–4-seriate, composed of pellucid, orange- to yellow-brown, thick-walled cells with 2–3 outer rows of elongate cells and basal rows of short, isodiametric cells; *peristome* single composed of 16 teeth, 340–420 μm long, orange-brown, irregularly split to the middle or slightly below into 2–3 filiform, terete, not clearly barred prongs, sometimes irregularly perforate, densely papillose with tall, peg-like papillae; *basal membrane* short, to 40 μm high, finely papillose; *preperistome* present as high as the basal membrane. *Spores* globose, finely papillose, pale yellowish-brown, 15–20 μm in diameter. *Calyptra* conic-mitrate, dark brown, somewhat roughened at the apex, naked, not plicate, 4–5-lobed at base.

OTHER SPECIMENS EXAMINED (PARATYPES). — **U.S.A. California.** *El Dorado Co.*: along South Fork of the American River at Carpenter Creek, 1 300 m, 7.IV.1981, *Norris 58441, 58448B, 58468* (KRAM, UC); along South Fork of American River at Bridal Veil Falls Campground, 1 000 m, 7.IV.1981, *Norris 58364* (KRAM, UC). *Tuolumne Co.*: Columbia, on bank of south fork of the Stanislaus River, 6.III.1935, *Gifford & Ikenberry 51* (DUKE). *Mariposa Co.*: Yosemite Valley, 4 200 ft., 29.VIII.1966, *Flowers 6507* (ALTA, KRAM). *Fresno Co.*: Sequoia National Forest, off California Hwy 180, just E of Deer Cove Creek, South Fork Kings River, 4 350 ft., 4.X.1996, *Shevock & York 14499* (KRAM, MO). **Idaho.** *Idaho Co.*: Selway Falls, 19.X.1975, *Wagner 810* (KRAM).

DISCUSSION

Racomitrium norrisii clearly belongs within subgen. *Cataracta* as defined by Bednarek-Ochyra (1995) on account of its papillose calyptra, dextrorse setae and the structure of the costa. Paradoxically, the basic diagnostic feature of the subgenus, namely the large, flat papillae over the cell walls covering a major part of the lumina are less evident in this species and most older leaves appear to be smooth or nearly so as seen in leaf cross-section. Nevertheless, the weak papillosity of the laminal cells can be easily observed on younger leaves. In contrast to all other species of this subgenus, except for *R. depressum* Lesq. and *R. dichelymoides* Herz., the papillae are not excessively large and they cover only the cell walls

leaving a major part of the lumina free, whereas in all other species the papillae cover most of the lumina leaving only a narrow slit in the centre.

Racomitrium norrisii shows a close alliance with *R. aciculare* and in fact almost all collections of this species were originally so-named. Both species share the lingulate leaves with rounded-obtuse apices and erose-dentate margins in the apical part and these characters warrant recognition of sect. *Stenotrichum* (Chev.) Bedn.-Ochyra to accommodate this complex. Apart from the type species, *R. aciculare*, this section comprises only two recently described species, namely *R. hespericum* from Portugal and Spain (Sérgio *et al.* 1995) and *R. aduncooides* from eastern North America (Bednarek-Ochyra 1999). Of these, only *R. hespericum* appears to be very closely related to *R. norrisii*, the other two being immediately distinct in their entirely unistratose laminal cells.

Both *Racomitrium hespericum* and *R. norrisii* have in common primarily multistratose leaf laminae. In the former, the entire distal part of the leaf is 2–4-stratose, with only occasional unistratose strands towards the mid-leaf. In contrast, *R. norrisii* has only bistratose leaf margins which form distinct multiseriate thickenings extending from the base to the apex and leaving unistratose laminae even at the extreme apex. In addition, *R. hespericum* has very large, flat papillae which cover almost the entire lumina of the cells, whereas in *R. norrisii* the papillae are lacking on older leaves or narrow and situated strictly over the cell walls. *R. hespericum* seems to have a stronger cortex of the stem, being composed of 3–4 layers of sclerenchymatous cells, whereas *R. norrisii* has only 1–3-layered cortex, but this structure is subject to considerable variation in aquatic mosses. Moreover, the axillary hairs in *R. hespericum* are relatively long, (10–)12–20-celled, whereas those in *R. norrisii* are shorter, 9–12-celled. In this feature the latter resembles much more *R. aciculare* in which the axillary hairs consist of 6–11(–13) cells. In general, *R. norrisii* shows relatively little variation in its diagnostic characters and therefore it is a well defined and easily distinguished species.

Like other species of sect. *Stenotrichum*, *Racomitrium norrisii* is a rheophytic moss. Most

of its collections come from wet habitats in and at banks of streams and rivers. It grows on moist, diffusely lit boulders in streams as well as on stones and rocks subject to temporary inundations and often the species was collected from submerged rocks.

Racomitrium norrisii is endemic to western North America and most of its localities are in the Sierra Nevada of California at elevations of 1 000–1 450 m in mixed conifer forest. Only once the species was found in Idaho.

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