

## On the occurrence of *Racomitrium aquaticum* (Schrad.) Brid. (Grimmiaceae, Musci) in Asiatic Russia

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**Abstract** – The voucher specimens of *Racomitrium aquaticum* (Schrad.) Brid. from the Russian Far East and Central Siberia in Asiatic Russia are re-assessed and some details of their gametophytes are illustrated. It is concluded that they represent muticous ecads of *R. sudeticum* (Funck) Bruch & Schimp. Accordingly, *R. aquaticum* is withdrawn from the moss flora of mainland Asia.

**Bryophyta / Musci / Grimmiaceae / *Racomitrium* / Asia / Russia / Siberia / Far East / taxonomy / distribution**

### INTRODUCTION

In the bryological literature *Racomitrium aquaticum* (Schrad.) Brid. has long been considered as a bipolar species, reported outside the Holarctic from widely scattered stations in the Southern Hemisphere, including southern South America, the Falklands and Îles Kerguelen (Wilson & Hooker, 1847), New Zealand (Wilson, 1854), Australia (Jaeger, 1874; Bastow, 1887; Watts & Whitelegge, 1902) and Tasmania (Wilson 1859). Although it was proved a long time ago that these records were erroneous and they actually referred either to the complex of *R. crispulum* (Hook.f. & Wilson) Hook.f. & Wilson (Müller, 1849, 1889; Dixon, 1926) or were described as the separate and very distinct species *R. lamprocarpum* (Müll. Hal.) A. Jaeger (Ochyra *et al.*, 1988), even in the latest bryogeographical treatments *R. aquaticum* is still recognized as a bipolar species (Ignatov & Cao, 1994; Dierßen, 2001).

After withdrawal of all austral records of *Racomitrium aquaticum*, the species has to be considered as a pan-Holarctic moss, having a strongly dissected boreal-montane range with distinct oceanic affinities and a maximum of occurrence in Europe (Ochyra *et al.*, 1990). However, during a revisionary study of the moss genus *Racomitrium* Brid. subg. *Cataracta* Villh., I found that *R. aquaticum* was erroneously reported from North America and the specimens so-named from the western part of the continent were described as a distinct species, *R. ryszardii*

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Bednarek-Ochyra, ranging from south-eastern Alaska to northern Oregon (Bednarek-Ochyra, 2000).

*Racomitrium aquaticum* has been reported from Asia, including Japan (Noguchi, 1974), China (Zhang, 1978) and Asiatic Russia. From the latter region Abramova and Abramov (1966) and Bardunov (1969) reported three specimens from Irkutsk Province in Central Siberia. It is worth noting that two of them were collected in the early 1920s by V. Smirnov and V. F. Brotherus determined them as *R. protensum* (Duby) Bruch & Schimp. which is identical to *R. aquaticum* (Bednarek-Ochyra, 1999). Later, this species was also reported from Kolymское Nagorye (= Kolyma Highland) in Magadan Province in the Russian Far East (Blagodatskikh, 1984). I was successful in locating the voucher specimens on which these records were based in LE, H and M and re-examination of these plants led me to the conclusion that they in fact had nothing to do with *R. aquaticum* but represented epilose ecads of the pan-Holarctic *R. sudeticum* (Funck) Bruch & Schimp.

## DESCRIPTION OF RUSSIAN PLANTS

*Racomitrium sudeticum* (Funck) Bruch & Schimp. in Bruch, Schimp. & W.Gümbel, *Bryol. Eur.* 3: 151, pl. 264 [Fasc. 25-28 Mon.: 7, pl. 1]. 1845 (Fig. 1)

**Plants** medium-sized and slender to rather large and robust, mostly stiff and coarse, in wide, somewhat lustrous, moderately loose to dense tufts or mats, golden-brown to yellow- or olive-green above, brown to dark brown below. **Stems** erect, 2-8 cm long, sparsely dichotomously branched with predominantly elongate erect branches, not or sparsely radiculose at base with long, brown, somewhat branched, smooth rhizoids, round in transverse section, lacking central strand and consisting of (1-)2-3-stratose cortex of small, brown, thick-walled stereid cells and 5-6 layers of large, hyaline medullary cells with thin to moderately thick walls; **axillary hairs** filiform, hyaline throughout, 8-10-celled, with short, barrel-shaped basal cells and elongate upper cells. **Leaves** crowded, erect and closely appressed above, often erect-spreading below, not or slightly altered on drying, erect-spreading on wetting, straight to somewhat falcate, lanceolate to oblong-lanceolate, 2.5-3.5 mm long, 0.7-0.9(-1.0) mm wide, not or somewhat decurrent, gradually acuminate to slender, narrowly obtuse, always mucous apex; **margins** unistratose in proximal part, broadly recurved or revolute to 1/2-3/4 the leaf length or somewhat higher up on one side, on the other side narrowly recurved in the broadest part or frequently plane, in distal part plane or somewhat deflexed, uni- or bistratose for one cell row; **costa** single, dark yellow to yellow-brownish, sharply demarcated from laminal cells, 90-100(-110)  $\mu\text{m}$  wide in the broadest part, strongly convex and smooth dorsally, semi-terete, bistratose near the apex, with 2 ventral epidermal cells, becoming flattened-lunate, (2-)3-stratose, with 3-4 large ventral cells in median and basal parts; **laminal cells** unistratose throughout, smooth, sinuose-walled, subquadrate to short-rectangular and transversely rectangular at margins in distal and median parts, 8-20  $\mu\text{m}$  long, 8-10  $\mu\text{m}$  wide, becoming short rectangular in proximal part, 20-45  $\mu\text{m}$  long, 9-11  $\mu\text{m}$  wide; **basal cells** rectangular, to 80  $\mu\text{m}$  long, less sinuose-walled, often porose, forming yellow-brown 1-2-seriate strip along insertion; **alar cells** not differentiated; **basal marginal cells** short

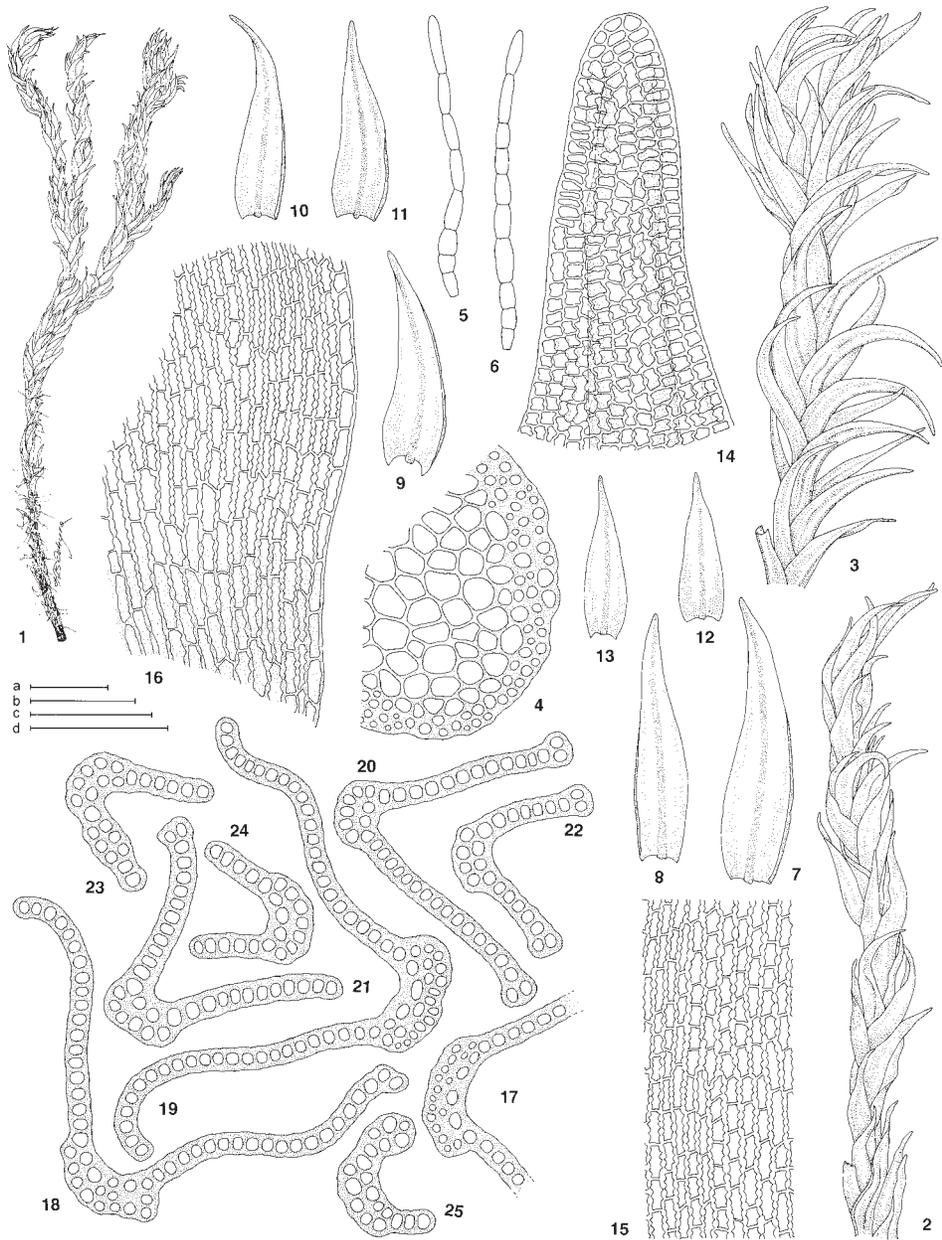


Fig. 1. *Racomitrium sudeticum* (Funck) Bruch & Schimp. – **1.** Habit. **2.** Portion of shoot, dry. **3.** Same, wet. **4.** Transverse section of stem. **5–6.** Axillary hairs. **7–13.** Leaves. **14.** Leaf apex. **15.** Mid-leaf cells. **16.** Basal cells of leaf. **17–25.** Transverse sections of leaves, a sequence from base (17–19) through middle (20–21) to apex (22–25). [1–3, 10–12 from Smirnov 26; 4–6, 13–15, 17–27 from Smirnov 181; 7–9, 16 from Blagodatskikh s.n., 19 Aug 1976; all in KRAM.] Scale bars: a – 1 mm (2, 7–13); b – 100  $\mu$ m (5–6); c – 0.5 cm (1) and 1 mm (3); d – 100  $\mu$ m (4, 14–25).

rectangular, yellowish, pellucid, mostly with thick, sinuose to nearly straight walls, forming  $\pm$  distinct row of about 5-10 cells long. Sterile.

**Specimens examined.** – RUSSIA. IRKUTSK PROVINCE. River-basin of the Irkut River, Khanar-Daban, near the spring of the Podkamarnaya River in the system of the Bystraya River, mossy tundra on the top of a bare boulder, Sep 1940, *Smirnov 26* (KRAM, LE); southern coast of Baykal Lake, bare boulders in the spring of the Slyudyanka River, on mossy north-facing slope, 15 Jun 1924, *Smirnov 181* (H, KRAM, LE, M) and 17 Jun 1924, *Smirnov 153* (KRAM, LE); Buryat Autonomous Republic, Baykal Lake, Svyatoy Nos Peninsula, the upper course of the Prav. Markovoy River, alpine meadows below snow patch, 24-26 Jun 1961, *Siplivinskiy & Lagutskaya s.n.* (KRAM, LE). MAGADAN PROVINCE. Sibat Tyellakh, on stones in the river-bed in the upper course of the river, 19 Aug 1976, *Blagodatskikh s.n.* (KRAM, LE).

## DISCUSSION

The plants from the Russian Far East and Siberia are remarkable in having consistently mucous leaves with narrowly obtuse apices. This gives them a peculiar appearance which may indeed be very suggestive of *Racomitrium aquaticum*, in which a hyaline hair-point is never present. Similar leaf apices are found in a number of species in this genus, for example in *R. ellipticum* (Turner) Bruch & Schimp., *R. depressum* Lesq., *R. aciculare* (Hedw.) Brid., *R. fasciculare* (Hedw.) Brid. and *R. cucullatifolium* Hampe. In addition, in a number of species there are frequent or predominant modifications with epilose leaves, apart from plants with normally piliferous leaves, for instance in *R. obtusum* (Brid.) Brid., *R. cucullatum* Broth., *R. macounii* Kindb., *R. canescens* (Hedw.) Brid. and *R. barbulooides* Cardot. Therefore the shape of the leaf apex is of less importance in the taxonomy of *Racomitrium* than some of the other structural characters of the gametophytes (e.g., anatomy of costa, papillosity of laminal cells) and sporophytes (e.g., peristome teeth, perichaetial leaves, seta, calyptra) which are fundamental to the internal classification of the genus and warrant its division into four distinct subgenera (Bednarek-Ochyra, 1995).

*Racomitrium aquaticum* clearly belongs to subg. *Cataracta* which is primarily recognized by the presence of large, flat papillae distributed over the longitudinal walls and most part of the lumina leaving only a narrow slit in the middle. In addition, the calyptra is densely papillose, the costa ceases well below the leaf apex and the seta is dextrorse (except for *R. fasciculare*). Although the sporophyte characters cannot be verified in the Russian material as it is sterile, the gametophyte characters appear to be sufficient to exclude any alliance of these plants with the subg. *Cataracta* because they have entirely smooth laminal cells. This character clearly indicates that they belong to subg. *Ellipticodryptodon* (Vilh.) Bednarek-Ochyra & Ochyra which is characterized, among other things, by smooth or merely pseudopapillose laminal cells due to the presence of cuticular thickenings over the laminal cells. In the other two subgenera, subg. *Racomitrium* and subg. *Niphotrichum* Bednarek-Ochyra the laminal cells are also papillose. In the type subgenus the papillosity is similar to that in subg. *Cataracta* and the only difference is the presence of small secondary papillulae over the outer surface of the primary papillae, whereas in subg. *Niphotrichum* the papillae are stout, tall and conical and scattered over the cell lumina.

Subg. *Ellipticodryptodon* is the largest subgenus within *Racomitrium*, consisting of over 40 species, i.e. about two-third of all taxa known in this genus. Of these, no less than 15 species are known to occur in Asia (Frisvoll, 1988) which may be classified into five sections sensu Bednarek-Ochyra (1995). Although recognition of sections within this subgenus is primarily based on the structure of the perichaetial leaves, the combination of the following gametophyte characters including the presence of the basal marginal border of pellucid, sinuose to esinuose cells, very short, mostly quadrate upper laminal cells, bistratose leaf margins in the distal portion, sinuose basal laminal cells and the lack of hair-point clearly indicate that the Russian plants initially named *R. aquaticum* should be associated with sect. *Sudetica* Bednarek-Ochyra. The internal structure of the costa which is (2-)3-stratose in the basal part and has only 3-4 enlarged ventral epidermal cells clearly indicate that these plants are *R. sudeticum*. In the closely related species *R. affine* (Schleich. ex F.Weber & D.Mohr) Lindb. the costa is stronger in the proximal part, being 3-4-stratose with 5-7 large ventral cells. Likewise, a strong costa is present in *R. macounii* Kindb. which is similar to the Russian plants in the frequent absence of the hair-point, which may also be very short, to 0.1 mm, and yellowish. However, this species has a very thick, 4-5-stratose costa in the lower part and frequently 2-3-seriate bistratose margins in the distal part of the leaves. It should be added that both *R. affine* and *R. macounii* have not yet been discovered in mainland Asia. On the other hand, *R. sudeticum* is widely distributed but scattered in Asia and occurs infrequently in the Altai Mts. (Ignatov & Cao, 1994), in the Russian Far East (Frisvoll, 1988), on Chukotka (Afonina, 1989), in China (Cao *et al.*, 2003) and in Japan (Noguchi, 1974).

Apart from Russia, *Racomitrium aquaticum* was only once reported from mainland Asia, namely from Shaanxi (Shensi) Province in central China (Zhang, 1978). Unfortunately, no voucher collections were available for examination, either during the present study or for the authors of the treatment of *Racomitrium* for the Moss Flora of China project (Li, 2000; Cao *et al.*, 2003). The occurrence of this species in China is doubtful and it is quite possible that this record refers to *R. carinatum* which is scattered in China. Examination of several collections of this species from various provinces in this country showed that they are externally very similar to *R. aquaticum* and the only real difference is in the anatomy of the costa. Until the voucher collections are studied, *R. aquaticum* should be excluded from the moss flora of China as it was in the English version of the Moss Flora of China (Cao *et al.*, 2003). Accordingly, this species should be excluded from the moss flora of mainland Asia.

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