

## *Racomitrium hespericum*, a New Species from the Iberian Peninsula

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**Abstract.** *Racomitrium hespericum* from the Iberian Peninsula is described as a new species of section *Papillosa* (Kindb.) Nog., and its diagnostic characters are illustrated. It is closely related to *R. aciculare* (Hedw.) Brid. *Racomitrium hespericum* is an aquatic moss, and its ecology is discussed. The distribution of the species is mapped. It is endemic to the Iberian Peninsula.

During revision of Iberian material of *Racomitrium* Brid. from various herbaria in order to find specimens corresponding to either *R. lusitanicum* Ochyra & Sérgio or *R. lamprocarpum* (C. Müll.) Jaeg.—two species recently recorded from this area (Ochyra & Sérgio 1992; Ochyra et al. 1988)—we found several collections that appeared to be close to the latter, but in obtuse and bluntly denticulate leaf apex approached *R. aciculare* (Hedw.) Brid. Because of the pluristratose leaf lamina, some plants were initially also included in *R. lamprocarpum*. Casas et al. (1992) recognized plants, collected by Casares in Sierra de Guadarrama in central Spain, as *R. lamprocarpum*, and it was one of the first records of this species from Spain. On the other hand, another specimen with blunt and slightly toothed leaf apex from Serra da Estrela, Portugal, was placed in *R. aciculare*, mostly because the plants in their overall appearance very much resembled vigorous phenotypes of this species.

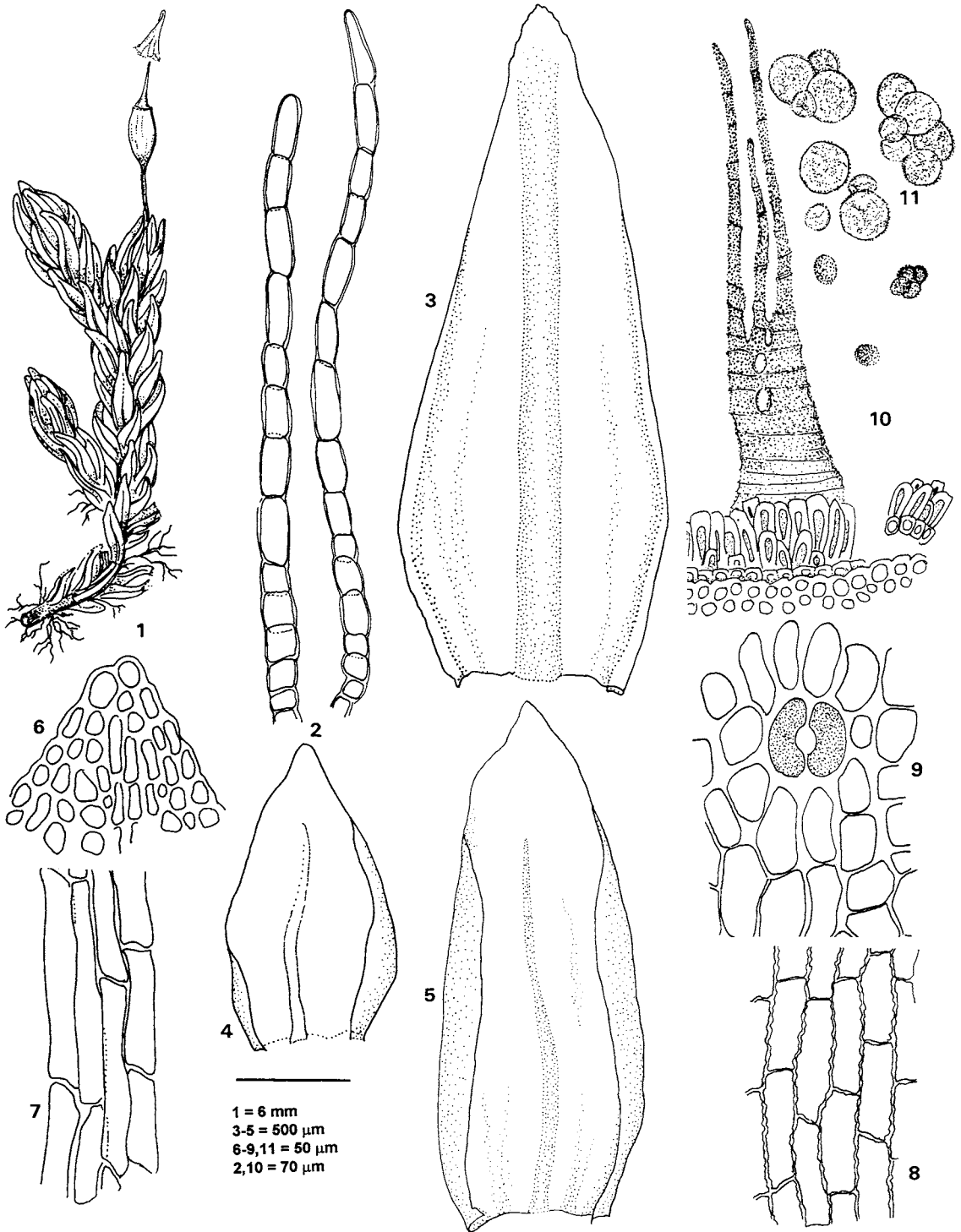
In January 1992 one of us (C.S.) revisited Serra da Estrela and was successful to find this plant in fine fruiting condition. Subsequent field work and herbarium search yielded many additional specimens of this species. These new records show this is a frequent *Racomitrium* in Serra da Estrela, where it grows generally at an elevation over 1,000 m, and additionally it is scattered in the Central Iberian Massif (Hesperic Massif). It is similar ecologically to *R. aciculare* and both species form sometimes mixed stands. Nevertheless these plants reveal a set of unique characters that fully justifies recognizing them as a new species.

**RACOMITRIUM HESPERICUM** Sérgio, Muñoz & Ochyra  
sp. nov. (FIG. 1–26)

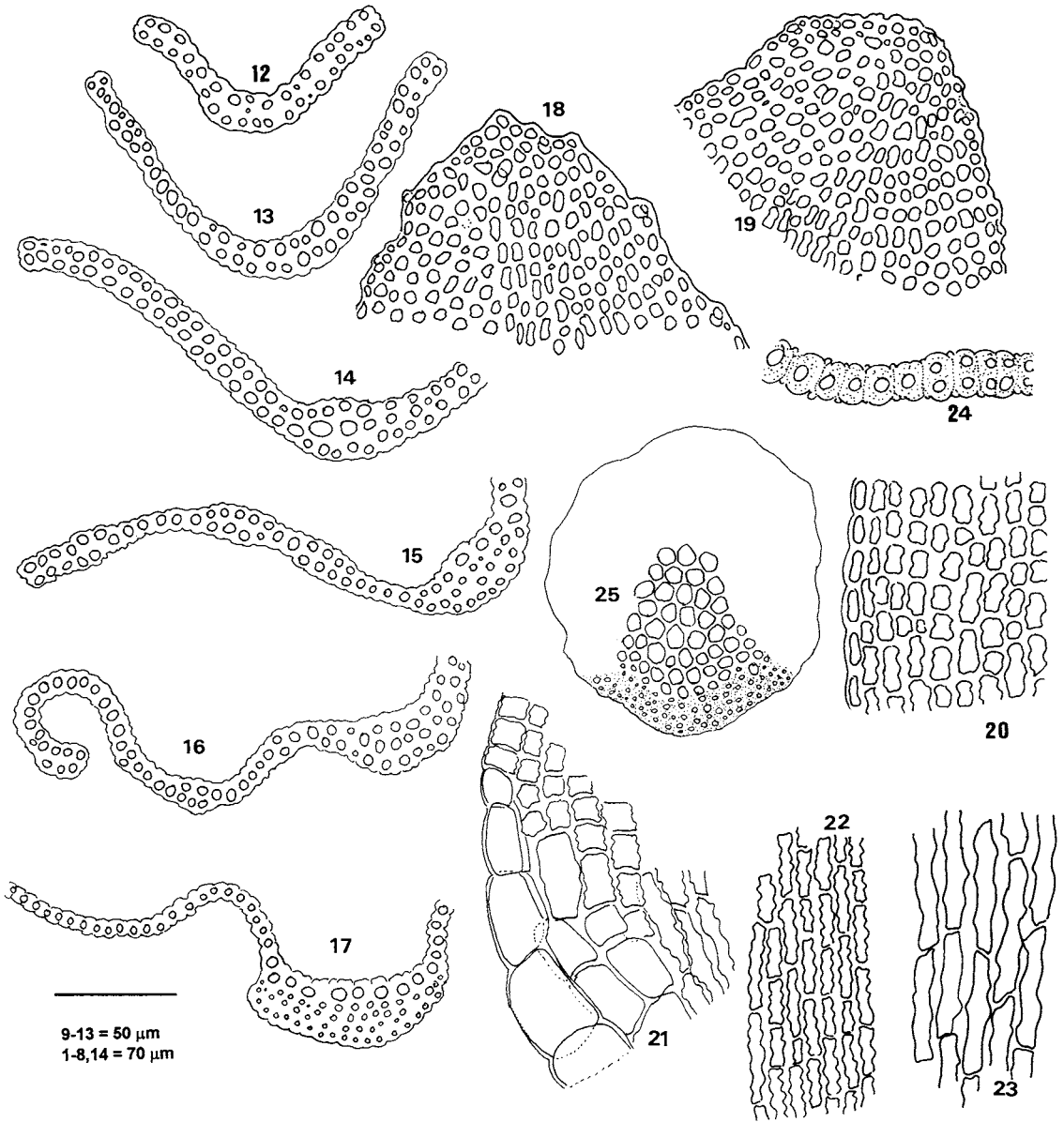
**TYPE:** PORTUGAL. 29T PE26, Beira Baixa, Serra da Estrela, a 1 km das Penhas da Saúde, 1,400 m, 1992.01.21, Sérgio 7785 (LISU, holotypus; IBA, KRAM-B, isotypi).

Species *Racomitrio aciculari* (Hedw.) Brid. similis, a quo foliis angustioribus, obtusiusculis eorumque lamina versus apicem 2–3-stratosa, costa unica inferne latissima (140–180  $\mu$ m), in sectione transversali superiore 3–4-stratosis, basi cellulis ventralibus magnis 8–10 atque stereidis valde incrassatis, minimis, 4–5(–6)-stratosis praedita, pilis in super axillaribus (10–)12–20-cellularibus facile discipitur.

Plants forming dull rigid loose medium-sized tufts, dark-brown, green to olivaceous-green above, reddish-brown below, rarely green or brownish throughout; stems arising from a rhizoidal disc attached to the substrate, few to numerous, fasciculate-branched; secondary stems 2–3.5(–7) cm long, ascending, sparsely to freely irregularly branched, densely tomentose at base with clusters of smooth, branched, reddish rhizoids, in transverse section round to polygonal, without central strand, composed of 3–4 layers of small, thick-walled, red-brown cells surrounding hyaline or red-yellowish medullary cells with thin to moderately thick walls; axillary hairs numerous, to 400  $\mu$ m long, hyaline (10–)12–20 celled, usually with short basal cells and elongate upper cells; leaves rigid, erect, straight or occasionally somewhat falcate, appressed along stem to apex when dry, erect-spreading when moist, often with leaf tips reflexed, (2.0–)2.2–2.5 mm long, (0.8–)1.0–1.2 mm wide in widest part above base, lanceolate to ovate-lanceolate, with distinct, shortly



FIGURES 1-11. *Racomitrium hespericum* Sérgio, Muñoz & Ochyra. — 1. Habit, dry. — 2. Axillary hairs. — 3. Vegetative leaf. — 4. Perigonial leaf. — 5. Innermost perichaetial leaf. — 6. Upper cells of perigonial leaf. — 7. Lower cells of perigonial leaf. — 8. Median paracostal cells of perichaetial leaf. — 9. Lower exothecial cells with the stoma. — 10. Portion of peristome with spores. — 11. Spores from same capsule with small aborted brown spores 10-14  $\mu$ m mixed with green spores (18-22  $\mu$ m and 26-32  $\mu$ m in diameter). (All from the holotype, excluding 4, 6, 7, and 11, Sérgio 8296).



FIGURES 12–25. *Racomitrium hespericum* Sérgio, Muñoz & Ochyra. — 12–17. Portions of transverse sections of leaves from apex to base. — 18–19. Leaf apex. — 20. Upper lamina cells at margin. — 21. Alar cells. — 22. Median lamina cells. — 23. Basal lamina cells. — 24. Transverse section of a portion of median lamina cells. — 25. Portion of transverse section of stem. (All from the holotype.)

decurrent auricles, concave in apex to canaliculate throughout, gradually tapering to an obtuse, muticous apex; margins at apex dentate, erect or somewhat inflexed above, plane, more or less recurved below, sometimes broadly recurved on one side, occasionally bordered with 2–4 rows of 2–3 (sporadically 4)–stratose cells from base to middle; costa single, clearly demarcated from laminal cells below and usually gradually merging into laminal cells above, almost reaching apex, yellow to yellow-

brown, ventrally canaliculate throughout and distinctly convex on dorsal side, in lower and central parts 140–160(–180) μm wide, somewhat thinner at middle, 110–120(–130) μm wide, above wider, to 160 μm; in transverse section 3–4–stratose and not prominent dorsally above, with 6–7 large ventral cells becoming 4–6–stratose, reniform and strongly convex in basal part, 8–10 large ventral cells and 4–5(–6) layers of strongly incrassate, small cells, forming a prominent stereid band; lamina bistratose

in upper part, occasionally with narrow unistratose streaks, unistratose in median and lower part with more or less frequent bistratose regions; laminal cells with large flat papillae over walls, with strongly incrassate and nodulose longitudinal walls and thin,  $\pm$  oblique or truncate transverse walls; upper laminal cells subquadrate to rounded, incrassate, (4–)6–10  $\mu\text{m}$  long, 8–12  $\mu\text{m}$  wide, in median part more elongate and arranged in rows, 10–20  $\mu\text{m}$  long in lower part, long-rectangular, 12–30  $\mu\text{m}$  long; marginal areolation above generally opaque and dentate, teeth with 1–3 cells; basal cells yellow to orange, rectangular, to 60  $\mu\text{m}$  long, with thickened, porose walls forming a narrow belt, becoming strongly nodulose toward margins; alar cells deeply yellow to brownish-yellow, enlarged, quadrate to short-rectangular, moderately firm-walled, often forming somewhat inflated and decurrent auricles, occasionally not differentiated; marginal cells above alar regions short-rectangular, sinuose and scarcely differentiated.

Dioicous. Perigonia bud-like; inner perigonial bracts broadly ovate ( $\pm$  1–1.2 mm long), rapidly or gradually narrowed into a broad short apex, costa single, not reaching apex, cells thin, long-rectangular, 60–90  $\mu\text{m}$  long, yellowish-brown and pellucid in lower part, with normal areolation of chlorophyllose, thick-walled, short cells in the apex; antheridia brownish, claviform, short-stalked. Outer perichaetial leaves similar to stem leaves, innermost perichaetial leaves strongly modified, sheathing below, yellowish-brown to hyaline, chlorophyllose only close to apex, with relatively weak costa vanishing below apex and areolation of thin-walled cells with rectangular, slightly thickened, sinuose walls. Sporophytes solitary or occasionally geminate, terminal on small branches near apex; setae brown to dark-red, (3.5–)4–7 mm long, smooth, dextrorse and usually flexuose when dry; vaginula 1.5–2 mm, naked; capsule erect, narrowly oblong-cylindric to cylindrical, sometimes slightly curved, 2–2.5 mm long, (1–) 1.2–1.4 mm wide, gradually or suddenly narrowed into seta, slightly constricted below mouth, smooth or lightly sulcate, brown to dark-brown, weakly lustrous to dull; exothecial cells predominantly elongate, mixed with irregularly-shaped cells, 12–25  $\mu\text{m}$  wide, 20–60  $\mu\text{m}$  long, thin- to moderately firm-walled, becoming shorter and thick-walled in neck, 1–2 rows around mouth subquadrate to rounded, incrassate, reddish-brown; stomata phaneropore, numerous (15–20) at extreme base of capsule, bicellular, with round pores; operculum 1.2–2 mm long, slanted, rostrate, somewhat curved at apex; calyptra conic-mitrate at base, narrowed to straight, elongate apex, naked, not plicate; annulus wide, well-developed, of 2 rows of cells, deciduous. Peristome single; teeth 16, yellowish-brown, erect to widely

spread when dry, densely low-papillose throughout, 300–350(–400)  $\mu\text{m}$  long, of 2–3 irregular prongs, usually split above and irregularly cribose or perforated along median line below; basal membrane to 60  $\mu\text{m}$  high, brownish-yellow to orange-yellow, finely papillose. Spores spheric, greenish-brown, frequently anisomorphic, finely papillose, (10–)18–20(–32)  $\mu\text{m}$  in longest dimension.

PARATYPES (UTM sequence): PORTUGAL. 29S ND95, Alto Alentejo, Crato, Ribeira de Sôr, Monte das Cortiças, *Sérgio* 8877 (LISU). 29T NE60, Beira Alta, Serra do Caramulo, S. João do Monte, *Sérgio* 8769 (LISU). 29T NF45, Douro Litoral, Valongo, *Newton* (COI). 29T NG32, Minho, Ponte de Lima, ribeiro do Moinho Velho, *Sampaio* (PO 985B). 29T PE06, Beira Alta, Serra da Estrela, Casal do Rei, Ribeira de Loriga, *Sérgio* 7806 (LISU). 29T PE16, Beira Alta, Serra da Estrela, Lagoa Comprida, *Luisier* (LISE 7548, LISU, PO 2193); Cântaro Raso, *Sérgio & Séneca* 8157 (LISU); Covão do Boi para o Cântaro Raso, *Sérgio & Séneca* 8149 (LISU); Ribeira do Cume, *Sérgio et al.* 8221 (LISU); Chafariz do Rei, *Sérgio et al.* 8281 (IBA, KRAM, LISU); Lagoa do Peixão para os Charcos, *Sérgio et al.* 8361, 8372, 8376 (LISU); Rua dos Mercadores, *Melo* (LISU). 29T PE17, Beira Alta, Serra da Estrela S. Romão, Senhora do Desterro, *Sérgio* 5806 (IBA, KRAM, LISU); Ponte do Soalheiro, *Sérgio* 8662 (LISU). 29T PE26, Beira Alta, Serra da Estrela, Cantaro Raso, Túnel para Manteigas, *Sérgio et al.* 8293, 8296 (LISU); Vale do Zêzere, Manteigas, *Sérgio & Séneca* 8120 (LISU); Sanatório, *Luisier* (LISU 53984). 29T PE27, Beira Baixa, Serra da Estrela, Nave, *Palhinha* (LISU); Serra da Estrela, *Henriques* (LISU 53989).

SPAIN. 29T PE85, Cáceres, Sierra de Jalama, S. Martin, *Luisier*, 1915 (INA 4853). 29T PF96, Salamanca, Aldeadávila de Ribera, *Rupidera* (IBA). 30T UN66, Palencia, Pozo de Curavacas, *Losa & Monserrat*, 1950 (BCB 18168). 30T TK67, Salamanca, Dehesa de Candelario, *Elias*, 1984 (BCB 24134). 30T VL22, Madrid, Sierra de Guadarrama, Siete Picos, *Casares* (MA). 30T VM97, Logroño, Sierra de la Demanda, Posadas, San Lorenzo, *Casas* (BCB 48157).

*Etymology.*—the species name is taken from the Latin word *hespericus*, meaning western. [In antiquity the area of the Iberian Peninsula was called Hesperia by the Romans; geologically it corresponds to the old Central Iberian Massif (Hesperic Massif).]

*Racomitrium hespericum* is a very distinct and almost unmistakable species of section *Papillosa* (Kindb.) Nog. The most distinctive feature indicating its placement in this section is the presence of large flat papillae over the cell walls that are clearly visible in transverse section of the leaf lamina. In addition, species of this section have obtuse and muticous, often variously toothed leaf apices always lacking a hyaline hairpoint. The section consists of about ten species and is badly in need of taxonomic revision. All taxa of section *Papillosa* described till now have unistratose lamina cells, the only exception being *R. fasciculare* (Hedw.) Brid. var. *hayachinense* Nog. from Japan with acroscopically bistratose leaf margins (Noguchi 1988). *Racomitrium hespericum*—with its perfectly bi- to rarely tristratose

lamina cells in the upper half and bistratose basiscopic leaf margins—is exceptional in relation to this character within section *Papillosa*, and consequently it is readily distinguished from its congeners.

*Racomitrium hespericum* is undoubtedly a close relative of *R. aciculare* and both species share the overall appearance, similar leaf areolation, and ecological requirements, both being aquatic and semi-aquatic plants. *Racomitrium aciculare* is a boreal-montane species widely distributed throughout much of the Holarctic. It has a marked oceanic affiliation (Ochyra et al. 1990) and is common in the north of the Iberian Peninsula (Casas et al. 1992). The species has recently been lectotypified and its lectotype includes the plants having entirely unistratose lamina cells (Bednarek-Ochyra & Ochyra 1994). This character is consistently found in all populations of this species from central Europe, Iberian Peninsula, and Macaronesia; additionally, we studied many specimens from Fennoscandia, the British Isles, North America, and Japan and we have never observed a tendency to bistratosity of the leaf lamina. It is a little astonishing since *R. aciculare* is an aquatic moss and in many aquatics there is a frequent tendency to the multiplication of the layers of lamina cells. In contrast, the lamina cells in *R. hespericum* are entirely 2–3-stratose distally and the leaf margins are bistratose in 1–3 rows of cells to the base. Moreover, the leaves in *R. aciculare* are rounded at the apex, while in *R. hespericum* they are usually more gradually narrowed to an obtuse or acute apex.

*Racomitrium hespericum* also differs from *R. aciculare* in its costa, which is 140–180  $\mu\text{m}$  wide at the base, whereas in *R. aciculare* it is much weaker, 70–120  $\mu\text{m}$  wide and only occasionally is stronger and reaches 140  $\mu\text{m}$  at the base. As seen in transverse section the costa in *R. aciculare* is bistratose in the upper half and consists of 4–5 enlarged ventral cells above and 6–7 below. In contrast, *R. hespericum* has the costa 3–4-layered above, with 6–7 large ventral cells above and 8–10 ventral cells below. Moreover, the stereid band in *R. aciculare* is weak and comprised of 2–3 layers of cells, while in *R. hespericum* the stereid band is much stronger and consists of (3–)4–5(–6) layers of strongly incrassate cells.

An additional character differentiating the species is the axillary hairs. They are generally shorter in *R. aciculare* and consist of 6–12(–13) cells, whereas in *R. hespericum* axillary hairs are much longer and (10–)12–20-celled.

It should be noted that Machado (1916, 1918) described from Serra de Arga, Portugal, *R. aciculare* var. *radiculosum* Mach. This variety includes robust plants with elongate stems that are densely tomentose at the base. Examination of the type material of this taxon showed, however, that it has nothing

in common with *R. hespericum* and actually is merely a large expression of otherwise typical *R. aciculare*. Unfortunately, we could not locate any original collection of *R. aciculare* var. *angustifolium* Hoehn., described from Sierra Nevada, Spain (Hoehnel 1895), but judging from the description this taxon with its “schmälere Blätter mit weniger breit abgerundeter Spitze” seems to have nothing in common with *R. hespericum*.

The only other species in Portugal and Spain for which *R. hespericum* is likely to be mistaken are *R. lamprocarpum* of section *Ellipticodryptodon* (Vilh.) Ochyra, Sérgio & Schum. and *R. lusitanicum* of section *Laevifolia* (Kindb.) Nog. with which it shares fleshy, multistratose leaf laminae. However, *R. hespericum* is immediately differentiated from those species by its papillose lamina cells. Additionally, *R. hespericum* differs in its broadly obtuse and denticulate leaf apex, while in *R. lamprocarpum* and *R. lusitanicum* the leaf apex is always entire.

*Racomitrium hespericum* shows relatively little variation in its diagnostic characters and consequently it is a well defined and readily recognized species. The only character that shows some variation is the spore size. In the majority of specimens examined, the spores are 18–22  $\mu\text{m}$  wide but in some specimens typical anisospory can be observed (Fig. 11). This phenomenon is known in some species of *Macromitrium* Brid. and in *Schlotheimia funiformis* Tayl. ex Dix. (van Rooy & van Wyk 1992; Vitt 1989). Until more studies are conducted it can be interpreted as a result of meiotic abnormalities by cytomixis during spore differentiation (Ramsay 1979). We have indeed observed in the same capsule small aborted brown spores 10–14  $\mu\text{m}$  wide mixed with medium-sized, green spores, 18–22  $\mu\text{m}$  wide and large green spores (26–)28–36  $\mu\text{m}$  diam. (e.g., Sérgio 8296). A similar case of development of anisomorphic spores was also observed in *R. lusitanicum* (Ochyra & Sérgio 1992).

It is generally assumed that multistratosity of the lamina cells in aquatic mosses can be interpreted as an adaptation to aquatic habitats and it is not an evolutionary trend. Such an interpretation was presented for *R. lamprocarpum* (Ochyra et al. 1988) and *R. lusitanicum* (Ochyra & Sérgio 1992). Nevertheless, in the case *R. hespericum* this explanation may be insufficient to explain the origin of this species. It is a sibling species of *R. aciculare* and both species often grow together in mixed stands. Hence this new species might have been derived as the result of a spontaneous aberration during meiosis due to increasing ambient temperature (Newton 1985).

After the first discovery of *Racomitrium hespericum* in Serra da Estrela, intense field work revealed that the species is widely distributed in the highest

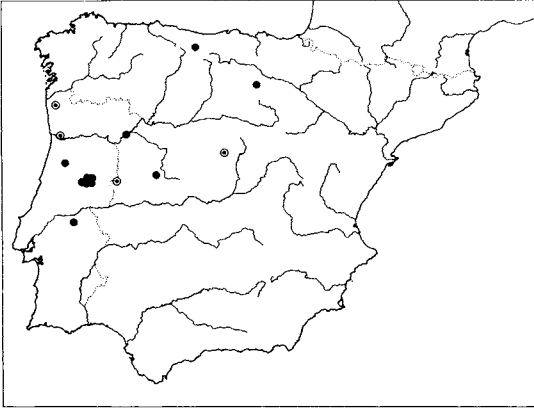


FIGURE 26. Distribution of *Racomitrium hespericum* Sérgio, Muñoz & Ochyra in the Iberian Peninsula; (●) since 1950, (○) before 1950.

plateau of this mountain range, with particular preference for areas over 1,000 m. It seems, however, to be widely scattered in other ranges of the Iberian Hesperic Massif and at present it is known from 15 squares of the 10 × 10 km grid (Fig. 26).

After examination of all old herbarium collections deposited in COI, IBA, INA, LISE, LISU, and PO we were surprised to find so much material of *R. hespericum* from Serra da Estrela originally misnamed as *R. aciculare*, whereas the latter seems to be less abundant here. The new species was collected for the first time in 1879 by Newton in Valongo and later, in Serra da Estrela, it was recollected by Luisier in 1909 and Palhinha (exact date not available).

*Racomitrium hespericum* is an acidophilous aquatic moss growing submerged on granite rocks along streams, brooks, and in cascades as well as on vertical rock faces sprinkled with water. The most frequent associates of this species include: *Marsupella emarginata* (Ehrh.) Dum., *M. emarginata* (Ehrh.) Dum. var. *aquatica* (Lindenb.) Dum., *Scapania subalpina* (Nees ex Lindenb.) Dum., *Scapania undulata* (L.) Dum., *Andreaea heinemannii* Hampe & C. Müll., *Bartramia ithyphylla* Brid. var. *ithyphylla*, *Bryum alpinum* With., *B. pseudotriquetrum* (Hedw.) Gaertn., Meyer & Scherb., *Dryptodon patens* (Hedw.) Brid., *Eurhynchium pulchellum* (Hedw.) Jenn., *Heterocladium heteropterum* B.S.&G., *Hyocomium armoricum* (Brid.) Wijk & Marg., *Racomitrium aciculare* (Hedw.) Brid., *R. lamprocarpum* (C. Müll.) Jaeg., *R. lusitanicum* Ochyra & Sérgio, *Rhynchostegium alopecuroides* (Brid.) A. J. E. Smith, and *R. riparioides* (Hedw.) C. Jens.

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