



Racomitrium obtusum in Britain and Ireland

Tom Ottley describes a misunderstood species

When Samuel Brewer and Johann Dillenius climbed Snowdon on 20 August 1726 (Hyde, 1931), they collected a patch of moss which Dillenius subsequently referred to as *Bryum hypnoides alpinum*, *operculis obtusis* ‘the Hypnum-like alpine Bryum, with blunt covers’ (Dillenius, 1741), this being before Linnaeus developed the binomial system. That was the beginning of a long and confused history of naming of the moss we now call *Racomitrium obtusum*. There was even controversy surrounding the collection since, as Lindberg (1875) pointed out, the opercula are not obtuse and there wouldn’t be many opercula, obtuse or otherwise, to be found in August. Brewer was, however, an avid collector and frequently sent specimens to Dillenius (Lawley, 2006) so the description may have been based on material collected at a different time of

△ *Racomitrium obtusum*. Tom Ottley

the year. Since then the moss has been through several changes of name, often being treated as a variety or a form of *R. heterostichum*, as in the *Atlas*, for example (Blockeel *et al.*, 2014).

The most significant revision of this section of the genus was the review by Frisvoll (1988) who examined specimens from around the globe, treating *R. obtusum* as a separate species and including both muticous (lacking awns) and awned forms of it. However, Blockeel (1991) carefully examined much British and Irish material and, noting the particular difficulty in separating awned *R. obtusum* from *R. heterostichum*, considered *R. obtusum* to be just a form of the latter, which is how Smith (1978) had treated it in the first edition of his *Flora*, retaining the same view in the second edition (Smith, 2004). It is only now, with the

publication of the latest checklist (Blockeel *et al.*, 2021), that *Racomitrium obtusum* has finally been accepted into our flora as a separate species. Many of the identification problems remain, primarily with awned forms, although a degree of clarity is hopefully presented in this paper.

It should be mentioned that, although the idea of the moss being a separate species has been generally adopted now, not all bryologists accept the name *R. obtusum* (Brid.) Brid. and a strong case has been made for splitting the genus, resulting in the name *Bucklandiella obtusa* (Brid.) Bednarek-Ochyra & Ochyra. This issue has been discussed by Larrain *et al.* (2013) and Sawicki *et al.* (2015). However, in Europe it is mostly referred to as *Racomitrium obtusum* (Hodgetts *et al.*, 2020).

In this account, the distinctions listed by Frisvoll (1988) have been assessed using British and Irish gatherings mostly loaned from private collections because of the current pandemic. All of his stated characters were found to be applicable in varying degrees, although, in the case of separating *R. obtusum* from *R. heterostichum*, no single character was found to be completely reliable. The aim has therefore been to give emphasis to those features that are the most helpful and to restate others, using photographs to assist.

Early indications from the specimens studied here and field observations point towards *R. obtusum* being considerably more common than *R. heterostichum* in many areas.

Characteristics of *Racomitrium obtusum*

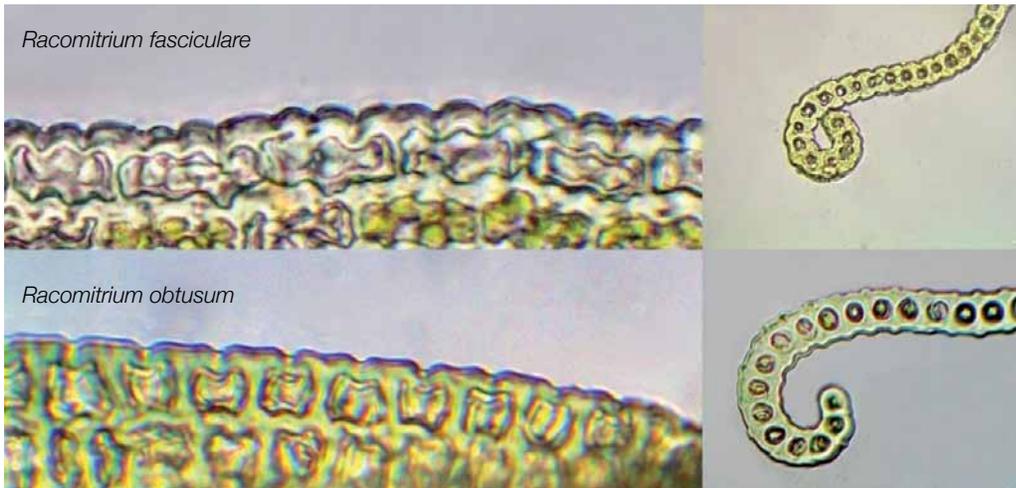
Racomitrium obtusum is similar in many respects to several other members of the same genus with which indeed it often grows. Thus it will be found on acid rock in open habitats, such as moorland, where it is commonly associated with *R. affine*, *R. fasciculare*, *R. sudeticum*, *R. heterostichum* and

other bryophytes that share the same habitat, such as *Grimmia trichophylla*. In more lowland localities it can be found on tile or slate roofs of buildings. It will form pure patches but may also occur as individual stems mixed in with other species of *Racomitrium*. In its awnless form it is probably most similar to *R. fasciculare* in general appearance and it is easy to overlook for that species in the field. Awned versions are readily confusable with *R. affine* and *R. heterostichum*, as well as species of *Grimmia*.

A full description is not given here because it has been so well described elsewhere, particularly by Frisvoll (1988). *Flora Briofítica Ibérica* (Muñoz *et al.*, 2015) also has exemplary drawings. Another good account of the genus may be found in Nyholm (1998).

One immediate issue is that, as described by Frisvoll (1988), mixed stands occur very frequently where two or more species of *Racomitrium* grow in such close proximity that individual stems become mingled and what appears to be a single patch is actually a mixture. Thus it is sometimes necessary to ensure that a single stem is being looked at when selecting leaves and capsules for identification, at least until experience has been gained in the varying forms of *R. obtusum* and of related common species.

R. obtusum is mainly to be found as slightly yellowish olive-green, spreading patches on boulders and rocks, sometimes bearing prolific capsules. There are often small, mid- to dark brown patches on the leaves, particularly towards the leaf apex. In exposed locations the base of the plant can be blackened, but the terminal bunches of leaves retain the usual colouring. As is the case with some other members of the genus, there is much variation in the development of awns. It occurs as entirely muticous forms or with a mixture of muticous and awned leaves



△ Figure 1. Upper leaf margins (with sections) for comparison. The pseudopapillae of *Racomitrium fasciculare* (upper) are small, irregularly shaped plates covering most of the surface. A mixture of what appears to be rounded and flat-topped papillae is often apparent in normal view. Those of *R. obtusum* (lower) are cell-length narrow ridges running down the leaf and frequently more uniform in appearance. Note also the difference in cell length and the more equal wall thicknesses in *R. obtusum*. Tom Ottley

in varying proportions, right through to patches with all leaves awned; thus the division into two named forms by Frisvoll (1988) appears to be more arbitrary than that paper suggests. The reader may, however, come across these in the literature as forma *obtusum* for awnless forms and forma *trichophorum* where awned. The branching pattern is quite irregular, with stems often being rather sparsely branched, but tighter forms with numerous short branches also occur. In mucicous leaves the apex is usually blunt and slightly rounded, as is sometimes the case with other members of the Grimmiaceae exhibiting this character as a variation, such as *R. ericoides*.

The leaf margins are often strongly and broadly recurved, even towards the leaf apex, becoming revolute in some samples and this can be on one or both sides of the leaf. However, not all leaves show this and some have only a modestly recurved margin on one side and are almost plane on the other. In any case, this is not a unique character – in particular, some leaves of

R. heterostichum can exhibit it – but can help if taken in conjunction with other features.

Lower cells are strongly sinuose like most species in the genus and upper cells are quadrate to shortly rectangular, although they may still be slightly sinuose. The cuticle is either smooth with minor irregularities or has small ridge-like pseudopapillae, as found in several related species, but it lacks the plate-like cuticular thickenings that are characteristic of *R. fasciculare* and *R. aquaticum*. In looking for papillae it is tempting to view the edge of the upper part of the leaf under high power but this can give rise to confusion. The leaf sections are, however, quite different as shown in Fig. 1. A good description of these pseudopapillae can be found in Deguchi (1978). SEM photographs of the irregular plate-like cuticular thickenings of *R. fasciculare* and *R. aquaticum* have been published in Bednarek-Ochyra (1995) and there are more, of various species, in Sawicki *et al.* (2015) where the differences between ridge-like thickenings and

plate-like thickenings can be seen very clearly.

The costa is broad, normally over 100 µm near the leaf base, mostly yellowish green and with a structure generally similar to that of *R. heterostichum*. It is flat and broad and 2-stratose for the most part, but usually 4(–5)-stratose near the base (Fig. 5). At mid-leaf the costa section is parallel-sided (i.e. equal in height across its width) and almost always curved (see Fig. 3). Where the costa is exceptionally thick at the base then it may be 3-stratose at mid-leaf.

In fruiting material, there are several other useful characters. The innermost perichaetial leaves are strongly differentiated from stem leaves but that only serves to differentiate it from *R. sudeticum*. Capsules are discussed below.

In the following sections on differentiation, it must be stressed that in some cases, no single diagnostic character has been found to work all the time and, as in many other bryophytes, it is necessary to take a balanced view based on as many characters as can be assessed. Because all *Racomitrium* species are very variable, particularly the commonest ones, it is also important, for example, to sample numerous mature leaves when considering vegetative characters.

Differentiation of muticous *Racomitrium obtusum*

Only the most likely sources of confusion are given here but the key (see later) covers all the British and Irish species in the genus.

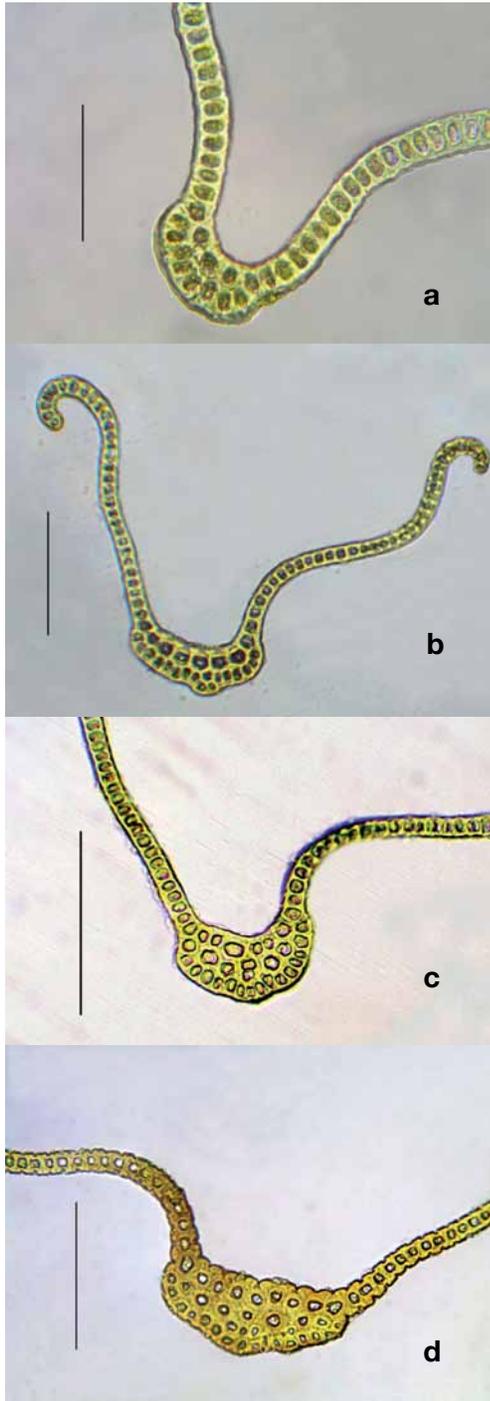
R. fasciculare in its typical form has leaves with long, narrow apices arranged in short branches and is often considered distinctive, but note that the leaf apex in that species is also usually rather blunt and that some forms of *R. obtusum* can have short branches with an overall branching pattern approaching that of *R. fasciculare*. A useful clue in the field is that the leaves of *R. fasciculare* tend to cling together when moist



△ Figure 2. *Racomitrium fasciculare* leaf apex. Tom Otley

(somewhat similar to *Sphagnum cuspidatum* and no doubt for the same reason); this effect was not observed in *R. obtusum* in this study. Microscopically, the small plate-like thickenings of the cuticle of *R. fasciculare* will separate it from *R. obtusum* and usually they can be seen along the edges of the leaf and particularly around the leaf apex (Fig. 2) without needing to section, but note the reservations already mentioned. *R. fasciculare* has elongate upper cells (see Fig. 1) with the cells often appearing to merge in the longitudinal direction. *R. obtusum* has shorter cells with approximately equal wall thicknesses.

R. aquaticum usually has densely packed, weakly branched stems carrying stiffly erect to patent, dark green leaves. In some patches the leaves may be secund but still appear stiff. The leaves have a stout costa which is commonly reddish at the base. It is unlikely to be mistaken for the much laxer, more branched, yellowish-green *R. obtusum*, but if necessary the cuticular thickenings in *R. aquaticum* are readily seen, again often without needing to take a transverse section, and they are of the same plate-like type as *R. fasciculare*; similar comments apply regarding possible confusion with the ridge-like pseudopapillae of *R. obtusum* and other species. Mid-leaf costa sections frequently show two rows of guide cells (Fig. 3), a character not observed in



< Figure 3. Costa sections at around mid-leaf of: a) *Racomitrium heterostichum*, b) *R. obtusum*, c) *R. affine*; d) *R. aquaticum* and e) *R. sudeticum*. Scale bars 100 μm . Tom Ottley

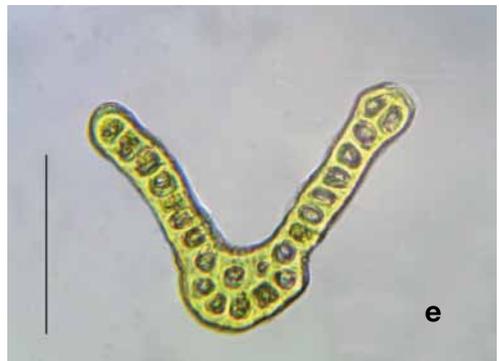
R. obtusum in this study.

R. sudeticum frequently occurs in completely awnless forms but more commonly perhaps with a mixture of very shortly awned and muticous leaves. The distinctions are covered below.

Differentiation of awned *R. obtusum*

This is really where the problems lie. The most similar common species are dealt with below.

R. affine can look very similar in the field. A useful character is that the leaves are frequently flatter across their width in this species. Like *R. obtusum* it can also have long awns or shorter ones, even with a few muticous leaves. The upper leaves are sometimes falcate, but they can be somewhat secund in *R. obtusum* too. The costa is narrower, often 60–80 μm and only occasionally over 100 μm . In *R. obtusum* the costa is almost always over 100 μm at maximum width towards the base of the leaf. At mid-leaf, the costa of *R. affine* is approximately semicircular, hence very rounded on the dorsal surface, and with 3 strata, the cells appearing homogeneous. In exceptional cases where *R. obtusum* is 3-stratose at mid-leaf then the cells are less homogeneous in size but the shape of the costa section is parallel-sided





△ Figure 4. Comparison between *R. heterostichum* (left) and an awned form of *R. obtusum* (right). Relatively few lower leaves of *R. obtusum* have long awns whereas many are visible in the *R. heterostichum* tuft. Tom Ottley

in that species and usually curved. There is generally little difficulty in naming *R. affine* once a section has been taken. The colour is often darker, but light green examples were frequently encountered whilst looking for awned *R. obtusum* and are likely to be troublesome, particularly in mixed patches.

R. sudeticum is usually much smaller, forming compact cushions, often likened to a *Grimmia*, whereas *R. obtusum* tends to form much laxer, often sprawling patches. But *R. sudeticum* can be laxer too and then it is confusable. The muticous or shortly awned leaves of *R. sudeticum* are usually smaller and narrower and are distinctly V-shaped in the upper half. The insertion of the awn at the leaf apex is often narrow. Although the awns are often reflexed, it must be borne in mind that other species can show a similar

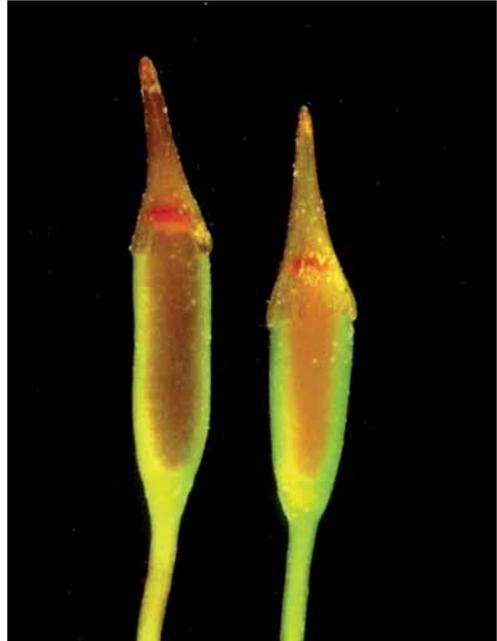
character. The upper leaf margins are plane or slightly recurved whereas *R. obtusum* usually has very recurved margins, at least on one side of the leaf. The costa is much narrower at around 50–85 μm compared to over 100 μm in *R. obtusum* and in section it is often tristratose and markedly rounded on the dorsal side. That is a clear difference to the bistratose, wider costa of *R. obtusum*. When inflorescences are present, the innermost perichaetial leaves of *R. sudeticum* are only weakly differentiated from the stem leaves whereas in *R. obtusum* they have a broad, often rounded apex. The lower leaf margin of *R. sudeticum* can frequently have a single row of hyaline cells (up to about 10 or occasionally more), but this border is less frequently developed in *R. obtusum*.

R. heterostichum very nearly always has awns

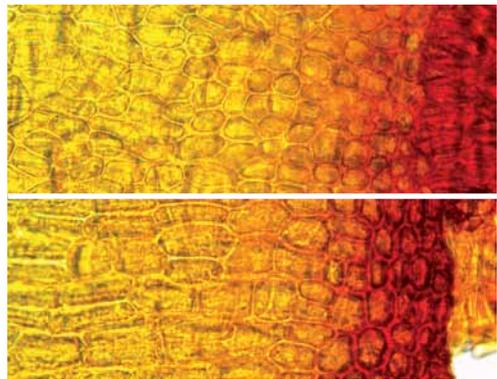


△ Figure 5. Costa section of *R. obtusum* towards base of leaf. This example has four, patchily five layers of cells.
Tom Ottley

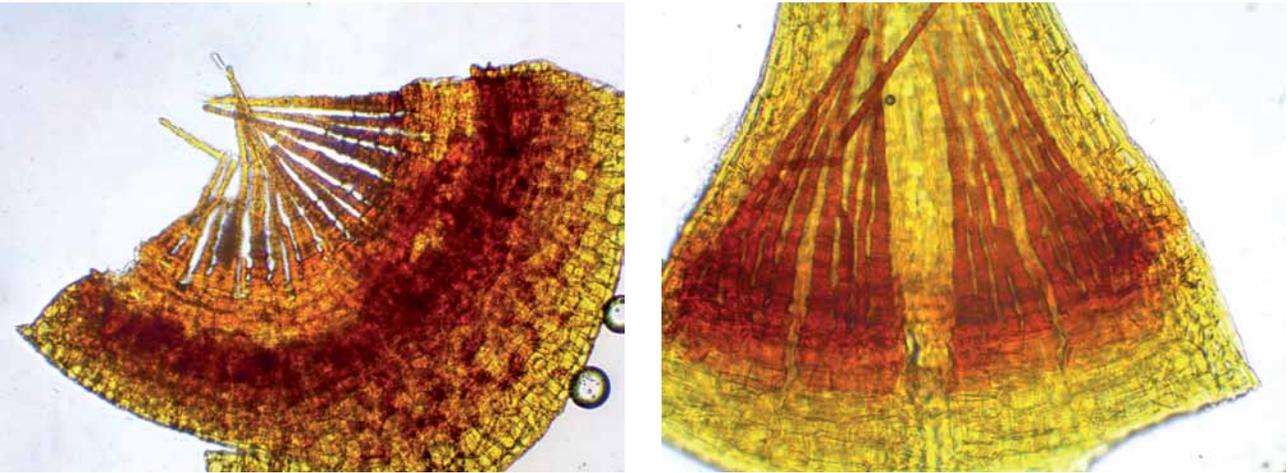
(Frisvoll, 1988) but occasional mucous leaves have been observed and hair points can get eroded too. In contrast, relatively few plants of *R. obtusum* were found here to be entirely lacking mucous leaves. In open situations, the blackish colour of the patches and the contrasting white hair points are a good guide but not infallible. In more shaded spots, however, the two species can be closely similar, although *R. heterostichum* generally lacks the yellowish tinge of typical *R. obtusum*. Caution is needed in assessing the colour of herbarium specimens which often exhibit a degree of yellowing, even extending to the awns. A useful character that was observed during this study is that, where *R. obtusum* has longer awns, and they may be up to about 1.3 mm, these are commonly only to be found in the upper leaves. The lower leaves are shortly awned or mucous. In *R. heterostichum* the awns are often well over 1.5 mm in length and long awns may be found on the lower parts of the shoots too (Fig. 4) which no doubt contributes to the well-known hoary appearance of such plants when dry. The leaf margins of *R. heterostichum* tend to be either less recurved or more narrowly so than in *R. obtusum*, particularly in the upper half of the leaf; this is one of the few characters



△ Figure 6. Typical capsule shape of *R. heterostichum* (left) and *R. obtusum* (right). *R. obtusum* may also have parallel-sided capsules but then they are shorter relative to their width than those of *R. heterostichum*.
Tom Ottley



△ Figure 7. Cells below capsule mouth of *R. obtusum* (upper, before dehiscence) and *R. heterostichum* (lower). The transition from differentiated cells below the mouth to the main exothecial cells is less rapid in *R. obtusum*. The exothecial cells in *R. heterostichum* are thinner-walled, elongate-rectangular and with less pronounced corner thickenings. Tom Ottley



△ Figure 8. Peristome of *R. obtusum* (left) and *R. heterostichum* (right). The basal membrane tends to be higher in *R. obtusum* and the teeth fuse together more to create apertures. Tom Ottley

that can be applied to non-fruiting specimens, but it is prudent to check many leaves before reaching any conclusion and to consider all available characters.

Leaf sections (Fig. 5) show that the costa of *R. obtusum* is usually 4-stratose near the leaf base, occasionally even 5-stratose, whereas *R. heterostichum* is more usually only (2–)3(–4)-stratose. Another observation is that the ventral wall of the costa is often much thickened in *R. obtusum*.

If fruiting, then the capsule shape is useful (Fig. 6). The urn of *R. heterostichum* is long, narrow and cylindrical. A typical ratio of length to width would be 4–5:1, with capsules only rarely exceeding 0.7 mm in width. The urn of *R. obtusum* is either more shortly cylindrical, with a ratio of around 3:1 or can be wider above (obovate) when most capsules exceed 0.7 mm in width. In assessing this, it is important to look at mature capsules, at least where the spore mass has turned brown, and in the moist condition. Other species, particularly *R. affine*, will also have capsules fitting the shape description for those of *R. obtusum*.

There are also differences in the exothecial cell structure. In most capsules looked at, those of *R. obtusum* had thick-walled exothecial cells whereas those of *R. heterostichum* were thin-walled and more rectangular (Fig. 7), but sometimes it was hard to decide. The best place to assess cell shape is in the upper part of the urn where the transition from several rows of small, reddish cells just below the mouth to the true exothecial cells is also more gradual in *R. obtusum*.

Reported differences in the peristome (Frisvoll, 1988) were confirmed, but only in relatively few specimens (Fig. 8). Some *R. obtusum* specimens had a clearly higher basal membrane (>50 µm), but others had a lower membrane, similar to that encountered on *R. heterostichum*. A similar comment applies to the reported cribose (sieve-like) nature of the peristome in *R. obtusum*. Apertures formed by the merging of adjacent teeth were readily seen in some examples of *R. obtusum*, but *R. heterostichum* also exhibited this feature on occasion and in otherwise typical material. In two dissected peristomes of *R. obtusum* it was the basal membrane that was finely perforate.

Key to *Racomitrium* in Britain and Ireland

In this key, only the most useful characters have been used and it may be possible to gain extra confirmation from additional features mentioned in the text. Not all characters will necessarily be present in a sample. Consideration should be given to several species of *Grimmia* and *Schistidium* which can also have strongly sinuose cells. One pointer is that *Racomitrium* usually has any differentiated basal marginal cells (esinuose, often hyaline) restricted to 1(–2) rows.

1	Plant with coarsely dentate hair points. Easily recognisable when forming large, thick cushions or mats spreading over rocks or soil, usually very hoary when dry.	<i>R. lanuginosum</i>
	Awns, if present, not coarsely dentate.	2
2	Leaves matt when dry caused by dense conical papillae on both leaf surfaces. Usually found on soil or gravel and not commonly on rock.	
(1)	Formerly the <i>R. canescens</i> aggregate.	3
	Leaves appearing smooth and translucent in the field but some species may have pseudopapillae consisting of either plates or ridges on surface which may become very noticeable microscopically. Most species usually found on acid to slightly basic rock.	5
3	Costa weak, only reaching ½ to ¾ of leaf length. An uncommon species.	
(2)		<i>R. canescens</i>
	Costa reaching leaf apex or nearly so.	4
4	Leaves often awnless or with short awns which are not reflexed when dry.	
(3)	Supra-alar marginal row of cells thin-walled, rectangular (check several leaves).	<i>R. ericoides</i>
	Leaves with long awns, flattened at base and decurrent down margins, reflexed when dry. Supra-alar marginal cells thicker-walled, quadrate.	<i>R. elongatum</i>
5	(2) All leaves awnless.	6
	At least some leaves with awns.	11
6	Small plants forming dark tufts or cushions. Leaves appearing rather opaque, bistratose over much of upper part of leaf. Capsules frequently present, small, shortly ovoid, reddish brown.	<i>R. ellipticum</i>
	Not as above. Leaves translucent and unistratose except for possibly a bistratose margin. Plants may form cushions, tufts or spreading mats and with more elongate capsules, brown when mature. <i>R. sudeticum</i> can also form small cushions and also has small capsules but they are uncommon.	7
7	Leaves broad in upper part with a rounded apex, commonly toothed	
(6)	(hand-lens). Pseudopapillae present and of the plate type (see text). Usually found growing where water flows, at least periodically. Some forms may approach <i>R. aquaticum</i> .	<i>R. aciculare</i>
	Leaves narrowing to a sharp or obtuse tip. Teeth absent. Pseudopapillae of plate type or ridge type (see text).	8

- 8** Upper half of leaf narrowly elongate. Leaves tending to cling together
(7) when wet making bunches of leaves in short branches particularly noticeable. Will often need checking: pseudopapillae flat, plate-like, very evident at leaf apex or in transverse section where they appear flat-topped (but see text regarding confusing appearance along margins). Upper cells elongate with thin transverse cell walls so cells can appear to merge at their ends. *R. fasciculare*
- Not as above. Upper cells short with thick longitudinal and transverse cell walls. **9**
- 9** Leaves narrow, V-shaped in upper half and thus not tending to lie flat
(8) on a microscope slide once cover slip is applied. Leaf apex acute. Costa 50–85 µm wide near base, 2–3-stratose around mid-leaf and strongly convex on dorsal surface. *R. sudeticum*
- Leaves wider, usually lying flat on microscope slide. Costa often over 100 µm towards base of leaf. Leaf apices blunt or narrowly rounded. **10**
- 10** Plants usually dark green with most stems unbranched or with branches
(9) at narrow angles to stems. Leaves stiffly erect to patent but may also be secund. Leaf apices blunt or narrowly rounded. Costa often reddish at base. Pseudopapillae plate-like, similar to those of *R. fasciculare* (see above). *R. aquaticum*
- Usually olive green, very often with a yellowish tinge and frequently with brown patches on newer growth. Branching more lax. Leaf apices blunt (hand-lens). There may be a few leaves with short awns. Pseudopapillae are short longitudinal ridges, often visible along upper margins but not particularly prominent at leaf apex. Costa at mid-leaf 2(–3)-stratose and parallel-sided (equal height across width), usually curved in section. *R. obtusum*
- 11** Plants reddish with short awns which may be hyaline or reddish too. *R. macounii* var.
(5) Upper margins are bistratose over 2–4 rows. A rare species. *alpinum*
- Plants rarely reddish and margins either unistratose or bistratose over 1(–2) rows. **12**
- 12** Upper cells narrowly rectangular. Rarity found in the Breadalbane
(11) Mountains in Scotland which will require further checking. *R. himalayanum*
- Upper cells shortly rectangular. The remainder are common species in upland areas. **13**
- 13** Leaves narrow and V-shaped in upper half. Costa 50–85 µm, clearly
(12) rounded on dorsal surface, (2–)3 cells thick in section from near middle of leaf. May need further checking unless forming tight cushions. A very variable plant. Where perichaetia have formed, the structure of their innermost bracts will confirm this species. *R. sudeticum*
- Leaves broader. Costa above 70 µm at maximum width or else leaf not V-shaped in upper half. **14**

14 (13) Costa almost always less than 100 μm in width, rounded on the dorsal surface and typically 3-stratose at middle of leaf, the cells appearing homogeneous. Plants can be dark green or blackish but paler forms are common too. Leaves may appear flatter than in similar species. Awns often long but leaves may occasionally be awnless. This is the awned species most likely to have falcate leaves.

R. affine

Costa usually exceeding 100 μm in width, not strongly rounded dorsally and typically 2 cells thick in middle of leaf where a section is characteristically parallel-sided and curved. Plants may be pale green to dark green to blackish.

15

15 (14) Mid- to dark-green but seldom with any yellowish tinge, with contrasting long white awns, patches often appearing very hoary when dry. There may be blackish patches on individual leaves in new growth. Awns of upper leaves usually over 1 mm and very flexuose when dry. Awns over about 0.5 mm usually present on older parts of plant as well and not or hardly narrowed at insertion. Margins usually not broadly recurved, or at least not beyond mid-leaf. Costa section at base 2–3(–4)-stratose. When fruiting, capsules are long and narrow, usually cylindrical or very slightly wider distally but rarely as much as 0.7 mm in width at the widest point. Exothecial cells rapidly transitioning from 2–4 rows of small, often reddish, often oblate cells below mouth to thin-walled, elongate, rectangular cells in remainder of urn.

R. heterostichum

Upper parts of plants usually yellowish green and often with mid-brown to dark-brown patches on individual leaves. Upper leaves with awns to 1.3 mm but lower leaves either awnless or with short awns to about 0.5 mm which are then usually narrowed at insertion. Awns typically less flexuose than *R. heterostichum* but difficult to gauge. Awns less contrasting with colour of lamina and patches not typically appearing hoary when dry. Leaf margins on many leaves broadly recurved (more detectable when moist), extending beyond mid-leaf. Costa section at base (3–)4(–5)-stratose, the ventral wall often being strongly thickened. When fruiting, capsules are usually short, with urns about 2 mm long and ellipsoidal or shortly cylindrical. When longer they are often obovate and greater than 0.7 mm maximum width. Exothecial cells transition gradually from 2–6 rows of small, reddish, circular or oblate cells below mouth through slightly elongate, thick-walled cells with very rounded lumens to the main, only moderately elongate cells with thicker walls in remainder of urn.

R. obtusum

Specimens

A selection of specimens was examined; these are listed by vice-county. In the case of both vc 46 and vc 57, a large number of further specimens were studied to assess the considerable local variation in morphology. Confirmed records of both *R. obtusum* and *R. heterostichum sensu* Frisvoll (1988) are listed below by vice-county.

R. obtusum 4: on granite boulder on bank of stream, West Okement River by Black Tor Copse, Dartmoor, SX56428923, 370 m alt., T.L. Blockeel, 48/189, 2019; 5: on slate boulders near Badgworthy Water, Exmoor, SS7943, J.W. Bates, B287, 1972; 13: clay roof tile, farm shed, Strettington, nr. Chichester, SU894073, H.W. Matcham, 1986; 14: roof of porch, village hall, Staplefield, TQ278278, H.W. Matcham, 1986; on clay-tiled roof, Horsted Keynes Mill, TQ38042862, T.W. Ottley, 16081502, 2016; 22: on two flat siliceous tomb stones on S. side of church, Speen, Newbury, SU455677, J.W. Bates, B2540, 1989; 35: on tile roof, Llanfihangel Court, SO327203, G.S. Motley, 2003; fallen from slate roof, west wing of Dingestow Court, SO450097, S.D.S. Bosanquet, 2002; 43: farmyard wall, Ty Gwyn, Llandrindod Wells, SO073590, T.W. Ottley, 16040503, 2016; 44: outcrop in SE-facing oak woodland above Nant y Gelynen, Mynydd Mallaen, SN748459, S.D.S. Bosanquet & G.S. Motley, 2003; 45: boulders on side of hill, Carningli, SN048374, M.D. Sutton, 2020; igneous boulder in *Molinia* mire, Cors Tewgyll, SN138307, 205 m alt., M.D. Sutton, 2020; 46: boulder near path, Nant Egnant, SN76996560, 250 m alt., T.W. Ottley & T.G.J. Rayner, 20112204, 2020; scattered rocks and boulders, Banc Trawsant, Goginan, SN70708227, 300 m alt., T.W. Ottley,

21010503, 2021; 49: on rocks, Cerrig yr Eglwys, above Morfa Bychan, SH5537, H.W. Matcham, 1986; exposed rock outcrop, Craig y Castell, Tremadog, SH56024037, S.D.S. Bosanquet, 2016; 52: on inclined rock face on knoll in area of moist herb-rich grassland, c. 1 km W of Llanddona, SH5679, T.L. Blockeel, 26/611, 1997; vertical rocks by Llyn Traffwl, SH32127710, S.D.S. Bosanquet, 2015; 57: on top of low gritstone boulder in light shade of nearby oak tree, Bray Clough, Kinder Scout, SK05019197, T.L. Blockeel, 49/185, 2020; 63: on gritstone in mixed woodland, Hardcastle Crags, Hebden Bridge, SD9730, T.L. Blockeel, 33/274, 2004; 64: on face of Millstone Grit crag, Caseker Crag nr Kettlewell, SD992743, T.L. Blockeel, 45/707, 2016; 87: on low rock outcrop, Trossachs, by eastern side of Glen Finglas Reservoir, NN522103, T.L. Blockeel, 37/330, 2008; 75: exposed boulder, Byne Hill, NX1778694432, 180 m alt., R.T. Whytock, 2020; 98: on rock outcrop in field, Kerrera, Upper Gylen, NM8126, T.L. Blockeel, 32/791, 2003; 100: on granite boulder, Glen Sannox, Arran, NR98514302, 405 m alt., R.T. Whytock, 2018; 104: rock on hillside, W. of Sgurr Breac, Sleat, Skye, NG590072, N.G. Hodgetts, 3560, 2000; H20: on granitic rocks in north-facing corrie above lough, Mullaghcleevaun, Cleevaun Lough, O069073, N.G. Hodgetts, 7068, 2007; H26: on stones of old wall, south side of The Gap, southern Ox Mountains, G3716, T.L. Blockeel, 41/334, 2012.

R. heterostichum sensu Frisvoll (1988) 4: scree in quarry, Lundy, SS13864529, S.D.S. Bosanquet, 2019; 8: clay roof tile on cottage, Gutch Common, Semley, ST894258, H.W. Matcham, 1989; 13: stonework of Shopham Bridge, SU985185, H.W. Matcham, 1988;

22: tiled roof of outbuilding, South Forest, Windsor Forest, SU943714, J.W. Bates, 1984; **35:** fallen from stone-tiled barn roof, Usk Castle, SO377010, S.D.S. Bosanquet, 2013; **37:** on sandstone in open Birch wood, Habberley Valley, NE of Bewdley, SO8077, T.L. Blockeel, 22/273, 1993; **45:** igneous boulder in *Molinia* mire, Cors Tewgyll, SN138307, 205 m alt., M.D. Sutton, 2020; **46:** exposed south-facing rocks, Graig Ddu, north of Hafod, SN760737, 300 m alt., T.W. Ottley & T.G.J. Rayner, 20120702, 2020; rock in mine spoil, Llechwedd Helyg, SN684848, 170 m alt., T.W. Ottley, 18121601, 2018; on rock with *Hedwigia stellata*, Banc Trawsnant, SN71068266, 340 m alt., T. W. Ottley, 20122605, 2020; **47:** on dry rocks, Breidden Hill, SJ2914, T.L. Blockeel, 21/040, 1992; **57:** on igneous rock outcrop, Cave Dale, Castleton, SK1482, T.L. Blockeel, 23/015, 1994 and 48/449, 2019; on small boulder on slope below crag, Glethering Clough, Alport Valley, SK122932, T.L. Blockeel, 49/182, 2020; **64:** on rock face in old quarry in ravine, Twisleton Glen, Ingleton, SD7074, 175 m alt., T.L. Blockeel, 20/688, 1991; **75:** Craig of Dalwine, NX3396, 225 m alt., R.T. Whytock, 2017; **76:** on crags of volcanic plug, Windy Hill, Muirshiel, NS3163, 300 m alt., T.L. Blockeel, 32/713, 2003; **88:** on rock, Cammoch Hill burn, Pitlochry, NN907598, 160 m alt., J. A. Norton, B1153, 2015.

Recording

The common convention of applying qualifiers such as *s.s.* (*sensu stricto*, in the narrow sense), as in *Ulota crispa s.s.*, needs extra caution with *R. heterostichum* and other taxa where there has been successive narrowing of concept such as the

Ulota example. Adding authorities only indicates who authored the name, and does not define the circumscription, often considerably restricted, to which the name was subsequently applied. Thus *R. heterostichum s.s.* could mean as described by Smith (1978) or Hill *et al.* (2008), by which time *R. sudeticum* and *R. affine* had been split off but the concept of *R. obtusum* was still included as a form, or as described by Frisvoll (1988) where *R. obtusum* was considered a separate entity. For clarity, the concept has to be defined too – for example: *R. heterostichum sensu* Frisvoll (1988). The use of BRC codes also makes it very clear and these are currently listed as 1072.1 for *R. heterostichum* and 1072.2 for *R. obtusum*, both *sensu* Frisvoll. In the case of some particularly difficult determinations, it may be necessary to continue using the aggregate of *R. heterostichum* and *R. obtusum* which is still available and will be listed in the forthcoming Census Catalogue as *Racomitrium heterostichum sensu* Hill *et al.* (2008) with a BRC code of 1072. For good accounts of the relationship between names and concepts and the issues raised, see Franz *et al.* (2008) and Jansen & Dengler (2010).

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