Trichostomum brachydontium, *T. herzogii* and *T. littorale* in Britain and Ireland

Sharon Pilkington revises *T. brachydontium* in Britain and Ireland and outlines the distribution of its three new segregates

Trichostomum brachydontium Bruch is a common moss that has long been regarded as showing great morphological variability. It is a Submediterranean-Subatlantic species most commonly associated with markedly calcareous coastal habitats in western districts, but it also occurs in a much wider range of situations. Its variability has been accommodated in the past through recognition of a number of different species and infraspecific taxa. Most recent floras and taxonomic studies are based to some degree on the important work of Herzog (1907), but tend to lump taxa together, leading

△ Figure 1. Coastal plants of *T. brachydontium*, Hope's Nose, Torquay, S. Devon. *Sharon Pilkington*

to confusion and overlooking the importance of morphologically distinct taxa. For instance, Smith (2004), whilst acknowledging the variability of *T. brachydontium*, asserted that its two then-accepted varieties (*littorale* and *cophocarpum*) 'both intergrade with the type to such an extent that they cannot be maintained.'

Recently, a European study (Ros *et al.*, 2022) investigated the variability of *T. brachydontium* using morphological and molecular characters, the first study to do so. The results confirmed that the species *T. brachydontium* as broadly defined is in fact a complex of four segregates. Three of these – *T. brachydontium sens. str.*, *T. herzogii* and *T. littorale* – have been confirmed from Britain and Ireland and are discussed below. The fourth, *T. meridionale*, is a diminutive moss of Mediterranean coasts and the Canary Islands and is not known from Britain or Ireland.

Segregates of *T. brachydontium* Bruch

Between October 2022 and April 2024 I examined 450 named British and Irish herbarium specimens of *T. brachydontium* loaned for research by Amgueddfa Cymru (National Museum Wales) and more than 50 other specimens from the private herbaria of various individual bryologists and my own collections. With reference to the keys and descriptions cited by Ros *et al.* (2022), I redetermined specimens and identified what I consider to be the most useful distinguishing morphological characters. Perhaps, understandably, given the large number of specimens I examined, I found more variation than set out by the European study, especially in *T. brachydontium* and *T. herzogii*. However, Ros *et al.* do stress that their study does not attempt to address the full degree of variation shown by *T. brachydontium* across its distributional range, which would require looking at many more collections.

When attempting an identification, it is important to bear in mind that the variability within and between the *T. brachydontium* segregates means that no single character can be relied upon and determination should be based on the balance of a range of character traits. Furthermore, the taxonomy of *Trichostomum* is probably even more complex than our current understanding suggests, so it will not always be possible to name specimens.

T. brachydontium sens. str.

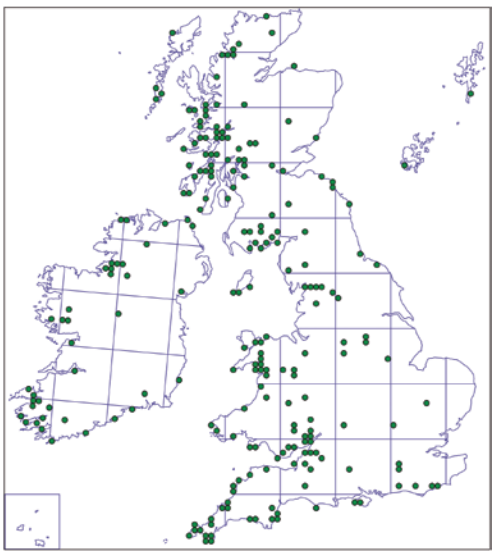
Typical examples of *T. brachydontium* (Fig. 1), with shortly acuminate, long narrow leaves and a longly excurrent costa, are relatively straightforward to identify. Our plants can exceed the stature of their continental cousins; normally shoots are 1–3 cm tall, but exceptionally up to 4 cm from sheltered situations in oceanic areas e.g. West Scotland and West Ireland. Conversely, plants growing in arid situations, especially near the coast, may only grow to 0.5 cm tall.

Stem leaves may vary in size and shape on the same shoot. Sometimes the uppermost (young) leaves have subacute to obtuse apices whilst mature leaves mid-stem have the typical acuminate apex of *T. brachydontium* (Fig. 2). The length of the excurrent costa of *T. brachydontium* is also variable and sometimes overlaps with *T. littorale*.

Other very useful identification characters include the presence of stem tomentum (also in *T. herzogii* but not *T. littorale*) and a leaf that is relatively flat (or slightly channelled). The leaf is often more markedly twisted and undulate (Fig. 3) than the other species and it is the only one that occasionally has a fragile lamina, a character particularly evident in rewetted herbarium specimens. *T. brachydontium* is also the only one of the three segregates that is likely to be found with capsules (albeit rarely), which are orange,

△ Figure 2. Acuminate apex and long-excurrent costa of *T. brachydontium*. *Sharon Pilkington*

△ Figure 3. Twisted and undulate leaf of *T. brachydontium*. *Sharon Pilkington*



△ Figure 4. Distribution of *T. brachydontium* in Britain and Ireland.

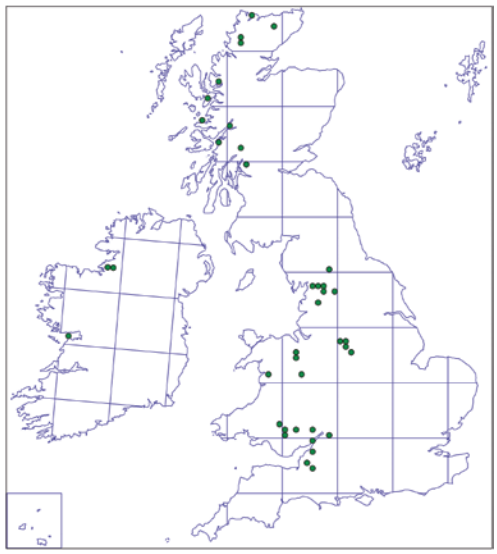
erect and borne on a long, pale yellow seta.

In Britain and Ireland *T. brachydontium* is the most widespread segregate (Fig. 4). It grows in a wide range of base-rich habitats, including on soil and rock on coastal slopes, on sheltered damp vertical rock faces and crags, wall tops and in ravines and gorges.

T. herzogii

T. herzogii presents little difficulty in identification and it also has the most exacting habitat requirements. In Britain and Ireland, it is a moss of sheltered limestone cliffs, rock ledges, ravines and crags in open or shaded upland situations. Its shoots grow up to 5 cm tall (more typically around 3 cm) and its cushion-forming habit (Fig. 5) is similar to *Amphidium*

△ Figure 5. *T. herzogii* (lower cushion) on limestone, Cwm Clydach, Brecon. *Claire Halpin*



△ Figure 6. Distribution of *T. herzogii* in Britain and Ireland.

△ Figure 7. Mid-stem leaf of *T. herzogii* (herbarium material). *Sharon Pilkington*

△ Figure 8. Strongly channelled mid-stem leaf of *T. herzogii* (herbarium material). *Sharon Pilkington*

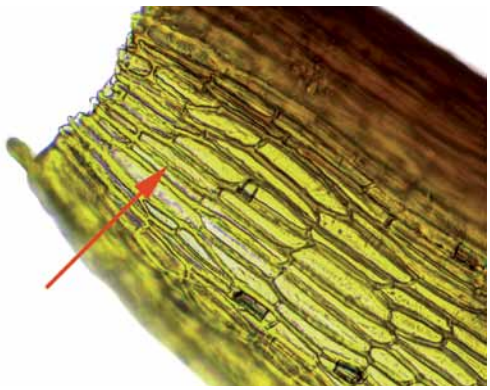
△ Figure 9. Leaf apex of *T. herzogii*. *Sharon Pilkington*

mougeotii, which may grow nearby. Many of the specimens come from areas which are well known for assemblages of rare vascular plants and bryophytes, such as Cheddar Gorge, the Avon Gorge, the Wye valley, Cader Idris, the Derbyshire Dales, the Craven limestone, Inchnadamph, the Durness limestone, the Ben Bulben massif and the Burren (Fig. 6). However, there is (as yet) no evidence that it occurs in similarly species-rich areas in eastern Scotland, such as the Breadalbane mountains.

Below the green shoot tips, *T. herzogii* is strikingly reddish, a character that immediately sets it apart from *T. brachydontium*, which shares its tomentose stems. Its stem leaves are narrower, more channelled and often longer than *T. brachydontium* with a narrower apex (acuminate to subulate) and a broad reddish costa (Figs 7–9). Unlike that species they are not twisted or fragile and look characteristically stiff when moist.

One of the best points of distinction from *T. brachydontium* (and *T. littorale*) is found in the basal leaf cells which are reddish and similar in colour (concolorous) to those in the upper leaf (Fig. 10). Basal cells (including the paracostal cells alongside the midrib and those in mid-lamina, but not those at the leaf margin) often have conspicuously incrassate and slightly nodulose walls (Fig. 11) (this character is visible only at magnifications of ×400 or greater). In *T. brachydontium* the basal cells are thin-walled, pale yellow or hyaline and contrast with those

△ Figure 10. The basal leaf cells of *T. herzogii* are a similar colour to those above – reddish in living plants but often turning deep yellow like this in herbarium specimens. *Sharon Pilkington*



△ Figure 11. Cells in the extreme leaf base of *T. herzogii* often have incrassate, slightly nodulose walls (arrowed). *Sharon Pilkington*

above (Fig. 12) .

Sporophytes of *T. herzogii* appear to be genuinely rare. I have only seen them once, in a 1972 collection from Argyll. However, perigonia were occasionally present in other specimens I examined.

T. littorale

I found shoots of *T. littorale* (Fig. 13) to be 0.5–3 cm tall, which agrees with the (mainly continental) material examined by Ros *et al.* (2022). Plants with leaves which have obtuse leaf apices, a costa excurrent in a short mucro

△ Figure 12. The basal cells of *T. brachydontium* are pale yellow or hyaline and contrast with the green cells of the upper leaf. *Sharon Pilkington*

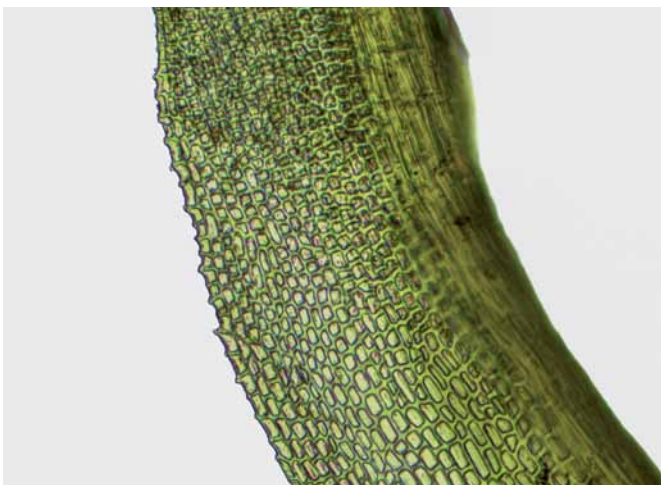
and irregularly dentate lower leaf margins (Figs 14, 15) are relatively straightforward to identify. However, problems may arise when one or more of these characters are poorly developed. A small number of specimens that I examined were intermediate in morphological characters between *T. littorale* and *T. brachydontium* and it was not always possible to name them.

In their key to *Trichostomum* species, Ros *et al.* (2022) highlight 'usually prominent' basal marginal leaf teeth, which are formed by the outgrowth of the transverse cell wall and may be slightly recurved or bifurcate, as a differential identification character of *T. littorale*. However, I examined a small number of otherwise convincing specimens of *T. littorale* with poorly developed teeth, and furthermore (weakly) denticulate basal margins were also present in some specimens of *T. brachydontium*, inviting confusion; in such situations it is important to examine a number of leaves. Ros *et al.* also found that the basal scale-like leaves of *T. littorale* are dentate from base to apex, a character also present in many of our plants and therefore a potentially useful differentiator from *T. brachydontium*.

One of the most unequivocal differential characters of *T. littorale* is the lack of tomentum

△ Figure 13. *T. littorale* showing its obtuse leaves with a very shortly excurrent costa, Allt yr Esgair, Brecon Beacons. *Claire Halpin*

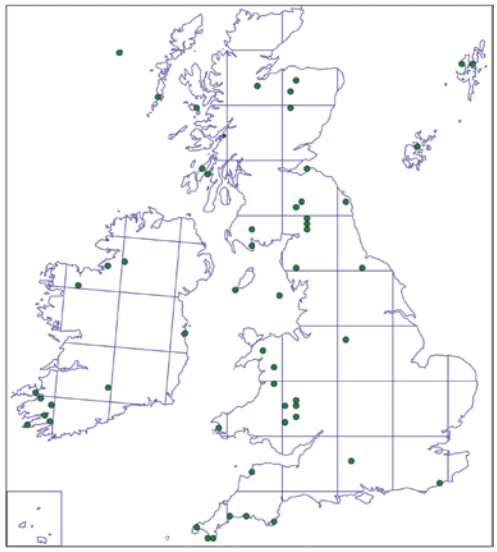
△ Figure 14. Mid-stem leaf of *T. littorale*. *Claire Halpin*



△ Figure 15. Prominent marginal teeth of mid-stem leaf of *T. littorale*. *Sharon Pilkington*

on its stems (the other two species have tomentose stems). Plants also commonly have flagelliform shoots, unlike *T. brachydontium.* The basal cell areolation is, however, similar to that species, with a zone of hyaline or pale yellow, thin-walled basal cells sharply differentiated from other basal cells and contrasting markedly with those in the upper part of the leaf. Unlike *T. brachydontium*, however, moist stem leaves do not twist and are not fragile.

I did not encounter any specimens with



△ Figure 16. Distribution of *T. littorale* in Britain and Ireland.

sporophytes or other reproductive structures when examining British or Irish material.

T. littorale is found mainly in the more oceanic parts of Britain and Ireland (Fig. 16). It appears to be less base-demanding than its sisters and so can be found on a range of hard rock and soil. In hill districts it grows on crags and boulders on mountain slopes, but it is also found on coastal rocks and soil, in ravines and on boulders by watercourses and lakes.

Morphological distinctions from related species

Trichostomum is a genus in the large Pottiaceae family, within the subfamily Trichostomoideae, which in Britain and Ireland also includes *Chionoloma, Tortella* and *Weissia*. All four genera have usually narrowly lanceolate leaves with plane, erect or incurved margins and a costa which in transverse section has two bands of stereids, one ventral and one dorsal (Frey *et al.*, 2006).

Although *Trichostomum crispulum* is normally straightforward to identify, it too is a markedly variable species and confusing forms are sometimes encountered in which the leaf apex is not markedly cucullate. However, the lower leaf margin of *T. crispulum* is never toothed and, unlike the *T. brachydontium* segregates, its stem turns black with age. Indeed, Zander (2023) has recently placed *T. crispulum* in a new genus, *Neotrichostomum*.

Chionoloma species have been included in *Trichostomum* in the past e.g. by Smith (2004). However, *Chionoloma* differs in having more or less flat (not channelled) leaves with plane margins and a costa that is not obviously excurrent. Markedly fragile laminae are often present in *living* leaves of *C. tenuirostris* and *C. cylindrotheca* and then confusion with *T. brachydontium* is possible (although the lamina of that species breaks up more in dried material than living plants). However, both species of *Chionoloma* also usually have irregular marginal teeth in the upper part of the leaf, unlike *T. brachydontium* which has entire upper margins. Capsules are rare in *Chionoloma tenuirostre* and have generally longer peristome teeth than those of *T. brachydontium*.

Tortella species are normally easily recognised thanks to the well-marked diagonal boundary between hyaline basal cells and the upper green cells. However, this demarcation is less clear in *T. nitida sens. lat*. A form of *T. nitida* is strikingly similar to *T. brachydontium* in both leaf characters and habit (especially when in the dry state). In such instances it can be surprisingly difficult to make a confident identification. However, even in this species, one or two rows of hyaline elongated marginal cells ascend the margins, a character trait not normally encountered in *Trichostomum*.

Most *Weissia* species have a strongly incurved

A Key to British and Irish species of *Trichostomum*

A modified version of the key included in Ros *et al.* (2022) is given below to include *T. crispulum* and to reflect the most useful morphological characters of British and Irish *Trichostomum* species.

Note: when selecting leaves to examine microscopically, it is important to avoid (i) old leaves toward the base of the shoots and (ii) immature leaves at the shoot tips as these may be atypical in dimension, shape of the leaf apex etc. As many leaves as possible from different plants in a cushion should be examined as there is often variation on the same plant/shoot.

1a Leaf apex flat, costa obviously excurrent. Older stem brown **2**

1b Leaf apex cucullate, costa percurrent or barely excurrent. Older stem blackish . . . . . ***T. crispulum***

2a Shoots 0.5–3 cm tall, without tomentum; flagelliform shoots often present. Leaf length/width ratio usually 3.0–5.0:1, leaf apex obtuse, costa excurrent in a short mucro 20–90 µm long. Lower leaf margin usually distinctly toothed (teeth sometimes slightly recurved or bifurcate). Leaves not twisted when moist, lamina not fragile . . . . . ***T. littorale***

2b Shoots up to 5 cm tall, stem tomentum present; flagelliform shoots absent or rare. Leaf length/width ratio usually 5.0–9.2:1, leaf apex sub-acute to acuminate, excurrent costa usually 90–150 µm long but sometimes less. Lower leaf margin weakly toothed or entire. Leaves twisted or not, lamina fragile or not **3**

3a Shoots brown below, leaves flat or slightly channelled, twisted when moist, lamina often fragile. Leaf length/width ratio usually 5.0–8.0:1, weak marginal teeth sometimes present in lower leaf. Basal cells hyaline or yellowish, contrasting with cells above, basal paracostal and mid-laminal cells thin-walled. . . . . ***T. brachydontium***

3b Shoots reddish below, leaves strongly channelled, not twisted, lamina not fragile. Leaf length/width ratio usually 5.0–9.0:1, lower leaf margins entire. Basal cells reddish, concolorous with cells above, basal paracostal and basal mid-laminal cells usually thick-walled and obscurely nodulose . . . . . ***T. herzogii***

leaf margin in the moist state, more so than seen typically in *Trichostomum*.

The stem leaves of *T. littorale* and, to a lesser degree, *T. brachydontium* can also resemble forms of *Barbula unguiculata* and *Streblotrichum convolutum*, both of which have leaves with at least lightly recurved margins (less markedly so in *Streblotrichum*, which more often have plane leaf margins, and they never have the basal teeth developed in *T. littorale*). *Barbula* and (especially) *Streblotrichum* are more likely to be confused with *T. meridionale* which does not occur in Britain and Ireland.

Vice-county distributions

Following the recognition of the segregates of *Trichostomum brachydontium*, it is necessary to record from scratch the vice-county distributions of each of the three new species. The following confirmed records are based on the British and Irish specimens cited by Ros *et al.* (2022) and over 500 additional specimens examined by me in a partial revision of British and Irish material. In the citations, the vice county number is printed in bold type before the remaining details of the record. I have not cited specimens considered intermediate.

The specimens listed are the most recent for their vice-county, and the vouchers are mostly deposited in the BBS herbarium (BBSUK), the Natural History Museum Wales, Cardiff (NMW) and the Royal Botanic Garden, Edinburgh (E). Details of all specimens identified are to be deposited in the BBS database. All have been used to produce the distribution maps published in this paper. It is not always possible to allocate historic specimens with confidence to a 10-km grid square, and some records on the maps may be misplaced by a single square.

Trichostomum brachydontium sens. str.

1: gravelly bank beside church, Manaccan, SW7625, 2007, J.A. Paton; **2**: Wet crevices of cliff, Trebarwith, near Tintagel, SX08, 1963, E.R.B. Little; **3**: on mud bank, Petit Tor Point, Torquay, SX9266, 1997, S.V. O'Leary; **4**: sea cliff, Lynmouth, SS74, 1971, J.A. Appleyard; **5**: on a bank, Mancombe, near Roundham, ST41, 1985, J.A. Appleyard; **6**: dense patches on sandy soil of steep unshaded limestone hillslope, Brean Down, ST295587, 1992, D.T. Holyoak; **8**: in bed of disused flinty track, Sidbury Hill, Salisbury Plain, SU21344993, 2022, S.L. Pilkington; **9**: on rock, West Weare Cove, Isle of Portland, 1981, E.C. Wallace; **10**: in chalk turf, Afton Down, 1963, E.C. Wallace; **13**: downs near Chanctonbury, 1931, E.C. Wallace; **14**: downs near Lewes, 1904, W.E. Nicholson; **17**: chalky bank of track, Picketts Hole near Wescott, 1962, E.C. Wallace; **20**: downs west of Ravensburgh Castle, 1957, F. Rose; **29**: in chalk grassland on south-facing slope, Devil's Ditch, TL61056218, 2005, C.D. Preston; **33**: on the ground by the River Windrush, near Seven Springs, on Harford Sands (substrate), 1913, H.H. Knight; **34**: near Green Valley, Clifton Down, Bristol, 1955, G.W. Garlick; **35**: turf among limestone, Mynydd Machen, Newport, ST233896, 1982, G.W. Garlick; **36**: on dry bank, Fownhope Common, 1932, C.H. Binstead; **39**: crevice in recess of limestone crag, Dovedale, near the junction with Hall Dale, SK1453, 1997, T.L. Blockeel; **40**: limestone quarry, Llanymynech Hill, SJ265217, 1985, R.J. Murphy; **41**: soil over dolomite in woodland, Talygarn estate, SW of Llantrisant, ST0379, 1977 A.R. Perry; **42**: rock crevice, Llangattock, SS1805316685, 2021, P. Martin; **43**: Water-break-its-neck, 1874, A. Ley; **45**: on rough soil near sea, Broadhaven, 1976, G.G. Geyman; **46**: turfy bank by sea, Cwmtudu, 1954, L.B.C. Trotter; **47**: Guilsfield, SJ220125, 1978, M.J. Wiggington (Ros *et al.*, 2022); **48**: on sea wall, west of Aber Tafol, SN640965, 1993, S.V. O'Leary; **49**: on limestone rocks, N end of mountain, Bardsey Island, 1967, E.R.B. Little; **52**: on sandy flat, Tywyn Aberffraw, 1978, E.C. Wallace; **53**: on patchy, dry limestone grassland, with *Festuca ovina*, *Hippocrepis comosa* and *Astragalus danicus*, 1948, F. Rose; **56**: on Magnesian limestone outcrop, Creswell Crags, SW of Worksop, SK5374, 1982, T.L. Blockeel; **57**: limestone rocks, Dovedale, 1948, J.H.G. Peterken; **58**: sheltered sandstone outcrop, Bickerton Hill, SJ4997253129, 2015, D.A. Callaghan; **60**: on limestone rock, New Laund Hill, Whitewell, 1973, E.C. Wallace; **62**: Kilton Wood, 1887, R. Barnes; **63**: Anston Stones Wood, 1952, E.M. Evans; **64**: ledges on limestone outcrops, by Gordale Beck, near Malham Tarn, SD9164, 1986, R.J. Murphy; **66**: soil pockets in Magnesian limestone coastal cliffs. Blackhall Rocks, NZ473390, 1975, G.G. Graham; **68**: near Seal at Embleton, 1927, J.B. Duncan; **69**: Haweswater Reservoir, near Haweswater Tarn, 1900, J.A. Wheldon; **70**: Boot, 1915, E.F. Noel; **71**: rock outcrop beside river in wooded glen, Groudle Glen, SC4111078445, 2022, D.A. Callaghan; **72**: shaly bank of ravine at head of Lime Cleuch, Nithsdale, NS850067, 1971, H. Milne-Redhead; **73**: rock crevice, Craigmurchie above Silver Rig, NX3873, 1973, H. Milne-Redhead; **74**: sea shore, Eggerness, Garliestown, 1937, E.C. Wallace; **78**: bare soil, head of Talla Reservoir, 1971, A.C. Crundwell; **81**: on banks, near Cove, 1930, J.B. Duncan; **84**: basaltic rock outcrop, Blackness Castle, NT0580, 1975, D.G. Long & D.F. Chamberlain; **86**: NE corrie, Ben Lomond, 1937, R. Mackechnie; **87**: weakly basic outcrops on steep slope, Glenwinnel Burn, Alva Glen, Ochil Hills, NS88269871, 2023, T.L. Blockeel; **88**: on peaty bank. Glen SE of Beinn Heasgarnich, 1961, I.D. Clear; **89**: soil on basic cliffs, Meall Gorm, Gleann Beag, Spittal of Glenshee, 1963, J.A. Paton & U.K. Duncan; **90**: cliffs, Arbroath, 1910, ex herb. R.D. Corstorphine; **95**: Lossiemouth, Elgin, 1896, E.M. Holmes; **97**: on old rail track, NE side of Loch Oich, 1971, E.C. Wallace; **98**: in wood, limestone strata south of Ardsheal House, Kentallen,

1978, E.C. Wallace; **99**: rocks on shore, promontory between Cardross and Helensburgh, 1976, E.C. Wallace; **100**: amongst grass and rocks on shore, Brodick, Isle of Arran, NS0136, 1961, A.R. Perry & E.F. Warburg; **101**: woodland south of Ellary, Loch Caolisport, 1972, E.C. Wallace; **102**: wet stones by road, Inverlussa, Jura, NR64318674, 2022, S.V. O'Leary; **103**: moorland, Iona, 1953, L.B.C. Trotter; **104**: On rocks in gully, Gillean burn, Sleat, Isle of Skye, 1968, E.C. Wallace; **105**: on limestone crags, Cnochan, Elphin, 1960, E.C. Wallace; **107**: Ben Griam Mor, 1902, D. Lillie; **108**: by caves, Allt nam Uamh, Inchnadamph, 1960, E.C. Wallace; **110**: Orosay, 1951, W.A. Clark; **111**: Rackwick, Isle of Hoy, 1922, L.B.C. Trotter; **112**: on boulders by stream, Burn of Catpund, Shetland, HU42472706, 2022, S.V. O'Leary; **H1**: on earthy walls, Cloghane, 1953, E.C. Wallace; **H2**: rocks in a stream between Lough Garagarry and Lough Managh, V9982, 1983, A.J.E. Smith; **H3**: On rocks by the shore, Adrigole, 1979, E.C. Wallace; **H4**: seepage in recess among coastal rocks, Charles Fort, Summercove, Kinsdale, W6549, 2002, T.L. Blockeel; **H5**: on stone in lane, Youghal, 1956, E.C. Wallace; **H6**: short turf on coastal cliff top, Tankardstown, X4511798689, 2023, D.A. Callaghan; **H8**: in the Abbey ruins, Askeaton, 1979, E.C. Wallace; **H9**: crevices in limestone pavement, Corkscrew Hill, 1965, A.J.E. Smith; **H11**: estuarine rocks, The Pink Point, S684230, 2010, S.D.S. Bosanquet & C.D. Preston; **H12**: hedgebank on coast, Duffcarrick Rocks, north of Courtown, 1975, J.A. Paton; **H16**: crevices of dry siliceous boulders on shore of Lough Corrib, east of Owenriff River, 1968, A.R Perry; **H24**: west of Cashel, N0060, 2007, D.T. Holyoak; **H26**: limestone pavement by Keil Bridge between Ballinrobe and Partry, M1668, 1962, A.J.E. Smith; **H28**: on earthy rocks, crags of Gleniff, Ben Bulben range, 1970, E.C. Wallace; **H29**: dripping limestone face, Peakadaw, Glenade, 1963, A.R. Perry; **H31**: in stony flush on moorland slope, Two Mile River, Carlingford Mountain, J1613, 1999, T.L. Blockeel; **H33**: on limestone, Marble Arch, Lough Macnean Lower, 1959, R.D. Fitzgerald; **H35**: on basic rocks, by old rail track below Muckish Mountain, 1962, E.C. Wallace; **H36**: on thin soil in shallow crevices of schistose rock in old quarry, slightly shaded by grasses, Butterlope Glen, H49169533, 2002, D.T. Holyoak; **H39**: on ground (wet), Craigagh Wood, near Viaduct, Cushenden, 1964, R.D. Fitzgerald; **H40:** on steep bank beside path on slope above lake, shaded by deciduous trees, west of Castlerock, C761358, 1999, D.T. Holyoak.

Trichostomum herzogii

6: on high limestone cliff in deep combe, Ebbor Gorge, ST5290248997, 2023, S.L. Pilkington; **33**: limestone, old quarry, Swift's Hill, Slad, SO878068, 1979, G.W. Garlick; **34**: cliff base, Court Wood, Wye Valley, SO5716215656, 2009, P. Martin; **35**: on limestone outcrop by path, The Blorenge, SO255112, 2002, S.V. O'Leary; **36**: Doward, 1914, C.H. Binstead; **40**: Alberbury, SJ3514, 1984, R.D. Porley (Ros *et al.*, 2022); **41**: limestone crag in wooded ravine, Cwm Taf Fechan, SO0404809142, 2022, D.A. Callaghan; **42**: deep cushions in sheltered corner of limestone cliff/ruined building, Cwm Clydach, SO21791215, 2023, S.L. Pilkington; **48**: Volcanic ash, Cader Idris, 1909, D.A. Jones; **50**: damp limestone ledges, World's End, Eglwyseg Rocks, 1960, R.D. Fitzgerald; **57**: on lightly shaded limestone cliff, Water-cum-Jolly Dale, SK16167295, 2021, T.L. Blockeel (Ros *et al.*, 2022), dup. NMW; **60**: near Greystoneley, 1904, A. Wilson; **64**: limestone pavement, Howrake Rocks, Ribblehead, SD7678, 1970, A.R. Perry; **69**: limestone rock ledges, Hutton Roof Crag, SD57, 1955, R.D. Fitzgerald; **97**: on limestone rocks, Onich, Loch Leven, 1950, E.C. Wallace; **98**: limestone rocks, South Lismore, NM83, 1972, J. Appleyard; **99**: on wet base-rich rocks in ravine, Tullich Farm burn, NS30519934, 2011, G.P. Rothero; **104**: on rocks in limestone ravine, Tokavaig, Isle of Skye, 1968, E.C. Wallace; **105**: Kishorn, 1986, H.L.K. Whitehouse; **107**: Ben Griam Beg, 1902, D. Lillie; **108**: beneath limestone boulder below Blar nam Fiadhag, Inchnadamph, NC252208, 1960, A.R. Perry; **H9**: in rocks, limestone grassland, Blackhead, The Burren, 1967, A. Coker; **H28**: on damp limestone, Annacoona Cliffs, Ben Bulben, G732463, 1983, S.L. Jury; **H29**: limestone cliffs, Peakadaw, Glenade, 1970, J. Appleyard.

Trichostomum littorale

1: rocks near stream, Zennor, SW4488938910, 2022, P. Martin; **2**: near Par, 1921, W.R. Sherrin; **3**: Torcross, 1899, E.M. Holmes; **4**: Bideford Bay, Saunton, SS43443812, 2003, R.D. Porley, (Ros *et al.*, 2022); **14**: Fairlight Down, near Hastings, 1847, W.M. (Ros *et al.*, 2022); **36**: on block of sandstone

in open place, c. 800 feet, Cefn Hill, 1921, C.H. Binstead; **42**: rocks of crag at 600 m, Cwm Llwch, SO00052238, 2022, S.L. Pilkington & P. Martin; **43**: Stanner Rocks, 1910, H.H. Knight; **45**: Syke Quarry, Walwyn's Castle, SM87081089, 2023, M.D. Sutton; **47**: Ffrwd Fawr, 1992, S.V. O'Leary; **48**: upper part of Cwm-yr Allt-Lwyd, SH80442883, 2021, T.L. Blockeel (Ros *et al.*, 2022); **49**: on rocks, Llyn Idwal, 1962, I.D. Clear; **57**: on igneous rock outcrop, Cressbrook Dale, SK17297519, 2022, T.L. Blockeel; **62**: Arncliffe Wood, Goathland, 1907, W. Ingham; **68**: Warenford, 1931, J.B. Duncan & W.C. Millar; **69**: Brown Gill, Pike o' Blisco, 1950, H.L.K. Whitehouse; **71**: short turf on coastal slope, Braddon Head, SC1850869796, 2022, D.A. Callaghan; **72**: rock wall just above burn, Tarras Valley Reserve, NY40198851, 2023, E.M. Kungu; **73**: on boulder, Buckdas of Cairnbaber, NX48707606, 2023, S.V. O'Leary; **74**: sea shore, Eggerness, Garliestown, 1937, E.C. Wallace; **79**: rocks beside Ettrick Water above Ettrickbridge End, NT3823, 1976, J.A. Paton; **82**: rocks by sea, Gullane Point, Old Quarry, NT462828, 1973, D.G. Long & D.F. Chamberlain; **92**: rock crevices, Craig Leek, NO1892, 1964, A.J.E. Smith; **94**: rocks by River Avon about 2 miles below Tomintoul, 1958, E.C. Wallace & A.C. Crundwell; **95**: rock face, near Craigellachie, 1953, R. Richter; **96**: on rocks, shore of Loch Ness, near 9th milestone, Achculin, 1974, E.C. Wallace; **98**: Glen Stockdale, Appin, 1949, E.C. Wallace; **100**: over calcareous rock near shore, Laggan, Isle of Arran, NR 9651, 1961, A.R. Perry; **101**: on limestone. Danna, Loch Sween, Knapdale, 1960, E.C. Wallace; **102**: on mud on path, Ruantallain, Isle of Jura, NR5062983537, 2022, S.V. O'Leary; **104**: near coast, Isle of Rhum, 1933, J.B. Duncan; **110**: Clash na Bearnaich, Hirta, St Kilda, 2013, R.D. Porley (Ros *et al.*, 2022); **111**: Egilsay, HY47032855, 2006, R.D. Porley (Ros *et al.*, 2022); **112**: on boulder, Loch of Brouster, SU26285217, 2022, S.V. O'Leary; **H1**: on rock in Lough Napeasht, 1952, A.L.K. King; **H2**: Torc Cascade, V966358415, 2021, N.G. Hodgetts (Ros *et al.*, 2022); **H3**: coastal turf on cliff-top, Dooneen, V5773645990, 2023, D.A. Callaghan; **H7**: boulder just above lake, Lough Muskry, R9124, 2005, N.G. Hodgetts; **H21**: thin soil over Cambrian metamorphic rock low on sea-cliff slope, Howth Demesne, O27303674, 2007, D.T. Holyoak; **H26**: by Glendaduff stream, 1910, W.N. Tetley; **H28**: limestone outcrops, Lugnagall, Glencar, 1963, A.R. Perry; **H33**: on boulders at lake edge, Carricknagower Lough, 1960, R.D. Fitzgerald.

Acknowledgements

I am indebted to Ron Porley and Claire Halpin, both of whom generously reviewed drafts of this article thereby improving it considerably, and Katherine Slade of Amgueddfa Cymru (National Museum Wales) who loaned me large numbers of specimens. My thanks also go to Tom Blockeel, who generously sent duplicates of verified specimens to enable me to familiarise myself with them and take microphotographs at an early stage, to Chris Preston, for preparing distribution maps and to many other BBS members for generously giving their time to join me in sometimes fruitless hunts for *T. herzogii* and *T. littorale*.

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