

Mixed northern hepatic mat: a threatened and unique bryophyte community

In the broadest sense of the term, a hepatic mat is a continuous weft of leafy liverworts, and may be dominated by a range of relatively common species, including *Scapania gracilis*, *Plagiochila spinulosa* and *Diplophyllum albicans*. It also refers to a snowbed community that is composed entirely of liverworts (G. Rothero, pers. comm.). The mixed northern hepatic mat is, therefore, one of a number of types of hepatic mat, and may be more appropriately called ‘hepatic heath’, as it frequently grows in association with heath vegetation. However, as the majority of published literature uses the term ‘hepatic mat’, that is the

term that will be used here when referring to mixed northern hepatic mat specifically.

Within Britain and Ireland, the most extensive and species-rich stands of mixed northern hepatic mat are found in the north-west Highlands of Scotland. This community is also well represented in other parts of the Scottish Highlands and a number of areas of western Ireland. Similar, less species-rich hepatic mats occur in the Lake District of England and North Wales (Averis, 1994). Species-poor hepatic mat vegetation has also been found in Norway (Jordal & Hassel, 2010) and the Faeroe Islands (Averis, 1994).



The mixed northern hepatic mat, or hepatic heath, is one of the most beautiful and conspicuous bryophyte communities found in Britain and Ireland. It forms large, colourful mats of liverworts on mainly north-facing mountain slopes in western Scotland and Ireland, under heather and in rocky areas. As **Rory Hodd** and **Micheline Sheehy Skeffington** describe, it is extremely limited in distribution, as it requires very specific climatic and topographic conditions which exist on only a handful of oceanic mountain ranges. For these reasons, this community is extremely vulnerable to a number of threats, notably overgrazing and climate change.

▲ The eastern corrie of Mt Brandon, Co. Kerry, which provides ideal conditions for the growth of hepatic mat species. *R. Hodd*

The species composition of mixed northern hepatic mat vegetation varies geographically, but all stands have a similar community structure and are dominated by species of a small group of large leafy liverworts. *Herbertus aduncus* subsp. *hutchinsiae* is a conspicuous species in many areas, forming red to orange cushions on shady slopes and cliffs, with *Pleurozia purpurea* and *Bazzania tricrenata* also frequent throughout. *Scapania ornithopodioides*, *Mastigophora woodsii*

and *Bazzania pearsonii* are relatively widespread, but are more confined to areas where conditions are most suited to their growth. *Scapania nimbosea* and *Plagiochila carringtonii* are widely distributed in western Scotland, but are very rare in Ireland, being restricted to two and one extant sites, respectively. Three species of *Anastrophyllum* – *A. donnianum*, *A. joergensenii* and *A. alpinum* – are not uncommon, and are sometimes dominant, in Scotland, but are unknown from Ireland. The rarest hepatic mat species are *Adelanthus lindenbergianus*, which is restricted to seven known sites in Ireland and

one on Islay in Scotland, and *Herbertus borealis*, which has its worldwide headquarters on Beinn Eighe in Wester Ross.

A further number of species frequently grow in hepatic mats, but cannot be said to be characteristic of, or confined to, this community. These include the liverworts *Scapania gracilis*, *Anastrepta orcadensis*, *Mylia taylorii*, *Plagiochila spinulosa* and *Lepidozia pearsonii*, the mosses *Sphagnum capillifolium*, *Racomitrium lanuginosum*, *Dicranodontium uncinatum* and

Campylopus setifolius, and the fern *Hymenophyllum wilsonii* (Hodd & Sheehy Skeffington, unpublished). A number of common pleurocarpous and large acrocarpous moss species also often grow sparingly among the large hepatic species.

Worldwide distribution

Many of the constituent species of hepatic mat are of disjunct distribution (Table 1), and are all, with the exception of *Bazzania tricrenata*, restricted within Europe to the hyper-oceanic

Table 1. The British, Irish and worldwide distribution of hepatic mat species, and altitude range at which they grow in Britain and Ireland (data from Paton, 1999)

Species	British and Irish distribution	Worldwide distribution	Altitude range (m) in Britain and Ireland
<i>Adelanthus lindenbergianus</i>	SW, W & NW Ireland, Islay	Tropical and southern Africa, Central and South America, Antarctica	380–800
<i>Anastrophyllum alpinum</i>	NW Scotland	Himalaya, W China, Alaska	700–950
<i>Anastrophyllum donnianum</i>	Cairngorms, NW Scotland	SW Norway, Tatra, Faeroes, W Canada, Alaska, Himalaya	300–1,060
<i>Anastrophyllum joergensenii</i>	Cairngorms, NW Scotland	Norway, W China	700–950
<i>Bazzania pearsonii</i>	SW, W & NW Ireland, Cairngorms, NW Scotland	E & SE Asia, Himalaya, NW North America	300–1,000
<i>Bazzania tricrenata</i>	S, W & N Ireland, Scotland, N England, N Wales	Montane Europe, Faeroes, North America, Guatemala, Asia	0–1,220
<i>Herbertus aduncus</i> subsp. <i>hutchinsiae</i>	S, W & N Ireland, W Scotland, N England, N Wales	W Norway, Faeroes	0–1,040
<i>Herbertus borealis</i>	NW Scotland	SW Norway	380–550
<i>Mastigophora woodsii</i>	SW & W Ireland, W Scotland	Faeroes, NW North America, C and E Asia	100–1,000
<i>Plagiochila carringtonii</i>	W Ireland, Cairngorms, W Scotland	Faeroes, Nepal	300–1,070
<i>Pleurozia purpurea</i>	SW, W, C & N Ireland, W & C Scotland	SW Norway, Faeroes, Jan Mayen, Alaska, Himalaya, Guadeloupe	0–915
<i>Scapania nimbosea</i>	SW, W & NW Ireland, Cairngorms, W Scotland, N Wales	SW Norway, E Himalaya, W China	400–1,070
<i>Scapania ornithopodioides</i>	SW, W & NW Ireland, Cairngorms, W Scotland, N England, N Wales	Norway, Faeroes, Himalaya, Asia, Hawaii	300–1,000



Northern hepatic mat

◀ Rocky hepatic heath, Loch A'Mhadaidh, Fannich Hills, Wester Ross. *R. Hodd*



◀ *Bazzania pearsonii*, *Herbertus aduncus* subsp. *hutchinsiae* and *Pleurozia purpurea* in Derrymore Glen, Slieve Mish, Co. Kerry. *R. Hodd*

regions of Ireland, Scotland, the Faeroe Islands and Norway. Outside north-western Europe, most of these species occur in either north-western North America or the Himalayas and western China. The one exception is *Adelanthus lindenbergianus*, which has also been found in tropical and southern Africa, South and Central America and Antarctica (Paton, 1999). In these areas, the British and Irish species, or closely related species, often grow together, forming hepatic mats, such as in the Gaoligong Shan

Mountains of China (Long, 2008). However, in the Sino-Himalaya, the species are associated with other similar liverworts which do not extend to Europe, such as several other large *Scapania* species (D. Long, pers. comm.)

Two hypotheses have been put forward for the origin of the current disjunct distribution of these species: first, they may previously have had a continuous distribution between their current centres of population, but due to changes in the climate have retracted to areas where



▲ *Mastigophora woodsii* among grassy vegetation, Brandon, Co. Kerry. R. Hodd

▲ Hepatic mat, dominated by *Herbertus aduncus* subsp. *hutchinsiae*, finding refuge from heavy grazing on a cliff ledge, Slievemore, Achill Island, Co. Mayo. R. Hodd

conditions are suitable for their growth. The other possible origin of these species in north-western Europe is through long-range dispersal of spores from other populations in the Himalayas, North America or Africa (Schofield & Crum, 1972). The latter hypothesis is gaining ground over the former, despite the fact that they are not known to regularly reproduce sexually in Britain or Ireland.

Ecological requirements

The climate of western Ireland and western Scotland is extremely suitable for the growth of hepatic mat bryophytes. These areas have a hyper-oceanic climate which results in, among other things, a lack of extreme high or low temperatures, a high temperature lapse rate (the rate of temperature decrease with height), high cloudiness, high and frequent rainfall and a low vapour pressure saturation deficit (the difference

between the amount of moisture in the air and how much moisture the air can hold when it is saturated; Crawford, 2000). There is a gradient of oceanicity from east to west, resulting in a high climatological contrast between the maritime western fringe of Britain and Ireland and the relatively continental interior of these islands (Sweeney, 1997).

Frequency, rather than the overall amount of rain appears to be the main controlling factor in the distribution of hepatic mats, since their distribution is closely associated with areas where there are more than 220 rain days (days with more than 1 mm of rain) per year (Ratcliffe, 1968). This high frequency of rain results in a constantly humid atmosphere and low evaporation and transpiration, particularly in mountain areas. Hepatic mats also show better growth in areas with cool summers and mild winters (Averis, 1994).

Topography is also highly important for hepatic mat species, as the local topography determines the microclimate that many hepatic species depend on. Thus in most sites, hepatic mats are confined to areas that have a specific combination of altitude, aspect, slope and shelter. Hepatic mats generally do not grow below about 300 m, as at higher altitudes there is a combination of lower temperatures, less solar radiation, higher rainfall and more moisture due to the presence of more mist and cloud than at lower altitudes (Hodd & Sheehy Skeffington, 2011). Hepatic mats can grow at altitudes of up to 1,000 m in areas where snow cover protects the species from winter frosts (D. Long, pers. comm.) Hepatic mats generally grow and

reach their full composition on north-east- to north-facing slopes, where there is less sunlight and lower evapotranspiration. They prefer steep, well-drained slopes, but can also occasionally occur on deep blanket peat. The degree of exposure also plays a role in determining where hepatic mats will grow, meaning that deep corries, with high humidity and low sunlight are the favoured habitat, along with areas shaded by boulders (Averis, 1994). All of these factors combine to greatly restrict the area of suitable habitat for the growth of hepatic mat bryophytes in Britain and Ireland.

▼ The almost endemic *Herbertus borealis*, Beinn Eighe NNR, Wester Ross. R. Hodd



Northern hepatic mat

Hepatic mats are often considered to occur mainly as an understory beneath an open canopy of heather (*Calluna vulgaris*) in dwarf shrub heath. However, they also grow in a wide range of other habitats in the UK, including montane heath, upland grassland, snowbeds, open rocky birch forest and on mountain ledges (Averis *et al.*, 2004). In Ireland, it has been found that hepatic mats primarily occur in two distinct habitats: under a canopy of heather in dwarf shrub heath and in rocky grassland on steep slopes in corries. Stands of hepatic mat have also

▼ One of only two Irish sites for *Scapania nimbosa*, Corrán Tuathail, Co. Kerry, under threat from damage caused by walkers climbing Ireland's highest peak. Erosion around the path is visible in middle right of photo. *R. Hodd*

been found on the rocky floor of corries, cliff ledges and in montane heath. The range of primary habitat in which hepatic mats occur displays a strong gradient from north-west to south-west Ireland. The majority of stands in Donegal, in the north-west, occur in dwarf shrub heath, while the Kerry stands in the south-west rarely occur in association with *Calluna vulgaris*, growing primarily on rocky, grassy slopes (Hodd & Sheehy Skeffington, unpublished). There is no evidence for differences in land use or grazing intensity between the areas and, therefore, it is likely that this gradient is mostly climatically driven.

Threats

Hepatic mats are under threat from a number of sources, which are mostly anthropogenically





▲ A severely overgrazed slope, Binn Bhán, Twelve Bens, Connemara, Co. Galway, which was formerly one of only two Irish sites for *Plagiochila carringtonii*. R. Hodd

driven. Hepatic mats are vulnerable to disturbance and change for a number of reasons. These species are extremely restricted in distribution to areas of very specific climatic and topographic conditions. They also have very few means of long-distance dispersal, as only one hepatic mat species (*Anastrophyllum donnianum*, on one occasion; Averis, 1994) has ever been recorded as producing sporophytes in Britain or Ireland. Spread is primarily by vegetative fragmentation, making the establishment of new populations slow and unpredictable (Rothero, 2003). Their tendency to form large mats on steep slopes also makes them particularly vulnerable to erosion.

Currently, the most pressing and widely recognized threat to hepatic mats is overgrazing by sheep. Burning is also a threat in some areas, especially in Scotland (Rothero, 2003). Overgrazing has had the largest negative impact in parts of Ireland, particularly in parts of counties Galway and Mayo, where overstocking of sheep has led to severe degradation of the vegetation cover of the mountains (Bleasdale, 1998;

McKee *et al.*, 1998). This has led to widespread loss of the cover of hepatic mat bryophytes in many sites where they were previously frequent (Holyoak, 2006). The most well-documented losses have occurred in the Twelve Bens of Connemara, where hepatic mats were once abundant and rich under a tall canopy of heather (Ratcliffe, 1962), but are now mainly restricted to occasional, small, depauperate patches with little healthy heather in the vicinity (Holyoak, 2006). *Plagiochila carringtonii* is presumed lost here from one of only two known Irish sites, while *Adelanthus lindenbergianus*, which was once abundant and plentiful throughout the Twelve Bens, is now restricted to one small patch on Binn Gabhar (Long, 2010).

However, grazing pressure is uneven across the range of hepatic mat distribution in Ireland, and moderately extensive stands, containing reasonably healthy populations of all of the Irish species, including *A. lindenbergianus*, are still present in parts of Mayo, Kerry and Donegal (Hodd & Sheehy Skeffington, unpublished). Stocking densities have also been reduced throughout western Ireland in the last decade, but it is unlikely that already damaged or lost stands will recover in the near future due to the widespread

loss of vegetation cover and soil erosion, making restoration nearly impossible (Long, 2010).

Response to climate change

It is thought that future changes in the climate are likely to have an impact on northern hepatic mat species (Porley & Hodgetts, 2005). The main aspects of climate change that may affect these species are potentially decreased summer rainfall and increased year-round temperatures, as well as an increase in extreme weather events. Work on modelling the future distribution of a number of hepatic mat species in Ireland (Hodd, Bourke & Sheehy Skeffington *et al.*, unpublished) suggests that suitable climate space for these species will be lost in the south of their range and gained in northern areas of Ireland. However, considering the limited dispersal capacity of these species, they are unlikely to be able to move their range northwards in time with the climate. Populations may therefore be lost in southern areas, but no new ones are likely to be established in the north. Increased competition from other species able to expand into the hepatics' niche, as a result of changes in the climate, may also have a major negative impact on existing populations of hepatic mat species. Therefore, climate change could provide a significant future challenge to the survival of these species in Britain and Ireland.

What does the future hold for hepatic mats?

The future of the mixed northern hepatic mat is currently unclear. Much damage has been caused by overgrazing in certain parts of its range, but extensive, thriving stands still occur in some areas, particularly in Scotland. However, if climate change does eventually have a widespread and far-reaching impact on the distribution and abundance of hepatic mats, they may become extinct in several regions.

Therefore, first, it is imperative to establish the current condition, composition and distribution of this community in these islands, and to ensure that further damage due to grazing and other preventable factors does not occur. Second, long-term monitoring is necessary to establish what impact climate change may have on this community, and to enable timely conservation efforts. Research is currently underway into this community in both Ireland (Hodd & Sheehy Skeffington, 2011) and Scotland which will increase the understanding of this community. But there is a need for continued monitoring, as well as addressing the technically difficult and ecologically problematic issue of potentially transplanting or propagating the component species. However, despite continued research it may be that the luxuriant, multicoloured mats of these liverworts will no longer be a prominent feature of the vegetation of the Scottish and Irish mountains in the future.

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◀ The very rare *Adelanthus lindenbergianus*, in one of only eight European sites, Errigal, Co. Donegal. R. Hodd

