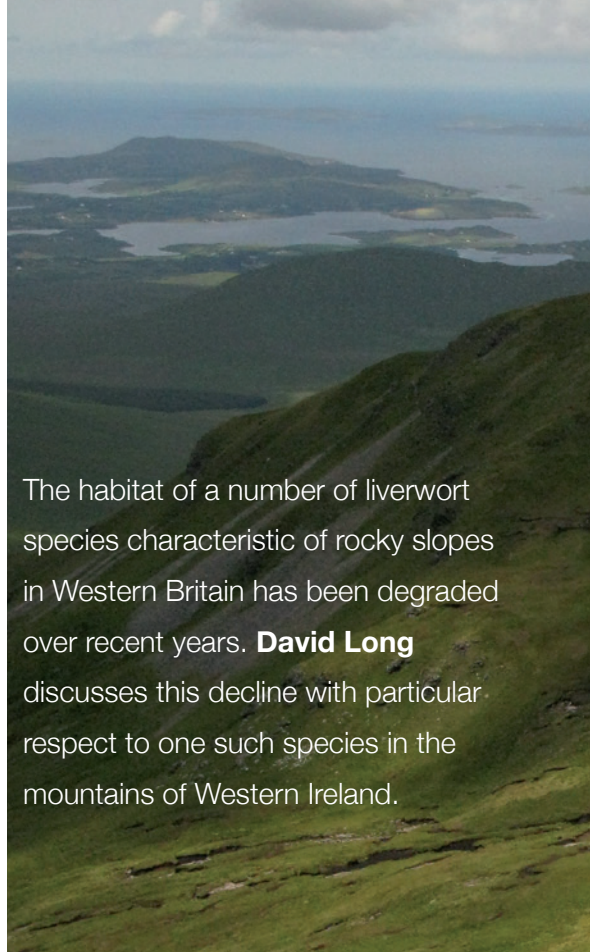


A *delanthus lindenbergianus* (Lindenberg's featherwort) is one of the rarest, and most interesting and enigmatic liverworts in the British Isles. Its main distribution is in the mountains of South America and tropical Africa (Grolle, 1969, 1972; Gradstein *et al.*, 1983). Its first discovery in Europe was on Achill Island, Co. Mayo, where it was found in June 1903 by Canon H.W. Lett. This material was described as a new species, *A. dugortiensis* Douin & Lett, in 1904 (Douin, 1904; Lett, 1904a, b); this was later synonymized by Müller (1951–1958) under *A. unciformis* (Hook.f. & Taylor) Mitt. (originally described from Hermite Island near Cape Horn) and later (Grolle, 1972) under the even older name *A. lindenbergianus*, originally described from South Africa. Since Lett's discovery, it has been found on the mountains of



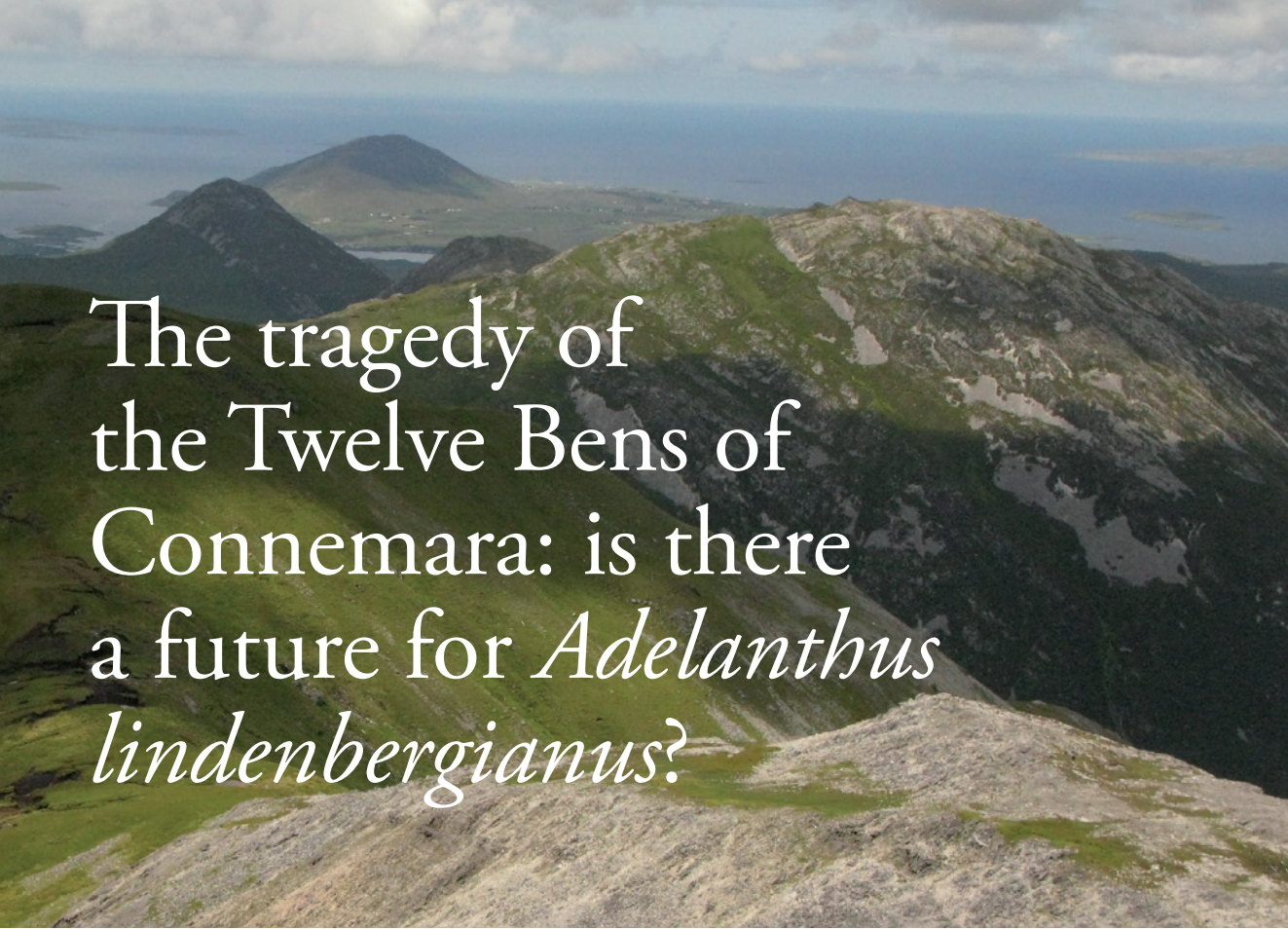
The habitat of a number of liverwort species characteristic of rocky slopes in Western Britain has been degraded over recent years. **David Long** discusses this decline with particular respect to one such species in the mountains of Western Ireland.



Donegal, Mayo, Galway and Kerry in Ireland, and on the Inner Hebridean island of Islay. These are the only European localities for this species, and in all of them it is very rare and (except perhaps on Islay) decreasing rapidly due to habitat degradation, to the point where it could become extinct in Ireland in the near future (Holyoak, 2006). As a regular visitor to Connemara since 1984, I have visited the Twelve Bens on numerous occasions and witnessed the rapid destruction of the *Calluna*-dominated, liverwort-rich heaths over many visits.

A. lindenbergianus is a member of a striking and unique plant community, a liverwort-dominated, dwarf-shrub heath, sometimes known as 'hepatic mat', found on rocky slopes and screes facing north to east on mountains of western Ireland and Scotland (Ratcliffe, 1962, 1968). It is composed of a mixed turf of large and often

◁ A surviving colony of *A. lindenbergianus* in the north corrie of Bengower (12 July 2007). *David Long*



The tragedy of the Twelve Bens of Connemara: is there a future for *Adelanthus lindenbergianus*?

colourful liverworts and mosses protected by a layer of dwarf shrubs, mainly heather (*Calluna vulgaris*), though it is often also protected by rocks and boulders. Many of the large liverworts in this community are of global significance for their remarkable disjunct distributions, most with the Sino-Himalayan region in Asia, some with Japan and British Columbia (e.g. *Anastrepta orcadensis*, *Bazzania pearsonii*, *Mastigophora woodsii*, *Mylia taylorii*, *Plagiochila carringtonii* and *Pleurozia purpurea*). *A. lindenbergianus* is unique within this community in that its disjunction is with the mountains of tropical America and Africa (Gradstein *et al.*, 1983). Therefore, the Irish communities are a globally unique assemblage of plants and merit the strictest protection.

There are two main theories about how these hugely disjunct distributions came about. The first is the 'vicariance theory' – that these plants in the distant past occupied relatively

△ The Twelve Bens. View to north-west from Benbaun across Laggantarriff, Benbrack, Knockbrack, Diamond Hill and Tully Mountain (16 July 2009). *David Long*

continuous, broad distributions, having spread short distances stepwise, but subsequently through climate change their broad ranges have shrunk to isolated outliers where conditions have remained favourable. The second is the 'dispersal theory' where these species are thought to have arrived more recently by wind-borne spores from South America or Asia. Both of these are considered at length by Schuster (1979). In the case of *A. lindenbergianus*, he favoured the 'dispersal theory':

'The presence of some taxa of probable American origin on Tristan da Cunha, in Africa and Ireland (A. lindenbergianus) ... can probably only be attributed to geologically recent dispersal via spores.'

Gradstein *et al.* (1983) agreed:

'The occurrence of such species on isolated, plus

young oceanic islands seems to confirm their air dispersal.'

Evidence that this is theoretically possible came from Van Zanten & Gradstein (1988) who demonstrated experimentally that spores of some liverwort species with intercontinental ranges could survive the conditions required to be successfully dispersed by trade winds. These alternatives can now be tested using molecular DNA sequencing techniques, because recent arrivals will show little genetic differentiation from the 'parent' plants in contrast to ancient disjunctions where considerable genetic differentiation is expected. This technique remains to be applied to *A. lindenbergianus* from Europe or Africa, but it has recently been tested on populations from South America (Feldberg *et al.*, 2009) where geographical genetic differentiation within five markers is demonstrated between populations from southern South America versus tropical America. It is quite possible that *A. lindenbergianus* will demonstrate vicariance in South America, but recent dispersal to Tristan da Cunha, Africa and Europe.

A. lindenbergianus in the Twelve Bens of Connemara

A. lindenbergianus was discovered in the Twelve Bens by Derek Ratcliffe on 21 September 1961 (Ratcliffe, 1962):

'I found Adelanthus unciformis growing quite abundantly in an identical [to Slievemore, Achill Island] hepatic-rich Callunetum which covered the steep, north slopes of Bengower and Benbreen', 'between 1,700 and 2,200 ft. The Adelanthus was rather more plentiful than on Slievemore, and it is quite likely to grow on steep, north to east slopes of other hills of the Twelve Bens which were not examined.'

Ratcliffe also reported the average height of the *Calluna* layer on those slopes of Bengower and



Benbreen as 9 inches. Perry (1983) in the *Flora of Connemara and the Burren* highlighted the beauty and importance of this community in the Twelve Bens:

'One of the most memorable sights in the mountains is the startling colour contrast provided by reddish-brown or rose-tinted hunks of Herbertus mixed up with the deep purple leafy liverwort Pleurozia purpurea. The local speciality of this liverwort turf is, however, Adelanthus unciformis. It is relatively common on the Twelve Pins above 550 m (1800 ft), under the Calluna canopy, especially on the north-facing slopes of Benbreen and Bengower.'

In April 1984, on my first visit to the Twelve Bens, I found *A. lindenbergianus* relatively easily on the north slope of Benbaun (L 78 54), growing in bryophyte turf amongst boulders at 520 m. Ten years later, in July 1994, the Bens were visited by the BBS, one of the main goals being to look for *A. lindenbergianus* in Derek



◁ *Bazzania pearsonii* and *Pleurozia purpurea* – healthy vegetation on north-facing slopes of Maulan above Kylemore Lough (22 July 2004). David Long

△ Top left. Overgrazed, eroded slopes, north corrie of Bengower (12 July 2007). Top right. Dead *Herbertus aduncus* on overgrazed slopes below the summit of Benbaun (16 July 2009). Bottom left. Overgrazed slopes and Connemara sheep below the summit of Benbaun (16 July 2009). Bottom right. Connemara sheep on Benbaun North (22 July 2004). David Long

Ratcliffe's sites. Only then did the harsh reality of the fate of this liverwort become clear, as reported by Blockeel (1995):

'We were scarcely prepared, however, for the devastation which awaited us in the northern corrie [east corrie of Benbreen]. Here, on the stony north-facing slope, a few broken fragments of heather and the dead remains of large Herbertus tussocks bore sombre witness to the destruction of the dwarfshrub heath which once clothed these slopes. We could only find small and sorry pieces of A. lindenbergianus,

with a little Bazzania tricrenata and B. pearsonii. Herbertus aduncus had fared slightly better. The Adelanthus must have been plentiful here only a few years ago. Several people observed that the overstocking with sheep had been precipitated and encouraged by EEC subsidies.'

Since 1994 I have searched the Bens several times without success, as has D.T. Holyoak in 2004 (N. Lockhart, pers. comm.). However, following further searching on 12 July 2007, I managed to find and photograph a small population surviving on the north slope of Bengower (L 78 50) on a steep rocky slope where *Calluna* and *Empetrum* formed a patchy cover, perhaps partly protected from grazing by the steep rugged terrain. This could be literally the last survivor in the Bens of a formerly widespread species.

As Blockeel (1995) and others (e.g. Holyoak, 2006) have subsequently observed, the dramatic decline in *A. lindenbergianus*, and other large liverworts of this community, has been caused

primarily by severe overgrazing by sheep and loss of the dwarf shrub layer. The devastating effects of overgrazing through subsidized overstocking of sheep on bog vegetation in the west of Ireland has been studied and reported by MacGowan (2000) and most of the effects she described apply equally to the heaths of the Twelve Bens. The 9-inch heather canopy reported by Ratcliffe (1962) has now almost entirely been lost, except perhaps in the Connemara National Park, but even there, severe overgrazing has occurred, as on the north slope of Benbrack, as sheep have not been effectively excluded due to difficulties of fencing. The remains of dead heather stalks and dead *Herbertus* hummocks are visible on many hillsides where few healthy heather plants can now be found. The large numbers of sheep have also caused significant nitrogen enrichment which is highly toxic to many bryophytes. Overgrazing has also caused severe erosion and loss of peat and soil, so that even if grazing pressure could now be drastically reduced, the habitat may be unsuitable for recolonization by dwarf shrubs and bryophytes in the short term. Sadly, the 'memorable sight' of this striking and colourful community as reported by Perry (1983) is now but a distant memory except in a few surviving pockets, such as the steep slope of 'Maulan' above Kylemore Lough where grazing pressure is tolerable.

The future

What is the future for liverwort-rich heath and particularly *A. lindenbergianus* in the Twelve Bens? According to Holyoak (2006):

'Unfortunately, the situation is now critical and it is already too late in County Galway for the vegetation to recover, unless destocking were to be followed by reintroductions'.

However, even on the most severely damaged slopes, young seedlings of heather can still be found, and in a few places (such as Benlettery),

patches of healthy heather occur on steep and less accessible slopes. Hence, it is theoretically possible that with greatly reduced grazing pressure, heather cover could be re-established in some places. However, an added problem is that the Connemara sheep appear to selectively favour the higher slopes in contrast to the apparently richer grazing at lower altitudes. Therefore, even with reduced numbers, the sheep may still congregate on and selectively graze the higher heathery slopes. Because of the ability of the sheep to range freely over large areas of common grazing, and difficulties of fencing sensitive areas, it will be challenging to protect the most damaged sites, even with reduced numbers.

Nevertheless, optimism has recently increased through the introduction in Ireland of the 'Rural Environment Protection Scheme' (REPS) which has enabled subsidies to be restructured *'to establish farming practices and production methods which reflect the increasing concern for conservation, landscape protection and wider environmental problems, to protect wildlife habitats and endangered species of flora and fauna and to produce quality food in an extensive and environmentally friendly manner'* (Anon, 2009). This optimism may be premature because in July 2009 the Irish government announced closure

▷ Left. Green shoots of recovery? Dead *Calluna*, young *Calluna* seedlings and sheep dung on Bengower (12 July 2007).

Right. Grazed *Calluna* sward at the *A. lindenbergianus* site on Bengower (12 July 2007). David Long



of the REPS-4 scheme to new applicants, though existing participants will continue to receive payments for up to 5 years. However, a number of other measures are in place which are actively seeking both to promote research and monitoring, e.g. by Upland Surveys and academic research, supported by the National Parks and Wildlife Service (NPWS) on Irish upland Special Areas of Conservation (SACs) and also their conservation under the European Community 'Habitats Directive'. In addition to REPS, other funding is available to farmers under the NPWS 'Farm Plan' scheme. There has also been a substantial effort made to determine stocking density and advice on appropriate stocking levels in all Irish uplands. These 'Commonage Framework Plans' have fed into REPS plans and will continue to feed into NPWS Farm Plans, as long as funding remains available (N. Lockhart, pers. comm.). Stocking densities are now declining, but it may take many years for the vegetation to respond.

It is to be hoped that the future protection

of such an internationally important habitat as the Twelve Bens will not entirely depend on the vagaries of changing agricultural subsidies – but the other measures in place give real grounds for optimism. The Bens deserve proper protection in their entirety, the ideal long-term mechanism being for the Connemara National Park to be extended to include the whole range so that it can be managed as a single entity as a sustainable resource for agriculture, wildlife, outdoor recreation and tourism. This could substantially increase the value of the Twelve Bens as a whole to the local rural economy. In the meantime, if grazing can be effectively managed at reduced levels, this should be carefully monitored to study the potential for full restoration of the *Calluna* cover and liverwort heath. Some areas of experimental livestock enclosure would be an essential part of this. Unfortunately, *A. lindenbergianus* and others of this community are always sterile and few produce gemmae (Paton, 1999) – even if the *Calluna* cover could be re-established, there is no guarantee that



the rarer liverworts would recolonize naturally. Nevertheless, habitat restoration is a growing science and the Twelve Bens would provide an excellent site for an experiment in large-scale upland restoration.

Modern genetic techniques provide a good opportunity for research on Irish populations of disjunct liverworts such as *A. lindenbergianus* – how distinct are these populations genetically from those in Africa and America, or in the case of species such as *Bazzania pearsonii*, *Mastigophora woodsii* and *Plagiochila carringtonii*, from populations in Scotland, the Himalayas and China? Such research could reveal much about the post-glacial colonization of Ireland by oceanic bryophytes, or detect possible past survival of these species in refugia from more ancient vicariant distributions.

The question is – will it be too little, too late for Lindenberg's featherwort?

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