As part of his British Trust for Conservation Volunteers (BTCV) Natural Talent Apprenticeship, **Oliver Moore** was asked to undertake a search for *Lejeunea mandonii* at a John Muir Trust reserve along the Drinan coast, Strathaird, Isle of Skye. The project eventually expanded to include all known sites for this species in Scotland. It is hoped that this report will stimulate efforts to find new records of this liverwort.

Current status of the known populations of *Lejeunea mandonii* in Scotland

Lejeunea mandonii (Steph.) Mull. Frib. (Atlantic pouncewort) (Fig. 1) is listed in the *Red Data Book* as endangered and is a rare plant worldwide, occurring on the Atlantic fringe of Europe, in Britain, Ireland, Spain and Portugal, and also in Macaronesia (Church *et al.*, 2001). Consequently, the British populations of this liverwort are of international importance and it is a Biodiversity Action Plan priority species.

L. mandonii was first found by Dr Symers Macvicar at Invermoidart in 1898. It is frequently found with other hepatics such as *Frullania* spp. and *Radula* spp. (Hill *et al.*, 1991), as well as mosses such as *Neckera complanata* and *Zygodon* spp. in lightly shaded situations. *L. mandonii* occurs by the coast, near sea level, in its Scottish and English localities, and here

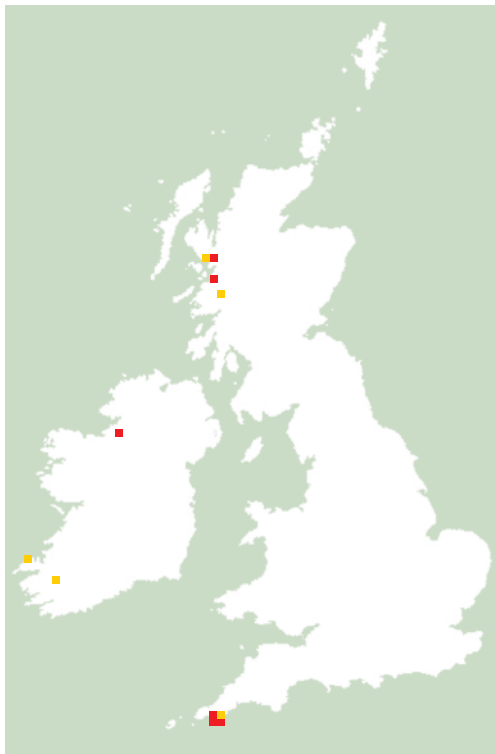
it grows in relatively dry places where there is constant humidity (Rothero, 2002). *L. mandonii* is a southern Atlantic liverwort according to Ratcliffe (1968) and its northernmost locality in the world occurs on the Isle of Skye (Fig. 2).

Surveys of the five recorded Scottish sites in 1996 and 2000 found the plant on just three individual ash (*Fraxinus excelsior*) trees. These were in fairly open ravines of calcareous rock, with a southerly or westerly aspect, where the humidity remained high, but where there was still a reasonable amount of insolation (Rothero, 2002). Rothero (2002) conducted a very thorough search of similar habitats at Moidart in ravines parallel to those where the species had been found, but without success.

At Laudale, Rothero (2002) was following up a vaguely located record from 1967, made by John Birks, from Meall a' Chuilinn. Most of the stands of *Lejeunea* spp. were rejected in the field and collections of small Lejeuneaceae from calcareous rock here proved to be small forms of *L. patens*. The author also noted that the ravines at Laudale were very different from those at Moidart, but a small population of *L. mandonii* would be easily overlooked amid the abundant *L. patens*.

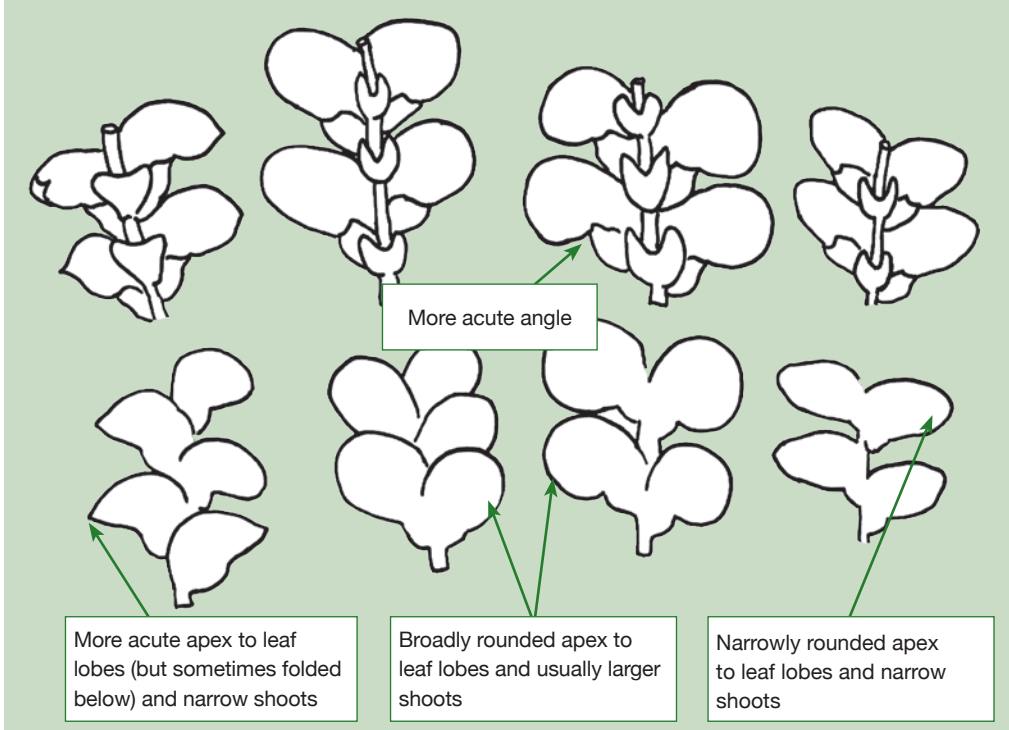
The present survey set out to monitor the status of the three existing populations of *L. mandonii* in Scotland and to search the Drinan coast thoroughly in another attempt to refind the locality reported by Birks & Birks (1974).

According to Paton (1999), well-developed populations of *L. mandonii* can be recognized in the field vegetatively by the consistently narrow shoots and the rather narrowly rounded apex of



◀ Fig. 1. *L. mandonii*. *F. Rumsey*.

◀ Fig. 2. 10 km distribution of *L. mandonii* in Great Britain and Ireland. ■, 2000–2010 records; ■, 1959–1999 records. *Map taken from the NBN gateway using data from the BBS and BRC. © Crown Copyright. All rights reserved NERC 100017897 2004*



▲ Fig. 3. Illustrations of some possible confusion species. From left to right: *H. molleri*, *L. lamacerina*, *L. patens* and *L. mandonii*. Postical view (upper row) and antical view (lower row). Magnification x40. *O. Moore*

many of the leaves. *L. mandonii* is the only British member of the genus that has terete, smooth perianths, but these may be very small and are then not always easily located in the field (Paton, 1999). Capsules are reported as being very rare, occurring in the spring (Holyoak, 2004), and perianths are occasional (Smith, 1990). There is no specialized means of vegetative spread (Rothero, 2002).

Confusion species in the field include *L. patens* and *Harpalejeunea molleri*, both of which may grow with *L. mandonii*, making things very difficult (Rothero, 2002). *H. molleri* differs in its underleaves and more acute leaf lobes, while in *L. patens* the angle between the postical margin and the keel is narrower (Paton, 1999). *L. patens* has a more broadly rounded leaf apex compared to its rarer congener. Fig. 3 illustrates some of the differences between the species mentioned above. It should be added that shaded stems of *L. lamacerina*, *L. patens* and *L. cavifolia* can produce leaves that are longer than usual (Holyoak, 2004) and when occurring on small specimens of these species, distinguishing them from *L. mandonii* is even more difficult.

Procedure

Herbarium specimens of *L. mandonii*, *L. cavifolia*, *L. lamacerina*, *L. patens*, *H. molleri* and *Drepanolejeunea hamatifolia* were scrutinized at the Royal Botanic Garden, Edinburgh, in preparation for field work. In order to become acquainted with the target liverwort in the field, a site visit to one of its known locations at Tokavaig was undertaken on 27 February 2010. On 1 March 2010, Nick Hodgetts joined me in the field on a spectacular day to begin the search for this elusive liverwort in sea caves along the Drinan coast (Fig. 4). A few days before, by means of an open canoe, a 3-km stretch of coast had been viewed to see which sea caves showed the greatest potential to search in.

According to Birks & Birks (1974), *L. mandonii* was said to be very rare (on Skye), restricted to a single locality in the Elgol Peninsula where it occurs with *Marchesinia mackaii* on dry but shaded Jurassic limestone rocks in a large sea cave. Rothero (2002) tracked down Birks' notes from his original discovery and was able to add '*… somewhere between grid reference 18/553 160 and 18/548 147*'. During the search, a vast amount

▲ Fig. 4. Drinan coast with view north to the Red Cuillins. *O. Moore*

of *M. mackaii* was examined, and every small-leaved patch of *L. patens* was studied carefully. A small amount of material was collected for checking with a microscope.

During the next couple of weeks, visits were made to different coastal gullies, sea caves and wooded ravines along this stretch of coast, and beyond the area specified by Birks & Birks (1974).

On 5, 19 and 20 March 2010, visits were made to the known locations for *L. mandonii* at Tokavaig (Skye), Allt Ailein and Allt a' Mhuillin (Moidart), respectively. At each site the distribution of the liverwort was mapped onto a sketch of the relevant facies of the tree. An estimate of the area of each patch, or extent of the scattered shoots, was made using a transparent overlay with 1 cm grid squares marked on. The total area on each tree was calculated by adding up all of these values (Table 1). Accurate grid references were determined with a GPS device and photographs of the trees and habitat were taken for future reference. A search of other suitable habitat in each of these ravines was made to try and find other populations of *L. mandonii*. A bad weather forecast limited my search to just one other adjacent ravine (Limekiln Burn) at Moidart.

Observations

Fig. 5 gives a crude idea of the extent of *L. mandonii* populations at its known localities in Scotland. More accurate and detailed mapping of the distribution of this species onto sketches of

Table 1. Total area of patches and/or scattered shoots of *L. mandonii* on different aspects of the three ash trees on which it occurs in Scotland

Date	Location	Area (cm²) of patches/scattered shoots on tree-faces			
		N-facing	NE-facing	W-facing	S-facing
5/3/10	Tokavaig	210	–	21	12
19/3/10	Allt Ailein	208	28	–	–
20/3/10	Allt a' Mhuillin	–	18	–	–

Table 2. Total area of *L. mandonii* from the three ash trees on which it occurs in Scotland in 2010 compared with that estimated by Rothero (2002) in 2000

Location	Estimated total area (cm^2) of scattered shoots/patches of *L. mandonii*	
	2000	2010
Tokavaig	Approx. 150	233
Allt Ailein	Might approach 600	236
Allt a' Mhuillin	Not more than 30	18

◀ Fig. 5. Distribution of *L. mandonii* on some of the ash trees observed in this study. (a) North-facing side (Tokavaig, lower trunk); (b) north-east face (Allt a' Mhuillin); (c) north-face (Allt Ailein, lower trunk). *O. Moore*

the trees gave the total estimated areas as shown in Tables 1 and 2. Table 2 also includes the areas estimated by Rothero (2002). Despite a great deal of effort, *L. mandonii* was not found along the Drinan coast or in potential locations further south. No new populations were discovered in Allt Ailein, Allt a' Mhuillin or Limekiln Burn.

Conclusions

Rothero (2002) points out that *L. mandonii* was intimately mixed with other Lejeuneaceae at the Scottish sites, making accurate assessments of population size difficult without much damage to the stands. No specimens were collected from the known populations in this survey and estimates of population size were entirely the result of close scrutiny of the epiphytes *in situ*.

The main disparity between the total area of *L. mandonii* estimated in the present survey and that of Rothero (2002) occurred at Allt Ailein, with nearly three times less measured in 2010. However, patches of *L. mandonii* still occur over some 2 m of the tree trunk (Fig. 5c) as they did in the 2000 survey. Rothero (2002) concedes that it was just possible that some of the stands recorded

were small forms of *L. patens*, but this could not be investigated without an unwarranted level of collection. In the present survey, these stands might well have been taken for the commoner species, resulting in a lower estimate of cover for *L. mandonii*.

Holyoak (2000) suggested that there might be a relationship between the vigour and growth of *L. mandonii* and the growth, persistence and decay of the mosses on which it usually grows. Therefore, the year to year variation in abundance could be a natural phenomenon and not a cause for concern. This went with the proviso that further investigation would be needed to test this hypothesis. Anecdotal evidence in support of this suggestion comes with the observation that the population of *L. mandonii* on the ash tree at Tokavaig appears to have moved around quite a bit over the years (N. Hodgetts, pers. comm.). Some evidence of sloughed bryophyte cover was observed at this site and it is possible that some of the patches recorded by Rothero (2002) had been lost as a result. *L. mandonii* is a brittle plant and it may well be susceptible to damage from raindrops or moving water (Holyoak, 2004), so a powerful rainfall event may have caused a loss to the population in the last 10 years. There were fewer patches found down the north-east aspect of the tree at Allt Ailein compared to 10 years previously (Rothero, 2002); this may have been due to a storm event. Following annual repetition of the measurements of patches from 1997 to 2003/4 at Cornish localities for *L. mandonii*, there were erratic fluctuations at most sites (Holyoak, 2004). Maybe a similar fluctuation is occurring in the Allt Ailein population.

There appears to have been an increase in cover of *L. mandonii* at Tokavaig and a decrease at Allt a' Mhuillin. The bulk of the populations of *L. mandonii* in Scotland occur on the north/north-east-facing aspects of ash trunks (Table 1). The best patches were found beneath branches on the trunk. Holyoak (2004) suggests that limitation to these places may be due to avoidance of competition from the vigorous growth of pleurocarpous mosses. Since *L. mandonii* obtains all of its water from humid air, this must be characteristic of the sites where it occurs. The aspects where it occurs, however, would generally confer drier and more shaded conditions for this liverwort.

The fact that *L. mandonii* is only known from just three ash trees makes this species extremely threatened in Scotland. Rothero (2002) expressed his concerns about the ivy on the ash at Tokavaig and this could yet become a problem, but at present the *L. mandonii* population appears to be doing well here. Competition from more robust bryophytes was a concern at Allt a' Mhuillin (Rothero, 2002) where the *L. mandonii* population is very small. This population does appear to have declined. At Allt Ailein, Rothero (2002) commented on the rather sorry-looking ash tree that holds a good population of *L. mandonii*. The tree still remains in 2010. *Rhododendron ponticum* was not seen in the vicinity of any of the three sites, but it does occur to the east of Allt a' Mhuillin. At present there is no immediate risk of shading by this species.

All three trees are close to a stream edge in steep-sided, rocky ravines and may be prone to an extreme rainfall event causing bank collapse or large debris being washed downstream. Such an event could be catastrophic to any species with so restricted a population. Rothero (2002) urged research into the *ex situ* cultivation of *L. mandonii*, with a view to transplantation into a suitable habitat. This proactive measure might ensure the survival of this liverwort at the northern limits of its range. More regular monitoring of these

populations is recommended so that decisions concerning conservation strategy can be made quickly in the event of disaster.

During the preparation of this report, Birks' herbarium arrived at the RBGE and contained two specimens of *L. mandonii*, both from the Drinan coast, Skye. Each had been refereed successfully. One specimen was collected on 2 July 1967 and the other on 9 August 1968. In each case it had been growing with *M. mackaii* and the latter collection was from a shaded sea inlet near Kilmarie. However, there was no accurate grid reference. Even after considerable time spent on unsuccessful searches of the Drinan coast during this survey and by others (Rothero, 2002; Averis 1995), it is still possible a few shoots of this tiny liverwort could have escaped detection.

Since all of the sites where *L. mandonii* occurs have enjoyed relative stability for centuries, Holyoak (2004) suggests there is a need for historically stable habitats within the Atlantic climate zone in order for this liverwort to grow. Bryologists are urged to keep an eye out for this rarity whenever they find themselves in humid ravines with overhanging, basic rocks and old woodland with ash trees in Scotland.

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