



The remarkable *Buxbaumia viridis* (Green Shield-moss) is regarded as endangered across Europe. However, dedicated survey work by **Stewart Taylor** has led to its discovery at several new sites in Scotland and it is the information associated with ongoing finds that has brought about this short note as an aid to others who might be interested in searching for the moss.

# *Buxbaumia viridis* in Abernethy Forest and other sites in northern Scotland

**B***uxbaumia viridis* was first recorded in Britain in 1847, with seven further records over the 40-year period to 1887. It was not recorded again until 1951, when it was found at Alvie (v.-c. 96). At Reelig Glen (v.-c. 96) it was first recorded in 1961, and this is the site with the greatest continuity of records. In 1999, a site was found at Kindrogan (v.-c. 89). In total, in 1999 the population of *B. viridis* in Britain was 31 sporophytes, on five logs at two locations (Church *et al.*, 2001).

In Britain, *B. viridis* is rated as Endangered (Church *et al.*, 2001), and is listed on Schedule 8 of the Wildlife and Countryside Act. It is sparsely distributed across Europe and appears on the Red List of most countries where it occurs. The European Committee for the Conservation of Bryophytes rates *B. viridis* as Vulnerable in

Europe, and it is listed in Annex II of the EC Habitats and Species Directive and on Appendix 1 of the Council of Europe Bern Convention. In Britain, it has its own Biodiversity Action Plan. Rothero (2008a, b) describes the history of its discovery, ecology and advice on management.

Searches in the RSPB Abernethy National Nature Reserve by Gordon Rothero and Andy Amphlett (RSPB) in 2002 and 2003 located four logs with capsules and a further two logs in the adjacent Craigmore Wood (RSPB) in 2004. A further survey in the general area of the 2003 finds by Amphlett, Dave Genney (SNH) and Pete Moore (SNH) in 2006 located a further four logs with capsules. The log hosts for all these finds were downy birch (*Betula pubescens*), Scots

△ A whole *B. viridis* capsule and predated capsules in Abernethy Forest (stand 13b). Stewart Taylor





△ *B. viridis* habitats. Top left. Scots pine root. Top right. Scots pine log by a track (with 90+ capsules). Bottom left. Alder (upper) and Scots pine (lower) logs. Bottom right. Live wood ant nest. Opposite top left. Norway spruce stump and log. Opposite top right. Bark of goat willow. Opposite bottom left. Capsules on the ground. Opposite bottom right. Norway spruce log. Stewart Taylor

pine (*Pinus sylvestris*) and alder (*Alnus glutinosa*). In January 2007, I saw my first *B. viridis* capsules when I visited the 2003 and 2006 sites to re-survey their populations. Capsules were found on all the logs occupied during the earlier surveys and a few days later capsules were found on two new alder logs 3 km from the original sites, and by May 2007 another ten logs with capsules had been found, all closely associated with the same river system as the earlier finds.

Prior to the sites reported in this article, *B. viridis* was considered to be restricted in Britain to decorticated fallen trunks and stumps of coniferous trees in humid, sheltered woodland (Church *et al.*, 2001). Wiklund (2002) defined suitable habitat as:

*'fairly moist bare wood, wood with algae or*

*with a sparse cover of liverworts or small shoots of mosses'.*

The search criterion for bryologists looking for potentially suitable habitat for *B. viridis*, was to look for logs with a cover of *Nowellia curvifolia* or, especially, *Riccardia palmata*. This type of habitat has continued to be important throughout my recent survey.

### *B. viridis* on trees

The first contradiction to this 'rule' were capsules found growing amongst *Dicranum scoparium* and *Hypnum cupressiforme* on intact bark of dead alder trees where the wood below the bark was still quite hard. The fallen trees were ca 30–40 cm in diameter. At one site, capsules were found growing on a section of alder bark that had become detached from the dead tree and at another site capsules were found on a live, upright alder, but in an area where the bark was maintained wet by a slight seepage of water.

The next log to break the typical site rule was a Scots pine log adjacent to a well-used forest





track in an apparently dry location. This log was well away from watercourses, but sheltered from full sun by adjacent trees. The log initially must have fallen on to the track before being moved, and had been cut square at each end by a chainsaw. Run-off from the track would appear to have kept the log moist even though part of the log was raised off the ground. To date, this log has produced the highest single emergence of capsules (96), though many of the young capsules fell prey early on to predator(s) unknown.

Capsules have also been found growing in the rotting root sections of several fallen trees (Scots pine and alder), some growing from the exposed decaying roots and some apparently from the soil/humus in between the roots. Most root sites are where the trees fell, but one site comprises an alder root stuck in a pile of river debris on an island in the River Nethy. Eight capsules were also found growing on the knobbly protrusions at the base of an ancient but live goat willow (*Salix caprea*). Heavy snow in February 2009 caused this tree to topple, tempting me to check similar

protrusions higher up the tree. Two capsules from that current growing season, established well before the tree fell over, were found at 4.9 m up the tree, and three at 2.1 m. An old capsule from the previous growing season was also found at the 2.1 m level.

The last tree habitat to describe may turn out to be the most suitable for *B. viridis*, despite the fact that the tree species is a commercially planted conifer. Checking through a group of Scots pines killed off by a fungal attack several years ago, led me to an area where mature Norway spruces (*Picea abies*) had been felled to 'waste or recycle' 9 years ago. The first log I checked was a spruce that had been felled and had all of its branches snedded off. This log was about 60 cm in diameter at its base and about 16 m in length, and had retained all of its bark. Sixty-two capsules were found along with six setae from predations along the log. The spruce trees were in a mixed stand with similar-aged Scots pine trees, covering about a hectare of damp ground, and over 3 days the logs from

the rest of the felled trees were checked. Some spruce trees had been felled but without having had their branches removed, remaining elevated off the ground. Very few capsules were found on these logs. However, capsules were also found on several of the root buttresses of the stumps of the felled trees, and in total 285 capsules on 29 logs/stumps were found.

Other sites in Abernethy Forest where Norway spruce trees had been removed during the last decade were checked and at nearly all the sites, capsules were found, mainly on the stumps/root buttresses because the logs had been removed at the time of felling. A few old capsules were also found on the stump/root buttresses of two felled Sitka spruce trees (*Picea sitchensis*). This follows a similar find I made on a Sitka spruce stump in Ruttle Wood near Beaulieu (v.-c. 96). Sandy Payne has also found capsules on a Scots pine stump in Reelig Glen, indicating this is a habitat worth searching.

### *B. viridis* on wood ant nests

In April 2008, I checked a wood ant nest (*Formica aquilonia* or *F. lugubris*) that had been disturbed by a mammal and found several capsules growing from the surface of the nest. Wood ants no longer occupied the nest and a more detailed search of the nest found a total of nine capsules and 15 setae. This particular nest was within about 100 m of the Scots pine log with the 96 capsules mentioned earlier. Checks of three other deserted wood ant nests within another 50 m found capsules on two of them. This would appear to be the first time this host habitat has been recorded in the UK. Later in 2008, a further deserted wood ant nest was found with capsules, along with an ancient nest still occupied by wood ants which had five mature capsules growing from a mossy substrate. Several more wood ant nests, both occupied and

deserted, have since been found with capsules. One of the nests from the April 2008 location was checked again during the 2008/09 growing season and amongst the *B. viridis* capsules was a single capsule of *B. aphylla*, probably the first time the two species have been found growing together in the UK. On the occupied wood ant nests *B. viridis* grows amongst an open cover of other bryophytes, avoiding the bare surface of the nests actively maintained by the ants.

### *B. viridis* growing on the ground

With time, I started to develop a feel for the general colour and appearance of the habitat requirements for *B. viridis*, leading to the speculative checking of non-typical locations on trees and wood ant nests. Similar habitats seemed to be present on certain wooded slopes in Abernethy Forest, and in December 2008, capsules were found growing, apparently on the ground, in this type of habitat. The capsules at the first couple of sites appeared to be growing out of the ground, but at other sites found in January 2009 there was a distinct appearance of well-decayed wood within the soil. The moss had been found in a similar habitat near Bridge of Brown (v.-c. 95) in 2005 by David Chamberlain. To date, I have only had time to search a small area of this type of habitat within Abernethy Forest (lunchtime searches) but, pointing out this type of habitat to Sandy Payne and Claire Geddes on a visit to Reelig Glen in April 2009, a single capsule was found on a mossy bank, suggesting further searches in areas of this habitat might be worthwhile.

During the 2008–09 growing season, I found 127 individual populations of capsules in 17 1 km OS grid squares within Abernethy Forest. That season, 101 new populations were found, bringing the total recorded at Abernethy post-2000 to 141.

**Table 1.** Host species/substrate of *B. viridis* in Abernethy Forest and other sites in north-east Scotland during the 2008–09 season

Host species/substrate	Abernethy Forest		Other sites in north-east Scotland		All sites	
	Stands/ populations	Capsules	Stands/ populations	Capsules	Stands/ populations	Capsules
Norway spruce ( <i>Picea abies</i> ) (log/stump)	54	393	9	24	63	417
Scots pine ( <i>Pinus sylvestris</i> ) (log/stump)	15	143	2	3	17	146
Birch ( <i>Betula</i> spp.) (log)	7	24	12	89	19	113
Soil/humus	18	64	2	2	20	66
Ant nest ( <i>Formica aquilonia</i> /F. <i>lagubris</i> ) (occupied)	6	64			6	64
Ant nest ( <i>Formica aquilonia</i> /F. <i>lagubris</i> ) (deserted)	5	59			5	59
Alder ( <i>Alnus glutinosa</i> ) (log)	16	56			16	56
Willow ( <i>Salix caprea</i> /Salix spp.) (log/trunk)	2	15	2	13	4	28
Unidentified tree species (log)	6	10	3	9	9	19
Scots pine ( <i>Pinus sylvestris</i> ) (root)	4	14			4	14
Western red-cedar ( <i>Thuja plicata</i> ) (log)			1	11	1	11
Sitka spruce ( <i>Picea sitchensis</i> ) (stump/root)	2	2	1	6	3	8
Bird cherry ( <i>Prunus padus</i> ) (log)	3	8			3	8
Alder ( <i>Alnus glutinosa</i> ) (root)	3	7			3	7
Rowan ( <i>Sorbus aucuparia</i> ) (log)			1	2	1	2
Maple ( <i>Acer</i> sp.) (log)			1	1	1	1
<b>Total</b>	<b>141</b>	<b>859</b>	<b>34</b>	<b>160</b>	<b>175</b>	<b>1,019</b>

### Sites outside Abernethy Forest

During the period of my current survey *B. viridis* capsules were found in 14 different woodlands, ranging from Contin (NH4458) and Alness (NH5774) in the north to Ballater (NO4299) and Dufftown (NJ3238) in the east, and Kingussie (NN7898) in the south. While I have visited most of the woodlands during my recent survey, I am indebted to the people listed in Acknowledgements at the end of this article for their records. The figure of 1,019 capsules given in Table 1 is a minimum for the season as a whole, but with high rates of predation at some sites and evidence of a loss of capsules at most sites, the percentage of capsules reaching maturity is probably in the region of 50–60%.

### Conclusions

It is now clear that *B. viridis* is more frequent in Abernethy Forest, and that the moss occupies a wider range of habitats than originally thought. However, the various habitats created by dead trees still provide the bulk of the records (81% of sporophytes). The recent records from Norway spruce trees both in Abernethy and in Reelig Glen show this to be an important habitat (41% of sporophytes). We also now know that many of the Norway spruce logs were utilized by the moss within 9 years of the trees death and that this habitat could, if needed, be created artificially to maintain *B. viridis* populations.

My records of *B. viridis* growing on the ground come from a very small area within Abernethy



Forest, the site receiving regular visits during my lunch breaks. The sloping bank has a covering of mature Scots pines with established alder woodland on alluvial deposits at the base of the slope, and the River Nethy is close by. The area has a well established *B. viridis* population on dead trees within the woodland on site. Some of the slope is well vegetated mainly by heather (*Calluna vulgaris*), but other areas, possibly due to mammal tracking and slight soil movement is very lightly vegetated. On the slope, it is possible to see exposed Scots pine tree roots and there is some evidence of well-decayed tree limbs in some areas. With time, it was almost possible to know where *Buxbaumia* capsules would be found, and though the slope was systematically searched, the capsules were usually found in lightly vegetated areas where the slope was crossed by a narrow track or flat section on the slope, the capsules often occupying the area where the slope meets the flattened section. In the 2008–09 season, 7% of recorded sporophytes were on this substrate.

Finding the moss growing on wood ant nests was a pleasant surprise, but when you look closely at the habitat created by the ant – layer upon layer of pine needles, twigs, grit and other humus forming woody materials – the habitat is not too dissimilar to a decaying log. The wood ant nests that prove to be suitable are, in their own rights, ancient habitats, created over many decades by the ants. Some deserted nests vegetate over very quickly and are not suitable, but others, possibly vacated by the ants due to increasing shade, remain lightly vegetated and suitable for the moss over many years. Occupied wood ant nests where the moss has been found usually comprise very large heaps of nest material and with time the nest mound may move slightly to the side leaving a section of the nest in a similar state to the unoccupied nest, usually with a light moss covering. On other nests, the sheer size of

the nest means that the basal section of the nest becomes unmanaged by ants (as the nest grows upwards) and again develops a light covering of bryophytes. These areas are where to look for *B. viridis* capsules. One very large nest, 1.2–1.5 m in diameter had at its base over 40 mature capsules growing from the mossy covering on the north side of the nest. In the 2008–09 season, 12% of recorded sporophytes were on wood ant nests.

I see the newly emerging capsules from late September and the season goes right through to late May and June, when the capsules dehisce. The best time to look for mature capsules is between November and April when they are standing erect, bright green and reasonably easy to see, though predation of young capsules is very high. In all my hours of searching I have only found four capsules of *B. aphylla* at two sites. Is this now the rarer of the *Buxbaumia* species?

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### References

- Church, J.M., Hodgetts, N.G., Preston, C.D. & Stewart, N.F. (2001). *British Red Data Books Mosses and Liverworts*. Peterborough: Joint Nature Conservation Committee.
- Rothero, G.P. (2008a). Ecology and management of deadwood for *Buxbaumia viridis* and other bryophytes. [www.plantlife.org.uk/uk/assets/Scotland/scotland-publications/Buxbaumia%20viridis%20course%20notes%20FINAL.pdf](http://www.plantlife.org.uk/uk/assets/Scotland/scotland-publications/Buxbaumia%20viridis%20course%20notes%20FINAL.pdf)
- Rothero, G.P. (2008b). Looking after Green Shield-moss (*Buxbaumia viridis*) and other mosses and liverworts on dead wood. [www.plantlife.org.uk/uk/plantlife-scotland-publications.html](http://www.plantlife.org.uk/uk/plantlife-scotland-publications.html)
- Wiklund, K. (2002). Substratum preference, spore output and temporal variation in sporophyte production of the epixylic moss *Buxbaumia viridis*. *Journal of Bryology* 24, 187–195.