An update on the alien liverwort *Lophocolea semiteres* (Lehm.) Mitt. at Greenham Common, Berkshire, and its spread in Britain and Ireland

Lophocolea semiteres was first noted in Britain in 1955 on the Isles of Scilly. Since then it has been found at many sites. **Ron Porley** and **Tom Haynes** discuss the discovery of this delicate liverwort in Berkshire, and assess its spread.

During a BBS field excursion following the 2000 AGM at Reading, David Long found a small colony of *Lophocolea semiteres* (Fig. 1), with immature archegonia, on a sandy bank under birch on the edge of Greenham Common (SU492641), together with *Atrichum undulatum*, at an altitude of 115 m. This was not only the first record for the site, but it was also new to Berkshire (Porley, 2001). Despite a large group of bryologists (>25) descending on Greenham, *L. semiteres* was not detected on the open heath areas, and neither had it been found in earlier years. However, the site (including the adjoining Crookham Common) is over 500 ha, and it is conceivable that the species had been overlooked.

△ Fig. 1. *Lophocolea semiteres*, amongst *Calluna*. *Tom Haynes, NatureBureau*

The first record of *L. semiteres* (sterile) in open *Calluna vulgaris–Ulex minor* heath (NVC: H2) was noted by Ron Porley in December 2004 in the south-east block (SU509645), present as a small patch of about 1 cm^2. It was not recorded at any other spot over the next 2 or 3 years, when visits to the site were less regular. In 2009, Tom Haynes, on behalf of NatureBureau, carried out a reassessment of the bryophyte and lichen interest of Greenham Common (Haynes, 2009). The survey revealed that *L. semiteres* had spread extensively within the open heathland and onto gravel areas in early stages of reversion to heathland. This rapid expansion of *L. semiteres* on the open heath prompted further investigation by Ron Porley during March–May 2009.

The site

Greenham Common has a long history of disturbance. Military use of the area goes back to 1872, but it was not until 1951 that it was requisitioned by the Air Ministry. Formerly a Site of Special Scientific Interest (SSSI), it was subsequently 'denotified', and Greenham was effectively out of bounds to both public and bryologists alike, with only peripheral areas outside the perimeter fence being accessible. In 1993, English Nature (now Natural England) was granted access to evaluate the condition of the site, and established that the heathland retained high botanical interest, including bryophytes, but *L. semiteres* was not reported (Porley, 1993). This

▽ Fig. 2. The habitat of *L. semiteres* on Greenham Common, a mosaic of *Calluna/Ulex minor* heathland and acidic grassland with patches of bare peaty ground. *Ron Porley*

led to Greenham being re-notified as an SSSI in 1994. It was not until 8 April 2000 that the airbase perimeter fence began to be dismantled and the Common was once again opened to the public. The area is popular for walking, horse-riding and other recreational activities, and the on-going disturbance probably offers enhanced opportunities for both accidental and intentional introductions. Many alien vascular plants are known from Greenham (Crawley, 2005), including *Crassula helmsii* which has rapidly colonized newly created pools. Restricted access in the past probably accounts for the relatively late detection of two other alien bryophytes at Greenham. *Campylopus introflexus* was first recorded in 1988 by Alan Crundwell and Jeff Bates outside the perimeter fence, and was not recorded inside the fence, in abundance, until 1993 (Porley, 1993); it is now common on acid substrata not only at Greenham but throughout Berkshire (Bates, 1995). *Orthodontium lineare*, a colonist of rotting logs, stumps and tree bases, was also first recorded in 1988 outside the perimeter fence. Eustace Jones failed to find it in the Newbury district, despite careful searching (Jones, 1953), and it was not until 1999 that it was noted on the Common on land formerly bounded by the fence.

Habitat of *L. semiteres* on Greenham Common

L. semiteres was first discovered on Greenham Common in 2000 under a light canopy of birch, which is its main niche in East Anglia (Finch *et al.*, 2000). Subsequent finds on Greenham have been on dry, open *Calluna vulgaris–Ulex minor* heath (NVC: H2) and *Festuca ovina–Agrotis capillaris–Rumex acetosella* acidic grassland (NVC: U1), or a mosaic of both (Fig. 2). It occurs with a range of lichens (mostly *Cladonia* spp.) and other vascular plant associates, including *Luzula campestris* and *Hieracium pilosella*. *L. semiteres* is also closely associated with several bryophytes, including *Archidium alternifolium*, *Brachythecium albicans*, *Campylopus introflexus*, *Ceratodon purpureus*, *Hypnum cupressiforme* var. *lacunosum*, *Lophocolea bidentata* (sometimes mixed), *Lophozia bicrenata*, *Pleuridium acuminatum* and *Polytrichum piliferum*. In addition to colonizing bare peaty or sandy ground, rhizoids were also attached directly to *Calluna* litter and other woody debris.

It also occurs as an early colonist on disturbed gravel areas, characteristically where *Calluna* seedlings and fine-leaved grasses have previously established, together with *Calliergonella cuspidata*, *Cephaloziella divaricata*, *Oxyrrhynchium hians*, *Lophocolea bidentata* and *Rhytidiadelphus squarrosus*. It is not the first colonist of bare gravel or peaty ground; *Campylopus introflexus* and *Polytrichum piliferum* characteristically fulfil this role. Although *L. semiteres* co-exists with *C. introflexus*, it does not appear to be able to compete with it. It is absent from wet ground where *Solenostoma gracillimum* occurs as a pioneer, and from areas dominated by *Ulex europaeus* or with a high cover of *U. minor*.

Adjacent to the acidic, stony soils (Southampton Association), supporting H2/U1 heathland, are deeper loamy soils, supporting a community with affinities to a *Centaurea nigra–Cynosurus cristatus* mesotrophic grassland (NVC: MG5). *L. semiteres* is absent from this community, although *L. bidentata* is occasional.

Distribution of sexes and spread on Greenham Common

Fig. 3 indicates the current extent of *L. semiteres*, which essentially follows the distribution of H2/U1 heath on Greenham Common, with some occurrences on gravel areas, and is most frequent

in the south-east block. Systematic mapping would be required to accurately assess the frequency of colonies, but currently it is rather scattered and many metres must be walked before further colonies are encountered. In 1994, Ron Porley established two permanent transects in the south-east heathland block as part of a long-term monitoring programme so that management could be modified accordingly (Porley, 1994). Floristic changes were anticipated as a result of moving from a regular cutting regime when in MOD ownership to a grazing regime once the site had been fenced and returned to public access. Data were collected in a series of 50 cm^2 nested quadrats in 1994, 1996, 1998, 2000 and 2009. The presence of *L. semiteres* was not recorded in the transects until 2009 (Haynes, 2009), where it was recorded from 21% of 50 cm^2 samples, and from 8% of 10 cm^2 samples (the smallest sampling scale). *L. semiteres* was recorded from samples with a more open vegetation structure and a limited occurrence of *Ulex* spp.

Whilst many patches of *L. semiteres* on Greenham Common are apparently sterile, male plants are frequent, whereas female plants with archegonia seem to be much less common (Fig. 3). It is possible that sterile material may ultimately be female, as generally only male plants are distinctive and easy to spot in the field. However, collections were carefully examined for the presence of archegonia. A mixed male and female colony was found once, together with a few old perianths (Porley: 3013) in the south-east heathland block. There appears to be an east–west bias in the distribution of sexes, with female plants mostly in the western half of the site, and male plants in the eastern blocks of heathland. In a dioicous species, separate spores are required for male and female plants to establish, and these need to be relatively close (centimetres or less) for fertilization to occur. The current distribution of sexes on Greenham Common could be interpreted as originating from two or more local spore sources, or the species may have arrived at least twice from different (unknown) regions. There may be a relationship between period of invasion (age) and area (Stieperaere, 1994), but the sexes may not be equal in their ability to establish or co-exist with other members of the community, perhaps providing another explanation for the apparent scarcity of female plants at Greenham.

Plants with regenerants (referred to as pluricellular buds and brood branches by Stieperaere, 1994) were observed in many collections, both on the margins of leaves and on male bracts, and intramarginally on the abaxial leaf surface, 4–5 cells in from the margin (Porley: 3018).

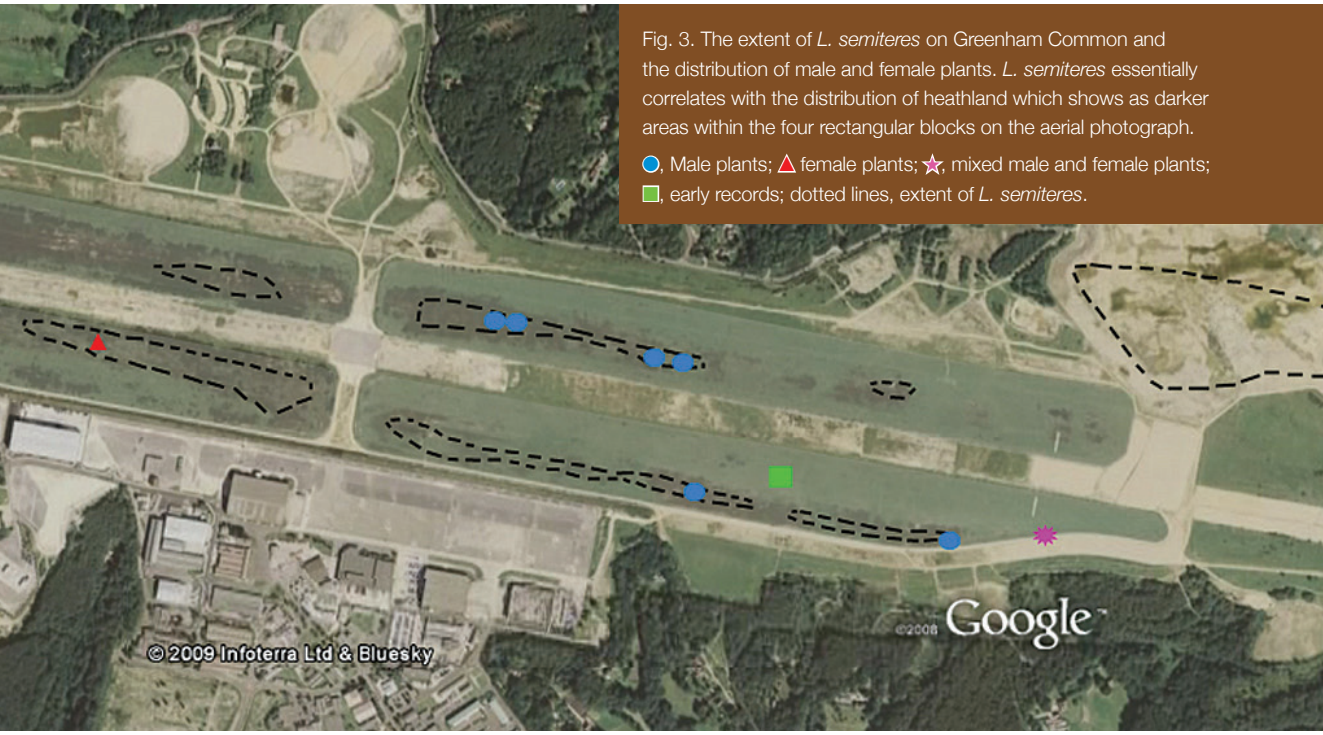

Fig. 3. The extent of *L. semiteres* on Greenham Common and the distribution of male and female plants. *L. semiteres* essentially correlates with the distribution of heathland which shows as darker areas within the four rectangular blocks on the aerial photograph.

●, Male plants; ▲ female plants; ★, mixed male and female plants; ■, early records; dotted lines, extent of *L. semiteres*.

Such propagules probably enable local dispersal on Greenham, perhaps spread by grazing animals, walkers or by wind. Regenerants were seen with increasing frequency during the later stages of the study, suggesting there may be an element of seasonality in their development. In Belgian and Dutch pinewoods, Stieperaere *et al.* (1997) indicated the high potential for regenerant production (up to 300 per cm^2) on older leaves, and the often large monospecific mats that result. In the south-west heathland block on Greenham (SU4953254715) a female colony with regenerants formed a mat of about 1 m^2 (Fig. 4). Intuitively, such clonal expansion may suggest competitive exclusion of smaller bryophytes, such as *Lophozia bicrenata* and *Riccia* spp., although it is possible that non-random clustering may actually promote co-existence (Warren & Topping, 2004).

The advance of *L. semiteres* in Britain and Ireland

L. semiteres is native to the southern hemisphere, including Australia, Tasmania, New Zealand, South America and South Africa. The first European collection was made in 1955, from a botanical garden on the Isles of Scilly (Paton, 1965) and in 1972 it was collected in Argyll, Scotland, also from a botanical garden (Long, 1982). In mainland Europe *L. semiteres* was first detected in 1987 in Belgium, and soon after in the Netherlands, where in both countries it is now known from numerous localities (Stieperaere, 1994) It is also known from Germany (Frey *et al.*, 2006).

Just over 50 years since its discovery in Britain, *L. semiteres* is known from 31 vice-counties in Britain and one in Ireland (Hill *et al.*, 2008), in a total of 62 10-km squares. Following the

△ Fig. 4. A large patch of *L. semiteres*, covering about 1 m^2 on bare ground amongst senescent *Calluna* plants. *Ron Porley*

initial detection of the plant in Britain in 1955 there appears to have been a lag phase where new records accumulated only very gradually, culminating in a rapid increase of records in the last decade (Fig. 5). This may reflect recording activities, such as the slow recognition of the plant as a member of the British flora by recorders (some early populations were recorded as *Lophocolea heterophylla*; Finch *et al.*, 2000) and/or the increased focus on this and other alien species in recent years. Equally, the marked increase may be real. Previously small and isolated populations may exceed (unknown) threshold levels, leading to a greater frequency of sporophyte development, and ultimately this may be contributing to a significant 'spore rain' within Britain.

Acknowledgements

We would like to express our gratitude to Peter Creed for helping with field work, Jeff Bates for information on other alien bryophytes at Greenham, and to Chris Preston for providing the distribution maps.

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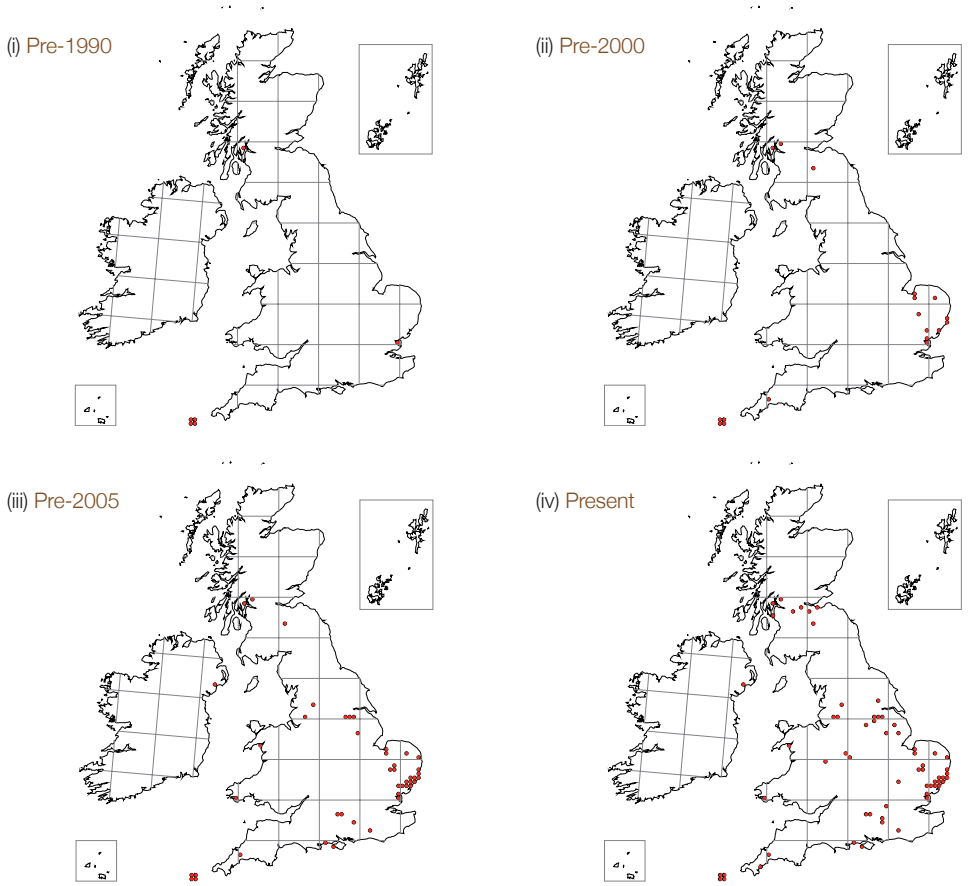

△ Fig. 5. A time-series of distribution maps showing the accumulation of *L. semiteres* records: (i) pre-1990, (ii) pre-2000, (iii) pre-2005 and (iv) up to the present.

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