January–March 2010

Number 1072
Volume 135

The Naturalist

A QUARTERLY JOURNAL OF NATURAL HISTORY FOR THE NORTH OF ENGLAND

Published by the Yorkshire Naturalists' Union

Editor **M. R. D. Seaward** MSc, PhD, DSc, FLS, The University, Bradford BD7 1DP

Notice to Contributors to 'The Naturalist'

A manuscript plus disc (WORD format) OR two manuscripts, typed double-spaced on one side of the paper only with margins at top and left-hand at least 2.5cm wide, should be submitted. Latin names of genera and species, but nothing else, should be in italics. S.I. Units should be used wherever possible. Authors must ensure that their references are accurately cited, and that the titles of the journals are correctly abbreviated. Volumes of *The Naturalist* for the years 1886 to 1975 have been retrospectively numbered 11 to 100 to accord with numbering before and after this period (see YNU *Bulletin* no. 3, pp. 21-22 1985); please cite these volume numbers in all references. Table and text-figures should be prepared on separate sheets of paper. Drawings and graphs, drawn about twice the linear size they are to appear, should be in jet-black Indian ink, and legends should not be written on the figures. Photographic illustrations, normally black and white, will be considered for inclusion. **Publishable manuscripts not conforming to the above requirements will be returned for alteration.**

e-mail: m.r.d.seaward@bradford.ac.uk

Registered Office (for all enquiries and correspondence):

Mr John A. Newbould, Stonecroft, 3 Brookmead Close, Sutton Poyntz, Weymouth, Dorset DT3 6RS (tel: 01305-837384; email: john_newbould@btinternet.com)

Subscriptions and Membership changes of address with effect from 1 May 2010.

Membership Officer, Yorkshire Naturalists' Union, c/o NEYEDC, St William College, 5 College Street, York YO1 7JF 01904 641631
Email: membership@ynu.org.uk

The Naturalist and *Bulletin* are issued free to individual members of the Yorkshire Naturalists' Union and to Affiliated Societies.

Institutions and Subscribers £32.00 (UK), £36.00 (elsewhere) Registered Charity No. 224018

The Naturalist

A QUARTERLY JOURNAL OF NATURAL HISTORY FOR THE NORTH OF ENGLAND

Editor **M. R. D. Seaward,** MSc, PhD, DSc, FLS,
The University, Bradford BD7 1DP

Volume 135
2010

Published by the Yorkshire Naturalists' Union

WHITEFLIES (HEMIPTERA: ALEYRODIDAE) OF WATSONIAN YORKSHIRE

CHRIS MALUMPHY
The Food and Environment Research Agency, Sand Hutton, York YO41 1LZ
e-mail: chris.malumphy@fera.gsi.gov.uk

ABSTRACT
Collection details are provided for 11 species of Aleyrodidae (eight native and naturalised introductions, one introduced species established on indoor plantings, and two non-established introductions on growing plants) recorded in Watsonian Yorkshire. Two native species (*Pealius quercus* (Signoret)) and *Siphoninus immaculatus* (Heeger)) and one introduced naturalized species (*Aleurotuba jelinekii* (Frauenfeld)) are recorded from the region for the first time. *Siphoninus immaculatus* is reported damaging an ornamental ivy plant for the first time in Britain and cultivated rose is recorded as a new host for *Aleyrodes lonicerae* Walker. A list of six non-native species that have been intercepted in the region by the plant health authorities of England and Wales on imported plant produce is also presented.

INTRODUCTION

Whiteflies comprise a single family, Aleyrodidae, which currently contains 1556 species in 161 genera (Martin & Mound, 2007). Fifty-six species occur outdoors in Europe and the Mediterranean basin (Martin *et al.*, 2000). All whiteflies are phytophagous and several species are economically important. Feeding by the immature stages reduces plant vigour by depletion of the plant sap, foliage is contaminated with eliminated honeydew on which black sooty mould grows, and the adults of a small number of species are important vectors of plant viruses.

Harrison (1915, 1916, 1917, 1917a, 1920, 1920a, 1931) studied the whiteflies of the North East of England and listed four native or naturalised species (i.e., an introduced species that overwinters outdoors) in Yorkshire (*Aleurochiton aceris* (Modeer), *Aleyrodes lonicerae* Walker, *Aleyrodes proletella* (Linnaeus) and *Tetralicia ericae* Harrison). Walsh (1918, 1920) recorded *A. lonicerae*, *T. ericae* and '*Aleurochiton avellanae*' from Yorkshire (the specific identity of the latter is uncertain and is discussed below). The purpose of this communication is to review the whiteflies of Watsonian Yorkshire (VCs 61 to 65), based on samples collected since 1997, published records and unpublished data held by The Food and Environment Research Agency (Fera).

METHODS

Whitefly samples were collected on woody and herbaceous plants growing outdoors and indoors between 1997 and 2009, mainly by the author. Puparia were slide-mounted following standard published methods (Martin, 1987) and deposited at Fera. They were identified using the diagnostic keys provided by Martin *et al.* (2000). The identity of some of the non-native species was confirmed by Jon Martin of the Natural History Museum, London. The nomenclature used follows Martin and Mound (2007).

Morphological descriptions and illustrations of the puparia of all native/naturalised species listed below are provided by Martin *et al.* (2000) and the adults of the majority of the species are described by Huldén (1986). The host and distribution data is obtained from Martin *et al.* (2000), and Mound and Halsey (1978).

RESULTS

Eleven species (8 native and naturalised introductions, 1 introduced species established on indoor plantings and 2 non-established introductions on growing plants) of Aleyrodidae are recorded here for Watsonian Yorkshire. Two native species (*Pealius quercus* (Signoret) and

Siphoninus immaculatus (Heeger)) and one introduced naturalized species (*Aleurotuba jelinekii* (Frauenfeld)) are recorded from the region for the first time.

The whitefly species have been divided into three categories below: the first includes the native and naturalized species; the second, non-native species established under artificial conditions (and occasionally found breeding outdoors in the summer but not overwintering outdoors); the third, includes non-native species that have been found breeding on imported plants but which are not known to have become naturalised or established anywhere in Britain. The author collected all of the samples recorded under 'Collection data', unless stated otherwise.

For the sake of completeness, 6 non-native species that have been intercepted in the region by the plant health authorities of England and Wales on imported plant material are listed in Appendix 1.

In addition to the whitefly species listed below, Walsh (1920) recorded the larvae of '*Aleurochiton avellanae*' in Raincliffe and Staintondale on *Corylus avellana*, in August and September 1920. *Aleurochiton avellanae* (Signoret) was synonymised with *Asterobemisia carpini* Koch by Mound and Halsey (1978), but this was not accepted by Zahradnik (1989, 1991) who considered them two distinct species. The species *avellanae* Signoret has also been confused with *P. quercus* in Britain, for example by Trehan (1940) (Mound, 1966; Mound & Halsey, 1978; Zahradnik, 1956). As both *A. carpini* and *P. quercus* occur on *Corylus* in England and there are no preserved specimens of the whitefly collected by Walsh available for study it is not possible to be certain which species he observed.

NATIVE SPECIES AND NATURALISED INTRODUCTIONS

Aleurochiton sp. (Figures 1-2)
Host plants: *Acer* spp.
Biology: bivoltine; overwinters as puparia in leaf litter.
Distribution: Europe.
Comments: there are three species of whitefly that feed exclusively on *Acer* spp. in Europe and they are all assigned to the genus *Aleurochiton* (Martin *et al*., 2000). Harrison (1916) recorded *A. aceris* (Modeer) in great numbers on maple in Gunnergate, Middlesbrough. He subsequently republished this record, adding that the host was field maple (*Acer campestris*) (Harrison, 1920a). Mound (1966) dismissed this record, as he assumed it was based only on adults. However, although adult whitefly may be found on non-host species, they are unlikely to occur in 'great numbers', particularly on a tree where the foliage is relatively high. Mound stated that the 'large size and striking appearance of the immature instars with their white dorsal wax' were not recorded by Harrison, proving that he did not see puparia. *Aleurochiton* species in Europe, however, are bivoltine and their puparia exhibit distinct dimorphism: only the mature winter puparia are conspicuous (dark with a dense coating of white wax on the dorsal surface) (Figure 1), whereas the summer puparia have a pale, translucent cuticle and are difficult to detect (Figure 2) (the present author observed numerous adult *A. aceris* on *Acer platanoides* trees in July 2008 in

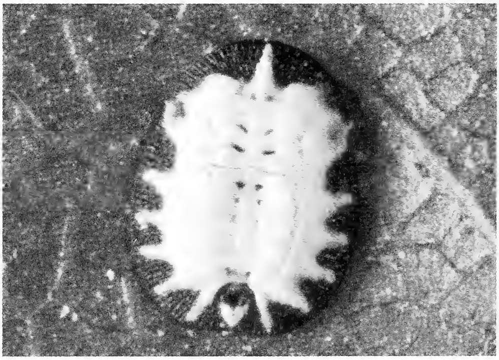

FIGURE 1. *Aleurochiton aceris* dark, waxy winter puparium on *Acer platanoides*.

Sawbridgeworth, Hertfordshire, but found it difficult to find a single summer pupal case). Adult *Aleurochiton* are only active for a brief period in the spring (when the dark, waxy, overwintered puparia are in the leaf litter) and in the summer (when the puparia on the foliage are inconspicuous). The presence of *A. aceris* in Britain was not confirmed until 1976 (Martin, 1978) and it is now locally common in southern England. It feeds on *A. platanoides* and is widely distributed across Europe (Martin *et al*., 2000). *Aleurochiton acerinus* Haupt has also been recorded in southern England by Dolling & Martin (1985) on *A. campestris*. It occurs widely in southern and central Europe (Martin *et al*., 2000). Unfortunately the specific identity of the *Aleurochiton* recorded in Yorkshire by Harrison cannot be verified, as Harrison did not appear to keep any voucher specimens. It would not be surprising if *A. aceris* was found to be present in the north of England as it occurs widely in Scandinavia and the Baltic region (Malumphy *et al*., 2009), whereas *A. acerinus* is more common in southern parts of Europe.

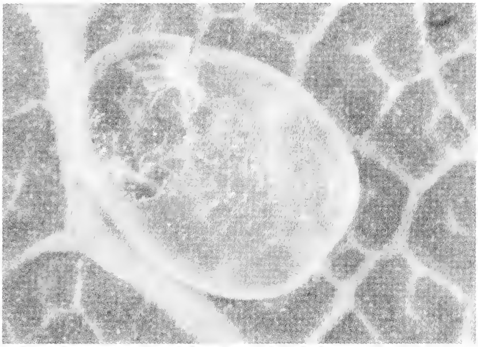

FIGURE 2. *Aleurochiton aceris* pale summer puparium on *Acer platanoides*

Aleurotuba jelinekii (Frauenfeld, 1867) – Viburnum Whitefly (Figures 3-4)
Host plants: appears to be mainly restricted to *Viburnum tinus* in Britain but on the continent it is also recorded on *Arbutus unedo, Arctostaphylos* sp., *Myrtus communis* and *Viburnum* spp..
Biology: univoltine; flight period early May to early August; overwinters as puparia.
Distribution: Europe and the USA.
Collection data: all records are on *V. tinus*. VC61, Elvington, 24.ii.2008, 10.iii.2009, 5.vi.2009 (pupal cases and eggs) (leg. S. Reid) (large infestation). VC62, Haxby, 7.iii.2009, 20.iv.2009 (abundant, widespread); Howsham, 11.v.2009 (abundant); Sand Hutton, various dates iii-viii.2009 (abundant, widespread; adults present from beginning of May; by June the new plant growth was covered in thousands of adults and eggs; first and second instars present at end of July); Stockton-on-the-Forest, 24.iv.2009 (abundant, larvae), 27.vii.2009 (adults); Strensall, 22.iv.2009 (abundant, widespread); York, city centre, 11.v.1997 (leg. L. MacLeod), 23.xi.2003, 3.iv.2006, 15.xi.2008, 18.vii.2009 (large infestations, widespread), Clifton, 7.iv.2009 (abundant), Clifton Moor, 9.iv.2009 (abundant, widespread), 1.viii.2009 (first and second instars), Homestead park, 12.vii.2009 (abundant, adults and pupal cases);

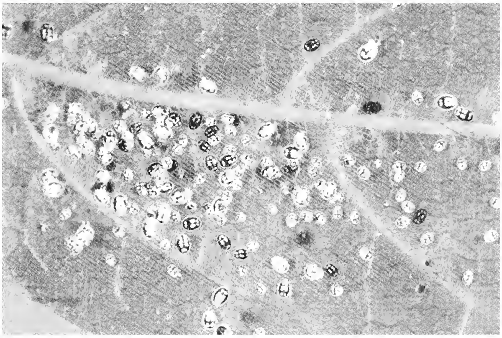

FIGURE 3. *Viburnum tinus* leaf with large infestation of *Aleurotuba jelinekii*

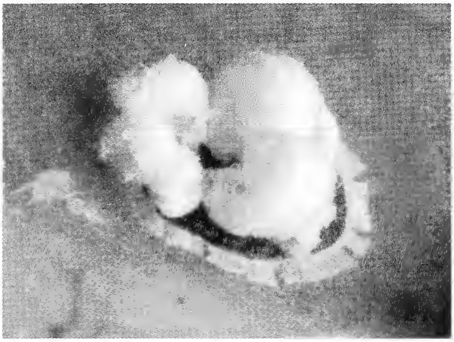

FIGURE 4. *Aleurotuba jelinekii* puparia with dorsal wax tufts

Wigginton, 9.iv.2009 (abundant, widespread); Wigginton Moor, 10.iv.2009 (abundant). VC 64, York, city centre, 14.iii.2009 (small infestation), Acomb, 1.iii.2009 (small infestation), Acomb wood, 9.v.2009 (large infestation, puparia and adults).

Comments: introduced into Britain in about 1936 (Mound, 1962, as *Aleurotrachelus jelinekii*). It is now very common and widespread in southern England (Andrew Halstead, *pers. comm.* 2009). It is recorded here for the first time from Yorkshire and is abundant in the centre of York, frequently occurring in very large populations smothering the undersides of foliage (Figure 3). It is one of the most common whiteflies found across Europe (Martin *et al.*, 2000).

Aleyrodes lonicerae Walker, 1852 – Honeysuckle or Strawberry Whitefly (Figure 5)
Host plants: broadly polyphagous.
Biology: multivoltine with overlapping generations; adults occur throughout the year; overwinters in the adult stage.
Distribution: Europe and Iran.
Collection data: VC61, Allerthorpe Common, on *Lonicera periclymenum*, 25.vii.1998; Beverley, plant nursery, *Euphorbia pulcherrima* (grown indoors), 5.xi.1998, from the Netherlands, various dates xii.2001 (Fera), *Lonicera* sp., 10.ix.1998 (Fera); Dunnington Common, Rabbit Warren, *L. periclymenum*, 30.vi.2009 (adults, eggs, first instars); Elstonwick, *Rubus* sp., 19.xi.2003 (leg. W. Dolling) (adults and wax patches); Halsham, *Fragaria x ananassa* grown in a polytunnel, 13.x.2000 (leg. W. Dolling); Hull, *Lonicera* sp., 25.ix.2007 (leg. T. Prior) (large infestation, all developmental stages); Skipwith Common, *L. periclymenum*, 2.viii.2009 (sparse, adults, eggs, first instars). VC62, Bossall, west-belt wood, *Rubus fruticosa*, 21.iv.2009 (eggs); Buttercrambe Moor wood, *L. periclymenum* and *R. fruticosa*, 22.x.2008 (several vacated pupal cases and parasitised puparia), 21.iv.2009 (adults, eggs), 10.vi.2009 (abundant, all stages); Haxby, *Lonicera nitida*, various dates viii.2007 (abundant, all stages), *L. periclymenum*, various dates iii.-viii.2009 (abundant), *R. fruticosa*, 19.iv.2009 (eggs, larvae); Haxby allotments, *F.* x *ananassa*, 31.vii.2009 (abundant, adults, eggs); Haxby, Westwoods, *Aegopodium podagraria*, 31.vii.2009 (abundant, all developmental stages); Nunnington, *Meconopsis cambrica*, 5.ix.2008 (leg. R. Hammon) (adults, eggs, first instars), *Rosa* sp., 28.vi.2009 (pupal cases and adults); Sand Hutton, *R. fruticosa*, 13.iii.2009 (sparse), Black Dike Plantation, *R. fruticosa*, 19.xi.2008 (adults, vacated pupal cases, parasitised puparia), 5.iii.2009 (adults, eggs, first instars), *L. periclymenum*, *R. fruticosa*, (adults, eggs, early

FIGURE 5. *Aleyrodes lonicerae* adult with one greyish spot on each forewing

instars; abundant), *Arctium lappa* and *Centaurea scabiosa* (adults only, *A. lappa* and *C. scabiosa* are not confirmed hosts), 20.viii.2009; Strensall, *R. fruticosa*, 29.ix.2008 (adults, vacated pupal cases; adults were active, making short flights despite an ambient temperature of -1°C); Strensall Common, *L. periclymenum*, 16.vii.2009 (adults, eggs). VC64, Fountains Abbey, *L. periclymenum*, 25.vii.2009 (eggs, larvae); York city centre, *R. fruticosa*, 8.vii.2003 (sparse, adults, eggs).
Comments: the puparia of *A. lonicerae* are morphologically very similar to *A. proletella* (Linnaeus) and one of the main characters used to distinguish between them (the degree of development of the caudal setae) should be used with caution, as this character exhibits more variation in both species than reported in the literature. Several specimens should be examined and an average character state used for identification purposes. The adults, however, are easily separated, as each forewing of *A. lonicerae* bears a single grey spot (Figure 5), whereas each forewing of *A. proletella* bears a pair of spots (Figure 6). The shape of the aedeagus also differs significantly between the two species (Huldén, 1986).

Harrison (1915, 1920) recorded this species in Gunnergate, Nunthorpe, and near Stainton, Middlesbrough, on *Lonicera* sp. He subsequently reported that it was extremely common everywhere in North Yorkshire (Harrison, 1931). Walsh (1920) recorded it in Hayburn Wyke, Raincliffe Woods and Staintondale, on *Lonicera* sp. during August and September 1920. It is an occasional pest of blackberry and strawberry in Britain (Alford, 2007). Cultivated rose is recorded here as a new host for this species.

Aleyrodes proletella (Linnaeus, 1758) – Cabbage Whitefly (Figure 6)
Host plants: broadly polyphagous.
Biology: four or five overlapping generations each year; adults occur throughout the year; overwinters in the adult stage.
Distribution: Europe, Iran, Africa, Hong Kong, New Zealand, Brazil, Mexico, Bermuda, Puerto Rico and the Virgin Islands.
Collection data: VC61, Beverley, plant nursery, on *Euphorbia pulcherrima* (grown indoors), 1.ix.2002, *Hebe* sp. (grown indoors), 6.viii.2003 (Fera); Elstronwick, *Brassica oleracea* kale, 1.xi.1998 (leg. W. Dolling) (adults); Stamford Bridge, allotments, *B. oleracea*, 23.vii.2009 (adults, eggs, larvae). VC62, Burythorpe, *B. oleracea*, 20.vii.2009 (leg. J. Ostojá-Starzewski); Haxby allotments, *B. oleracea*, 31.vii.2009 (adults, eggs, larvae); Nunnington, *B. oleracea*, 20.viii.2003, 21.viii.2008 (leg. R. Hammon) (abundant); Stockton-on-the-Forest, herbaceous plant, 24.iv.2009 (abundant, adults), *Chelidonium majus, Sonchus arvensis* and other herbaceous plants, 25.vii.2009, (abundant, hundreds of adults, eggs); York, city centre, *Tropaeolum* sp., 5.vii.2009 (leg. A. Korycinska) (adults only, *Tropaeolum* is not confirmed as a host), Clifton allotments, *B. oleracea*, 1.viii.2009 (spares, adults, eggs). VC64, Knaresborough, plant nursery, *E. pulcherrima* (grown indoors), from the Netherlands, 21.xi.2004 (Fera); Leeds, *B. oleracea* kale, 27.viii.1997 (leg. T. Prior) (abundant); York, Acomb, *B. oleraceae*, 8.vii.2001 (abundant) (leg. R. Natt).

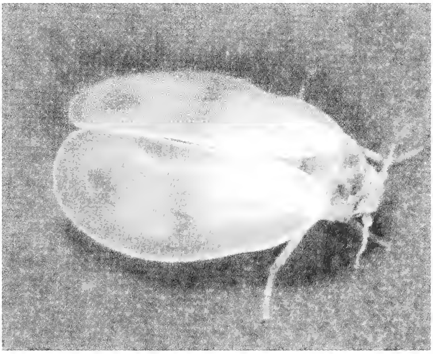

FIGURE 6. *Aleyrodes proletella* adult with two greyish spots on each forewing

Comments: Harrison (1915, 1916) recorded this species in Great Ayton, on *C. majus*. It is a frequent pest of *Brassica* spp. in Britain.

Bemisia afer (Priesner & Hosny, 1934)
Host plants: broadly polyphagous on woody plants.
Biology: not recorded in Britain but suspected to be multivoltine if climatic conditions are suitable.
Distribution: occurs throughout the warmer regions of the World and is widespread in the Mediterranean.
Collection data: VC64, Huddersfield, plant nursery, on *L. nobilis* from Italy, 11.x.2000 (Fera); York city centre, *L. nobilis* (in sheltered walled private garden on a well established tree with no recent import connection) 23.vi.2003, 8.vii.2003 (sparse); Wetherby, plant nursery, *L. nobilis* from Belgium (probably originated in Sicily), various dates between ix.1999 to i.2001 (Malumphy, 2003).
Comments: *B. afer* has been introduced and become naturalised in Gloucestershire and Greater London (Halstead, 1981, as *B. hancocki* (Corbett); Malumphy, 2003) but in England has only been found breeding outdoors on *L. nobilis*.

Pealius quercus (Signoret, 1868)
Host plants: deciduous Betulaceae and Fagaceae.
Biology: univoltine; flight period May and June; overwinters as puparia in the leaf litter.
Distribution: north and central Europe.
Collection data: VC64, Gormire Lake, on *Quercus robur*, 27.v.1997 (adult and early larval instar). Not found in the same location in May 2009.
Comments: W. Dolling observed adult whitefly without any wing markings on oak in Haw Park, Wakefield, 17.v.2003, that were highly likely to be *P. quercus*. This species is widespread and locally abundant in England and parts of Scotland (Mound, 1966). This is the first time that it has been recorded in Yorkshire.

Siphoninus immaculatus (Heeger, 1856) – Ivy Whitefly (Figures 7-8)
Host plants: *Hedera helix* in Britain; also recorded on *H. canariensis* on the continent.
Biology: univoltine; flight period from June to August; overwinters as first instars.
Distribution: central and northern Europe, and Iran.
Collection data: in all cases it was found on *H. helix* growing against a solid surface, for example brick or stonewalls or a wooden fence, usually with a southerly aspect. VC61, Elstronwick, 26.vi.2003 (leg. W. Dolling) (adults, puparia, eggs). VC62, Haxby, 31.vii.2009 (mature puparia, many parasitized, foliage covered in sooty mould); Howsham, 11.v.2009 (few first instars, many second and third instars, old vacated pupal cases and parasitized puparia), 21.v.2009 (many third instars and a few teneral puparia), 15.vi.2009 (mature puparia), 25.vi.2009 (adult females and eggs); Castle Howard, 2.iv.2009 (first and second instars). VC64, Fountains Abbey, on a variegated plant, 29.iii.2009 (first instars, vacated pupal cases; foliage covered in honey dew and black sooty moulds and suffering from necrosis and premature leaf drop; vacated Syrphidae puparia present), 27.vi.2009 (thousands of adults and vacated pupal cases, eggs, teneral and mature puparia; puparia dorsal pigmentation varied from being absent, to a cepahalic and posterior

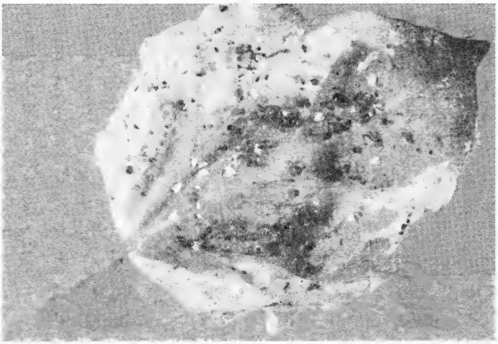

FIGURE 7. *Hedera helix* leaf covered in honeydew and mould due to a large infestation of *Siphoninus immaculatus*

dark spot, to a broad longitudinal band; sex ratio 1 male to 4.4 females (n = 113); many adults were caught in spiders webs but were not seen being eaten by spiders), 25.vii.2009 (abundant, hundreds of adults, thousands of eggs, most laid on leaves that were already heavily infested with whitefly; three predatory cecidomyid larvae present among the eggs; several puparia contained a single hymenopterous parasitoid larva or pupa).

Comments: occurs widely in continental Europe and as far north as Sweden (Gertsson, 1987; Martin *et al.*, 2000). It is infrequent in southern England (Mound, 1966). This is the first time that it has been recorded in Yorkshire and appears to be the most northerly published record in Britain. This is also the first occasion in Britain that it is reported causing damage to its host plant.

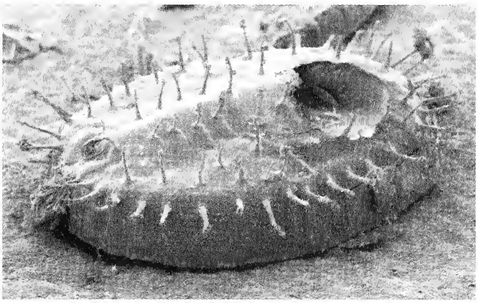

FIGURE 8. Electron micrograph of a *Siphoninus immaculatus* pupal case showing the dorsal siphons

Tetralicia ericae Harrison, 1917 – Cross-leaved Heather Whitefly
Host plants: *Erica tetralix* in England; also *E. carnea* on the continent.
Biology: univoltine; flight period May; overwinters as third instars.
Distribution: Europe and Iran.
Collection data: VC62, Strensall Common, on *Erica tetralix*, 29.vi.1997 (single puparium). Not found in 2007-9 despite extensive searching although sheep had heavily grazed the heather plants.
Comments: Harrison (1917, 1917a, 1920a) originally described this species from specimens collected on *E. tetralix* at Waldridge Fell, Durham and subsequently recorded it from Skipwith Common. G.B. Walsh and W.J. Fordham found it on every tuft of *Erica* at Skipwith Common on 1 August 1918 (Walsh, 1918). It has also been recorded at Middlesbrough (1917) (Bink-Moenen, 1989), and Hatfield Moor (1992) and Thorne Moor (1995) (Skidmore, 2006). It occurs widely in England from the south coast as far north as Northumberland (Mound, 1966) but is rarely recorded. It also occurs widely in continental Europe as far north as Sweden (Gertsson, 1987; Martin *et al.*, 2000).

INTRODUCED SPECIES ESTABLISHED ON INDOOR PLANTINGS

Trialeurodes vaporariorum (Westwood, 1856) – Glasshouse Whitefly
Host plants: broadly polyphagous.
Biology: multivoltine with overlapping generations.
Distribution: cosmopolitan.
Collection data: the data has been summarised due to the large number of records, mostly from Fera; all are on indoor plantings either in plant nurseries, private premises or laboratory glasshouses. VC61: Beverley, Halsham and Hull, on *Ajuga reptans* from the Netherlands, 2008, *Asclepias* sp. from the Netherlands, 2000, *Brachychiton* sp. from Israel, 2000, *Datura* sp. from Israel, 2005, *Euphorbia pulcherrima*, 1997-2001, from Germany, 2003, 2007, Portugal, 1998, the Netherlands, 2001-2006, and Sweden, 2008, *Fuchsia* sp., 1997, *Hardenbergia violacea* from the Netherlands, 2004, *Hedera* sp. from the Netherlands, 2002, 2008, *Hypericum androsaemum* from the Netherlands, 2008, *Hypoestes* sp. from the Netherlands, 2001, *Lycopersicon esculentum*, 13.x.2000 (leg. W. Dolling), *Mentha* sp. from Israel, 2001, *Pelargonium* sp. from Israel, 1997, *Pyracantha* sp., 2003, *Verbascum* sp., 2002, and *Zelkova* sp. from China, 1999. VC62, Sand Hutton, on *Borago*

officinalis, 2003, *Calendula* sp., 2003, *Camelina* sp., 2003, *Cannabis sativa,* 2008, *Chrysanthenum* sp., 2003, 2007, *Fragaria* sp., 2008, *Lunaria* sp., 2003 and *Urtica dioica,* 2002. VC64, Leeds, Richmond, Wakefield and Wetherby, on *Aster* sp. from Colombia, 1996, *Lantana* sp. from Italy, 1996, *Lysimachia* sp. from Israel 1996, *Mentha* sp. from Israel, 2001, *Mrytus communis* from unknown origin, 2008, *Origanum vulgare* from Israel, 2001, *Pelagonium* sp., 2009, *Phyla* sp. from Israel, 2007, *Rosmarinus officinalis* from Israel, 2003, *Salvia officinalis* from Israel, 2002, and *Urtica* sp., 2001.
Comments: growing plants imported into England and Wales are routinely inspected shortly after arrival by the Plant Health and Seeds Inspectorate (PHSI). The countries listed above refer to the origin of the plants that in most cases are the likely source of the whiteflies. However, it is possible that some of the plants became infested after arrival in Britain, as *T. vaporariorum* is very common throughout the country in commercial and private ornamental indoor plantings. It also breeds outdoors during the summer, most frequently in southern England and in large urban areas. *Trialeurodes vaporariorum* is probably much more common and widespread in Yorkshire than the records here indicate. It is under-recorded because it is so ubiquitous.

Non-established incursions

Bemisia tabaci (Gennadius, 1889) – Tobacco Whitefly
Host plants: broadly polyphagous.
Distribution: cosmopolitan.
Collection data: the tobacco whitefly has been found on imported plants and plant material at a botanical garden and at plant nurseries distributed throughout the region (specific locations are not given for reasons of commercial confidentiality as this is a regulated pest). On *Abutilon* sp., *Ajuga reptans, Argyranthemum* sp., *Asclepias* sp., *Begonia* sp., *Brugmansia* sp., *Cassia* sp., *Crossandra* sp., *Diascia* sp., *Euphorbia amygdaloides, E. pulcherrima, Hardenbergia violacea, Hibiscus rosa-sinensis, Hibiscus* sp., *Gerbera* sp., *Jatropha* sp., *Lantana camara*, *Origanum vulgare*, *Pelargonium* sp., *Salvia officinalis*, *Solidaster* sp., *Solanum* sp., *Rosmarinus officinalis*, *Thymus* sp., *Trachelium* sp., *Verbena* sp. and *Zelkova* sp. imported from Belgium, Brazil, Canary Islands, China, Denmark, Germany, Israel, Netherlands, Portugal, Spain and Sweden.
Comments: this species is listed in the plant health legislation of the European Union. All interceptions and incursions of *B. tabaci* have been, or are being, eradicated by Fera. Any suspected cases of *B. tabaci* must be reported to the PHSI.

Dialeurodes citri (Ashmead, 1885) – Citrus Whitefly
Host plants: broadly polyphagous but exhibits a strong preference for citrus.
Distribution: Central and North America, Caribbean, southern Europe, Asia, and Pacific.
Collection data: VC61, plant nurseries, *Ligustrum chinensis* penjing (grown indoors) from China, various dates xi.2000 (Fera).
Comments: this species has been found on several occasions at commercial nurseries on citrus plants imported from the Mediterranean and on penjing from China (Fera).

Discussion

Fifteen native and naturalised species of whiteflies occur in Britain (Burckhardt, 2007; Malumphy, 2003, 2005; Martin *et al.*, 2000) of which half have been recorded in Watsonian Yorkshire. Two native species, *Pealius quercus* and *Siphoninus immaculatus*, and one naturalized species, *Aleurotuba jelinekii*, are recorded from the region for the first time. The whiteflies of Watsonian Yorkshire, however, remain inadequately studied and it is probable that other species will be found to occur in the region. It would be interesting to confirm the presence and identity of the *Aleurochiton* species recorded by Harrison (1916, 1920, 1920a) and the identity of the whitefly observed by Walsh (1920) on hazel.

Siphoninus immaculatus was observed damaging a large variegated ivy plant growing against a wall at Fountains Abbey (Figure 7). This species has not been reported causing plant damage in Britain before (Andrew Halstead, *pers. com.*, 2009). The symptoms exhibited by the plant were typical of those caused by sap-feeding bugs. The upper surfaces of the leaves growing near the base of the plant were covered in sooty moulds growing on honeydew eliminated by the whitefly larvae. The undersurfaces of the leaves were covered in whitefly exuviae, pupal cases and waxy deposits. The most heavily infested leaves were crinkled, showed signs of necrosis and were dropped prematurely. Only a single plant was infested while other ivy plants growing nearby were completely free from the pest.

There appears to have been an increase in the abundance and distribution of *A. jelinekii* in and around York during the last decade; for example, only a single population of *A. jelinekii* was recorded in York in 1997, yet by 2008-9 it was very common throughout the centre of York, frequently occurring in very large populations smothering the undersides of *Viburnum tinus* foliage (Figure 3). It was also found in Elvington, Haxby, Howsham, Sand Hutton, Strensall and Wigginton for the first time. The puparia of *A. jelinekii* are conspicuous, being black with white wax tufts (Figure 4), and it is unlikely that it was simply over-looked previously. This is a thermophilic species and its increase in abundance and distribution may be in response to climate change.

Bemisia afer appears to have an exceptionally wide climatic tolerance, ranging from tropical Africa, through the Mediterranean and even over-wintering outdoors in the centre of York. It is a broadly polyhagous species but has only been found on *L. nobilis* when breeding outdoors in Britain.

The most common whiteflies in Yorkshire are *Aleyrodes lonicerae* on *Lonicera* and *Rubus*; *Aleyrodes proletella* on *Brassica*; and *A. jelinekii* on *Viburnum*. All three of these species frequently occur in enormous populations that can be damaging to their hosts (covering the foliage with honeydew on which sooty moulds grow). *Aleyrodes lonicerae* was found to be breeding on cultivated rose for the first time although it was not observed causing any damage to the host plant. *Trialeurodes vaporariorum* is very common on indoor plantings and frequently found in large numbers.

Any finding of a suspected non-native whitefly in England and Wales should be reported to the local PHSI office or to PHSI headquarters, Sand Hutton, York (Tel. 01904-465625, Fax. 01904-465628).

Acknowledgements

I would like to express my sincere gratitude to Bill Dolling for allowing me to include his collection data and providing me with several key references. I would also like to thank Roger Hammon, Anastasia Korycinska, Louise MacLeod, Richard Natt, Tom Prior, Sharon Reid and Joe Ostojá-Starzewski for collecting samples of whiteflies.

References

Alford, D.V. (2007) *Pests of Fruit Crops. A Colour Handbook*. Mansion Publishing, London.

Bink-Moenen, R.M. (1989) A new species and new records of European whiteflies (Homoptera: Aleyrodidae) from heathers (*Erica* spp.). *Entomol. Gaz.* **40**: 173-181.

Burckhardt, D. (2007) Hemiptera, Aleyrodidae. In: Burkhardt, D. (ed.) *Fauna Europaea*. Version 1.1. [Available online at http://www.fauneur.org]

Dolling, W.R. and Martin, J.H. (1985) *Aleurochiton acerinus* Haupt, a maple-feeding whitefly (Hom, Aleyrodidae) new to Britain. *Entomol. Mon. Mag*. **121**: 143-144.

Gertsson, C.A. (1987) Den svenska mjöllusfaunan. *Entomol. Tidskr.* **108**: 85-91.

Halstead, A.J. (1981) A whitefly pest of sweet bay. *Plant Pathol*. **30**: 123.

Harrison, J.W.H. (1915) Notes and records. Aleyrodidae. Snowy winged flies. *Vasculum* **2**: 57.

Harrison, J.W.H. (1916) Coccidae and Aleyrodidae in Northumberland, Durham and north-east Yorkshire. *Entomologist* **49**: 172-174.

Harrison, J.W.H. (1917) A new species and genus of Aleyrodidae from Durham. *Vasculum* **3**: 60-62.
Harrison, J.W.H. (1917a) New and rare Homoptera in the Northern Counties. *Entomologist* **50**; 169-171.
Harrison, J.W.H. (1920) Notes and records. Aleyrodidae. *Vasculum* **6**: 59.
Harrison, J.W.H. (1920a) New and rare British Aleurodidae. *Entomologist* **53**: 255-257.
Harrison, J.W.H. (1931) Some observations on Aleurodidae. *Entomologist's Rec. J. Var.* **43**: 84-86.
Huldén, L. (1986) The whiteflies (Homoptera, Aleyrodidae) and their parasites in Finland. *Notul. ent.* **66**: 1-40.
Malumphy, C. (2003) The status of *Bemisia afer* (Priesner & Hosny) in Britain (Homoptera: Aleyrodidae). *Entomol. Gaz.* **54**: 191-196.
Malumphy, C. (2005) The Neotropical solanum whitefly, *Aleurotrachelus trachoides* (Back) (Hem., Aleyrodidae), intercepted in the UK on sweet potato leaves imported from Gambia. *Entomol. Mon. Mag.* **141**: 94.
Malumphy, C., Ostrauskas, H. and Pye, D. 2009. A faunistic review of whiteflies (Hemiptera, Aleyrodidae) of Lithuania. *Acta zool. litu.* **19**: 49-57.
Martin, J.H. (1978) *Aleurochiton complanatus* (Baerensprung) (Aleyrodidae) – confirmation of occurrence in Britain. *Entomol. Mon. Mag.* **113**: 7.
Martin, J.H. (1987) An identification guide to common whitefly pest species of the world (Homoptera, Aleyrodidae). *Trop. Pest Managmt* **33**: 298-322.
Martin, J.H., Misfud, D. and Rapisarda, C. (2000) The whiteflies (Hemiptera: Aleyrodidae) of Europe and the Mediterranean. *Bull. Entomol. Res.* **90**: 407-448.
Martin, J.H. and Mound, L.A. (2007) An annotated check list of the world's Aleyrodidae (Insecta: Hemiptera: Sternorrhyncha). *Zootaxa* **1492**: 1-84.
Mound, L.A. (1962) *Aleurotrachelus jelinekii* (Frauen.) (Homoptera, Aleyrodidae), in Southern England. *Entomol. Mon. Mag.* **97**: 196-197,
Mound, L.A. (1966) A revision of the British Aleyrodidae (Hemiptera: Homoptera). *Bull. Br. Mus. (Nat. Hist.) ent.* **17**: 399-428.
Mound, L.A. and Halsey, S.H. (1978) *Whitefly of the World. A Systematic Catalogue of the Aleyrodidae (Homoptera) with Host Plant and Natural Enemy Data.* British Museum (Natural History), London / John Wiley, Chichester.
Skidmore, P. (2006) An inventory of the invertebrates of Thorne and Hatfield Moors. *Thorne & Hatfield Moors Monographs* **2**: 1-162.
Trehan, K.N. (1940) Studies on the British Whiteflies (Homoptera – Aleyrodidae). *Trans. R. Entomol. Soc. Lond.* **90**: 575-616.
Walsh, G.B. (1918) Field Notes, Entomology, Hemiptera-Homoptera in East Yorkshire. *Naturalist* **43**: 302.
Walsh, G.B. 1920. Field Notes, New Scarborough Hemiptera. *Naturalist* **45**: 328.
Zahradnik, J. (1956) Trois nouvelles especes des aleyrodides pour la faune tchecoslovaque. *Sb. faun. Praci Entomol. Odd. Nár. Mus. Praze* **1**: 43-45.
Zahradnik, J. (1989) La révision des aleurodes des pays Tchêques (Sternorrhyncha: Aleyrodinea) III. *Acta Univ. Carol.* **31**: 407-443.
Zahradnik, J. (1991) Taxonomisches und Faunistisches über europäische Mottenlaüse (Aleyrodinea). *Acta Univ. Carol.* **35**: 111-118.

Appendix 1.

Non-native whiteflies intercepted on imported plant produce in Yorkshire.
The six non-native whitefly species listed below do not occur anywhere in Britain and are unlikely to survive for long on imported produce. Most of them were actually found on foliage used for packing, rather than directly on the plant produce itself.

Aleuroclava bifurcata (Corbett, 1933)
Interception data: VC64, Bradford, *Dimocarpus longan* foliage used for packing longan fruit, from Thailand, 2.x.2000 (Fera)

Aleuroclava psidii (Singh, 1931)
Interception data: VC64, Bradford, *Psidium guajava* foliage used for packing guava fruit, from India, 9.ix.1999 (Fera).
Aleurodicus dispersus Russell, 1965 – Spiralling Whitefly
Interception data: VC64, Bradford, *Mangifera indica* foliage attached to mango fruit, from Ghana, 6.xi.1996 (Fera).
Crenidorsum sp.
Interception data: VC64, Bradford, *Dimocarpus longan* foliage used for packing longan fruit, from Thailand, 2.x.2000 (Fera).
Pealius misrae Singh, 1931
Interception data: VC64, Bradford, *Psidium guajava* foliage used for packing guava fruit, from India, 9.ix.1999 (Fera).
Trialeurodes lauri (Signoret, 1882)
Interception data: VC61, Beverley, *Arbutus unedo* foliage from Turkey, 14.xii.2002 (Fera).

BOOK REVIEWS

Darwin in Ilkley by **Mike Dixon** and **Gregory Radick**. Pp. 127, with numerous b/w illustrations. The History Press, Stroud. 2009. £12.99, softback.

Darwin's stay in Ilkley occurred at a momentous period in his life. The pressure of work was getting to him and he needed a break – but why take it at a time when the last of the proofs of his monumental *On the Origin of Species* had yet to arrive and it was about to be published? Was Darwin genuinely ill or did he suffer from hypochondria? Recent research on the numerous symptoms (abdominal pains, nausea and vomiting) which he displayed suggest that he may have suffered from lactose intolerance, and the other symptoms (depression and anxiety) he had developed over the years can be described as a "psychological background".

Debilitated yet again, Darwin could not face such pressure. He needed a bolt-hole and a cure. He settled for a new hydrotherapy establishment, Wells House, on the edge of Ilkley Moor. The water had no chemical properties; it was merely pure and cold (4°C in both summer and winter), and thereby suitable for both drinking and bathing. Wells House was filled with uncongenial patients, mainly from the upper-classes, suffering from a wide spectrum of complaints ranging from lameness to neurosis.

The *Origin of Species* was launched whilst Darwin was at Ilkley. It was an immediate success, the first printing selling out before publication. The publisher wanted an immediate reprint with corrections; a second edition duly appeared only six weeks later. Darwin left Wells House to return home on 7 December, having stayed at Ilkley for nine weeks. In his time at Ilkley he not only saw his most famous book published, and was busily engaged on amendments for a second edition, but he was also deeply involved in correspondence, which included carefully constructing individual letters of explanation to accompany the complimentary copies of his book he sent out to many people, responding in detail to their views, and particularly their praise. Fortunately, he was also in Ilkley when the storm broke out over his book.

These and many other fascinating topics are covered in this delightfully illustrated book which not only provides diagnoses and analyses of Darwin's supposed ailments, but also a detailed picture of the ambience generated by Wells House and the wide range of treatments administered to its patients. Strongly recommended, not only to Yorkshire readers and Darwin enthusiasts, but also to those interested in the 19th century, particularly its medical history.

MRDS

Fumitories of Britain and Ireland by **Rose J. Murphy.** Pp. vi + 121, with descriptions, line drawings, photographs and maps showing the distribution in Britain and Ireland of all 10 *Fumaria* species, plus four hybrids and two casuals; also contains a detailed section on plant characters important for identification, glossary and summary of vice-counties where *Fumaria* spp. have been recorded. Botanical Society of the British Isles Handbook No 12. 2009. £12.50 (paperback) plus p. & p., available from Summerfield Books, 3 Phoenix Park, Skelton, Penrith, Cumbria CA11 9SD.

We are all aware of the critical and difficult botanical genera including *Rubus, Hieracium, Taraxacum, Euphrasia* and *Alchemilla*, and various other publications have dealt in whole or in part with these groups. The present volume has been accepted by the BSBI Publications Committee as the first in a series of mini-handbooks describing small genera that are difficult to identify.

In a small genus of only 10 British species, most botanists are readily familiar only with common fumitory (*Fumaria officinalis*), and several of the others are indeed rare and local. This little handbook deals in great detail with this small group, providing, firstly, a comprehensive dichotomous key to the species and subspecies, and secondly, a more rigorous extended key which additionally separates out varieties and forms of each species. The individual species accounts are clear and unambiguous, written in language the non-specialist can understand, and are accompanied by stunning line drawings and excellent photographic images, which show flower parts, sepals, fruits and other critical or important characters with pin-sharp accuracy. More general habitat shots or photos of the whole plant are also included. The book also contains a generous bibliography and a full index, giving synonymy where applicable. The whole topic has been thoroughly researched and there is virtually nothing that one can quibble with. The author has obviously made a painstaking study of the genus and is to be congratulated on producing a comprehensive and lucid account. This is a book that the non-specialist botanist can pick up with confidence and tackle a fumitory which is unknown to him. It is a valuable addition to one's bookshelf and I recommend it to all who are interested in the genus.

GTDW

The Orchids of Ireland by **Tom Curtis** and **Robert Thompson**. Pp. 160, incl. coloured illustrations & maps. National Museums Northern Ireland, Belfast. 2009. £20.00 hardback, plus postage & packing. [Available from: National Museums Northern Ireland, Cultra, Holywood, Co. Down, Northern Ireland BT18 0EU, or via info@nmni.com]

This useful guide contains excellent coloured plates of each orchid *in situ* and close-up, as well as distribution maps of all species to be found in Ireland. Keys to genera and to species are also provided, together with an informative introductory chapter on morphology, habitats and ecology, and classification of orchids, as well as a bibliography, glossary and index.

A Dictionary of Environment and Conservation by **Chris Park**. Pp.vi + 522, incl. 21 line drawings. Oxford University Press. 2008. £10.99 paperback.

This valuable addition to the naturalist's reference bookshelf is packed with up-to-date information and well as definitions of more than 8,500 environmental terms and issues. Highlighted key words have been treated in more detail, and appendices dealing with on-line data sources, international treaties, the Beaufort (wind), Saffir-Simpson (hurricane), Fujita (tornado), Torino (asteroid and comet impact hazard) and Richter and Mercalli (earthquake) scales, geological time-scale, chemical elements, and SI units and conversions are also provided.

WALL FERNS IN EAST HULL, 2004-2008

R. MIDDLETON
12 Meaux Road, Wawne HU7 5XD
e-mail: r.middleton@hull.ac.uk

INTRODUCTION

Casual observations over the last ten years have suggested that the fern flora of Hull has become both more diverse and more abundant. This seems to match observations made in London by Edgington (2000, 2003). In the *Flora of East Yorkshire* (Robinson 1902) no ferns are recorded in the (admittedly smaller at that time) urban area of Hull. In the East Riding as a whole, *Phyllitis scolopendrium* was described as 'not common and apparently vanishing', *Asplenium ruta-muraria* as 'frequent, but sparing in quantity', *A. trichomanes* as 'frequent on old walls', and *A. adiantum-nigrum* was only known on Easington Church. The Millennium survey of Hull (Middleton 2000) revealed the presence of all of these species growing on suburban walls in Hull (Figure 1).

A subsequent study (Middleton 2005b), mapped the distribution of ferns in more detail and established that low (c. 1 m) suburban garden walls, built of impervious bricks bonded with lime mortar, provided an ideal environment for the growth of many calcicole fern species. In the Hull area such walls are typical of suburban housing built during the 1920s and 1930s. It was also proposed here that the observed increase in species diversity within the city was a direct result of lower levels of atmospheric sulphur dioxide, a conclusion also reached by Edgington (2003) for London ferns. Recent studies of the lichen flora of Hull by Seaward (2004, 2007) revealed a similar increase in species diversity and attributed this to the same cause.

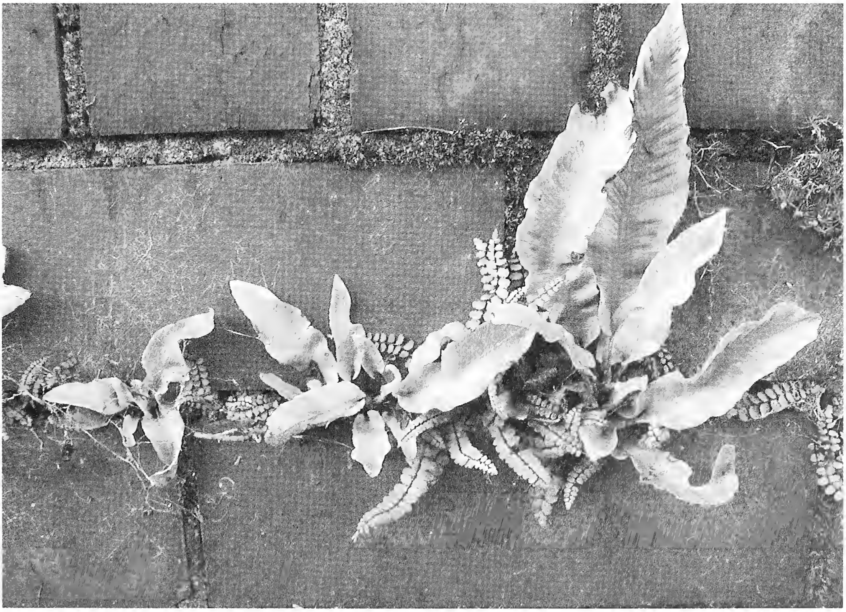

FIGURE 1. *Phyllitis scolopendrium* and *Asplenium trichomanes* growing on a garden wall in suburban Hull.

Method

The increase in fern diversity is relatively easy to monitor and since the Millennium Flora Survey two new fern taxa have been added to the City's flora, namely *Asplenium marinum* and *Cyrtomium falcatum*. Although it is likely that improved air quality has made it possible for these species to survive, long-term climate change and spore availability are probably just as important.

In order to establish whether there is any change in the abundance of ferns a long-term sampling study is required. Garden walls provide ideal study sites for repeat surveys as there is always easy access and their gates are conveniently labelled with a number! Two areas a little over 1 km apart in eastern suburbs of Hull, each comprising three adjacent, sub-parallel, streets of inter-war housing and known "ferny" garden walls, were selected for monitoring (Table 1). The three species most commonly encountered on garden walls in this part of the city are *Asplenium trichomanes*, *A. ruta-muraria* and *Phyllitis scolopendrium*. *Dryopteris* spp. and *Asplenium adiantum-nigrum* are also to be found, but not with a high enough frequency for meaningful comparisons to be made. In June 2004, July 2006 and August 2008, the street-facing sides of all garden walls in the study areas were examined and a count made of the number of walls bearing ferns of each of the target species. In 2006 and 2008 an attempt was also made to count the individual plants of each fern taxon but in some clustered colonies it was not always possible to make a consistent count.

TABLE 1 Sampling areas

Area	**1**	**2**
Orientation	SSE – NNW	ESE – WNW
	Ellesmere Avenue Waldegrave Avenue Shaftsbury Avenue	Lancaster Drive Burlington Road Skirbeck Road
Total length (m)	1050	560
Centroid	TA 130 316	TA 117 320

Results and Discussion

As can be seen from Table 2 and Figure 2a, the number of properties with "ferny" garden walls has shown a steady increase, doubling over the 4-year period. The effect was smaller in area 1 (55%), but very marked in area 2 (138%). The difference is due, at least in part, to the observed loss of suitable walls for colonisation in the first area. Here the slightly wider streets and bigger front gardens have encouraged some residents to demolish their garden walls and create off-street parking areas, resulting in a loss of suitable habitat and offsetting some of the potential for gain.

The increase in properties with any type of fern on the garden wall is mirrored by each of the individual fern taxa monitored. Figures 2b–2d demonstrate that the colonisation of walls has been proportionally similar indicating that the factor influencing the change is affecting all species equally. If the change was solely a function of climate amelioration it might be expected that it would influence the taxa differentially, which does not appear to be the case. If it were warmer or moister conditions driving the change then it would be expected that Hart's Tongue, which is a species with a more dominantly south-western distribution, would be favoured. The data presented here do not support this supposition.

An alternative explanation is that the expansion is a direct result of the improvement in air quality in suburban Hull. Sulphur dioxide, and to a lesser extent oxides of nitrogen, in the atmosphere dissolve in precipitated moisture to decrease the pH of rain water. The reproductive biology of ferns is fundamentally different from that of vascular plants and

TABLE 2

a: Number of ferny garden walls in each street

	2004	2006	2008
Ellesmere Avenue	9	14	14
Waldegrave Avenue	12	11	17
Shaftsbury Avenue	1	0	3
Lancaster Drive	14	15	20
Burlington Road	5	10	15
Skirbeck Road	7	19	27
Total	**48**	**69**	**96**

b: Walls with *Asplenium trichomanes* (total number of plants bracketed)

	2004	2006	2008
Ellesmere Avenue	3	8(20)	10(80)
Waldegrave Avenue	3	4(13)	8(55)
Shaftsbury Avenue	0	0	0(0)
Lancaster Drive	2	1(1)	2(9)
Burlington Road	5	8(34)	11(37)
Skirbeck Road	3	5(47)	15(135)
Total	**16**	**26(115)**	**46(316)**

c: Walls with *Asplenium ruta-muraria* (total number of plants bracketed)

	2004	2006	2008
Ellesmere Avenue	0	2(4)	1(1)
Waldegrave Avenue	4	3(6)	6(25)
Shaftsbury Avenue	0	0	1(1)
Lancaster Drive	12	13(137)	18(207)
Burlington Road	1	4(6)	6(23)
Skirbeck Road	2	6(107)	17(258)
Total	**19**	**28(260)**	**49(515)**

d: Walls with *Phyllitis scolopendrium* (total number of plants bracketed)

	2004	2006	2008
Ellesmere Avenue	7	9(32)	11(78)
Waldegrave Avenue	9	7(13+)	9(25)
Shaftsbury Avenue	0	0	2(3)
Lancaster Drive	2	1(3)	5(7)
Burlington Road	1	0	2(2)
Skirbeck Road	2	12(64)	12(106)
Total	**21**	**29(112+)**	**41(221)**

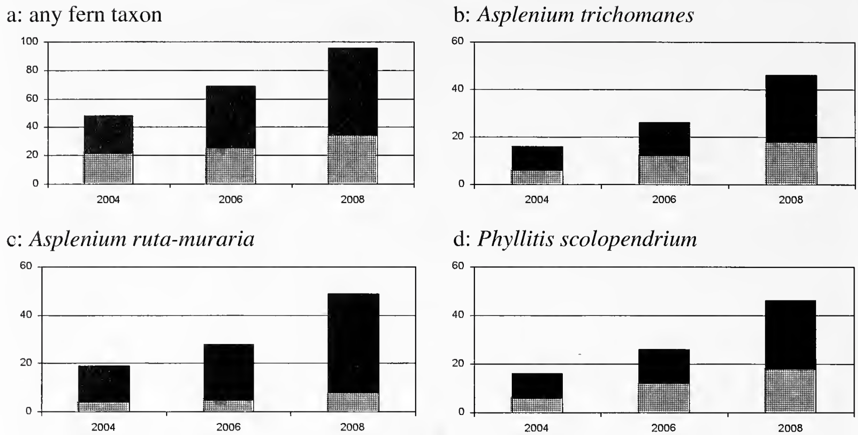

FIGURE 2. Number of houses with a ferny garden wall; area 1 – hatched, area 2 – solid.

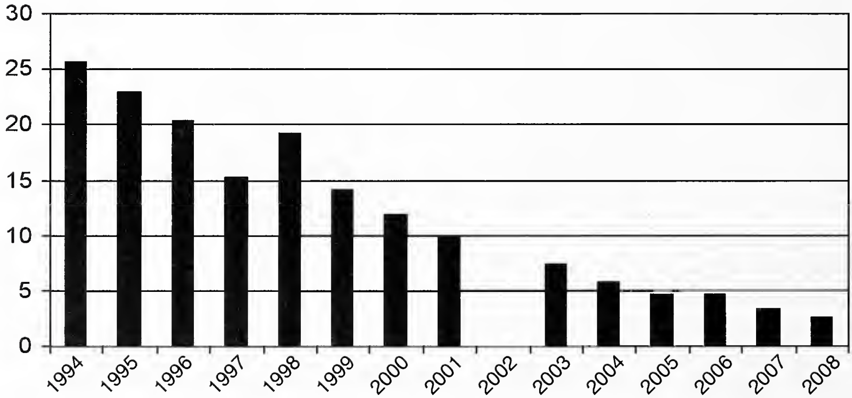

FIGURE 3. Mean hourly sulphur dioxide levels (µg.m^{-3}) in central Hull, 1994-2008. Note that in 2002 the monitoring site was moved a short distance. The 2008 figure is for the first eight months of the year, comparison with 2007 for the same period suggests that the yearly average would be expected to rise by less than 0.2

involves the transmission of genetic material as gametes from one plant to another through a film of water rather than through the air as pollen. This means that the composition of the water film is critical to the reproductive success of ferns and can be enough to inhibit it completely. In a recent, and temporally overlapping, study of the lichen flora of Hull (Seaward, 2004, 2007), an increase in diversity was similarly attributed mainly to a reduction in atmospheric sulphur dioxide.

In 1970 the total UK atmospheric release of SO_2 was around 6.4 Mt, slightly over half of which was resulting from public power generation (Dore *et al*. 2008). By 1990 this had fallen to a total of 3.7 Mt, with little of the decline being attributable to power stations.

After 1990 there was a marked reduction in emissions from power stations which, coupled with a continued decline in other sources, reduced the UK total output to 1.0 Mt SO_2 by 2000 (Dore *et al*. 2008).

Although Hull's own coal-fired power station was closed in the latter half of the 1970s there are three of Britain's largest power stations, Drax, Ferrybridge and Eggborough, sited downwind of the city at the head of the Aire Valley. With this in mind, it is not to be expected that background sulphur dioxide levels would have fallen significantly between 1970 and 1990. Road vehicle fuels were, until relatively recently, also a significant local source of atmospheric sulphur with total UK output peaking at 64 kt in 1990, but falling rapidly to 4 kt by 2001. Reduction in duty on low-sulphur fuels probably contributing, at least in part, to this decline. Figure 3 illustrates the steady decline in atmospheric SO_2 as measured in central Hull, the closest long-term monitoring station, over the last 15 years. The concentration of the gas can be seen to have fallen by almost 78% over the decade which preceded the study period and by almost 90% at the end.

Locally the situation is a little more complex as the Holliday Pigments factory, a leading producer of ultramarine blue, was situated on the banks of the River Hull just 2.5 km WSW of area 1 and 1.5 km SW of area 2. Until flue-gas desulphurisation equipment was installed in the late-1990s, the factory was emitting around 6.6 kt of SO_2 per year. This would have contributed significantly to the atmospheric SO_2 in both survey areas. Problems with the equipment meant that after a promising start the discharge consent had to be increased from the initially stipulated 200 to 500 tonnes each year in 2004, but still representing more than a 90% reduction (Hull City Council 2004). The site closed completely in 2007.

CONCLUSIONS

The data show that over the monitoring period there has been a marked and consistent increase in both the number of walls bearing ferns and the number of individual fern plants within the study areas. This increase amounts to a little more than a doubling of the number of walls colonised and is consistent for each of the three species monitored. Although it was only measured over the last two years, the total number of plants of each taxon also increased by a factor of 2 or more.

Measurements taken in central Hull over the same period show a consistent fall in the background concentration of atmospheric SO_2. Local factors have also reduced the amount of sulphur discharged into the air around the study areas and it would be tempting to suggest a simple inverse relationship between the number of individual ferns counted and the level of SO_2. What seems more likely is that regeneration is effectively inhibited when the atmospheric sulphur is above a certain level. The increase observed in both the number of sites and individual plants is evidence of a natural colonisation process which only started when concentrations fell below a critical level, possibly over a decade ago. The critical level was probably dependent on several factors including the amount of rain at crucial periods in the fern's reproductive cycle.

REFERENCES

Crackles, F. E. (1990) *Flora of the East Riding of Yorkshire*. University of Hull, Hull.

Dore, C.J. *et al*. (2007) UK Emissions of Air Pollutants 1970 to 2005. Download available at: http://www.airquality.co.uk/archive/reports/cat07/0801140937_2005_Report_FINAL.pdf

Edgington, J. (2000) Aspleniaceae and Polypodiaceae in London. *The London Naturalist* **79**: 51-54.

Edgington, J. (2003) Ferns of the metropolis – a status report. *The London Naturalist* **82**: 59-73.

Hull City Council (2004) Air quality annual report. Download available at: http://www.hullcc.gov.uk/pls/portal/docs/PAGE/HOME/ENVIRONMENT/POLLUTION/AIR%20QUALITY/AIR%20MANAGEMENT/AIR%20MONITORING/MAY2004DETAILEDASSESSMENT.PDF

Middleton, R. (2000) The plants of Hull: a millennium atlas. Available online at: http://www.hull.ac.uk/hullflora/ viewed Jan. 2009.
Middleton, R. (2005a) Suburban ferns in Kingston-upon-Hull – exploitation of a decomural environment. *BSBI News* **98**: 28-30.
Middleton, R. (2005b) *Ferns in Kingston-upon-Hull*. Unpublished report for the Hull Biodiversity Partnership. 25pp.
Robinson, J. F. (2003) *The Flora of the East Riding of Yorkshire*. Brown, Hull.
Seaward, M. R. D. (2004) The lichen flora of Hull, with particular reference to zonal distribution and environmental monitoring. *Naturalist* **129:** 61-66.
Seaward, M. R. D. (2007) The lichen flora of Hull: biodiversity update, 2002-2006. *Naturalist* **132**: 41-49.

BOTANICAL REPORT FOR 2009
FLOWERING PLANTS AND FERNS

Compiled by
P.P. ABBOTT

It is amazing and gratifying that every year rare and uncommon plants are still being found in new sites, some of them even new to Yorkshire although these are usually non-native plants which have escaped from gardens. However, the star find this year must be *Cotula alpina*, an Australian species native to New South Wales, Victoria and Tasmania, which is believed to be new to Britain and to Europe. It was found and identified by Linda Robinson, first on Kirkby Malzeard Moor and then in several other sites in VCs. 64 and 65 on the moorland between Nidderdale and Wensleydale. The identification was confirmed by Eric Clement. In 1995 it had been found on Dallow Moor and misidentified as *C. squalida* since *C. alpina* is not mentioned in any of the British Floras. Similarly, it was found in September this year, by members of the Ryedale Natural History Society, on Rudland Rigg in VC 62 and initially identified as *C. squalida*. The plants at this site have now also been redetermined as *C. alpina*.

Other notable finds include *Oenanthe pimpinelloides* in fields near Priory Meadows in Hull, its only site in northern England, and *Salvia verbenaca*, found this year in Staveley churchyard, which had not been recorded in VC 64 since 1876. It was pleasing to learn that the iconic *Cypripedium calceolus* has produced flowers in all its reintroduction sites. Other interesting records are listed below.

Nomenclature is according to *Vice-county Census Catalogue of Vascular Plants of Great Britain* (2003) edited by C.A.Stace *et al*. * denotes a new vice-county record.

SOUTH-EAST YORKSHIRE (VC 61)

Anacamptis pyramidalis Hull, Priory Meadows, TA0531, D.R.Grant
Carex divisa North Ferriby, field edge, SE988252, P.Cook
Carex viridula ssp. *viridula* Allerthorpe Common, SE7647, D.R.Grant
Filipendula vulgaris Cleaving Combe, SE8646, D.R.Grant
Gentiana pneumonanthe Skipwith Common, SE653372, D.R.Grant
Hieracium umbellatum Allerthorpe Common, SE7547, D.R.Grant
Hordeum secalinum North Ferriby, field edge, SE998252, P. Cook
Oenanthe aquatica Hull, Priory Meadows, TA0531, R.Middleton
Oenanthe fistulosa Hull, Priory Meadows, TA0531, R.Middleton
Oenanthe pimpinelloides Hull, fields near Priory Meadows, TA0531, R.Middleton
Ophioglossum vulgatum Hull, Priory Meadows, TA0531, R.Middleton
Silaum silaus Hull, Priory Meadows, TA0531, R.Middleton
Thalictrum flavum Hull, Priory Meadows, TA0531, R.Middleton

NORTH-EAST YORKSHIRE (VC 62)

Actaea spicata Gilling, Scar Wood, SE619768, G.Smith
Allium scorodoprasum Broughton, north side of track, SE767720, G.Smith
Antennaria dioica Sand Dale, SE858848, G.Smith
Aphanes australis Lodge Hag, SE670741, W.Thompson
Atropa belladonna Hutton Common, on hillside, SE7087, G.Smith
Berberis vulgaris Gilling, SE607771, G.Smith
Campanula glomerata Broughton, Flowery Lane road verge, SE766716, G.Smith
Carex divulsa ssp. *leersii* Hovingham, Socarrs Lane, SE675761, W.Thompson
Cirsium eriophorum Hutton Common, on hillside, SE7087, G.Smith
Cirsium eriophorum Wath, old quarry, good colony, SE676749, W.Thompson
Clinopodium acinos Gundale, base of old quarry, SE800881, G.Smith
Colchicum autumnale Castle Howard Arboretum in rough grassland, SE703701, W.Thompson
Convallaria majalis Wath Wood, a large patch, SE673741, W.Thompson
Cuscuta epithymum Gundale, on Rockrose, SE800880, G.Smith
Dactylorhiza traunsteineri Sand Dale, SE858848, G.Smith, det. R.Bateman
Epipactis palustris Sievedale Fen, at base of slope, SE853878, G.Smith
Equisetum hyemale Goathland, footpath behind hotel, NZ826010, G.Smith
Eriophorum latifolium Sand Dale, SE858848, G.Smith
Filipendula vulgaris Yatts, SE807881, G.Smith
Frankenia laevis Howkeld, roadside, SE685856, G.Smith
Gagea lutea Appleton, near top of bank, SE742880, G.Smith
Gagea lutea Kirkdale, SE677857, G.Smith, W.A.Thompson
Gymnadenia conopsea ssp. *densiflora* Sievedale Fen, SE853878, G.Smith
Helleborus viridis Ashberry, many plants, SE5784, G.Smith
Hordelymus europaeus Kitscrew Wood, SE671748, W.Thompson
Lathraea squamaria Gilling, on Hazel above church, SE616768, G.Smith
Lathraea squamaria Robson's Spring, by bridleway east of Low Parks farm, SE6381, G.Smith
Listera cordata Darnholme, 2 clusters, NZ838023, G.Smith
Lithospermum officinale Wath SINC, woodland edge, SE670746, W.Thompson
Monotropa hypopitys Sutherbruff, under Pine tree, SE870875, G.Smith
Narcissus pseudonarcissus Appleton, woods to east, SE742880, G.Smith
Neottia nidus-avis Yedmandale, old quarry; many flower spikes, SE978860, M.Walshaw
Ophrys insectifera Yatts, many plants, SE806879, G.Smith
Orchis morio Hole of Horcum, SE849936, G.Smith
Orchis ustulata Yatts, on bank, SE806879, G.Smith
Orobanche elatior Broughton, Flowery Lane, SE767721, G.Smith
Orobanche elatior Swinton Lane, SE760720, W.Thompson
Paris quadrifolia Gilling, SE619769, G.Smith
Phegopteris connectilis Brandsby Dale, 4 colonies beside stream, SE595735, W.Thompson
Picris hieracioides Hovingham quarry, on quarry faces and spoil, SE669752, W.Thompson
Platanthera bifolia Yatts, SE806879, G.Smith
Platanthera chlorantha Hutton Common, SE7087, G.Smith
Populus nigra Stonegrave, regeneration from base of tree blown down in gale. Last known Black Poplar in the area, SE756775, W.Thompson
Potentilla anglica Bulmer Hagg, SE7167, G.Smith
Ranunculus lingua Whitwell, SE715668, G.Smith
Rhamnus cathartica Wath SINC, woodland edge, SE670745, W.Thompson
Rorippa microphylla Hovingham, in and beside beck, SE666758, W.Thompson
Rubus amplificatus Carlton, NZ506041, V.Jones
Rubus cinerosus near Great Ayton, NZ574108, A.Newton
Rubus conjugens Whitby, Upgang ravine, NZ850118, A.Newton

Rubus incurvatiformis near Kildale, NZ613098, V.Jones
Rubus infestus Yearsley Moor, SE579750, A.Newton
Rubus pallidus Goathland, NZ824001, D.R.Grant
Silene noctiflora Whitwell, set aside field, SE7266, G.Smith
Spergularia rubra Lastingham, SE729908, M.Walshaw
Stellaria neglecta Horse Coppice, grass verge, SE654751, W.Thompson
Stellaria neglecta Brandsby, laneside, SE595723, W.Thompson
Trientalis europaea Hovingham High Wood, SE648755, W.Thompson
Verbascum nigrum Hartoft, SE749931, G.Smith
Vicia sylvatica Cawthorn, Peat Rigg Bank, SE770895, G.Smith

SOUTH-WEST YORKSHIRE (VC 63)
Asplenium adiantum-nigrum Horbury Junction, brick wall, SE302177, D.R.Grant
Clematis vitalba Shafton, Rabbit Ings, SE378114, J.Greaves
Dactylorhiza praetermissa Bullcliffe Wood, old mine site, SE285149, D.Proctor
Dactylorhiza maculata Wessenden Head, SE070070, M.J.Lucas
Frangula alnus Howell Wood Country Park, SE435096, J.Lambert
Hieracium umbellatum Bolton-on-Dearne, old mine site, SE432028, T.Schofield
Narthecium ossifragum Wessenden Head, SE070070, M.J.Lucas
Picris echioides Kilnhurst, railway wall-top, SK459971, T.Schofield
Rubus echinatus Bullcliffe Wood, old mine site, SE285149, D.R.Grant
Rubus rufescens Howell Wood Country Park, SE4309, YNU, det. D.R.Grant

MID-WEST YORKSHIRE (VC 64)
Allium oleraceum Leeds, Gipton Wood, SE325367, P.P.Abbott
Allium scorodoprasum Newton Kyme, roadside, SE451447, P.P.Abbott
Allium vineale Leathley, SE229482, N.Vernon
Andromeda polifolia Red Syke Head, SD679605, P.C.G.Green
Aquilegia vulgaris Oxenber Wood, SD7868, Bradford Botany Group
Asperula cynanchica Ledsham Banks, SE4630, S.Joul
Asplenium adiantum-nigrum Ilkley, SE1046, Wharfedale Naturalists' Society
Campanula glomerata Farnham, road verge, SE354669, P.P.Abbott
Campanula glomerata Roach Lime Hills, many plants, SE419315, P.P.Abbott
Campanula trachelium Follifoot, railway cutting, SE340576, I.Wallace
Carex disticha Ribblehead Quarry, SD767787, J.Newbould, T.Whitaker
Carex elongata Bishop Wood, second.record in V.C. 64, SE551326, M.Hammond
Ceterach officinarum Foxup, by Foxup Beck, SD860766, B.Burrow
**Dactylorhiza* x *formosa* Ribblehead, SE776784, N.Barrett, M.Wilcox
Dactylorhiza x *insignis* Otley Wetlands, SE1844, Bradford Botany Group
Dipsacus pilosus Bolton Abbey Woods, SE075555, B.Brown
Dipsacus pilosus Fountains Abbey, SE280688, I.Wallace
Dryopteris submontana Giggleswick Scar, SD809654, R.Wilding, conf. M.Canaway
**Dryopteris* x *ambrosiae* Ingleborough, SD743747, B.Brown, conf. K.Trewren
Equisetum x *litorale* Ribblehead Quarry, SD766787, M.Wilcox, conf. B.Brown
Filago vulgaris near Hellifield station, SD8557, E.Shorrock
Filipendula vulgaris Ledsham Banks, SE462302, Leeds Naturalists' Club
Groenlandia densa Harden Bridge, in Austwick Beck, SD762678, C.R.Abbott, P.Abbott
Gymnocarpium robertianum Feizor, in scree below scar, SD789681, Bradford Botany Group
Hottonia palustris Spofforth, SE364514, I.Wallace
Huperzia selago Antley Gill, SD670596, P.C.G.Green
Hypericum humifusum Fewston, SE160564, M.Atkinson
Lathraea squamaria Hubberholme, SD918783, N.Moore

Neottia nidus-avis Fountains Abbey, 29 spikes, SE281688, I.Wallace
Onobrychis viciifolia Follifoot, SE340576, I.Wallace
Orobanche minor Newton Kyme, road verge; on *Vicia sepium*, SE455447, A.Hanson, R.Masheder det. P.P.Abbott
Polystichum setiferum Dunsop Fell, SD6854, E.F.Greenwood
Polystichum setiferum Otley, riverbank, SE206461, B.Brown
Pulicaria dysenterica Otley Chevin, SE201445, B.Brown
Ranunculus penicillatus Clitheroe, SD7242, E.F.Greenwood
Rhamnus cathartica Kettlewell, SD7242, T.Whitaker
Ribes spicatum Barden, SE054584, B.Brown, conf. M.Wilcox
Rubus polyanthemus Adel, SE281401, D.R.Grant
Salix x *ambigua* Ribblehead, SD776784, M.Wilcox
Salvia verbenaca Staveley churchyard, SE362626, B.Lobo, conf. K.Walker
Saxifraga x *polita* Slaidburn, SE7052, E.F.Greenwood
Stellaria neglecta Edisford, SD725414, M.Wilcox
Thlaspi caerulescens Yarnbury, old lead mine, SE017657, Wharfedale Naturalists' Society
Tilia platyphyllos Ledsham, Claypit Lane, small tree in hedge, SE450293, Leeds Naturalists' Club
Veronica polita Edisford, SD724414, M.Wilcox

NORTH-WEST YORKSHIRE (V.C. 65)
Alopecurus borealis Great Shunner Fell, SD842970, R.Corner, L.Robinson
Allium scorodoprasum West Burton, SE0186, YNU Botany Section
**Asperula cynanchica* Widdale Bridge, hay meadow, SD825876, F. Graham
**Dactylorhiza* x *grandis* Marfield Wetlands, SE2082, L.Robinson, A. Gendle
**Epilobium* x *facchinii* Shunner Fell, flush, SD844971, J.Somerville, M.Wilcox
Equisetum x *litorale* Ballowfield NatureReserve, SD9889, BSBI
**Equisetum* x *rothmaleri* Ballowfield Nature Reserve, SD9889, BSBI
Euphrasia arctica ssp. *borealis* West Burton, SE0086, YNU Botany Section
Galium x *pomeranicum* Kilmond Scar, NZ0212, J.Clarke, L.Robinson
**Hieracium leyi* Widdale, gill, SD799886, B.Burrow, conf. D.McCosh
Vaccinium uliginosum Great Shunner Fell, peat hags on summit plateau, SD848972, R.Dimon, M.Owen
Vaccinium uliginosum Great Shunner Fell, acid mire, SD843969, S.Hewitt

ALIEN PLANTS
Aconitum lycoctonum Amotherby Church grounds, SE749733, W.Thompson
Allium subhirsutum Chellow Dene, SE131339, B.A.Tregale, M.Wilcox
Alopecurus myosuroides Dentdale, head of dale, SD764843, J.Clarke
Alyssum saxatile Thackley, on garden wall, Old Windhill Road, SE168384, B.K.Byrne, BATregale, M.Wilcox
Amaranthus retroflexus Middlesborough, waste ground, Douglas St, NZ503193 V.Jones, W.Thompson
**Anemanthela lessoniana* York, waste ground, SE599519, V.Jones, W.Thompson
**Astilbe* x *arendsii* Stonehouse Bridge, riverside, SD7684, M.Canaway, L.Robinson
Bassia scoparia Middlesborough, NZ503193, V.Jones, W.Thompson
**Bergenia* x *schmidtii* Eldwick, woodland, SE121386, B.A.Tregale, M.Wilcox
**Bergenia* x *schmidtii* Bradford Horton Bank, SE126310, BATregale, MWilcox
Camelina sativa Thornaby, Tees-side, NZ471184, V.Jones, W.Thompson
Chiastophyllum oppositifolium Dentdale, by road bridge, SD7686, B.Burrow
Chrysanthemum segetum Whitwell, 1 plant, SE719661, G.Smith
Clematis tangutica Scarborough Crossing, TA030459, J.Killingbeck
Cordyline australis Bradford, Queens Avenue, SE164349, B.A.Tregale
**Cotula alpina* Kirkby Malzeard Moor, SE176760, L.Robinson

**Cotula alpina* Potts Moor, SE119754, L.Robinson, conf. E.Clement
**Cotula alpina* Rudland Rigg, SE649956, Ryedale Natural History Society
**Cyclamen coum* Hirst Mill, on dumped soil, SE131384, B.A.Tregale, M.Wilcox
Cyclamen coum Thackley, field, Old Windhill Road, SE163381, B.A.Tregale, M.Wilcox
Cymbalaria pallida var. *beguinotii* Thackley, outside of garden wall, Old Windhill Road, SE163381, B.A.Tregale, M.Wilcox
Cyrtomium falcatum Hull, Wilberforce House, garden wall of museum, TA103288 R.Middleton
Dipsacus laciniatus Otley, Crow Lane, SE205455, J.Hartley, N.Vernon
Doronicum pardalianches Harden Bridge, SD762678, C.R.Abbott, P.P.Abbott
Duchesnia indica Yarm, West Street, NZ417129, V.Jones, W.Thompson
**Escallonia* x *langleyensis* Bradford, bank by Boar's Well, SE164357, B.A.Tregale
Geranium macrorrhizum west of Cowgill, in lay-by, SD742864, J.Somerville *et al.*
Geum macrophyllum Shipley Glen, SE128389, Bradford Botany Group
**Helianthus* x *laetiflorus* Champion, SD7452, E.F.Greenwood
**Iris* x *robusta* Stonegrave, by pond, SE654777, W.Thompson
**Jasminum officinale* Yarm, waste ground, Bridge Street, NZ418131, V.Jones, W.Thompson
Juncus tenuis Skipwith Common, old runway, SE647370, R.Middleton
**Knautia macedonica* Bradford, waste ground, Fairweather Green Mills, SE133334, B.A.Tregale, MWilcox, det. E.J.Clement
Kniphofia uvaria Dalton-on-Tees, woodland edge, NZ2808, L.Robinson
Lemna minuta South Wood, in pond, SE666742, W.Thompson
Leucojum vernum Shackleton Lane End, SE653721, W.Thompson
Lilium martagon Austwick, wide verge by track, SD773768, Bradford Botany Group
Luzula luzuloides Cowgill, edge of rail track, SD764875, J.Clarke
Lychnis coronaria Masham, edge of lagoon, SE219821, L.Robinson
Malva alcea West Marton, roadside, SD889503, J.Clarke
Mimulus moschatus Northdale, marsh, Castleton Rd, SE718978, M.Walshaw
Nectaroscordum siculum Farnhill, below trees, SE009460, M.Canaway
**Osteospernum jucundum* Saltwick, near caravans, NZ915107, V.Jones, A.Ritson
**Oxalis tetraphylla* Nunthorpe, lane near Grange Farm, NZ542140, V.Jones
Petrorhagia prolifera Redcar, South Gare, amongst slag, NZ557273, V.Jones
**Phlox paniculata* Dent, in hedge, SD705866, J.Clarke
Phytolacca acinosa Skelton-on-Ure, by windmill, SE375695, I.Wallace
Pratia pedunculata Pickering, lawn in Lintondale, SE792847, V.Jones, W.Thompson
**Primula denticulata* west of Cowgill, in lay-by, SD742865, J.Somerville *et al.*
**Primula* x *pruhonicensis* Thackley, field by Old Windhill Road, SE163381, B.A.Tregale, M.Wilcox
Rhus typhina Chellow Dene, SE129340, B.A.Tregale, M.Wilcox
Saxifraga x *geum* Dentdale, along river, SD7686, B.Burrow
Sedum hispanicum Greenhow, stone wall, SE113641, BSBI det. G.M.Kay
Senecio inaequidens Hull, Priory Road, TA049320, J.Dews
Solanum physalifolium York, Water End, Clifton, grass verge, SE590528, V.Jones, W.Thompson
Sorbus commixta Shipley, riverside in scrub, SE131384, B.A.Tregale det. H..McAllister
**Trollius* x *cultorum* Thackley, disused railway, SE168384, B.A.Tregale
**Tulipa gesneriana* Leyburn Shawl, SE094903, B.Armstrong, L.Robinson
**Viola* x *wittrockiana* Masham, edge of lagoon, SE219821, L.Robinson

THE OSTRACOD *SCOTTIA PSEUDOBROWNIANA* KEMPF, AN ADDITION TO THE FRESHWATER FAUNA OF YORKSHIRE, AND A NOTE ON THE EVOLUTION OF TERRESTRIAL HABITS IN OSTRACODS AND OTHER CRUSTACEANS

ANDY GODFREY,
90 Bence Lane, Darton, Barnsley, South Yorkshire S75 5DA

GEOFFREY FRYER
Elleray Cottage, Windermere, Cumbria LA23 1AW
and
DAVID J. HORNE
Dept. of Geography, Queen Mary University of London, Mile End Road, London E1 4NS and *Dept. of Zoology, The Natural History Museum, Cromwell Road, London SW7 5BD*
email: d.j.horne@qmul.ac.uk

Introduction

In 1850 T. Rupert Jones described from Pleistocene deposits at Clacton, England, an ostracod which he named *Cypris browniana*, of which only the carapace valves (the so-called shell) were preserved (Jones, 1850). The genus *Cypris* was at that time used to embrace forms that were later assigned to several genera. In 1889 Brady and Norman reported that they had received from Thomas Scott material of an ostracod that he had found living "in pools near Loch Fadd" on the Island of Bute, Scotland, which they regarded as being conspecific with Jones' fossil *C. browniana*. Although the fossils were of Pleistocene age, and therefore not very old, geologically speaking, this was nevertheless an interesting situation. From their living Scottish material they described and illustrated some of the appendages (Brady & Norman, 1889). They also assigned the animal, adult females of which achieve a length of up to c. 0.83 mm, to a new genus, *Scottia*, named for the finder of the living specimens.

Its describers were sufficiently intrigued by the discovery of living *Scottia* for Norman to visit the site where it was collected, which was later described by Brady and Norman (1896). Although the animal was originally said to be from "pools near Loch Fadd", they described its habitat more precisely as a spring which "rises on the bank close to the loch, into which the water finds its way among the grass; the water is nowhere trickling more than two or three inches deep among the herbage". Here *Scottia* was living with a rich assemblage of other ostracods, *Psychrodromus robertsoni*, *Herpetocypris reptans*, *Eucypris pigra*, *Candona candida*, *Candonopsis kingsleii* and *Plesiocypridopsis newtoni*, whose generic assignments given here are the modern ones, not necessarily those used by Brady and Norman. Of these, all save *P. newtoni* are non-swimming, creeping species.

Examples of living *Scottia*, assigned to *S. browniana*, were subsequently recorded from various sites in Europe under this name. However, Kempf (1971) showed that living representatives of what had long been regarded as conspecific with the Pleistocene fossils referred to as *S. browniana* are in fact distinct from it, and he therefore renamed the living species *S. pseudobrowniana*. The situation is, however, more complex than this simple statement implies. In fact three distinct species are involved: *S. browniana*, *S. pseudobrowniana* and *S. tumida*. The last-mentioned had been described (as *Cypris tumida*) as a Pleistocene fossil from Essex by Jones (1850) and subsequently, also as a Pleistocene fossil, as *Cyclocypris huckei* by Triebel (1941), but Kempf (1971) recognised not only that these were conspecific but also that the species they represent belongs in the genus *Scottia*. Fossil *S. browniana* is sometimes a major component of ostracod assemblages in certain palaeoenvironmental settings in British Pleistocene deposits (Robinson, 1980). In Europe, both *S. browniana* and *S. tumida* are extinct, Early to Middle Pleistocene species, the youngest British occurrence of *S. browniana* being in the Hoxnian interglacial (Marine Isotope Stage 11), while *S. tumida* ranges higher, as far as the Purfleet interglacial (MIS 9) (Whittaker & Horne, 2009). The extant *S. pseudobrowniana*, which is now also known as a fossil, is apparently confined as such to the Late Pleistocene and Holocene (De Deckker, 1979; Robinson, 1980). Thus, although Brady and Norman (1889) were in fact in error when they assigned the living *Scottia* from Bute to *S. browniana*, it does indeed belong to a species that also occurs in the fossil state!

As no appendages of *S. browniana* and *S. tumida* are known, discrimination of the three species has to be based entirely on carapace shape, but Kempf (1971) demonstrated convincingly that this is possible. Compared to *S. pseudobrowniana*, both *S. browniana* and *S. tumida* have relatively shorter, approximately semi-circular carapaces (in lateral view); that of *S. browniana* has a short, straight dorsal marginal section, while that of *S. tumida* is relatively higher with a more arched dorsal margin. It is interesting to note that, in common with several other British Pleistocene species such as *Ilyocypris salebrosa* (see Bates *et al*., 2002), *S. tumida* may still be living in North America although it is evidently extinct in Europe; however, records from the USA of both *S. tumida* and *S. pseudobrowniana* (e.g. in the NANODe database: Forester *et al*., 2005) have yet to be verified by careful comparison of specimens with European material; for example, *S. pseudobrowniana* has been reported in the USA from Tennessee (Cole, 1966) and Nevada (Külköylüoğlu & Vinyard, 2000), but Smith *et al*. (2002) point out differences in the appendages of the latter record which suggest that it may be a different species.

It should be noted that the illustrations of the whole animal (i.e. the carapace and appendages) given by Brady and Norman (1889) and reproduced by Klie (1938) were based on material of the living *S. pseudobrowniana* from near Loch Fadd and not on fossil *S. browniana*. Meisch (2000) provided a description and excellent illustrations, including the appendages, of *S. pseudobrowniana*.

The known distribution of all three species is shown on a map provided by Kempf (1971) and their ranges have only been extended slightly by more recent finds. Although Kempf differentiated between sites at which living and fossil representatives of *S. pseudobrowniana* were found, curiously he indicated the Bute site, from which the first living examples were described, as that of a fossil find. Its distribution (Fig. 1) is predominantly north-central and eastern European but it is also known from northern Italy

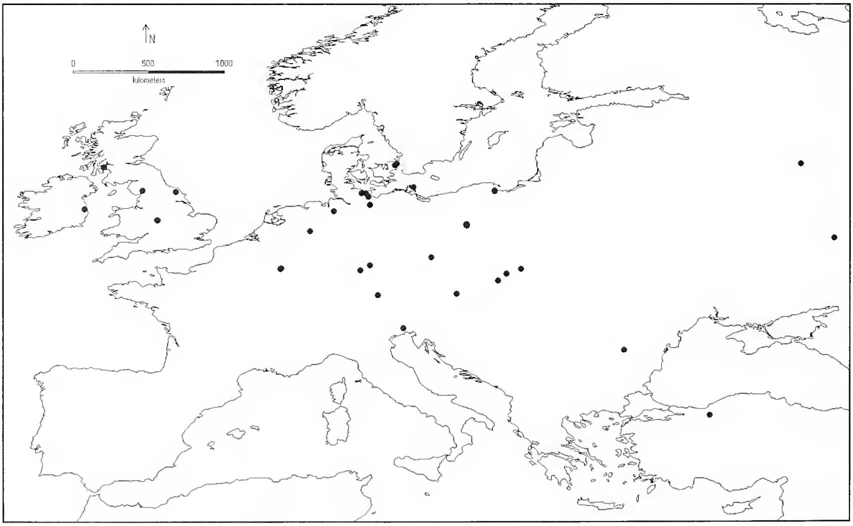

FIGURE 1. European distribution of extant *Scottia pseudobrowniana*, from the NODE database (Horne *et al*., 1998).

and has been reported in Turkey (Külköylüoğlu, 2003, 2005). As noted above, it may also live in North America. In Britain it is known from relatively few sites. Apart from the original site on Bute, it has been found near Birmingham (a few males only) by Lowndes (1930) and at the margin of Skelsmergh Tarn in Cumbria by Danielopol *et al.* (1996). Henderson (1990) indicated, on a map, a site apparently in Essex, which may in fact be the fossil type locality of *S. browniana*. It is known from one site in Ireland (Douglas & McCall. 1992).

FIRST RECORD OF *SCOTTIA PSEUDOBROWNIANA* IN YORKSHIRE

Here we report the discovery of *S. pseudobrowniana* in Yorkshire by Andy Godfrey who collected it in moss from tufaceous springs and seepages at Seive Dale Fen, Low Dalby, North Yorkshire (SE854881) on 1 July 2005. The seepages and springs are on an open and gently sloping flushed hillside and the streams issuing from these flow eastwards where they join Dalby Beck at the foot of the slope. Vegetation around the open seepages and springs included *Schoenus nigricans*, *Carex* spp., *Filipendula ulmaria*, *Dactylorhiza* sp., *Cardamine pratensis*, *Lychnis flos-cuculi*, *Succisa pratensis*, *Pedicularis palustris* and *Hydrocotyle vulgaris*, with fringing *Salix caprea* and *Alnus glutinosa* woodland. Stoneworts were also frequent at the springheads and in the channels. The streams issuing from the springs and seepages were generally no more than 10cm wide and usually less than 5cm deep. Their water was clear brown with flow only perceptible in the narrower parts of the channels. The following single measurements were made in the springs: pH 7.81, water temperature 11.6°C, conductivity 612µS cm^{-1} and total dissolved solids 308ppm. The substrate was a combination of mud and organic detritus and included obvious tufa fragments. The area around the seepages and springs was poached but no cattle were present on the day of the visit. Other invertebrates associated with the springs and seepages included the aquatic larvae of the Red Data Book 1 and UK Biodiversity Action Plan soldier-fly *Odontomyia hydroleon* and the larvae of other scarce or local soldier-flies (*Oxycera morrisii*, *O. pygmaea* and *Stratiomys singularior*), the Nationally Scarce water-penny beetle *Eubria palustris* and the local Sphagnum-bug *Hebrus ruficeps*.

HABITAT REQUIREMENTS

Kempf (1971) surveyed the published information on the ecology of *S. pseudobrowniana* that was available at the time. A preference for springs or spring-fed situations is evident; these are of various kinds, often swampy and sometimes grassy or mossy and, not surprisingly, predominantly cool, though there are records of it at 22°C in a spring-fed area of horsetails (*Equisetum*) and sedges and at 17°C in a stand of *Chara* fed by a highly calcareous spring. Springs with lime-encrusted moss, or in which ferruginous deposits are present, are among those frequented.

A recent find by Külköylüoğlu (2003, 2005) in Turkey confirms earlier suggestions that it is a crenobiont, preferring cool springs or waters connected to such springs. Its associates in spring-fed areas include several ecologically-tolerant species of ostracods but also *Cryptocandona vavrai* and *Potamocypris zschokkei* as well as (most frequently) *Psychrodromus olivaceus* and *Eucypris pigra,* all of which favour such sites and seepages. It has also been found in springs and swamps in woodland among wet leaf-litter (Meisch 2000) where, as it does in moss, it leads a semi-terrestrial (as opposed to fully aquatic) existence. In a Romanian lake it has been found inhabiting floating "swamp islands" (Danielopol & Vespremeanu, 1964) comprising masses of *Phragmites*, *Typha*, *Carex* and plant detritus, quite similar to the "floating fen" habitat in which it was found at the margins of Skelsmergh Tarn in Cumbria, UK (Danielopol *et al.*, 1996). In such habitats it is commonly associated with the ostracods *Candonopsis kingsleii* and *Metacypris cordata*.

The ecology of the Seive Dale Fen animals is in accord with previous knowledge of the species. The Seive Dale springs are tufaceous, cool and characterised by vegetation including mosses and charophytes, which closely matches the observations recorded by Kempf (1971), Meisch (2000), Külköylüoğlu (2003) and others. They are also characterised by the local black bog rush *Schoenus nigricans* and it is possible that searches in other springs where this distinctive calcicole plant occurs may reveal further occurrences of this scarce and probably under-recorded ostracod. It is interesting that as a result of extensive work on Pleistocene fossil faunas, the genus *Scottia* has come to be regarded as an indicator of small, shallow, permanent water bodies, with a marked tendency to weed growth and the ultimate development of a fen (e.g. Robinson, 1980), which is not at variance with the preferences shown by its living representative in Europe.

Functional morphology

Scottia pseudobrowniana is a crawling species, as is apparent from the shortness of the so-called natatory setae on its antennae and from the robust nature of the furcal (or uropodal) rami that are armed distally with a pair of strong claws (among the stoutest of any podocopid species) which are used for levering the animal forwards. The antennae, which have stout distal claws, serve mainly to pull the animal along and cannot be used for swimming (in many freshwater ostracods the antenna has a dual role in both crawling and swimming). Probably related to its crawling habits is the presence, at the distal extremity of the sixth limb (the so-called walking leg), of not only the robust, curved, terminal claw or spine usual in cypridids, but also a second spine, more slender but of similar length. Both spines are denticulate. In cypridids other than *Scottia*, the second terminal spine is usually represented only by a small, slender seta. Exactly how the twin terminal spines are used is not clear, but they may aid in climbing among the vegetation through which the animal crawls. The carapace valves (Fig. 2) are thick and robust, which may be an advantage when the animal leaves the cushioned aquatic environment, as is probably the ability to close them tightly when necessary.

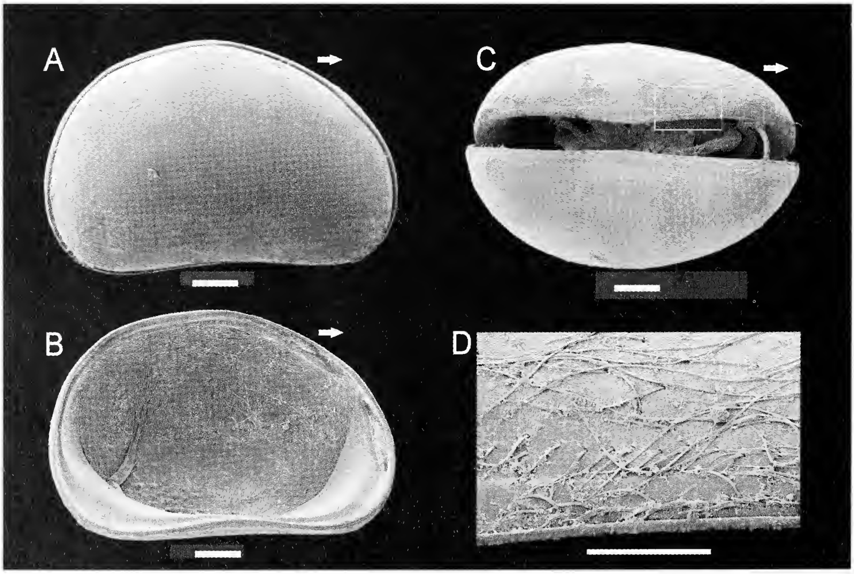

FIGURE 2. *Scottia pseudobrowniana* from Seive Dale Fen, North Yorkshire.
Figured specimens deposited in the Zoology (Crustacea) collection at the Natural History Museum, London; catalogue numbers given in brackets. A: female carapace, right lateral view (2010.245); B: male left valve, internal view (2010.246); C: female carapace, ventral view (2010.247); D: detail of framed area of (C) showing rows of sensilla near outer margin of right valve. Arrows indicate anterior direction. Scale bars A-C: 100 μm; D: 50 μm.

SCOTTIA AND THE EVOLUTION OF TERRESTRIAL HABITS IN OSTRACODS

For more than 70 years *S. pseudobrowniana* remained the only known extant species of *Scottia*. Subsequently three living congeners have been discovered which throw interesting light of the history of the genus from geographical and ecological standpoints. The description of *S. audax* from New Zealand by Chapman (1961) (who originally placed it in the genus *Mesocypris*) gave *Scottia* an unexpectedly wide and disjunct distribution (De Deckker, 1980). A second species, *S. insularis* (Chapman, 1963) is known from Australasia but is inadequately described. More recently *S. birigida* has been described from Japan by Smith *et al.* (2002). Such a wide distribution hints at an ancient origin for the genus although pre-Pleistocene fossil records appear to be sparse and uncertain; Swain (1999) lists several species from the Tertiary of the USA that are assigned to *Scottia* with varying degrees of confidence, the oldest being of "late Cretaceous or early Tertiary" age, but these records are in need of verification. Ecologically, the extant species share with *S. pseudobrowniana* a propensity for a semi-terrestrial or even entirely terrestrial way of life. *S. birigida*, for example, was found in wet leaf litter, and exploration of its habitat revealed it to be living among wet fallen leaves and on the soil surface at all times of the year, in a climate where the temperature reaches 30-35°C in summer and may fall as low as -5°C in winter, when the area is often covered with snow. *S. audax* was described as a truly terrestrial species.

This preference of species of *Scottia* for habitats that lead to a semi-terrestrial or even terrestrial way of life is reflected in the affinities of the genus which lie with ostracods, most of which have been described relatively recently, that have similar habits. *Scottia* is assigned to the Subfamily Scottiinae (of the Family Cyprididae, Superfamily Cypridoidea), the only other members of which are *Mesocypris* and the recently described *Austromesocypris*, neither of which has British representatives, and all of which show a marked preference for terrestrial or semi-terrestrial habitats. The vast majority of members of other subfamilies of the Cyprididae, which are common and diverse in non-marine waters, are fully aquatic. That ostracods include truly terrestrial taxa was not known until 1953, when *Mesocypris terrestris* was described from forest humus in the Knysna Forest, South Africa. Of this species Harding (1953) gives a well-illustrated account. It is interesting that there is nothing in its morphology that immediately indicates that its habits are terrestrial and not aquatic. An earlier known species of this genus, *M. pubescens*, was already known as a frequenter of wet moss in the splash zone of a waterfall and similar situations in Kenya (Klie, 1939), but *M. terrestris* has taken the tendency to emancipate itself from water even further. Since its discovery, two more species of *Mesocypris* have been found to be terrestrial, as have three species of *Austromesocypris* from Australia (Martens *et al.*, 2004). *Mesocypris* and *Austromesocypris* are believed to be more closely related to each other than to *Scottia* and have been recognised as constituting a tribe, the Mesocypridini, while *Scottia* has been allocated to a second tribe, the Scottiini.

The discovery that some ostracods have adopted terrestrial habits led to searches and discoveries elsewhere (e.g. Danielopol & Betsch, 1980; De Deckker, 1983); indeed we now know that the terrestrial mode of life has arisen more than once among ostracods. Terrestrial species not closely related to the Scottiinae have been found in widely scattered parts of the world, and most are related to freshwater taxa. For example there are terrestrial representatives of the subfamilies Callistocypridinae and Candoninae (family Candonidae) and Terrestricypridinae (family Cyprididae), all belonging to the superfamily Cypridoidea, as well as the family Darwinulidae (superfamily Darwinuloidea) (Pinto *et al.*, 2003, 2004, 2005; Martens & Horne, 2009). The route from freshwater, via damp mosses and leaf litter, seems an obvious one. More surprising, perhaps, has been the discovery of a completely separate superfamily, the Terrestricytheroidea, making the transition to terrestrial habitats from marine and brackish water environments. Schornikov (1969) found in Iturup, one of the Kuril Islands north-east of Japan, an ostracod that he described as *Terrestricythere pratensis*, which he found living in a coastal locality among small pebbles which were always kept damp by mist, rain and sea spray. The same author described a second species of the genus from a monsoonal salt marsh with brackish groundwater at a coastal site near Vladivostok, and also recorded *T. pratensis* living nearby among supralittoral salt-tolerant plants (Schornikov, 1969). Two more species of *Terrestricythere* were discovered in England, one (which remains un-named) represented by a single male specimen found in an intertidal rock pool on the Bristol Channel coast, the other, described as *T. elisabethae*, by a large population inhabiting a shaded locality on a tidal creek in Hampshire, where the animals were found crawling among damp leaves (Horne *et al*., 2004). More recently, further species have come to light in Japan (Hiruta *et al*., 2007) and the Black Sea (Schornikov & Syrtlanova, 2008). It is clear that adaptation to terrestrial habitats was an entirely independent evolutionary venture for *Terrestricythere*, not only because it originated in marine/brackish-water rather than freshwater habitats, but because it constitutes a separate superfamily only distantly related to other terrestrial ostracods. While the Terrestricytheroidea, Darwinuloidea and Cypridoidea all belong to the same order, the Podocopida, each is very distinct. Although no fossil representative has yet been recognised, the Terrestricytheroidea may be a very ancient superfamily, possibly hundreds of millions of years old (Horne, 2003; Horne *et al*., 2004).

CONVERGENT EVOLUTION OF TERRESTRIAL AND SEMI-TERRESTRIAL HABITS IN OSTRACODS AND OTHER SMALL CRUSTACEANS

The acquisition of terrestrial and semi-terrestrial habits by ostracods involved the solution of ecological and physiological problems. Although small, the animals concerned are often too large and bulky to live completely within the thin film of water that covers surfaces in damp situations (which is otherwise sufficiently "deep" for protozoans, rotifers, tardigrades and even harpacticoid copepods). Many, if not all, ostracods (aquatic as well as terrestrial) are capable of surviving adverse conditions by sealing themselves tight shut inside their carapaces, and this undoubtedly serves them well if terrestrial environments become too dry. However, at least some terrestrial ostracods are capable of continuing to move in relatively dry conditions, dragging with them a small bubble of water as they crawl, as was observed and illustrated for *Terrestricythere elisabethae* by Horne *et al*. (2004). In this they are aided by having "hairy" carapaces, furnished with abundant sensilla that are particularly densely spaced, and sometimes brush-like, around the ventral margins of the valves, which help to retain water. However, while some taxa (e.g. *Terrestricythere*, some species of *Mesocypris* and *Scottia*) are abundantly adorned with such sensilla, others, including *S. birigida* and *S. pseudobrowniana* are not particularly well-endowed in this respect although the latter, at least, displays rows of closely-spaced sensilla near the free outer margins of the valves (Fig. 2D) . It may be that the degree of "hirsuteness" of these ostracods is a reflection of how far along the adaptive path to terrestrial habits they have progressed, but there is clearly much to learn about how these animals cope with their environment.

Semi-terrestrial habits have evolved also in branchiopod crustaceans of the Order Anomopoda that are very distantly related to ostracods and provide a remarkable example of convergent evolution. The branchiopod exponents of this way of life are members of the family Chydoridae which, like many ostracods, are predominantly crawlers. They live in wet moss on forest floors and among mosses growing on tree trunks in cloud forests where the air is saturated with moisture for most of the time. All are very small, which enables them to live in small interstices among moss leaves where a film of water is easily retained. Thus the first two terrestrial species to be described, by Frey (1980), which he assigned to a new genus *Bryospilus*, are no more than 0.35mm in length and are among the smallest known chydorids. Like ostracods they have a functionally bivalved carapace, but in their case this is a single, folded structure with no dorsal hinge, although its two valves can be brought together by means of adductor muscles, just as can those of the hinged bivalved carapace of ostracods. They crawl by the use of the trunk limbs, assisted at times by levering with a median post-abdomen that is the functional equivalent of the posteriorly-located furca (or uropods) of many cypridoidean ostracods, including terrestrial species.

The antennae, used for propulsion when anomopods swim (which most of them can), or, less frequently, for levering them through detritus, are reduced in size and play no part in locomotion. In this respect semi-terrestrial chydorids are unique among anomopods. The small size of these animals presumably enables them to retain water within the carapace chamber when living in a thin film of it. *Bryospilus* proves to be a very distinctive genus, not closely related to previously known genera. Among its peculiarities is that it lacks the single compound eye (derived from two fused eyes) possessed by most anomopods, but it retains the small ocellus. The first semi-terrestrial chydorids, of which Frey (1980) gave excellent illustrations, were found in damp forests in New Zealand, Venezuela and Puerto Rico. Additional species, one of them allocated to a new genus, with similar habits, have since been described from wet forests in West Africa (Chiambeng & Dumont, 1998).

The other group of small crustaceans that is well represented in freshwater, the Copepoda, also includes a few species that have emancipated themselves from truly aquatic conditions. Unlike ostracods and anomopods, copepods lack an enveloping carapace that can retain water. One member of the Cyclopoida, *Ectocyclops phaleratus*, which has creeping habits and can move over wet surfaces, pushing a film of water with it (as perhaps can its congeners), may exhibit a potentially early stage in the evolution of terrestrial habits. Already better-adapted to a semi-terrestrial life, however, are various smaller, creeping species, often no more than 0.5 mm in length, that belong to several genera whose relationships are uncertain. These, whose four pairs of locomotory thoracic limbs have short rami, often reduced to two segments from the basic three, often live among mosses, in springs, seepages and groundwater. British representatives are few but include *Speocyclops demetiensis*, two of whose three recorded sites in Britain are in Yorkshire, and *Graeteriella unisetiger*.

Perhaps even better exponents of such habits are found among the Harpacticoida, freshwater representatives of which are predominantly crawlers rather than swimmers, and of which some frequent wet moss or the leaf carpet of woodlands where they use their thoracic legs as oars when they "row" through a thin film of water, or as levers where the film is thinner. Species of *Maraenobiotus* and *Epactophanes*, both of which have British representatives, live in wet (or sometimes even only damp) moss and occasionally among decaying leaves or on moist peat. In Yorkshire two species of *Moraria*, one very common, the other much less so, usually frequent *Sphagnum*, another has been found in a seepage, and two other species of the genus have been found in the leaf carpet of woods (Fryer, 1993).

While of less relevance in the present context, for completeness it can be mentioned very briefly that various larger, malacostracan crustaceans have also to a large degree adopted terrestrial habits. Large size is beneficial in that, for example, surface area to volume ratios are more advantageous in combating losses by evaporation and a thick, more water-retaining cuticle can be employed than in minute animals – though terrestrial crustaceans lack the waxy layer of epicuticle typical of other terrestrial arthropods. Gills can also be housed in an enclosed humid chamber, as they are in crabs that adopt such habits.

Most successful on land have been the isopods which, as well as being very diverse in the oceans where they have, for example, given rise to a spectacular array of deep sea forms, are well represented on land as the wood lice. Amphipods have been less successful in this respect, though "beach-hoppers" are common on sea coasts, but a few species thrive in the damp tropics and one semi-terrestrial invader, *Orchestia cavimana*, has been found in Yorkshire. Various crabs are highly successful in terrestrial habitats – the Coconut Crab *Birgus latro* even climbs trees – but many retain aquatic larval stages, which means that adults have to return to the sea to reproduce and are therefore restricted in their ability to venture far inland. Some freshwater crabs, which have eliminated larval stages from the life cycle, roam freely on land, especially when conditions are moist. Perhaps surprisingly, hermit crabs of the genus *Coenobita* have successfully colonised terrestrial habitats, where they use the shells of terrestrial snails as "homes", but have to return to the sea to breed.

Nevertheless the New World *C. clypeatus* is a highly successful species in the Caribbean and adjacent mainland areas.

TAILPIECE

When, just over 120 years ago, Thomas Scott discovered the ostracod whose name perpetuates his memory, and George Stewardson Brady and Alfred Merle Norman described it, they had no idea that it would eventually prove to be related to terrestrial species whose existence was then not even suspected, and were not to begin to be known until more than 60 years later. Nor did they know that their findings, with those of later naturalists, would enable its ecological preferences, habits and morphological attributes to be compared with those of other ostracods, both related and unrelated, and throw light on the route or routes whereby these seemingly unlikely animals have come to occupy semi- and fully terrestrial niches. In recalling this chain of events the role of three pioneers in the study of small crustaceans is inevitably and happily remembered.

ACKNOWLEDGMENTS

Andy Godfrey would like to thank the Environment Agency (York office) who funded the project which was aimed at studying the ecology of the Red Data Book 1 and UK Biodiversity Action Plan soldier-fly *Odontomyia hydroleon*. Werner Hollwedel kindly informed us that the term "Schachtelhalm", translated as "shavegrass" (which we were unable to equate with any common English name), in fact refers to "horsetails", the common name for *Equisetum*. We thank Gilly Walsh-Kemmis (née McCall) for supplying coordinates for the Irish record of *Scottia pseudobrowniana*.

REFERENCES

Bates, M.R., Keen, D.H., Whittaker, J.E., Merry, J.S. and Wenban-Smith, F.F. (2002) Middle Pleistocene molluscan and ostracod faunas from Allhallows, Kent, UK. *Proc. Geol. Assoc.* **113**: 223-236.

Brady, G.S. and Norman, A.M. (1889) A monograph of the marine and freshwater Ostracoda of the North Atlantic and of Northwestern Europe, Section 1, Podocopa. *Sci. Trans. Roy. Soc. Dublin* series 2, **4**: 63-270.

Brady, G.S. and Norman, A.M. (1896) A monograph of the marine and freshwater Ostracoda of the North Atlantic and of Northwestern Europe, Sections 2-4, Myodocopa, Cladopocopa and Platycopa. *Sci. Trans. Roy. Soc. Dublin* series 2, **5**: 621-746.

Chapman, M.A. (1961) The terrestrial ostracod of New Zealand, *Mesocypris audax* sp. nov. *Crustaceana* **2**: 255-261.

Chapman, A (1963) A review of the freshwater ostracods of New Zealand. *Hydrobiologia* **22**: 1-40.

Chiambeng, G.Y. and Dumont, H.J. (1998) New semi-terrsterial chydorids from the tropical rainforest of northwest Cameroon (Africa): *Nicsmirnovius camerounensis* n. gen. n. sp. and *Bryospilus africanus* n. sp. (Crustacea: Anomopoda). *Hydrobiologia* **391**: 259-270.

Cole, M.E. (1966) Four genera of ostracods from Tennessee (*Darwinula*, *Limnocythere*, *Ilyocypris* and *Scottia*). *J. Tennessee Acad. Sci.* **41**: 135-146.

Danielopol, D.L. and Betsch, J.M. (1980) Ostracodes terrestres de Madagascar: systématique, origine, adaptations. *Revue Ecol. Biol. Sol.* **17:** 87-123.

Danielopol, D.L., Horne, D.J. and Wood, R.N. (1996) Notes on the ecology of *Metacypris cordata* (Ostracoda, Timiriaseviinae); why does it not colonise groundwater habitats? *In:* Keen, M.C. (ed.), *Proc. 2nd European Ostracodologists' Meeting, Glasgow 1993*, 175-180, British Micropalaeontological Society, London.

Danielopol, D.L. and Vespremeanu, E.E. (1964) The presence of ostracods on floating fen soil in Romania. *Fragm. Balcan.* **5**: 29-36.

De Deckker, P. (1979) Middle Pleistocene ostracod fauna of the West Runton Freshwater

Bed, Norfolk. *Palaeontology* **22**: 293-316.
De Deckker, P. (1980) On *Scottia audax* (Chapman). *Stereo-Atlas Ostracod Shells* **7**: 37-44.
De Deckker, P. (1983) Terrestrial ostracods in Australia. *In:* Lowry, J. K. (ed.) The conference on the biology and evolution of Crustacea. *Mem. Austral. Nat. Mus.* **18**: 87-100.
Douglas, D. J. and McCall, G. (1992) The freshwater Ostracoda of Ireland. *Bull. Irish Biogeogr. Soc.* **15:** 91-109.
Forester, R.M., Smith, A.J., Palmer, D.F. and Curry, B.B. (2005) North American Non-Marine Ostracode Database "NANODe" Version 1: http://www.kent.edu/NANODe, Kent State University, Ohio.
Frey, D.G. (1980) The non-swimming Chydorid *Cladocera* of wet forests, with descriptions of a new genus and two new species. *Int. Rev. Hydrobiol. Hydrogr.* **65**: 613-641.
Fryer, G. (1993) *The Freshwater Crustacea of Yorkshire. A Faunistic and Ecological Survey.* Yorkshire Naturalists' Union and Leeds Philosophical and Literary Society, Leeds.
Harding, J.P. (1953) The first known example of a terrestrial ostracod, *Mesocypris terrestris* sp. nov. *Ann. Natal Mus.* **12**: 359-365.
Henderson, P.A. (1990) *Freshwater Ostracods.* Synopses of the British Fauna (New Series) **42**. Universal Book Services/Dr W Backhuys, Leiden.
Hiruta, S.F., Hiruta, S. and Mawatari, S.F. (2007) A new, interstitial species of *Terrestricythere* (Crustacea: Ostracoda) and its microdistribution at Orito Beach, northeastern Sea of Japan. *Hydrobiologia* **585**: 453-456.
Horne, D. J. (2003) Key events in the ecological radiation of the Ostracoda. In: Park, L.E. & A.J.Smith (eds), *Bridging the Gap: trends in the ostracode biological and geological sciences. Paleontol. Soc. Pap.* **9**: 181-201.
Horne, D.J., Baltanás, A. and Paris, G. (1998) Geographical distribution of reproductive modes in living non-marine ostracods. *In:* Martens, K. (ed.), *Sex and Parthenogenesis: evolutionary ecology of reproductive modes in non-marine ostracods*, 77-99, Backhuys, Leiden.
Horne, D.J., Smith, R.J., Whittaker and Murray, J.W. (2004) The first British record and a new species of the superfamily Terrestricytheroidea (Crustacea, Ostracoda): morphology, ontogeny, lifestyle and phylogeny. *Zool. J. Linn. Soc.* **142**: 253-288.
Jones, T.R. 1850. Description of the Entomostraca of the Pleistocene beds of Newbury, Copford, Clacton and Grays. *Ann. Mag. nat. Hist.* **6**: 25-28.
Kempf, E.K. (1971) Ökologie, Taxonomie und Verbreitung der nichtmarinen Ostrakoden – Gattung *Scottia* im Quartär von Europe. *Eiszeitalter. Gegenw.* **22**: 43-63.
Klie, W. (1938) Krebstiere oder Crustacea, III: Ostracoda, Muschelkrebse. *Die Tierwelt Deutschlands* **34**, Gustav Fisher, Jena.
Klie, W. (1939) Ostracoden aus dem Kenia-Gebiet, vornehmlich von dessen Hochgebirgen. *Int. Rev. Hydrobiol.* **39**: 99-161.
Külköylüoğlu, O. (2003) A new report and the loss of *Scottia pseudobrowniana* Kempf, 1971 (Ostracoda) from a limnocrene spring in Bolu, Turkey. *Crustaceana* **76**: 257-268.
Külköylüoğlu, O. (2005) Ecological requirements of freshwater Ostracoda (Crustacea) in two limnocrene springs (Bolu, Turkey). *Annls Limnologie* **41**: 237-246.
Külköylüoğlu, O. and Vinyard, G.L. (2000) Distribution and ecology of freshwater Ostracoda (Crustacea) collected from springs of Nevada, Idaho and Oregon: a preliminary study. *Western North Amer. Nat.* **60**: 291-303.
Martens, K. and Horne, D.J. (2009) Ostracoda. *In:* Likens, G.E. (ed.), *Encyclopedia of Inland Waters,* 405-414. Elsevier Ltd., Amsterdam.
Lowndes, A.G. (1930) Some rare and little-known British freshwater ostracods. *Rep. Marlborough Coll. Nat. Hist. Soc.* No. **79**: 82-112.

Martens, K., De Deckker, P. and Rossetti, G. (2004) On a new terrestrial genus and species of Scottiinae (Crustacea, Ostracoda) from Australia, with a discussion on the phylogeny and the zoogeography of the subfamily. *Zool. Anz.* **243**: 21-36.

Meisch, C. (2000) *Freshwater Ostracoda of western and central Europe*. Süsswasserfauna von Mitteleuropa **8/3**., Spektrum Akademischer Verlag, Heidleberg/Berlin.

Pinto, R.L., Da Rocha, C.E.F. and Martens, K. (2003) On two new species of the genus *Vestalenula* Rossetti and Martens, 1998 (Crustacea, Ostracoda, Darwinulidae) from semi-terrestrial habitats in São Paulo State (Brazil). *Zool. J. Linn. Soc.* **139**: 305-313.

Pinto, R.L., Da Rocha, C.E.F. and Martens, K. (2004) On the genus *Penthesilenula* Rossetti and Martens, 1998 (Crustacea, Ostracoda, Darwinulidae) from (semi-)terrestrial habitats in São Paulo State (Brazil), with the description of two new species. *J. Nat. Hist.* **38**: 2567-2589.

Pinto, R.L., Da Rocha, C.E.F. and Martens, K. (2005) On new terrestrial ostracods (Crustacea: Ostracoda) from Brazil, primarily from São Paulo State. *Zool. J. Linn. Soc.* **145**: 145-173.

Robinson, J.E. (1980) The ostracod fauna of the interglacial deposits at Sugworth, Oxfordshire. *Phil. Trans. Roy. Soc.Lond.* (B) **289**: 99-106.

Schornikov, E.I. (1969) Novoe semeystvo rakushkovykh rachkov (Ostracoda) iz supralitorali Kurilskikh Ostrovov (A new family of Ostracoda from the supralittoral zone of Kuril Islands). *Zool. Zhurn.* **45**: 32-49. [Russian with English abstract]

Schornikov, E.I. (1980) Ostracody v nazemnykh biotopakh (Ostracodes in terrestrial biotopes). *Zool. Zhurn.* **59**: 1306-1319. [Russian with English abstract]

Schornikov, E.I . and Syrtlanova, N.M. (2008) A new species of *Terrestricythere* from the Black Sea, in zones of gas seepage. *Senckenb. leth.* **88**: 121-126.

Smith, R.J., Matzke-Karasz, R., Kamiya, T. and Ikeda, Y. (2002) *Scottia birigida* sp. nov. (Cypridoidea: Ostracoda) from western Honshu, Japan and a key to the subfamily Scottiinae Bronstein, 1947. *Zootaxa* **126**: 1-20.

Swain, F.M. (1999) Fossil nonmarine Ostracoda of the United States. *Developments in Palaeontology & Stratigraphy* **16**: 1-401.

Triebel, E. (1941) Die ersten Ostrakoden aus der Paludinenbank. Z. *Geschiebeforsch.* **17**: 61-75.

Whittaker, J.E. and Horne, D.J. (2009) Pleistocene. *In:* Whittaker, J.E. & Hart, M.B. (eds), *Ostracods in British Stratigraphy,* 447-467. The Micropalaeontological Society Special Publications, The Geological Society, London.

BOOK REVIEW

Palms of Southern Asia by **Andrew Henderson**. Pp. 199 (incl. line illustrations & 336 maps), plus 64 pages of coloured plates. Princeton University Press, Princeton & Oxford. 2009. £53.00 hardvack.

Although rather an exotic title for most readers of *The Naturalist*, this is an exemplary field guide in presenting a wealth of taxonomic, ecological and biogeographical information within the compass of a relatively small volume. The pages are packed with succinct but informative data (including detailed keys and maps) on 352 naturally occurring palms in southern Asia.

The author, Andrew Henderson (Curator at the New York Botanical Garden), will be known to some of us as one of the speakers at the Linnean Society Conference on the Yorkshire botanist Richard Spruce, held at York University in September 1993. His contribution on 'Richard Spruce and the palms of the Amazon and Andes' is to be found in *Richard Spruce (1817-1893) Botanist and Explorer* edited by M.R.D. Seaward and S.M.D. Fitzgerald (1997) – see *The Naturalist* **122**: 24-26 (1997).

MRDS

THE STATUS OF MOORLAND BREEDING BIRDS IN THE PEAK DISTRICT NATIONAL PARK 2004

PETER MIDDLETON
33 Wilthorpe Road, Redbrook, Barnsley S75 1JA
and
GEOFF CARR
300 Higham Common Road, Higham, Barnsley S751PF

The decline of lowland farmland breeding birds in the UK is now well documented and reasonably understood, but does this national trend also extend to upland breeding birds? A survey of the upland breeding birds of the Peak District National Park was conducted in 1990 by A.F.Brown and K.Shepherd and various other sample surveys have been conducted by the RSPB, the National Trust, the Peak District National Park Authority and English Nature, but it is 14 years since the whole area was surveyed for upland breeding birds. This article presents a summary of the results from a repeat Moorland Breeding Bird Survey of the Peak District National Park in 2004 conducted by the Moors for the Future Partnership and funded by the Heritage Lottery Fund.

The moors of the Peak District National Park present a diversity of breeding bird habitats of national importance. Nevertheless, the Peak District moorland has suffered significant losses and degradation of moorland habitats through fringe agricultural improvement, past poor management of burning and grazing regimes and plantation afforestation. Surrounded on all sides by the heavy industry of northern England, the vegetation of the Peak District has also been severely degraded by atmospheric pollution. Furthermore, the area is within close proximity to huge urban areas and this has resulted in enormous visitor pressure. The designation as Britain's first national park, rights of access to large areas of wilderness through open access agreements and the increase in car ownership has resulted in huge numbers of visitors engaging in an array of activities throughout the year. In spite of this, the Peak District retains the most southerly viable populations of typical moorland breeding birds in England. For a number of species, particularly European Golden Plover *Pluvialis apricaria*, the South Pennines Peak District may hold the most southerly breeding populations in the world.

The 2004 survey covered the unenclosed upland area of the Peak District National Park. It was therefore mainly concentrated within the SSSIs of the Dark Peak (between Edale in the South and Marsden in the north), the Eastern Moors and the South-West Peak (Staffordshire moors between Buxton and Leek). The 1990 census covered the Dark Peak and South Pennines as far north as Ilkley. Therefore to analyse the population trends and spatial distribution of breeding birds it was necessary to deduct the data from the northern section north of Marsden from the1990 survey.

The Peak District vegetation

An important correlation exists between the breeding birds of the Peak District moorlands and the vegetation of the area, which in turn influences both densities and the distribution of typical moorland birds. The vegetation of the Peak District moors can broadly be described in terms of five vegetation types, each associated with particular facets of topography or management. The vegetation generally is severely degraded and much of the SSSIs have been designated by English Nature as being in unfavourable condition.

On the plateau of the Dark Peak, where the depth of peat can exceed four metres, the vegetation is dominated by *Eriophorum vaginatum*. Relatively huge expanses of this vegetation exist on the moorlands and it is particularly characteristic of the South Pennines blanket bog (Ratcliffe, 1997; Brown & Shepherd, 1991). *E. angustifolium* can be abundant along the edges of pools and where the peat is eroded; typical associates are *Calluna vulgaris*, *Empetrum nigrum*, *Vaccinium myrtillus* and *Rubus chamaemorus*. Although these blanket bogs are amongst the most species poor floras in Britain they are unique and support high densities of European Golden Plover and nationally important numbers of Dunlin *Calidris alpina*. The highest densities of both these species are found on *Eriophorum* bog that contains abundant *Empetrum nigrum* and *Rubus chamaemorus*. The latter is certainly characteristic of moorlands that support high densities of these waders. In contrast there are extensive areas devoid of vegetation that are seriously eroding and in these areas birds are at very low densities or absent. The present extent of peat occurred some 4000 years ago and severe erosion is perhaps part of a natural cycle due to climate change. However, this process has been accelerated by un-natural events such as moorland fires, overgrazing, increased public access, atmospheric pollution and particularly acid precipitation (Anderson & Yalden, 1998). The latter is thought to be responsible for the loss of peat-forming sphagnum mosses in the mid-18th century. Once peat is exposed it is particularly vulnerable to erosion and oxidization that prevents colonisation of plants, thus it remains bare and the process accelerates.

Away from the plateau the vegetation of the moorland slopes is mostly dominated by Heather, and these areas are mostly managed for Red Grouse *Lagopus lagopus scoticus*. As a consequence, the heather moors are burned at regular intervals to provide nutritious young shoots for the grouse to forage. *Empetrum nigrum* and *Vaccinium myrtillus* are common associates and the latter is often present in relative abundance. According to Anderson and Yalden (1981) areas dominated by pure heather in the northern part of the Peak District appear to have declined by some 35% since 1913. These losses are thought to have resulted from past overgrazing and poor burning management. Peak District bird surveys in recent years have revealed that these pure heather moorland or monocultures attract only small assemblages of moorland birds and often only Red Grouse and Meadow Pipit *Anthus pratensis* are present in such areas. However, recent heather burns, particularly on wet moors with regenerating *Eriophorum angustifolium,* often attract breeding European Golden Plovers. Emphasising those differences in land management may affect breeding bird densities (Sim *et al*., 2005).

Much of the Heather moorland has been replaced by some form of acid grassland. These areas of grassland are particularly favoured by Sky Lark *Alauda arvensis*, Eurasian Curlew *Numenius arquata* and Meadow Pipit, the latter often found in local abundance. Acid grassland is an underestimated resource, indeed, there appears to be a misconception that extensive heather moorland is best for biodiversity and this is often not the case. *Molinia caerulea* is often dominant on gentle, wetter slopes where it usually forms a species poor, tussocky sward. *Nardus stricta* also forms smaller but similar tussocks and this type has probably spread most in recent times as a consequence of heavy grazing, this grass is unpalatable to sheep. The most interesting and species rich acid grassland type found in the Peak District is *Deschampsia flexuosa*. It often occurs on the steeper ground and it is particularly palatable to sheep, this is perhaps the reason why this grassland type is not more abundant in the area.

Juncus spp. are also common throughout all areas of the Peak District where water is abundant at the surface. *J. effusus* is the most abundant and occurs in the damp places particularly where there is a marked change in slope, and variable sized areas of *Juncus* also occur alongside streams. Two species of birds are associated with this habitat, notably, Common Snipe *Gallinago gallinago* and Reed Bunting *Emberiza schoeniclus*.

Cloughs, tors and gritsone edges, with their associated rock litter are often dominated by *Pteridium aquilinum* which may invade heather or acid grassland. This vegetation type is a very important habitat for typical moorland birds such as Northern Wheatear *Oenanthe oenanthe*, Whinchat *Saxicola rubetra*, Common Stonechat *S. torquata* and Ring Ouzel *Turdus torquatus*. Whinchats are never found away from this vegetation type and Twite *Carduelis flavirostris* also have a strong association with it.

Clough woodlands containing *Quercus* sp., *Betula pendula* and *Sorbus aucuparia* occur in the Peak District but generally they are considered by many conservationists as a threat to the important moorland habitats. Nevertheless, natural regeneration of managed and fenced areas has occurred in some cloughs and as a consequence, an assemblage of birds has colonised these areas. Lone trees high in cloughs have been found to attract breeding Willow Warblers *Phylloscopus trochilus*, Chaffinches *Fringilla coelebs* and Tit *Parus* species are also attracted to such locations. The survey also revealed that Woodcocks *Scolopax rusticola* and Redstarts *Phoenicurus phoenicurus* breed in the wooded cloughs and, as these trees become mature, they may attract Wood Warblers *Phylloscopus sibilatrix* and Pied Flycatcher *Ficedula hypoleuca*.

Results

During the 2004 survey, data were gathered concerning the distribution and numbers of 39 species of breeding birds, unlike the 1990 survey when data were presented for 27 species. However, not all the species are considered typical upland breeding birds therefore discussion on the numbers and distribution change will be largely centered upon what is considered to be typical of moorland. Notable exceptions include some wildfowl species, Common Buzzard *Buteo buteo* and Reed Bunting. Three species of wildfowl were found breeding on the Peak District moors and increases in their numbers have occurred since 1990. Three pairs of Teal *Anas crecca* were found in 2004 compared to none in 1990 and likewise, the breeding population of Mallard *Anas platyrhynchos* has increased from two pairs in 1990 to 23 pairs in 2004. The largest increase is not surprisingly of Greater Canada Goose *Branta canadensis*. Three pairs were present in 1990 compared to 56 breeding pairs in 2004, also many more birds were present on the reservoirs. These birds were found grazing at all altitudes and therefore any increase in population could result in additional pressure on the moorland vegetation.

Raptors have also seen similar increases in population since 1990. However, the dramatic increase in their population and distribution has followed the cessation of much of the pesticide usage originally responsible for their population crash. Peregrine Falcon *Falco peregrinus* and Merlin *F. colombarius* were particularly affected and it was not until the 1980s that a slow recovery began. Both species have increased their populations and distribution in the Peak District since 1990. Peregrines have increased from seven pairs in 1990 to 25 pairs in 2004. Likewise the Merlin has increased from 15 pairs to 31 pairs. Common Buzzards have also increased considerably since 1990 when only a single bird was recorded during the entire survey. During the 2004 survey Common Buzzards were recorded in 20 1 km^2 and two pairs were confirmed as breeding. This species nevertheless remains a scarce breeder in the Peak District in spite of being a common resident in the lowlands of Derbyshire. Likewise, there are also limiting factors inhibiting the successful colonization by Hen Harrier *Circus cyaneus*. This species successfully bred in the area in 1997 after an absence of approximately 200 years (Frost, 1978), however, the establishment of a small breeding population has not followed.

Red Grouse is a species synonymous with heather moorland, and where this habitat exists, their densities are highest. Management of the moors appears to be the key to the species range and abundance over time and therefore the heavily managed moors have densities in excess of 50 pairs/km^2. Interestingly, on the heather monocultures where densities of Red Grouse are greatest the overall biodiversity is far less and often the only other bird species present is Meadow Pipit. A total of 2337 individuals was recorded in the study area during the survey in 1990 compared to 5416 individuals in 2004. The increase in the population is dramatic and therefore may reflect the intensive management that occurs on keepered estates; burning is much more evident than a number of years ago. Some caution must be applied when considering the present increase in numbers because these can vary significantly from year to year resulting from a variety of factors, particularly intestinal parasites. The distribution of Red Grouse has also changed considerably and birds were found in 422 km^2 in 2004 compared to 324 in 1990.

Waders overall, within the Peak District National Park have remained stable or increased in numbers; the only exception is Dunlin where the losses are directly correlated with the loss of suitable habitat in the Bleaklow area. This loss is nonetheless significant because Dunlins were found in only 33 1 km^2 in 2004 compared to 54 1 km^2 in 1990. This species is found exclusively on blanket bog, preferably with pool complexes. A total of 91 pairs of Dunlins were recorded during the survey in 1990 compared to 67 in the same area in 2004. The data suggest that there has been a reduction of 25% in the breeding population of the Dunlin in the study area over the period. The average density throughout the study area was 2.27 pairs/km^2 and the highest density was 4.2 pairs/km^2 in prime habitat on Howden Edge.

European Golden Plovers were common throughout the study area in areas above 400m and where the vegetation is dominated by *Eriophorum vaginatum*. Birds were also found nesting on areas of recently burnt heather moorland. Their distribution has changed little: a total of 419 pairs was recorded in 2004 compared to 436 in 1990. The data suggest that the population has remained stable; however there is clearly a paucity of records in the east of the Dark Peak where Heather dominates; therefore, the species has a distinct westerly bias. The average density of this species in the study area was 1.90 pairs/km^2.

The Brown and Shepherd (1991) methodology used for this survey is clearly inadequate for censusing Common Snipe *Gallinago gallinago*. Nevertheless, the same methodology was used in 1990 and 2004 therefore one can still determine the trend for this species in the Peak District National Park; 135 territorial males were recorded in the survey area in 2004 compared to 56 in 1990. The birds recorded may well be a fraction of the true population and this species is perhaps the most common breeding wader in the Peak District National Park.

The Curlews range and population in the Peak District appears to have enjoyed a significant increase since 1990; 259 pairs were recorded in the study area in 1990 compared to 453 pairs in 2004. Furthermore, birds were found in 288 km^2 in 2004 compared to 189 km^2 in 1990. There appears to be no obvious preference of nesting habitat and the species is evenly distributed throughout the study area, the only requirement of habitat is its proximity to inbye land where this species does much of its foraging. Consequently, Eurasian Curlews are largely absent from the central massifs of the Kinder and Bleaklow areas. The average density of Curlews in 2004 was 1.54 pairs/km^2.

An increase in population and distribution is also evident for Short-eared Owl *Asio flammeus* and Raven *Corvus corax*, Indeed, Ravens have undergone a successful colonisation of the district since 1990 when Brown and Shepherd (1991) stated that 'there seems little immediate prospect of the return of this species'. This emphasises how the fortunes of some species can change dramatically in only a very short time and how little we know about the changing numbers and distribution of birds. There has been a gradual increase in the population of Ravens since the first confirmed breeding in 1992 and the estimated breeding population in 2004 is in the region of 65 pairs, however, only 18 pairs were confirmed as breeding. Short-eared Owls have also increased significantly from 18 pairs in 1990 to 27 pairs in 2004. This species is well known for considerable fluctuations of breeding pairs that can occur from one year to the next depending on the vole (*Microtus agrestis*) population.

The smaller passerines do not all share the upward trend in numbers of the species already described. Indeed, some have suffered serious declines in numbers and distribution. However, this cannot be said for both Whinchat and Common Stonechat. The former has increased by more than 60% from 59 pairs in 1990 to 97 pairs in 2004. This species favours the bracken covered lower slopes of the moorland fringe where they can be easily detected by there loud characteristic song that is delivered from a prominent perch. One reason for this rise may be an increase in suitable habitat resulting from the spread of bracken since 1990. Even more pronounced is the increase of the Common Stonechat. Interestingly, no breeding Stonechats were found in the Peak District in 1990, but since that time colonisation has been dramatic and 91 pairs were recorded in 2004. Stonechats were often found at higher altitudes than Whinchats but unlike the latter, there appears to be no obvious preference of vegetation type for nesting. Northern Wheatear is also a species that inhabit all of the upland area, but in the Peak District is often associated with rocky areas of moorland. The numbers of territorial Wheatears recorded in 2004 was more than half the number recorded in 1990, only 45 pairs compared to 109 in 1990. This species is not considered to be of conservation concern, nevertheless, Sim *et al.* (2005) also found a similar significant decrease in the South Pennines between 1990 and 2000.

In contrast, Ring Ouzel is a Red Listed species of high conservation concern due to its serious breeding population and range decline over the last 25 years. Interestingly however, no significant decline was witnessed in the Peak District between 1990 and 2004 (98 and 83 pairs respectively). Although a slight decline of 15% was proven from the data collected, it is assumed that this species also occurred in reasonable numbers in the cloughs of the private grouse moors where access was denied. The distribution of this species has however changed a little and in 1990 it was notably absent from the eastern moors, but this was not the case in 2004. This is perhaps not significant as the birds will take up territories wherever the opportunity arises as they do not appear to be site faithful. This was probably proven during the foot and mouth outbreak in 2002 when many pairs bred on Stanage Edge when access was denied to climbers. This species is especially vulnerable to disturbance; therefore they do not usually nest in areas frequented by recreational users.

Of all the species recorded during the survey the biggest and most alarming change was of Twite. This is a Red Data Book species (Batten *et al.*, 1990) and a Red Listed Species of conservation concern due to an historical decline in the UK: a total of 136 pairs of Twites were found in the study area during the survey in 1990, compared to only ten pairs in the same area in 2004. The species was found at three localities within the study area: Wessenden and Melthem moors west of Huddersfield, Edale in the extreme south of the Dark Peak and the Combs Moss area in Staffordshire. Twites are thought to breed in loose colonies therefore it is unlikely that these small numbers reflect the true breeding population, nevertheless, the decline in the breeding population has been catastrophic. Anecdotal evidence does however exist of a slightly larger population in Staffordshire than the data suggest. Furthermore, small populations were known at two other localities in the northeast of the study area in 2004, Winscar west of Barnsley and Black Hill near Holmfirth (*pers. obs.*). The decline of the British breeding population has been attributed to the deterioration in quality and quantity of the inbye land, in particular the seed rich hay meadows in which the species feeds in summer (Brown *et al.*, 1997). However, the explanation is perhaps more complex: indeed, a small study by English Nature conducted in 2003 revealed that the species preferred to feed in semi-improved pasture with a higher nutrient level resulting in an abundance of Common Sorrel *Rumex acetosa* (Middleton, 2003). The fact remains that this species has vanished from areas that appear to provide prime habitat (*pers. obs.*). This species has a strong preference for nesting in bracken; indeed, there are many bracken-covered areas of moorland adjacent to seed rich hay meadows in the study area that no longer support breeding Twites which were found in only seven 1 km^2 during the 2004 survey, compared to 88 in 1990. The species is, however, known to breed in a few other localities within the study area. Nevertheless, Twites have vanished from former haunts and their range contraction is dramatic. In 1990 the species bred in 14 tetrads in the Sheffield area and ten years previously they nested in 26 tetrads. The decline has continued and they are literally ‘hanging on’ in a few localities in the south of the study area.

Brown and Shepherd (1991) stated that the Twite was thinly distributed throughout the study area following the survey in 1990; furthermore, although they had declined in the Sheffield area there was no evidence to suggest any marked change in its distribution in the study area. The birds were said to be more thinly distributed south of the line between Stalybridge and Holmfirth and it is therefore interesting to note that south of this line is where they have declined most in the intervening time. If the birds are indeed loose colony nesters, could it be possible that sites are abandoned once the minimum critical level is reached? There is perhaps little evidence to support this hypothesis at present, but recent ringing studies in the South Pennines may provide more information. Following the survey in 1990, Brown and Shepherd (1991) estimated the total South Pennines’ population at around 415 pairs. This was perhaps however an underestimation of the true breeding population at that time. Interestingly, the population at present is estimated between 200 and 500 pairs (RSPB 2001), so if Brown and Shepherd (1991) were accurate in their estimation, perhaps the species has not suffered a population decline but perhaps a pronounced range contraction. English Nature conducted a small study in 2003 that revealed that it was indeed abundant in certain parts of the Pennines and that there was a 'hot spot' for this species in the circle of moorland between Marsden, Halifax, Todmorden and Rochdale (Middleton, 2003). Radiating away from this area the birds become more thinly distributed. Considering that Brown and Shepherd (1991) stated that the birds were thinly distributed throughout the study area, it is worth considering that perhaps the Twites' overall population in the South Pennines may have remained stable, and it is just their distribution that has changed. Indeed, they have vanished from areas that provide prime habitat; therefore their foraging requirements are perhaps not the main reason for the decline. A study by Batty *et al.* (1999) provided evidence of considerable distribution change since the 1990 Brown and Shepherd survey. Whilst Twites were found in only 20% of the squares in which they were recorded in 1990, they were found in 18% of the sample of squares where they were not recorded in 1990. This might suggest that the species has undergone some redistribution. Most important, however, is the finding that the increase in densities in occupied squares has increased from 2.91 to 5.75. This again, is evidence that may suggest the species has undergone a range contraction rather than a decline in population.

SUMMARY

Providing evidence of increases in the distribution and numbers of many moorland breeding birds in the Peak District National Park is a pleasing outcome from the survey that is in direct contrast to the decline of many lowland farmland birds in the UK. Indeed, many of the birds in the study area have remained stable or increased, and of the 27 species that were recorded during both the surveys of 1990 and 2004, only eleven species have suffered a decline and only nine of those have undergone a significant decrease (see Table 1).

There is perhaps little doubt that densities of Red Grouse of the race *scoticus*, indigenous to the British Isles, are found nowhere in such abundance as on the eastern area of the Dark Peak. However, although this species appears to have doubled over the last 14 years, the figures mean little when the species is managed and kept in such artificially high numbers; for example, 2005 was a bad year for this species and the numbers were subsequently much reduced.

What is however, of great consequence is that many species of national importance have remained in high densities, such as European Golden Plover. This species is at the southern extremity of its range and its population has remained stable, therefore there is perhaps little evidence to suggest any affects from global warming. Other species have increased in range and numbers such as Peregrine Falcon, Merlin and Short-eared Owl. Furthermore, Raven has colonised the area since 1990 and Hen Harrier is perhaps attempting to re-colonise. Waders have also fared reasonably well; Dunlins are slightly down in both range and numbers resulting from loss of suitable habitat in the Bleaklow area, but Eurasian Curlew, Northern Lapwing and Common Snipe have all increased in numbers.

There is no real evidence to suggest that the status of Ring Ouzel has changed since 1990, whilst Whinchat, Common Stonechat, Reed Bunting and Dipper have all increased in both range and numbers. There is perhaps little change for Sky Lark and Meadow Pipit, especially as these species were not recorded in the same detail as other species.

The declines of some species are perhaps less evident but nonetheless significant. Common Cuckoo *Cuculus canorus* has undergone a massive 69% reduction in numbers in 14 years that is greater than the national trend (Glue, 2006). Northern Wheatears were also much reduced in 2004, but most notable was the catastrophic reduction in both range and numbers of Twite.

TABLE 1. 2004 Peak District Moorland Breeding Bird Survey

Species	**Breeding Pairs**		**Occupied km²**		**Percentage Change**	
	1990[a]	2004[a]	1990[a]	2004[a]	Abundance	Occupancy
Common Buzzard[b]	1	18(2)	1	18	1700%	1700%
Greater Canada Goose	3	57	4	37	1800%	825%
Carrion Crow	117	11	67	11	-91%	-84%
Common Sandpiper[d]	14	28	10	20	100%	100%
Common Cuckoo	49	15	48	14	-69%	-71%
Eurasian Curlew	259	453	189	288	-75%	-52%
Dipper	12	21	12	20	75%	67%
Dunlin	91	67	54	33	-26%	-39%
European Golden Plover	436	419	225	218	-4%	-3%
Grey Wagtail	26	46	24	41	24%	41%
Common Kestrel[b]	68	84(5)	68	77	24%	13%
Northern Lapwing	61	131	44	65	115%	48%
Meadow Pipit[c]	10410	8432	476	472	-19%	-1%
Merlin[b]	21(9)	31(6)	21	30	48(50)%	43%
Peregrine Falcon[b]	7(3)	25(5)	7	25	286(40)%	257%
Red Grouse[c]	2337	5416	324	422	132%	30%
Common Redshank	9	6	8	4	-33%	-50%
Reed Bunting	16	143	13	91	794%	600%
Ring Ouzel	98	83	69	65	-15%	-6%
Short-eared Owl[b]	18(5)	27(18)	18	27	50(260)%	50%
Sky Lark[c]	1153	1069	311	306	-7%	-2%
Common Snipe	56	135	42	82	141%	95%
Common Stonechat[e]		83		64		
Twite	131	10	88	7	-92%	-92%
Northern Wheatear	109	45	65	37	-59%	-43%
Whinchat	59	97	37	64	64%	73%

[a] data for only those 489 km_2 surveyed in both periods
[b] raptor sightings (in brackets confirmed breeding pairs)
[c] number of individuals, not pairs (1990 counts in broad classes, 2004 actual)
[d] indication of change not reliable, as species associated with reservoirs not included in surveys
[e] no records of Common Stonechat during 1990 survey

Perhaps some of the declines were predictable, especially in the case of Dunlin, because large areas of blanket bog in the Bleaklow area have deteriorated to such an extent that they have become devoid of vegetation and are eroding. The purpose of the Moors for the Future Project is to preserve and enhance the moors for wildlife but also for future generations to enjoy, therefore work in the Bleaklow area to restore and revegetate the badly eroding moors has begun and already there are signs of success. Furthermore, paved, formally eroded footpaths have surprisingly had the positive effect of increasing numbers of breeding waders in these areas and both Dunlins and European Golden Plovers were found nesting extremely close to the Pennine Way. Indeed, some of the work to be addressed by the MFF project will be to repair such badly eroded rights of way. Therefore, if the long term aim of the 'Moors for the Future' project is achieved then perhaps we can look forward to further increases in the range and numbers of some of our nationally important species in the Peak District National Park.

Acknowledgements

The authors would like to thank the land owners who gave access to their land, the surveyors, English Nature, RSPB and the 'Moors for the Future' team.

References

Anderson, P. and Yalden, D.W. (1981) Increased sheep numbers and the loss of heather moorland in the Peak District, England. *Biological Conservation* **20**: 195-213.

Batty, R., Langston, R.H.W. and Gregory, R.D. (1999) South Pennines Twite survey 1999. RSPB, Sandy.

Brown, A.F. and Shepherd, K. (1991) *Breeding birds of the South Pennine Moors*. JNCC, Peterborough.

Frost, R.A. (1978) *Birds of Derbyshire*. Moorland, Buxton.

Glue, D. (2006) Cuckoos in crisis? *BTO News* **263**: 22-23.

Middleton, P. (2003) Survey of moorland fringe wading birds and Twite around the South Pennine moors SSSI/SPA/cSAC. Unpublished report to English Nature

Ratcliffe, D.A. (1997) *A Nature Conservation Review*. Cambridge University Press, Cambridge.

RSPB (2001) Twite inventory, Peak District to M62. RSPB, Denby Dale.

Sim, I.M., Gregory, R.D., Hancock, M.H. and Brown, A.F. (2005) Recent changes in the abundance of British upland breeding birds. *Bird Study* **52**: 261-275.

BOOK REVIEWS

Grasses of the British Isles by **T.A. Cope & A.J. Gray.** Pp. 612, with numerous line drawings. Botanical Society of the British Isles. 2009. £19.99 (plus p. & p), paperback with plastic cover, available from Summerfield Books, 3 Phoenix Park, Skelton, Penrith, Cumbria CA11 9SD.

This is the latest (No 13) and largest (in terms of content) of any of the BSBI handbooks, and has been eagerly awaited for some time. The previous definitive and authoritative text, Hubbard's *Grasses,* upon which many of us relied for the last fifty years or so, has been somewhat overtaken by advances in grass taxonomy and the need to develop more workable and user-friendly keys to identification. The present volume can be best summed up in two words – detailed and comprehensive – since it contains descriptions of 220 native and introduced grass species including subspecies, hybrids and varieties, together with line drawings of each species. It also contains detailed sections on the morphology, reproduction and fruiting characteristics of the grass plant; classification from the subfamily level, with very explicit keys for tribes, genera and species; and a very useful section on how to use the book and interpret the species descriptions. There is a comprehensive glossary of terms, bibliography and index at the end of the book.

The major part of the book deals with 220 species, covering the newly coined native and casual categories as identified in *New Atlas of the British & Irish Flora* (2002). Within each species, the textual content follows a clear and well-defined sequence, usually in five paragraphs. Paragraph one gives a formal description of the structural and physical features necessary to identify the species; paragraph two deals with the plant's distribution and habitat; paragraph three is concerned with its biology and ecology, discussing annual, biennial and perennial status, reproductive and dispersal strategies; paragraph four looks at its status, i.e. native or introduced in the British Isles, and its wider distributional (i.e. European) context, and the IUCN categories of conservation importance, as outlined in *The Vascular Plant Red Data List for Great Britain* (2005), i.e. Critically Endangered, Endangered, Vulnerable and Near Threatened, are given for those species, such as *Calamagrostis scotica*, which are included on the Red Data list. The page reference is also given where the species can be found in *New Atlas of the British & Irish Flora* (or in its accompanying CD). The species accounts are accompanied by superbly executed pen and ink line drawings of all parts of the plant requisite for accurate identification. These illustrations, by Margaret Tebbs, who is internationally acclaimed as a botanical artist, are among the best I have ever seen of any plant material.

The very comprehensive section on Keys (pp. 34-103), may appear, at first glance, somewhat daunting to the average botanist. The introduction of keys on Tribes will be unfamiliar to many of us in Great Britain, and has been developed from Tom Cope's familiarity with writing Tropical Grass Floras, where Tribes and, indeed, Genera, are just as important as species. Do not be put off, however, by the amount of detail and the sometimes difficult terminology employed in the keys. I did a trial run, employing the keys, on one or two specimens of well known grasses in my herbarium, and I have to say that they seem, with practice, to work quite well. As with anything else, one needs practice to assimilate and become familiar with new techniques, and I think this new system of keys will, in time, largely remove the risk of going off up 'blind alleys' that we have all done when using various grass keys in the past. To supplement the section on Keys, there is also a short discussion on Classification, in which the characteristics of the six sub-families making up all grass genera are highlighted. The last part of the comprehensive introductory part of the book deals with structure and reproduction, covering the following features: root, stem and leaf; inflorescence; spikelet; reproduction and breeding behaviour; vivipary and proliferation; fruit; and anatomy and metabolism. Some of the terminology within this section is somewhat esoteric, but, by and large, the average reader can gloss over these areas, with little detriment.

This is an eminently useable book, of a convenient size to be carried in the field and with a plastic cover to minimise wear and tear. It is a very worthy successor to Hubbard's *Grasses*, and the authors are to be congratulated in producing what is now and will continue to be the standard identification text for grasses in the British Isles for many years to come. I recommend it to amateurs and professionals alike who have an interest in or involvement with the study of grasses or grassland ecology.

GTDW

The Scramble for the Arctic by **Richard Sale** and **Eugene Potapov**. Pp.223, incl. b/w illustrations, plus 20 colour plates. Frances Lincoln, London. 2010. £16.99 hardback.

This is a readable, fascinating, yet sobering book which takes a global perspective. Each chapter recounts how the different countries possessing arctic regions have dealt with particular issues. The book begins with an historical account of how humans moved into and settled in the Arctic. It ends with an account of the first contacts between the aboriginal peoples and the explorers sent out by countries to the south. The following chapter documents how these countries took ownership of arctic lands and how the indigenous people suffered. If you wondered how the USA rather than Britain came to purchase Alaska and why, you will find interesting insights here into politics and power struggles. The attempts to reach the North Pole and navigate the Northwest Passage are described. The gradual regaining, by indigenous people, of some autonomy is compared between the various countries with arctic lands. The key treaties which led to current ownership of particular arctic island and land masses are mentioned.

The central chapters in the book deal with exploitation. The first phase was for furs and one is astounded by the enormous number of animals that were sacrificed. It was only after Prince Albert popularized the wearing of silk top hats that the demand for beaver pelts to make hats dropped. The development of central heating and the economic crash of the 1930s further reduced the demand for furs in the West. The Arctic was considered of relatively little importance after the Second World War so that nuclear bombs were tested there by both the Russians and the Americans. The former did value the extraction of coal in the Arctic and there had been a gold-rush in Alaska earlier; both are mentioned. A second wave of exploitation starting around the 1960s involved mineral extraction, which expanded in all the arctic countries in spite of the problems of dealing with the climate, waste and local inhabitants. Finally it was realized what a rich resources of oil and gas lay in the Arctic. Countries rushed to exploit these huge reserves which are documented in the book. Conservation issues and protests by aboriginal people are described. There is a chapter on international law in the Arctic which describes how countries hammered out agreements on environmental protection for the Arctic, the law of the sea, and the Northwest and Northeast Passages.

The final chapter deals with the future and it is clear that the Arctic is one of the most fragile ecosystems in our planet, vulnerable to pollution, a thinning ozone layer, and global warming. The potential danger of the release of frozen gas hydrates and methane from permafrost with their capacity to exacerbate global warming needs to be appreciated more widely. The likely rush to exploit the most northerly reserves of oil and gas to fuel a world that refuses to address energy conservation is likely to lead to another 'scramble for the Arctic which will result in a new and far more dangerous cold war'. This book is illustrated by 20 colour photographs and a few black and white illustrations. It is packed with fascinating information on wildlife and is highly recommended to naturalists, students and teachers, as well as to a wider readership.

DHSR

The Buildings of England. **Yorkshire West Riding** by **Peter Leach** and **Nikolaus Pevsner**. Pp. xx + 824, incl. numerous line drawings, plus 64 pages of full colour plates. 2009. Yale University Press, New Haven & London. £29.99 hardback.

Naturalists who spend a significant amount of time in the field usually appreciate their cultural as well as their natural heritage, often working in a wide range of habitats supporting historically and architecturally interesting buildings. For those, like me, whose special interests are attracted to churchyards, a copy of the relevant 'Pevsner' has been an essential item in their field kit; the useful detail contained therein, particularly geological and chronological, is of great importance to environmental interpretation. A revision of the West Yorkshire volume (essentially vice-county 64), the last edition appearing in 1967, is long overdue. For a more balanced view of our heritage, the complementary use of such texts with the usual armoury of field guides is strongly recommended. Remarkable value – a mine of information contained in a reasonably handy volume.

MRDS

Printed in Great Britain by Titus Wilson & Son, Kendal ISSN 0028-0771