

1. Summary of 2002 Report

1.1 The background of the 2002 research programme and a summary of the 1998, 1999, 2000 and 2001 programmes are given.

1.2 The outline programme for 2002 is given.

1.3 A summary of the research and development of suitable habitat management in Somerset is given. This project is being developed in association with local DEFRA officials. New locations for *B. sylvarum* and *B. muscorum* are noted.

1.4 A summary of further researches into the distribution and autecological studies in North Kent and Essex is given. This deals mainly with populations of *B. sylvarum* and *B. humilis* on the Hooe Peninsula and Isle of Sheppey. An excellent example of grassland management which provides good bumblebee habitat is noted. Progress on the possibility of adjusting sea-wall cutting management regimes to provide better forage habitat for bumblebees, without compromising Flood Defence operational requirements, is reported.

1.5 The failure of the planning process to effectively consider BAP bumblebee issues in the Thames corridor area is noted.

1.6 Distributional and autecological studies of *B. humilis*, *B. jonellus*, *B. muscorum*, *B. ruderarius*, *B. soroeensis* and *B. sylvarum* are reported. Considerable information concerned with the ecology of *B. soroeensis* was gained, in particular its association with extensive, late-flowering, grassland habitats; together with information concerning typical forage plants on such grasslands.

1.7 A small inland population of *B. humilis* in Warwickshire is reported.

1.8 Projects to restore bumblebee habitat in Hampshire, Wiltshire and Kent are reported. These have identified the need for further revision of the trial WM2 Pollen and Nectar Mix for Countryside Stewardship, whilst confirming their basic suitability for foraging habitat restoration. The outcome of restoration of suitable established grassland habitat by alteration of grazing regimes is also reported.

1.9 Non-BWG Projects concerned with bumblebees in Wales and Scotland are reported.

1.10 A summary of the progress in research into the autecology of *B. monticola* is given. Investigation of queen foraging behaviour in Scotland and England which supports a link with areas of tall, well-flowering Bilberry growing in open situations is reported.

1.11 Research into the identity, identification and autecology of *B. ruderatus* in the UK has progressed considerably, with specimens agreeing to the description of this species being identified in a number of localities. A project to investigate this species in New Zealand is reported.

1.12 A summary report on progress with developing methods to restore bumblebee habitat in the wider countryside and the responses of bumblebees to these is given. Results from the 2002 programme have resulted in consideration of alterations in the detail of the WM2 Stewardship mix.

1.13 A possible mechanism for the ecological separation of bumblebee species by time of emergence of queens and timing of initial forage abundance is suggested.

1.14 The future of research under the BWG is given and the lack of further financial support for its activities noted.

2. Summary of Previous Reports

1998

2.1 Concern over the modern distribution and population status of British bumblebees led to the inclusion of five species: *Bombus distinguendus*, *B. humilis*, *B. ruderatus*, *B. subterraneus* and *B. sylvarum* in the short and middle lists for the U.K. Biodiversity Action Plan. As these species are all likely to have been affected by similar ecological changes it was decided to investigate these bumblebees as one project, specialising on a particular species as opportunity arose.

2.2 During 1997, searches and preliminary autecological investigations were carried out specifically for *B. distinguendus* in the Outer Hebrides (funded by Scottish Natural Heritage (S.N.H.)) and *B. sylvarum* in England and Wales (funded by English Nature (E.N.) and World Wide Fund for Nature -UK (W.W.F.)). Separate reports have been produced for these studies.

2.3 These searches found a healthy population of *B. distinguendus* still present on the Outer Hebrides, with the species known to be still present post-1990 on several of the Inner Hebridean Isles, and Orkney. No post-1990 records are known from anywhere else in the U.K..

2.4 The searches for *B. sylvarum* located only three populations in 1997: North Kent, Salisbury Plain and South Wales coast. The numbers of individuals found were very low; (single workers (North Kent, Salisbury Plain) or two queens (South Wales)).

2.5 Of the other BAP species, *B. humilis* was found at a number of search sites and in reasonable numbers at many of them; *B. ruderatus* was present at only one site and *B. subterraneus* was not seen at all.

(1998 Report, Section 2, p.1)

2.6 The habitat requirements of bumblebees were outlined. These covered four main components: foraging areas, nesting areas, mating areas, hibernation areas.

2.7 The characteristics of foraging areas include a spring to summer-long presence of sufficient flowers of suitable families to sustain the entire nest at all stages of its development. Flowers of plants of the families Fabaceae and Lamiaceae are identified as particularly important forage resources.

(1998 Report, Section 5.2.1-5.2.2, p.4)

2.8 It was suggested that the decline in bumblebee populations, especially in those with longer tongues, has been directly associated with the intensification of farmland, especially the increasing use of short-term grass-only leys or continuous cereals. Red Clover, *Trifolium pratense*, was identified as being very likely to be of prime importance to bumblebee populations occupying less intensive agricultural systems. The flowers of labiates, typically hedge-bottom plants in less intensive agricultural situations, were also recognised as being important forage components.

(1998 Report, Section 5.2.5-5.2.8, p.6)

2.9 It was noted that nesting areas tended to be associated with areas of taller grassland. Queens of subterranean nesting species (most) utilise old underground nests of small mammals (voles and mice) as the initial nest site, whilst surface-nesting species (sub-genus *Thoracobombus*, includes *humilis*, *muscorum*, *ruderarius*, *sylvarum*) utilise old summer nests of small mammals. (The above/below ground distinction is not complete, as examples of nests just underground have been found for all the above species.) Such small mammals are much more plentiful in taller grassland. The structure of the taller grassland is apparently important, with many surface-nesting bumblebees requiring an open grass structure which allows the sun to warm the top of the nest. Modern agricultural methods have resulted in a large reduction of suitable bumblebee nesting habitat.

(1998 Report, Section 5.3, p.6-8)

2.10 Characteristics of mating and hibernation areas for bumblebees were noted, although there is much less information concerning the possible effects of these habitat components on population sizes.

(1998 Report, Section 5.4, 5.5, p.8)

2.11 The need to restore a matrix of suitable bumblebee habitats within a modern agricultural landscape was discussed. It was suggested that suitable bumblebee habitat operates at the landscape scale. With successful nesting densities probably in the order of a of one nest per square kilometer, the minimum areas involved need to be large in order to support viable populations of bumblebees.

(1998 Report, Section 6, p.9)

2.12 Research during 1998 concerned with the northern bumblebee *Bombus distinguendus* on the Outer Hebrides was noted. Two visits were made to South Uist, one during June and one during July: this visit was extended into August by Lynn Hughes, a Masters Student from University College London.

(1998 Report, Section 7.1-7.6, p.10-11)

2.13 Nest-searching behaviour by queens was studied, with one nest being studied intermittently between mid-June and late-August. Queens were strongly attracted to areas of tussocky grassland, where they entered old mouse and rabbit burrows. However, they were also seen to enter rabbit burrows in very short turf. Three nest sites were identified: all were underground.

(1998 Report, Section 7.8, p.12-14)

2.14 The 1998 research highlighted the importance of extensive forage areas. The flowers of Bird's-foot Trefoil, *Lotus corniculatus*, were most frequently visited by queens in the spring and those of Red Clover and Black Knapweed, *Centaurea nigra*, were most frequently visited later in the year. The data from field observation of foraging workers was supported by the results of pollen sampling from worker loads taken during the 1997 project. Further pollen samples were taken as part of the 1998 project and were submitted for analysis.

(1998 Report, Section 7.9, p.15-18)

2.15. The increasing intensification of machair grazing was highlighted as a major threat to the populations of *Bombus distinguendus*, with fenced summer sheep grazing being particularly damaging. It was noted that a return to older patterns of grazing, with the machair being grazed by cattle in the winter only and rotational strip cropping within the machair, would be highly beneficial.

(1998 Report, Section 7.10, p. 18)

2.16 Searches during 1998 for the southern bumblebee species *Bombus humilis*, *B. ruderatus*, *B. subterraneus* and *B. sylvarum* were reported. These took place in a number of areas: Essex, Kent, Salisbury Plain, Dorset, Somerset, South Wales.

(1998 Report, Section 8, p.19-26)

2.17 The ecology of *Bombus humilis* was reviewed. Foraging habitat was felt to be dependent upon the structure of the grassland (tall and open) as much as the exact composition of the flora, although there were clearly plant species which were favoured. Pollen samples were collected from foragers and submitted for analysis.

(1998 Report, Section 9.2, p.27-29)

2.18 It was noted that *B. humilis* utilised similar nesting habitat as did the related *B. muscorum*, requiring an open, tall grassland with moss present at the base of the grasses. The surface nests of both species are very vulnerable to hay-cutting machinery, especially in levelled fields where the cut is very tight.

2.19 It was noted that *B. humilis* appeared to have a much higher nesting density than the other southern species being studied, although many of these nests were attacked by badgers.

(1998 Report, Section 9.3, p.29-30)

2.20 Populations of *Bombus sylvarum* were confirmed as present at Kenfig/Margam Moors, Newport Levels, Somerset Levels, Salisbury Plain Training Area and the Kent and Essex fringes of the Thames Estuary. Searches of further areas are reported.

(1998 Report, Section 10.3, 10.4, p.31)

2.21 Preliminary investigations into the foraging requirements of *B. sylvarum* suggested that this species utilises a similar range of leguminous plants as the other species studied under this project. Vipers-bugloss, *Echium vulgare*, was noted as an important forage resource but its reliability as an essential component of the floral resources for a population was questioned. The use of Red Bartsia, *Odontites verna*, as a forage plant during August was noted. Pollen samples were collected from foragers and submitted for analysis.

(1998 Report, Section 10.5, p.33-37)

2.22 Nesting and hibernation habitats were noted as being little known.

(1998 Report, Section 10.6, 10.7, p.37)

2.23 The state of knowledge regarding *B. ruderatus* was noted. The question of the taxonomic separation between *B. ruderatus* and *B. hortorum* was raised.

(1998 Report, Section 11, p.38)

2.24 The lack of sightings of *B. subterraneus* was noted.

(1998 Report, Section 12, p.38)

2.25 The role of grazing and hay-meadow management in maintaining bumblebee habitat was explored. It was emphasised that the impact of grazing during the spring and summer was generally negative for bumblebee populations. The impact of winter and autumn grazing was, on the other hand, generally positive for bumblebee populations. It was recommended that bumblebee conservation required the maintenance of rotational grazing systems. Some areas (nesting areas) should not be grazed or cut every year, encouraging the build-up of small mammal populations and hence providing nesting habitat. The majority of the habitat (foraging areas) should be managed so as to maintain a supply of flowers of major forage species throughout the year within a larger area.

2.26 The need for informed conservation action on a landscape scale as the way of achieving the required matrix of habitats over a large enough area was emphasised.

(1998 Report, Section 13, p.39-41)

2.27 The provision of identification training days for site managers and other interested persons was noted.

(1998 Report, Section 14, p.41)

2.28 A programme of future research was suggested. This should cover survey to establish the national distribution of target bumblebees, their autecology and experimental habitat management.

2.29 The need to inform a wider section of the conservation and agricultural community about the requirements of bumblebees was noted.

2.30 The need for further literature searches was highlighted.

2.31 The involvement of the University College London Conservation Masters Course during 1998 was noted.

(1998 Report, Section 15, p.42-44)

1999

2.32 The understanding of general bumblebee habitat requirements remained, in outline, that given in the 1998 Report.

2.33 The suggestion that large potential foraging ranges are required by individual nests was supported by the fact that no small areas supporting bumblebee populations were found.

2.34 Pollen analysis from a wide variety of samples underlined the importance of legumes as pollen sources in the July-August sampling period. A table of the results of pollen analysis carried out during 1998 was given.

2.35 Details of *B. distinguendus* male/queen behaviour on emergence of queens from the natal nest were given.

(1999 Report, Section 5, p.6-15)

2.36 A review of the known distribution and habitat requirements of *B. distinguendus* was given. This confirmed the presence of a population (probably a small one) on the coasts of northern mainland Scotland. This population seemed to be less dependent upon Red Clover than those in the Western Isles.

2.37 A review of the known distribution and habitat requirements of *B. humilis* was given. The probable association of this species with tall, but open, grassland was suggested.

2.38 *B. humilis* was felt to be the least threatened of the BAP bumblebee species.

2.39 The review of *B. sylvarum* listed the presence of this species in just 7 discrete areas in the UK (south Essex, north Kent, Salisbury Plain, Somerset Levels, Newport Levels, Kenfig/Margam, Castle Martin). It was felt, however, that the first two of these should probably be considered as one population.

2.40 The adverse effects of heavy sheep grazing during the summer at Kenfig was noted.

2.41 The importance of the newly discovered population at Castlemartin was noted.

2.41 The continuing taxonomic confusion surrounding the identify of records attributed to *B. ruderatus* was noted.

2.42. The lack of records of *B. subterraneus* during 1999 was noted.

(1999 Report, Section 6, p.16-24)

2.43 More detailed reports from the following individual projects formed the second part of the Report. These covered: *B. distinguendus* in South Uist; *B. distinguendus* in Caithness and Sutherland; *B. distinguendus* on Coll and Tiree; *B. distinguendus* and *B. sylvarum* in South-eastern Ireland; *B. sylvarum* and *B. humilis* in south Essex; *B. sylvarum* and *B. humilis* in Kent; *B. sylvarum* and *B. humilis* on Salisbury Plain; *B. sylvarum* on the Somerset Levels and in South Gloucestershire; *B. sylvarum* and *B. humilis* in Cornwall; *B. sylvarum* and *B. humilis* in South Wales.

2.44 A summary of Claire Carvell's MSc. research on Salisbury Plain was given. This highlighted the need for appropriate grazing management to maintain suitable bumblebee foraging habitat.

(1999 Report, Section 7-18, p.25-74)

2.45 Ongoing liaison between FRCA, The Environment Agency and NGO conservation bodies to progress the BAP for *Bombus* spp. was reported.

(1999 Report, Section 19, p.75)

2.46 Research on developing suitable seed mixes for bumblebee habitat restoration was reported.

(1999 Report, Section 20, p.76)

2.47 Progress with further literature searches was reported.

(1999 Report, Section 21, p.78-79)

2.48 Suggestions for research in 2000 were given.

(1999 Report, Section 22, p.80-81, p.25-74)

2000

2.49 A survey of Northern Ireland by Brian Nelson to establish the continuing presence of *Bombus distinguendus* in Northern Ireland is reported.

(2000 Report, Section 5, p.7)

2.50 Continuing autecological research by Bill Neill on *B. distinguendus* in the Outer Hebrides was reported.

(2000 Report, Section 5, p.7)

2.51 An extensive survey, co-ordinated by John Crossley, of the occurrence of *B. distinguendus* in Orkney was reported. The species is still well established on many parts of the archipelago.

2.52 Survey of suitable localities in northern Scotland for *B. distinguendus* by Murdo Macdonald was reported. Five areas which held the species were reported.

2.53 Further survey of *B. distinguendus* on Coll, undertaken by Emma Grant, was reported.

2.54. The importance of agri-environment based action in Scotland to maintain and restore large areas of suitable habitat for *B. distinguendus* was emphasised.

(2000 Report, Section 5, p.8)

2.55 The extensive project on *B. sylvarum* and *B. humilis* undertaken by Claire Carvell at Castlemartin and Kenfig was reported. This study confirmed the need of bumblebee species for large areas with a continuum of foraging resources throughout the colony life. These resources were similar to those already noted elsewhere, involving plants from the families Fabaceae, Lamiaceae, Scrophulariaceae and Section Carduae of the Asteracea. Claire noted that, unlike most previous study areas, *B. sylvarum* and *B. humilis* were not the least frequently found species in favourable habitat. The habitat at Castlemartin was outstanding, both in its provision of good resources and the extent of the available resource. The finding of a nest of *B. sylvarum* is reported and some studies of worker foraging were carried out by Annie Poole after Claire had finished.

2.56 Further localities for *B. humilis* in Wales were reported, including an inland one, fairly high in the southern hills.

(2000 Report, Section 6, p.10-13)

2.57 Further distributional studies of *B. sylvarum* in Somerset are reported. Robin Williams and Jan Boyd were able to increase the known area occupied by this species to over 10km².

2.58 Changes in the management of parts of Shapwick Heath NNR which have increased the available bumblebee habitat were noted.

(2000 Report, Section 6, p.13)

2.59 The re-discovery of *B. sylvarum* at more localities in northern Kent (Cliffe and Grain) was reported. These had been unsuccessfully surveyed by Paul Williams in 1998 but were areas from where he knew the species in the 1980s. The Murston locality had fewer bees present when visited. This was expected following the loss of a further substantial extent of habitat to development during the winter. The Brick-works management was reported as keen to include management for *B. sylvarum* in its restoration programme for the pits.

2.60 Research in southern Kent was reported. A number of Bumblebee nest boxes were deployed Two of these at Dungeness RSPB Reserve were occupied (one each by *B. muscorum* and *B. humilis*) but both colonies were lost to badgers.

2.61 Due to changes in management at the RSPB Reserve at Dungeness, habitat and bumblebee density survey previously carried out was discontinued and replaced with a new bumblebee timed walk survey and fixed-point photograph schedule. *B. humilis*, *B. muscorum* and *B. ruderarius* were all recorded (just!). The establishment of red-clover following hay-strewing in previously intensive arable fields on the Reserve was reported.

2.62 The clover-rich margins on Scotney Court Farm lost most of their clover cover during 2000. This appeared to be correlated with lack of winter grazing on these margins, as adjacent areas which were grazed maintained their clover interest. *B. humilis* was again recorded on the farm.

2.63 Reduction in grazing pressure on several areas of marshland allowed the flowering of previously unknown clover-rich swards during 2000.

(2000 Report, Section 6, p.13-17)

2.64 An extensive project on the status and foraging requirements of *B. sylvarum* and *B. humilis* in south Essex, undertaken by Peter Harvey, was reported. This report showed the importance to the East Thames Corridor populations of these bees of the newly discovered Canvey Island locality, which is under threat from development. The major foraging resources were, as elsewhere, plants from the families Fabaceae, Lamiaceae, Scrophulariaceae and Section Carduae of the Asteracea.

(2000 Report, Section 6, p.17-18)

2.65 Survey visits to Salisbury Plain were made by a number of different group members, these found *B. sylvarum*, *B. humilis* and *B. ruderarius*. Nest boxes were laid out in Tilshead Park and at Parsonage Down NNR, but none were utilised.

2.66 The ongoing monitoring (by George Else) at the Cholderton Estate, where extensive areas of bumblebee forage have been established, was reported. Although *B. humilis* had been found in 1999, it was not seen during 2000, possibly because of the loss of the tall grass habitat on the farm.

(2000 Report, Section 6, p.18)

2.67 Observations of *B. sylvarum* in Lozère, France, by Stuart Roberts were reported. This bumblebee was widespread and abundant in the region. The habitat features reported are very similar to those which have been identified as making good quality habitat in the UK, i.e. large areas of suitable forage plants with an extended flowering season as a result of rotational grazing of the grasslands.

(2000 Report, Section 6, p.19-21)

2.68. Other surveys for target bumblebees were reported, these mostly concern *B. monticola* in the Peak District of England. Pollen taken from foraging workers during mid-summer again highlighted the importance of plants from the family Fabaceae although Raspberry and Cross-leaved Heath pollens were also frequent.

(2000 Report, Section 7, p.21-22)

2.69 The problem of recognising *B. ruderatus* in the field was also tackled. Independent, detailed studies by Paul Williams and Paul Westrich failed to provide any consistent field characters to separate this species from *B. hortorum* and, in the absence of reliable characters it was recommended that it would not be possible to progress the BAP for this species any further.

(2000 Report, Section 8, p.22)

2.70 The construction and setting out of nest boxes was discussed and the making of protective cages to foil badgers suggested.

(2000 Report, Section 9, p.22-23)

2.71 The ongoing identification of pollen taken from foraging workers was reported. Murdo Macdonald undertook a preliminary analysis of the results from this. He concluded that these confirm the strong preferences for plants from the families Fabaceae, Lamiaceae, Scrophulariaceae and Section Carduae of the Asteracea which had been noted from field observation of bumblebee foraging behaviour. He noted that samples taken from individual nests would be particularly valuable, if these could be found.

2.72 The problems of studying bumblebee populations without referring to pollen preferences were discussed.

(2000 Report, Section 10, p.23-24)

2.73 The problems of restoring foraging habitat are discussed, the start of research on this topic and progress on informing agri-environment schemes of the need for such restoration is noted.

(2000 Report, Section 11, p.24-25)

2.74 Projects to raise awareness of the need for bumblebee conservation, including the preparation of a general leaflet are noted.

(2000 Report, Section 12, p.25)

2.75 Suggested directions for research in 2001 are made.

(2000 Report, Section 13, p.25)

2001

2.76 Autecological research in southern Germany is reported. This indicates that similar pressures, especially the decline in the extent of suitable habitat, are resulting in similar declines of both *B. humilis* and *B. sylvarum*, with *B. sylvarum* showing the greatest decline.

(2001 Report, Section 4, p.9)

2.77 Both species show clear preferences for habitats with a large proportion of red clover, which is a typical component of unimproved mesotrophic meadows in the area. Areas with a large proportion of suitable habitat matrix needed to be extensive in order to support these species.

(2001 Report, Section 4, p.9)

2.78 Changes in land ownership, especially the demise of small family orchard/meadow holdings, were happening rapidly. Intensification and increasing specialisation of farming was leading to the large-scale loss of suitable bumblebee habitat. This was particularly so in the change from hay to silage production.

(2001 Report, Section 4, p.10)

2.79 We were able to find just one queen of *B. subterraneus*. This was in an area which was unlikely to support this species for much longer.

(2001 Report, Section 4, p.10)

2.80 Although White Dead-nettle *Lamium album* was plentiful at the edges of the most intensively farmed areas, Bush Vetch *Vicia sativa* was preferred as a forage plant if it was available. White Dead-nettle was not a typical component of the unimproved grasslands, whereas Bush Vetch was.

(2001 Report, Section 4, p.11)

2.81 The species which are still fairly frequently found in the UK were clearly associated with woodland clearings and gardens, whilst *B. sylvarum* and *B. humilis* were associated with the open grasslands.

(2001 Report, Section 4, p.11-13)

2.82 Bumblebees were strongly associated with extensive areas of rotationally grazed, or cut, flower-rich grasslands. Extensive areas which were cut all at one time, or which were frequently grazed, supported few, or no, *B. sylvarum* or *B. humilis*.

(2001 Report, Section 4, p.13)

2.83 Further survey of *B. sylvarum* on the Somerset levels is reported. This shows the species to be very widely dispersed, but at low density, in this area.

(2001 Report, Section 5, p.16)

2.84 Further distributional studies in Kent were reported. Studies in northern Kent could not be undertaken due to Foot and Mouth Restrictions, so all work was carried out in the south-eastern corner of the county.

(2001 Report, Section 6, p.16)

2.85 *B. humilis* was searched for again at Dover (a third search), but only *B. ruderarius* was found. A record of *B. humilis* had been reported from slightly west of the surveyed area in 2000 so it may be present at very low density in the area, which has quite an extensive network of chalk grassland valleys.

(2001 Report, Section 6, p.16)

2.86 A survey of the Deal-Sandwich coastal dune system was undertaken in the hope of finding *B. humilis*. This species was not found, but *B. muscorum* and *B. ruderarius* were found to be present.

(2001 Report, Section 6, p.16)

2.87 A record of *B. humilis* from some 10km south of the north Kent coastline was reported.

(2001 Report, Section 6, p.16)

2.88 A nest was also discovered well inland on Romney Marsh in a fairly small area of tall grassland.

(2001 Report, Section 6, p.18)

2.89 Research concerning foraging by *B. monticola* during the Spring was also affected by Foot and Mouth, but it was possible to undertake some research on foraging and distribution during the mid summer on Exmoor, Dartmoor and the Peak District. This work supported earlier suggestions that there is a link with areas with abundant tall bilberry and Bird's-foot Trefoil or White Clover. It also supports the concern about the decline of this species, both in England and Scotland.

(2001 Report, Section 7, p.18)

2.90 Extensive research concerned with *B. sylvarum* and *B. humilis* at Canver Island was reported in summary. This research raised concerns about situations where bumblebee populations are dependent upon one major pollen and nectar resource which may fail. This underlined the need for a wider, more dispersed population as well as a local, (usually) highly productive, locality.

(2001 Report, Section 8, p.18-19)

2.91 New, modern, locations for *B. distinguendus* and *B. humilis* were reported, as well as very interesting historical, northerly records for *B. humilis* and *B. sylvarum*.

(2001 Report, Section 9, p.19)

2.92 Bumblebee nest boxes were tried in several locations, without success.

(2001 Report, Section 10, p.19)

2.93 Progress on the experimental restoration of bumblebee forage habitat is reported. The outcome of the trial at Old Romney was strongly positive in terms of the numbers of bumblebees present on the flowers after two years. It was clear that the agricultural legume mix has a limited life span.

(2001 Report, Section 11, p.20-22)

2.94 The establishment of small-scale management trials using agricultural legume mixes on Romney Marsh was reported.

(2001 Report, Section 11, p.22-23)

2.95 The ongoing improvement in available bumblebee habitat at RSPB Dungeness and the management associated with this was reported.

(2001 Report, Section 11, p.23-28)

2.96 A number of meetings concerned with liaison between BWG and statutory and non-governmental conservation bodies were reported. A common theme of these meetings was the lack of availability of pasture-type red clover for grassland habitat restoration.

(2001 Report, Section 12, p.28-29)

2.97 The production of a leaflet publicising bumblebee conservation to farmers and landowners was noted.

(2001 Report, Section 12, p.29)

2.98 A summary of the accumulated pollen analysis data from three species of bumblebees, *B. distinguendus*, *B. humilis* and *B. sylvarum*, was presented. This highlighted the limited numbers of plant families which provide suitable forage and emphasised the disproportionate importance of legume flowers.

(2001 Report, Section 13, p.29-30)

2.99 A preliminary analysis of the continuing decline in populations of target bumblebees was presented for *B. subterraneus*, *B. distinguendus*, *B. humilis* and *B. sylvarum*.

(2001 Report, Section 14, p.30-31)

2.100 Sugestions for future research were made.

(2001 Report, Section 15, p.31-32)

3. Outline of the 2002 Programme

3.1 Research in Somerset concentrating on developing contacts with a view towards habitat restoration projects on the Somerset Levels.

3.2 Further distributional studies in North Kent to be carried out. These to be followed up by approaches to land-owners and managers to further habitat restoration as appropriate.

3.3 The research on *B. sylvarum* and *B. humilis* in southern Essex to be continued (not a BWG project, but in full consultation with BWG).

3.6 A further inland population of *B. humilis* to be investigated in Warwickshire.

3.7 To continue research into restoring bumblebee habitat and monitoring the effects of this at Cholderton, Hants; Parsonage Down, Wilts and Romney Marsh/Dungeness, Kent.

3.8 To maintain monitoring of *B. sylvarum* (Wales) and *B. distinguendus* (Scotland) (not BWG projects, but liaison with BWG is to be maintained)

3.8 To carry out further survey and autecological research into *B. monticola* in England and Scotland (this last not as a BWG project, but in full consultation with BWG).

3.9 To explore further the identity of *B. ruderatus*. In particular, to look for it near Peterborough.

3.11 Liaison with relevant conservation bodies, especially Agri-environment staff and land-owners, to be continued.

3.12 Further pollen samples to be collected and sent to Paul Westrich for analysis. The 2001 sample results to be added to the database.

4. Research and Development of Suitable Habitat Management in Somerset.

4.1 This project has been ably undertaken by Janet Boyd. Jan has written a full report of her work on the Somerset Levels this year and this should be consulted for detail.

4.2 Following the very successful mapping of the distribution of *B. sylvarum* on the Somerset Levels during the previous three years it was decided to develop the focus for work in this area towards enhancement of the population through appropriate habitat restoration.

4.3 This phase of the project was launched at a meeting of BWG representatives, local farmers and conservation organisations held on 8th January at Catcott in Somerset. The purpose of the meeting was to explain the requirements of bumblebee habitat restoration to local landowners and introduce Janet Boyd, who had agreed to be the BWG representative in the area, to the attendees. There was considerable interest from all in the ideas which were put forward and Jan was able to make a number of contacts for her work during the rest of the year. Our thanks to EN Somerset Team for organising this meeting.

4.4 At the beginning of December 2002 we heard that Emorsgate Seeds would be able to offer a small quantity of wild-type red clover for projects in 2003. This is very welcome news as much of The Levels area is established grassland which would be improved as bumblebee habitat by an increase in wild-type bumblebee forage plants, rather than arable land for which agricultural legume mixes are more appropriate. This information came too late to be incorporated in Jan's report, but she will be actively pursuing this option for habitat restoration over the coming winter.

4.5 As a result of her work the case for bumblebee habitat restoration has been taken seriously at a number of locations. These include:

- a) RSPB Ham Wall and Walton Heath Reserves, both within a core area for *B. sylvarum* on the Levels.
- b) Individual land owners and managers within core areas for *B. sylvarum* on the Levels.
- c) Wyvern Waste landfill site near Pawlett.
- d) Current and future peat extraction sites where restoration after extraction may offer opportunity for suitable habitat creation.

4.6 Jan and DEFRA officials Gill Swash and Richard Penny have produced a leaflet explaining the situation and possible habitat restoration approaches for the Somerset Levels. It also asks for help from people with suitable seed source material. This leaflet will be circulated with ESA papers during 2003. Our thanks to Steve Falk for providing an excellent line drawing for this leaflet.

4.7 Further records for *B. sylvarum* and *B. muscorum* were made. Maps showing these locations are included in the report.

5. Distributional and Ecological Studies in North Kent and Essex.

5.1 Almost all work in North Kent had to be halted during 2001 because of the Foot and Mouth outbreak. Surveys on The Isle of Sheppey, at Murston and on the Hoo Peninsula (Cliffe Pools) were completed in 2003.

5.2 These surveys confirmed the continuing presence of *B. sylvarum* on the Hoo Peninsula and gave an idea of the size of the population at Cliffe Pools RSPB Reserve. They confirmed the species' continued presence at Murston, Lower Swale NR (Kent Wildlife Trust) and the Elmley area of Sheppey, giving a much better idea of the size of the population in the Elmley area (which is narrowly separated from Murston by The Swale).

5.3 Stuart Roberts and I visited Cliffe at the request of the RSPB warden, Michael Ellis, on 2nd August. Michael had seen workers of *B. sylvarum* and was interested in any management advice which we could provide. We were delighted to find large numbers of both *B. sylvarum* and *B. humilis* on the dryer parts of old silt lagoon which forms much of the Reserve. These workers were mainly to be found on Narrow-leaved Bird's-foot Trefoil *Lotus glaber* flowers (photo 1), but were also found on those of the much less frequent Red *Trifolium pratense* and White Clovers *T. repens*, as well as at considerable stands of the Melilots *Melilotus alba* and *M. altissimus*. Pollen samples were taken from some of the workers of both species. An interesting record was that of a worker *B. jonellus*, showing once again that this species is not restricted to heathland and moorland sites.

5.4 Geoff Allen and I returned to Cliff on 18th September, mainly to look for the salt-marsh specialist bee *Colletes hallophilus*, but we were amazed at the numbers of *B. sylvarum* males (estimated at over 100 in an hour) which were patrolling along a narrow line of reeds fringing a ditch (photo 2), as well as visiting Sea Aster *Aster tripolium* and a yellow crucifer, probably *Sisymbrium altissimum*, flowers. A queen of *B. sylvarum* had been seen in this area two years earlier, but it was not clear at the time how important this area is for the species, nor the fact that it is one of the few North Kent sites to support *B. humilis*.

5.5 This habitat, with large stands of Narrow-leaved Bird's-foot Trefoil, was very similar to that identified by Peter Harvey as being very important at Canvey Island. Indeed, this site can be seen from Cliffe, reinforcing the consideration of the South Essex and North Kent areas as being occupied by one Thames Corridor population of each species.

5.6 Management of the site was discussed with Michael, who was considering grazing as a management option. Overall, we felt that a management programme which aimed to increase the diversity of forage plants, without significantly reducing the established valuable forage should be pursued.

5.7 We felt that a careful regime of winter cattle grazing would be very unlikely to damage the bumblebee interest, and would probably increase the representation of clovers on the site, especially where dense mats of sea-couch were establishing. However, we were not happy with the idea of summer grazing, but would prefer to see experimental intermittent disturbance management with the aim of maintaining the Narrow-leaved Bird's-foot Trefoil interest on the drier parts. This disturbance cycle would also suit other aculeate species associated with the dry grasslands. Peter has shown these to be of very high conservation value on the Essex side and it is likely that the Cliffe site will prove to have a similar high value assemblage, as well as the bumblebees.

5.8 We then turned our attention to The Isle of Sheppey (3-4/8/2002), where we had found a few workers of *B. sylvarum* during 2000 at the Elmley Trust/RSPB Reserve area. The plan was to determine the extent of the species on this side of The Swale and to quantify the habitat which supports target bumblebee species. I had made an earlier reconnaissance visit to potential sites at the eastern end (Swale NNR) with David Rogers of EN (7/5/2002).

5.9 Our first target was the RSPB Reserve area (3/8/2002). The weather during this visit was not particularly good, with a violent thunderstorm interrupting survey in the early afternoon, but we were able to resume survey by mid-afternoon. Parts of the sea wall had been uncut for several years, yearly growth being removed by winter grazing, although this had not always been possible on a strictly yearly rotation. This uncut area of sea wall had good sections of Narrow-leaved Bird's-foot Trefoil present, but these were



Photo 1 (left). RSPB Cliffe. Large areas of flowering Narrow-leaved Bird's-foot Trefoil were associated with previous disturbance. These flowers were the main ones being visited by *B. sylvarum* and *B. humilis* workers during early August.

Photo 2 (below). By mid September there were many males of *B. sylvarum* present. Most of these were patrolling along this line of reed beside a ditch.



Photo 3. RSPB Elmley. Temporarily restricting access for grazing animals to the left of the wire had produced a more flowery and bumblebee-friendly habitat.

not extensive, neither were there large areas of clovers. We felt that there was a need for further investigation of the management needs of this area if it was to realise its full potential as bumblebee forage habitat. (See section 5-22/3 for further discussion of this in the context of the Lower Swale NR). The weather conditions were against finding many bumblebees at the time we were looking at this area, but several workers of *B. muscorum* were recorded here, despite the weather.

5.10 Most of the Reserve area was still fairly heavily grazed at the time of our visit. This grazing level was sufficient to suppress the flowering of most of the legumes which we could find as rosettes in the sward. One area in the eastern section of the Reserve had plentiful flowering Bird's-foot Trefoil, *Lotus corniculatus*, and several workers of *Bombus muscorum* were found here and at two areas of Black Hoarhound *Ballota nigra* nearby. There was no sign however of *B. sylvarum*. Completely unexpected, however, was Stuart's discovery of a worker of what I have, this year, come to regard as typical *B. ruderatus* (see Section 12), which was foraging at one of the areas of Black Hoarhound.

5.11 Whilst the weather was unsuitable for survey, Barry O'Dowd of the RSPB staff kindly took us round the Reserve in an RSPB vehicle. It was clear that, whenever the grazing pressure was reduced, a suitable forage flora was present over all the Reserve area. In one place Barry had set up electric fencing to keep the animals away from the flowers (photo 3). The results of this were very encouraging and he felt that, as a short-term measure, this action would probably not have any effect on the overall suitability of the area for waders later in the year. He agreed to investigate the possibility of similar corridors elsewhere on the Reserve. We felt that this was a very encouraging outcome of the visit.

5.11 However, Barry had not finished with us. In view of the sighting of several *B. sylvarum* workers in the garden of the Reserve Office during 2001, he suggested that he accompany us onto an adjacent area owned and managed by The Elmley Trust which he thought might provide good habitat. This suited us well, as we had already earmarked the Elmley Trust Land for further investigation and had obtained access permission from the owner, Mr. Philip Merricks.

5.12 On stopping at the end of the trackway to the old jetty at Elmley Hills we looked over a stand of Black Hoarhound and immediately saw a worker *B. sylvarum*. Spurred on by this, we investigated the Jetty area fairly thoroughly, but, although we found potential forage plants, most of the area was heavily grazed by rabbits. We did find males of *B. ruderarius*, but no *B. muscorum* and no further *B. sylvarum*. Clearly our first worker had come from elsewhere.

5.13 Barry suggested looking at the fields on Elmley Hills, which overlook Murston. He knew this area as being largely ungrazed during the summer, with a mesotrophic meadow flora, but had not really considered looking for bumblebees here. As we walked over the fields we were quickly presented with *B. muscorum* workers foraging at Spiny Rest Harrow *Ononis spinosa*. Our search was then further rewarded with several workers of *B. sylvarum* foraging at Red Clover. We quartered the hillside and found that, even this late in the evening (about 6.00 p.m.), a considerable number of workers of both *B. sylvarum* and *B. muscorum* were working the red clover which was scattered throughout the field, although, due to the fairly tussocky nature of the grassland, the plants were not always easy to see from a distance (photos 4, 5).

5.14 We were not able to investigate the entire area which Barry thought was under this management regime, with low-density and rotational grazing, but it clearly is a very suitable one for these two bumblebee species and provides a good model for bumblebee management elsewhere on similar areas. It is intended to ask Mr. Merrick's Farm Manager whether he can inform BWG about his management policy for this area.

5.15 Encouraged by this success we set off the next day to look at the eastern end of Sheppey. Our first stop was at a patch of Common Mallow *Malva sylvestris* growing alongside the road at Muswell Manor on the way to Shellness NNR. Here we found males of *B. ruderarius* and a worker *B. muscorum*.

5.16 Unfortunately that was to be the highlight of a day which otherwise was a great disappointment. On arrival at Shellness we found that the sea wall had been completely mown and there was very little suitable forage in the rank grassland of the berm. The large areas of set-aside/arable reversion pointed out to me by David Rogers on my earlier visit had all been hay-cut, some were being grazed and there was very little sign of suitable forage on the longer-established margins of the fields which I walked (photo 6).



Photo 4, 5. Elmley Hills, Elmley Trust. This taller grassland (left) at first sight did not appear to be very interesting for bumblebees. However, once closer to it we could see that it was full of Red Clover (below) which had many workers of *B. sylvarum* and *B. muscorum* foraging at it.



Photo 6. In contrast, these fields near Shellness were every bit as poor as they first appeared, with very little in the way of forage plants being present.



Photo 7. At first, these piles of old beetroot and oranges mystified us.

Photos 8, 9. But when we arrived at the western end of The Swale NNR (right) all was revealed—the old food was being used to feed a herd of cattle (below). In our opinion this practice was doing enormous damage to the grassland habitat. This held the same plant species as the brickearth fields at Elmley Hills and, with better use, could make another very valuable bumblebee habitat.



5.17 We decided not to walk all the way along the sea wall of the NNR, but to try gaining access from a footpath at the western end. On our way we saw a peculiarly coloured pile of something which turned out to be oranges and beetroot, clearly condemned food (photo 7). Wondering what this could all be about, this being an unlikely place to dump condemned food, we walked onto the Reserve. Then, sadly, all was revealed (photo 8). The food was being used to feed a herd of cattle, ostensibly being used to graze the Reserve, but in fact the Reserve was being used as a piece of hard standing to feed cattle! The colour of the dung (photo 9) confirmed the evidence of the trail of old beetroot into the Reserve.

5.18. The grassland was very hard grazed and the cattle were actively breaking out into fenced off areas of salt-marsh, there was so little forage left for them. Consequently there was also very little bumblebee forage, although the flora of this brick-earth hill was, from the rosettes, very similar to that of the very good fields at Elmley Hills. *B. sylvarum* was later confirmed as present at the old Harty Ferry point on the Sittingbourne side (part of Lower Swale NR) and was known to have been present at Nagden in 2000, so this area was well within utilisation range by this species.

5.19 We felt that the situation we had witnessed at Swale NNR was not suitable for Nature Reserve management under any circumstances and have reported this fact to English Nature in the hope that some constructive management outcome will be forthcoming. In this context we understand that Philip Merricks is to take over practical management of this Reserve. If this is so, he already provides an excellent example of the sort of management which produces high quality bumblebee habitat (and, we assume, must provide good bird habitat) at Elmley Hills and we hope that he will be able to establish a similar regime on the Swale NNR.

5.20 Likewise, we would like to explore the possibility of using the fields behind Shellness in a more bumblebee-positive way if this is possible under the arable reversion scheme.

5.21 I visited Lower Swale NR in the company of Tony Swandale, the Kent Trust Warden on 6/8/2002. Unfortunately the weather was even less settled than at the weekend and we saw very little evidence of bumblebees. Tony was, however, able to show me further examples of similar habitat to that at Elmley Hills. Although it was rather more grazed than I would have liked for bumblebees there is a definite possibility of a respectable amount of low-density bumblebee habitat on the grazed part of the Reserve.

5.22 The sea-wall was another story however. When I had first visited this area with Paul Williams in 1998 the sea-wall had just been re-topped and was devoid of any bumblebee forage at all. Now the berm in this area had large areas of Narrow-leaved Bird's-foot Trefoil, with some Red Clover, and there had been good stands of Sea Clover *Trifolium squamosum* earlier in the year (photo 10). All these plants had become established in the wake of the disturbance of the re-building of the sea-wall and this may suggest one way in which suitable forage plants may be encouraged - by intermittent disturbance of the berm.



Photo 10. A combination of the effects of disturbance and rotational grazing management of the berm of sections of the Lower Swale NR has produced some excellent foraging habitat, with plenty of suitable legumes of several species present. The 1999 Nagden site is to the left under the pylons in the background.

5.23 Parts of the sea wall within the Reserve are also grazed on a rotational system and this will also help to maintain suitable habitat. Whatever management, or combination of managements is decided upon to keep the sea-wall grasslands short: cutting, grazing or disturbance, it is important that areas of standing flowers are left throughout the flight season of the bees from May to September. (See 5.28 below on joint project with the Area Environment Agency Flood Defence Team and EA ecologists)

5.24 I was able to re-visit Lower Swale in better conditions with Bryan Pinchen on 13/8/2002. This time we found a *B. sylvarum* worker at the Narrow-leaved Bird's-foot Trefoil very quickly, establishing the continued presence of this species since the record by Richard Moyle in 2001.

5.25 Stodmarsh NNR is within a large area of eastern Kent which has, albeit tenuous, connections with areas known to support *B. sylvarum*, *B. muscorum*, *B. ruderarius* and *B. humilis*. It was felt important to check this area in case any of these species were present. On 13/8/2002 Bryan Pinchen and I, with the help of local EN staff, looked at two areas of the Reserve, the eastern end by Grove Ferry and the dry grasslands which have developed on the old coal-spoil tip at Stodmarsh itself. Neither of these areas produced records of any target bumblebee species. The eastern end was, as so often is the case where wading birds are the focus, far too heavily grazed to be very promising, although one morning's visit is not really sufficient to write the area off. The old coal-spoil heap had a promising feel about it for other insects associated with hot, dry sparse grasslands and further survey for these would be well worth carrying out, but no evidence of significant bumblebee interest was found.

5.26 Murston Brickworks were visited on two occasions during 2002. The programme of rotational scraping of dug-over areas under the ash-reclamation project is well established and producing results. Andrew Grimshaw, the plant manager, has also arranged for other areas of rank grassland to be included in a programme of intermittent scraping. The first of these areas is now re-vegetating, with a good establishment of red clover. Although the conservation work is being carried out in a very suitable way the production of a management plan for this area is still outstanding and needs doing in order to formalise the agreement. The conservation commitment of The Brick Business and their staff on this site is very commendable.

5.27 The second visit to the site was as part of a bumblebee identification and ecology training day organised by Richard Moyle of the Kent Wildlife Trust held on 7/8/2002. This was based in Murston and attended by a variety of conservation bodies and local government officials. This was a very successful event. Not only were we able to show attendees both *B. muscorum* and *B. sylvarum* at Murston, together with the management regime, but we also made significant contact with engineers from the Environment Agency Flood Defence Team and EA Ecologists. Our thanks to Roselle Chapman for her input to the day.

5.28 The contact with the Environment Agency Flood Defence Team resulted in a further meeting. At this it was agreed that the engineers responsible for the sea wall would identify sections on which the cutting regime could be altered so that these were not cut completely during July, leaving areas of forage for bumblebees at about one Km. intervals. These areas are now being identified and Paula Wadsworth, EA Ecologist, and I are looking at a representative sample during the winter, with view to undertaking monitoring of their use by bumblebees during 2004. Before the areas are finally agreed there will be consultation with EN (Kent Office) and RSPB (Southern Region) to make sure that there are no serious conflicts of interest between different conservation projects.

6. Comment on the Failure of the Planning Process to Effectively Consider Biodiversity Issues in the Thames Corridor Area.

6.1 It was noted that none of the proposed bumblebee mitigation management has taken place over a three year period on the much larger area of the Murston site on which planning permission was granted, with mitigation being one of the conditions. This area is not the responsibility of The Brick Business (formerly Chelwood Brick), but was sold off directly by Blue Circle, which at one time owned most of the area. The upshot of this development is that what had formerly been a large area with a good number of nests of *B. sylvarum* has been effectively lost during the period of the Biodiversity Action Plan - not a very good advert for the long-term effectiveness of the Plan!

6.2 Peter Harvey has been continuing with his research into the utilisation of Northwick, Canvey Island by *B. sylvarum* and *B. humilis*. This research was commissioned by the agencies involved in the Thames Gateway Development Project in order to provide information for proposed mitigation in the eventuality of development of part of the site. We were amazed to hear that Planning Permission had been granted for the most important area of the site before any report of Peter's research had been presented, let alone the importance of the site for the conservation of its bumblebee populations considered, or the local Office of English Nature consulted. Once again this gives very little confidence in the ability of the Biodiversity Action Plan to deliver in the face of commercial interests. This is especially so as the site is overseen by a quasi-governmental body.

6.3 In the current round of reporting back to JNCC/DEFRA infrastructure development has been returned as a high priority constraint on delivery of the Biodiversity Action Plan for both *B. sylvarum* and *B. humilis* on the basis of these experiences.

7. Distributional and Autecological Studies of *B. humilis*, *B. jonellus*, *B. muscorum*, *B. ruderarius*, *B. soroensis* and *B. sylvarum* on Salisbury Plain.

7.1 During 2002 several BWG surveyors were involved in a survey of Salisbury Plain for Defence Estates. Under this project nine, one kilometre square, sample sites were visited once a month between late April and late August. The target insects recorded on these visits included bumblebees. All species seen were recorded. Here the results for *B. humilis*, *B. jonellus*, *B. muscorum*, *B. ruderarius*, *B. soroensis* and *B. sylvarum* are discussed in the light of their ecology. The full Report for this project, Edwards et al., *An Insect Survey of Selected Sites Within ATE Salisbury Plain*, 2002, DE/Entec UK, should be consulted for further distributional data.

7.2 Sampling throughout the project was severely hampered by the weather conditions of 2002, with short warm, dry periods interspersed with longer cold, wet ones until August. This fact goes some way to explaining the low overall numbers of insects recorded, although comparisons between species have validity as they were all subject to the same influences.

7.3 *Bombus humilis* was found in all nine sample sites, although in low numbers and not very reliably at most sites, showing the influence of the weather conditions.

7.4 *Bombus jonellus* was found in three out of nine sites. Data is included here to support our growing conviction that, whilst this species undoubtedly does well in heathland situations, it is by no means restricted to them.

7.5 *Bombus muscorum* was found much less frequently than *B. humilis*, being confirmed (mostly by microscopic examination of dead specimens) from four out of nine sites. This agrees with our previous conclusion of the two species having similar ecological requirements, with both being associated with tall-grass habitats, but with *B. humilis* having the general ecological advantage on Salisbury Plain.

7.6 *B. ruderarius* was found in four out of nine sample sites. It was mostly met with as queens during the April visit. This carder-bee species emerges from hibernation a little earlier than *B. humilis* and *B. sylvarum* and completes colony growth similarly earlier. Hence the species was only flying during the less favourable early and mid periods of the survey and may well have been missed from some of the locations. It is, however, possible that the conditions on Salisbury Plain suit it less well than they suit *B. humilis* (cf. the situation in southern Germany reported in the 2000 Report, Section 4.15)

7.7 The situation with *B. soroensis* was very interesting. We have gradually become aware that this species is widespread and often common on Salisbury Plain, with workers being easily miss-identified for *B. lucorum/terrestris* workers at first glance. It is a very late emerging species, with queens (looking like rather small *B. lucorum* queens) flying in June or even July and males maturing in September. It was recorded on eight out of nine sample sites. As time progressed we became more and more confident with identifying this species on the wing and it is suspected that it was just overlooked at the missing site.

7.8 Identification of *B. soroensis* in the field is best carried out by checking the extent and colour of the first abdominal yellow band. This band is of a clear lemon yellow colour and usually extends from the second abdominal tergite well up onto the first (photo 11). *B. lucorum/terrestris* do not have this extension of yellow from tergite two to tergite one. The 'break' in this band, whilst often present as a narrow band of black hairs in specimens under a microscope, is not a good field character. There is often a variable band of pinky-orange hairs at the base of the final white tail band. Sometimes this band spreads over almost the entire tail, especially so in males. The structural characters associated with the mandible are virtually impossible to use in live specimens.

7.9 Workers of *B. soroensis* were usually found foraging at Ribbed Melilot *Melilotus officinalis* during July and August, but were also found frequently associated with Devil's-bit *Succisa pratensis* and Clustered Bellflower *Campanula glomerata* in the latter month. A number of pollen samples collected from these bees have been included in the 2002 samples sent to Paul Westrich.

7.10 An additional visit to Salisbury Plain was made with Ted Benton and Christine Mueller on September 7th. On this occasion at least three queens were seen which were investigating grass tussocks, we presume in order to find hibernation sites.



Photo 11. *Bombus soroensis* worker foraging at Devil's-bit. Note the extension of the first abdominal yellow band from the second tergite onto the sides of the first and the narrow pinky-orange band at the base of the white tail band.

7.12 *Bombus sylvarum* was only met with on isolated occasions and never more than one or two individuals. Altogether, it was found in three out of nine sample sites and only found on two occasions in one sample site. The low numbers/density of this species was rather surprising as the forage plants in many of the areas we were sampling were in very good overall condition for bumblebees, largely as a result of the rotational grazing management encouraged by DE over the past five years.

8. The Confirmation of a Small Inland Population of *B. humilis* in Warwickshire.

8.1 Whilst collating data for *B. humilis* under the BWARS mapping programme during 2001 I was informed by Steven Falk of a small population of this species which was surviving in Warwickshire. This population was based on flower-rich, dry grasslands associated with a series of Lias Clay pits owned by Cement Manufacturers. Steve had seen *B. humilis* at these sites several times in the past ten years and I was very keen to see these for myself.

8.2 I visited the area with Steve on 11/7/2002. At the first quarry we looked in at Southam we were able to find several workers of *B. humilis* (photo 12). Although we looked at several nearby potential habitats, these were the only representatives of the species which we found. This population must be in a highly critical state and it is important to find out the its current extent so that appropriate habitat restoration can be set in place. Such restoration should aim to establish an area of at least 10km² of suitable habitat matrix.



Photo 12. This dry, tall, flower-rich grassland had developed on the old workings of Southam Quarry, Warwickshire. We found several workers of *B. humilis* here during 2002.

9. Research into, and Monitoring of, Restoration of Bumblebee Habitat, Hampshire, Wiltshire and Kent.

9.1 George Else continued his monitoring of Bumblebees on Cholderton Farm, Hampshire and has submitted a Report for 2002 to BWG. Only one area of the farm, the restored grassland of Hills Copse, was monitored this year, a reduced monitoring programme compared with previous years. Visits were made on 17/7/2002 and 8/8/2002. It was also the last year of monitoring under the current project, as we have come to the end of funding.

9.2 George reports that, in common with many other areas, fewer bumblebees were seen at Cholderton than in previous years, and that these did not include *B. soroeensis* (although this may have been because this species was very late to build up numbers in 2002). *B. ruderarius* was present however.

9.3 During the three years of monitoring *B. humilis* has only been recorded as an odd male and *B. sylvarum* has never been recorded. George feels that the grassland does not get long enough to encourage *B. humilis* to nest here.

9.4 The monitoring of this experimental area of restoration has shown that establishing grassland on ex-arable land and enriching it with locally collected flower seed does produce valuable bumblebee habitat, although the exact species utilising such habitat will depend upon both their local abundance and the management regime which is used to maintain the habitat. Over the monitoring period of three years good numbers of the recorded species have often been present, this has included several nests of *B. ruderarius*.

9.5 The field sown with Red Clover seed at Parsonage Down NNR was checked for this plant during April 2002 (two years after sowing). Several plants of this species were found for the first time. It is now two years since sowing the Clover, Scabious and Knapweed. The results of this very basic trial suggest these plants will not establish readily in intensively managed grassland. The trial was an early attempt to discover something about Red Clover establishment in particular, this plant not having been considered desirable in previous botanically-biased restoration attempts. Events have rather overtaken the trial, with the subsequent involvement of CEH, DEFRA and the Farmed Environment Company in the establishment of bumblebee habitat within farmland. Our thanks to Roger Marris and his staff at Parsonage Down for their co-operation in this trial which must come to an end as we are now out of funding.

9.6 The Romney Marsh trials on establishment of suitable bumblebee forage habitat on arable margins were monitored during 2002. These continue to provide excellent information for this type of restoration and the usefulness of agricultural legume mixes in it.

9.7 The establishment trial strips have now completed their first full year of growth and have been excellently managed by the farmer, Simon Ashworth, who has impeccably maintained a complicated cutting management regime on small areas along the margins of his fields (photo 13).



Photo 13. The establishment management trial strips at Scotney Court Farm started to provide valuable information on management of agricultural legume margins and a comparison with natural regeneration and sowing a harvested wild-flower mix.

9.8 The next year of the trial requires that all the strips are managed in the same way in accordance with Countryside Stewardship guidelines. This will mean that any bumblebees which are using the strips may need to be able to forage elsewhere during the cutting period, as this may remove all forage. The trial is looking at the establishment and longevity of the plants and is not concerned with the use of plants by bumblebees. It is possible, however, that we will ask Simon to operate a partial cut system, where only half the strip is cut in the summer. This will need to be decided early in 2003 in consultation with DEFRA ecologists. Our thanks to Simon for his willing co-operation and allowing us to use part of his farm.

9.9 The development of the plant composition of the strips has been monitored by Tim Gardiner of Writtle College for the second year. We hope that Tim will be able complete a third year of monitoring of plant establishment and will then be in a position to write a short report on his findings.

9.10 When Bryan Pinchen and I visited the trial area (which also had plantings of legume not under trial management) on 12/8/2002, we were delighted to find about ten very fresh queens of *Bombus muscorum* visiting the Red Clover flowers for nectar. We think that it is very likely that these must have come from nests which had successfully completed their development utilising the forage habitat provided by Simon on his farm.

9.10 This trial will be continued under a larger project looking at the restoration of bumblebee habitat on Dungenes/Romney Marsh which we are hoping to have funded for 2003.

9.11 The monitoring of the original area of Red Clover on the fields at Old Romney was continued. These had been sown for three years and were looking decidedly the worse for wear, losing much of their Red Clover content by this time, despite the farmer carrying out the agreed management. This short life-span of agricultural clover was the topic of much debate at the field assessment meeting held with DEFRA and reported in section 13 of this report. Our thanks to Chris Finn-Celsey for putting up with our demands and providing such a useful trial site.

9.12 Inevitably, the number of bumblebees recorded on the transect was well down on that for 2001, there being little forage available to attract the bees. The results are given in Table 1 overleaf.

<i>Species</i>	Transect 1, 20/5/2002 Overcast, moderate breeze 15°C, 10.00 - 10.30	Transect 2, 1/7/2002 Overcast, moderate breeze 15oC, 10.30 - 11.00	Transect 3, 12/8/2002 Hazy sun, slight breeze 20°C, 10.15 - 10.45
<i>Bombus hortorum</i>		<i>Trifolium repens</i> 1w (nectar) TOTAL CONTACTS 1	<i>Trifolium pratense</i> 1w (pollen) <i>Trifolium repens</i> 1w (Nectar) TOTAL CONTACTS 2
<i>Bombus jonellus</i>	1w In flight TOTAL CONTACTS 1		
<i>Bombus lapidarius</i>		<i>Lotus corniculatus</i> 1w (pollen) 2w (nectar) TOTAL CONTACTS 3	<i>Lotus corniculatus</i> 1w (pollen) 4w (nectar) <i>Picris echioides</i> 7w (nectar) <i>Trifolium repens</i> 1 (nectar) TOTAL CONTACTS 13
<i>Bombus pascuorum</i>			<i>Lotus corniculatus</i> 4w (nectar) <i>Picris echioides</i> 4w (nectar) <i>Trifolium pratense</i> 2w (pollen) 4w (nectar) <i>Trifolium repens</i> 15 (nectar) TOTAL CONTACTS 29
<i>Bombus pratorum</i>			<i>Picris echioides</i> 1w (nectar) TOTAL CONTACTS 1
<i>Bombus terrestris</i>	1w (immobile on ground!) TOTAL CONTACTS 1		<i>Trifolium repens</i> 16w (nectar) <i>Trifolium pratense</i> 1w (pollen) 2w (nectar) <i>Lotus corniculatus.</i> 1w (pollen) 1w (nectar) <i>Picris echioides</i> 6w (nectar) TOTAL CONTACTS 27

Table 1. Results from transect surveys of bumblebees on clover margins at Old Romney, year 3.

9.13 The monitoring of bumblebee numbers and the use of nest boxes around the electricity sub-station at Dungeness Power Station continued during 2002. No nest boxes were used during 2002. On checking these we found the most had lost their nesting material and it was decided to take all boxes and protective cages (one of which had disappeared from the sub-station!) into store at Dungeness RSPB Reserve. It is hoped to refurbish the boxes and deploy them on the Reserve as part of the bigger project referred to in 9.10 above. The results of the Power-station transects are given in Table 2 below.

<i>Species</i>	Transect 1, 20/5/2002 Hazy sun, moderate breeze 19°C, 11.55 - 12.55	Transect 2, 1/7/2002 Overcast, very heavy rain, transect aborted, moderate breeze 15oC, 11.30 - 12.00	Transect 3, 12/8/2002 Overcast, slight breeze 20°C, 11.15 - 11.45
<i>Bombus jonellus</i>			<i>Echium vulgare</i> 1w (nectar) TOTAL CONTACTS 1
<i>Bombus hortorum</i>		transect aborted	<i>Echium vulgare</i> 11w (nectar) <i>Teucrium scorodonium</i> 1w (nectar) TOTAL CONTACTS 13
<i>Bombus lapidarius</i>	<i>Lotus corniculatus</i> 2w (pollen) TOTAL CONTACTS 2	transect aborted	<i>Senecio jacobaea</i> 1w (nectar) <i>Teucrium scorodonium</i> 1w (nectar) TOTAL CONTACTS 2
<i>Bombus pascuorum</i>		transect aborted	<i>Carlina vulgaris</i> 1w (nectar) <i>Echium vulgare</i> 2w (nectar) <i>Teucrium scorodonium</i> 2w (nectar) TOTAL CONTACTS 5
<i>Bombus pratorum</i>			<i>Carlina vulgaris</i> 1w (nectar) TOTAL CONTACTS 1
<i>Bombus terrestris</i>	<i>Crambe maritima</i> 2w (nectar) TOTAL CONTACTS 2	transect aborted	<i>Carlina vulgaris</i> 3w (nectar) <i>Cirsium vulgare</i> 1w (nectar) <i>Echium vulgare</i> 5w (pollen) 27w (nectar) <i>Epilobium</i> sp. 2w (nectar) <i>Picris echinoides</i> 1w (nectar) <i>Senecio jacobaea</i> 11w (nectar) <i>Teucrium scorodonium</i> 1w (pollen) 16w (nectar) 'Yellow crucifer' 1w (nectar) TOTAL CONTACTS 68

Table 2. Results from transect surveys of bumblebees, sub-station at Dungeness Power Station, year 3.

9.14 The monitoring of bumblebee numbers and the use of nest boxes on the RSPB Dungeness Reserve continued during 2002. No nest boxes were used during 2002. On checking these we found the most had lost their nesting material and it was decided to take all boxes and protective cages into store. It is hoped to refurbish the boxes and deploy them on the Reserve as part of the bigger project referred to in 9.10 above. The results of the RSPB Dungeness transects are given in Table 3 overleaf.

9.15 The fields under experimental grazing management continued to improve in terms of legume forage for bumblebees. These were winter grazed again, part of one was shut up earlier than the rest to allow for earlier flowering of the clovers. This area should be kept in the longer grazing period next year, with a different area shut up early on. We feel that this two year period fully justifies the experimental management and are hoping to work with the Reserve Management to extend the general principle over more of the reserve in future years (photo 14).

9.16 Overall, we are seeing slightly more target species of bumblebees each year on the Reserve, with the most constant and noticeable change in the experimental grazing field (Badgers Field).

9.17 We are hoping to be able to take seed/hay from this field to restore grassland habitat elsewhere on the Reserve



Photo 14. The experimental winter-only grazing field (Badgers Field) at Dungeness RSPB continued to provide very good bumblebee forage, with a high proportion of legumes present.

<i>Species</i>	Visit 1 transect 1, 20/5/2002 Hazy sun, moderate breeze 19°C, 13.00- 15.30	1/2	1/3	Visit 2 transect 1, 1/7/2002 Hazy sun after heavy rain, strong breeze 14oC, 14.10 - 16.20	2/2	2/3	visit 3 transect 1, 12/8/2002 Overcast, moderate breeze 20°C, 12.20 - 14.25	3/2	3/3
<i>Bombus hortorum</i>	Iris pseudacorus (nectar)		1w	<i>Digitalis purpurea</i> 1w (pollen) <i>Echium vulgare</i> (nectar) Rubus fruticosus (nectar) <i>Stachys palustris</i> (nectar)	1q 1w	 1w 1w	<i>Ballota nigra</i> (nectar) <i>Echium vulgare</i> 1w (pollen) 7w (nectar) <i>Dipsacus fullonum</i> 1w (nectar) <i>Lathyrus pratensis</i> (pollen) (nectar) <i>Rubus fruticosus</i> agg. 5w (pollen) 1w (nectar) <i>Senecio jacobaea</i> 5w (nectar) <i>Teucrium scorodonium</i> 1w (nectar) <i>Trifolium pratense</i> (nectar) <i>Trifolium repens</i> (nectar) <i>Vicia cracca</i> (nectar)	 5w 1w 1w 2w 2w 1w	3w 1w
	TOTAL CONTACTS		1	TOTAL CONTACTS 1	2	2	TOTAL CONTACTS 21	12	4
<i>Bombus humilis</i>	Lotus corniculatus (nectar)	1q		<i>Stachys palustris</i> (pollen) (nectar)	1w 2w		<i>Cirsium vulgare</i> 2w (nectar) <i>Echium vulgare</i> 1w (nectar) <i>Lathyrus pratensis</i> (pollen) (nectar) <i>Trifolium pratense</i> (pollen) (nectar) <i>Vicia cracca</i> (pollen) (nectar)	 1w 2w 5w 2w	 1w 1w 2w 1w
	TOTAL CONTACTS	1		TOTAL CONTACTS	3		TOTAL CONTACTS 3	10	5
<i>Bombus jonellus</i>							<i>Picris echinoides</i> 1w (Nectar) <i>Rubus fruticosus</i> agg. (pollen) <i>Senecio jacobaea</i> 1w (nectar)	 3w	
							TOTAL CONTACTS 2	3	

<i>Bombus lapidarius</i>	In flight 1w <i>Iris pseudacorus</i> (nectar)		1q	<i>Lotus corniculatus</i> (nectar) <i>Stachys palustris</i> (nectar) <i>Trifolium repens</i> (nectar)		3w 1w 1w	<i>Lathyrus pratensis</i> (pollen) <i>Picris echinoides</i> 1w (nectar) <i>Senecio jacobaea</i> 1w (nectar) <i>Trifolium pratense</i> (pollen)	1w 1	1
	TOTAL CONTACTS 1	1		TOTAL CONTACTS	5		TOTAL CONTACTS 2		
<i>Bombus muscorum</i>	In flight (possibly <i>B. humilis</i>) Nest searching (checked in net)		1q 1q	<i>Trifolium pratense</i> (nectar)		2w	<i>Lathyrus pratensis</i> 1w (nectar) <i>Trifolium pratense</i> (pollen)	1w 3w	
	TOTAL CONTACTS	2		TOTAL CONTACTS	2		TOTAL CONTACTS 1	4	
<i>Bombus pascuorum</i>							In flight 1w <i>Vicia cracca</i> (nectar)		1w 1
							TOTAL CONTACTS 1		
<i>Bombus pratorum</i>	In flight <i>Digitalis purpurea</i> 1q (nectar) <i>Iris pseudacorus</i> 2q (nectar)		1w 1w	<i>Echium vulgare</i> (nectar) <i>Trifolium repens</i> (nectar)	1w 1w		<i>Echium vulgare</i> 1w (pollen) 2w (nectar) <i>Lythrum salicalum</i> (nectar) <i>Rubus fruticosus</i> agg. 1w (pollen)	3w 3	1w 1
	TOTAL CONTACTS 3	1	1	TOTAL CONTACTS	2		TOTAL CONTACTS 4		
<i>Bombus terrestris</i>	<i>Echium vulgare</i> (nectar) <i>Iris pseudacorus</i> (nectar)	1w	1w	<i>Echium vulgare</i> (nectar) <i>Lathyrus pratensis</i> (nectar) <i>Rubus fruticosus</i> (nectar) <i>Senecio jacobaea</i> (pollen) (nectar) <i>Trifolium pratense</i> (nectar) <i>Trifolium repens</i> (nectar)	6w 3q 1q 2w 1w 1w 1w	3q 1q	<i>Carlina acaulis</i> 2w (nectar) <i>Cirsium arvense</i> (nectar) <i>Cirsium vulgare</i> (nectar) <i>Dipsacus fullonum</i> nectar <i>Echium vulgare</i> (nectar) <i>Lathyrus pratensis</i> (nectar) <i>Ononis repens</i> (nectar) <i>Picris echinoides</i> 2w (nectar) <i>Senecio jacobaea</i> (nectar)	1w 1q 1q 6w 1w 2w 7w	1w 2w 1w 1w
	TOTAL CONTACTS	1	1	TOTAL CONTACTS	13	7	TOTAL CONTACTS 4	18	6
<i>Bombus terrestris/lucorum</i>	<i>Iris pseudacorus</i> 1w (nectar)								
	TOTAL CONTACTS 1								

Table 3. Results from transect surveys of bumblebees at RSPB Dungeness Reserve, year 3.

10. Continuation of Monitoring of *B. sylvarum* in Wales and *B. distinguendus* in Scotland.

10.1 CCW contracted Annie Poole to undertake further searches of the area around Castlemartin Ranges in Pembrokeshire, where Claire Carvell had undertaken her research in 2000. As a result of these searches more locations for the species within the overall known range were reported.

10.2 Mark Pavett, of The National Museum of Wales, found further examples of *B. sylvarum* on the Gwent Levels. Mike Howe (CCW) is looking into the possibility of making more detailed searches for this species in this area in 2003.

10.3 Bill Neill undertook his annual survey of *Bombus* species and their forage plant species on the Outer Hebrides and has submitted a copy of his results to BWG. The data is to be incorporated with the BWARS database.

10.4 A research project which aims to investigate the colony density and range size of *B. distinguendus* in northern Scotland (RSPB/Zoological Society of London Ph.D project) was started. Preliminary results suggest that there is less gene flow between *B. distinguendus* individuals in the Hebrides and those of northern mainland Scotland and Orkney than there is between the latter two areas. This is the result expected from maps of the known modern distribution of this species. It is hoped that this research will enable quantification of the likely dispersion of queens and the overall extent of habitat occupied by each population as well as the foraging range and density of individual nests.

10.5 No further locations for *B. distinguendus* in northern Scotland were reported to Murdo Macdonald (Highland Bumblebee Mapping Project) for 2002.

11. Further Survey and Autecological Research into *B. monticola* in England and Scotland.

11.1 Research on queen foraging by *B. monticola* based in The Peak District and Dartmoor, which had to be abandoned in 2001 due to Foot and Mouth Restrictions, was undertaken in 2002.

11.2 Bryan Pinchen and Adam Wright undertook survey in The Peak District between 13th and 17th May. A full report has been submitted, a summary is given here. Poor weather conditions made this survey less successful than it might have otherwise been, it was also clear that the visit was too late to record the behaviour of queen bees. None-the-less, *B. monticola* was recorded at six out of eleven sites visited and pollen samples collected where possible. These have been sent to Paul Westrich with all other 2002 samples.

11.3 Further 2002 records, together with flower records have been received from Dr. D.W. and Mrs P.E. Yalden. These will be added to the BWARS database.

11.4 The results of this survey support the hypothesis that abundant flowering Bilberry is an important component of early-mid season habitat for *B. monticola*. Although overall *B. monticola* was found at fewer sites than *B. lucorum*, there were more workers in total of *B. monticola* than those of *B. lucorum*. The survey results also highlight the need for a low grazing pressure in order for Bilberry (which flowers on the previous season's wood) to flower profusely (see below).

11.5 Matt Smith and myself visited Dartmoor between 17th and 20th April, after being informed that queens were out by Norman Baldock, Ecologist with Dartmoor National Park, who was able to join us in searches for one day - and whose information provided a vital link in the research, right at the end of the survey!

11.6 We had found *B. monticola* workers during the summer of 2001 on the open moorland running along the top of Yarner Wood NNR. There was not a lot of ungrazed (therefore likely to flower the following spring) bilberry in this zone, but we could see plenty of relatively ungrazed, taller (therefore more likely to flower the following spring) Bilberry within the wood boundary. We therefore decided to start by concentrating on looking inside Yarner Wood itself. We were kindly helped in this by the advice and co-operation of Albert Knott, the English Nature Site Manager.

11.7 The first day on site was raining heavily. In the brief interludes between the heavier bursts we were able to make some investigation of the lower reaches of the wood, guided by Albert. Flowering Bilberry was plentiful, but we found no *B. monticola* queens, although other species were present.

11.8 The next day was much better, weather wise, and we managed to complete a circular walk going from the lower reaches to the top of the wood where it joins the moorland edge and where we had found *B. monticola* workers the previous year. This took about three hours. We recorded many bumblebees, mostly queens (apart from *B. pratorum*, which was about 50% workers) foraging at Bilberry, but the only *B. monticola* seen was a queen in an open area right against the moorland edge. The results of this walk and the previous day's count (all at low altitude) are presented in table 4 (social parasite species not included). The solitary bee *Andrena lapponica*, which is a pollen specialist on bilberry was recorded within the wood.

Species	17/4/2002	18/4/2002 (inside)	18/4/2002 (above)
<i>B. hortorum</i>	1	8	0
<i>B. jonellus</i>	1	1	1
<i>B. lapidarius</i>	1	3	1
<i>B. lucorum</i>	12	48	17
<i>B. monticola</i>	0	1	0
<i>B. pascuorum</i>	2	13	2
<i>B. pratorum</i>	10	22	3
<i>B. terrestris</i>	2	6	2

Table 4. Yarner Wood NNR, numbers of bumblebee species recorded within the wood on 17th April and both within and on moorland immediately above the wood on 18th April 2002.

11.9 We then went to the road along the top of the woodland which we had used as the sampling base during 2001 and made three sampling stops along this, spending about one and a half hours overall, as a very heavy shower stopped all work for the last part of the afternoon. The amalgamated records are presented in table 4. *B. monticola* queens were not recorded at all on this section and there was very little flowering bilberry present as it was all heavily grazed.

11.10 We spent the next day repeating the lowland - moorland search pattern starting at Neadon Cleave and working up the hillside to the open moor at Manaton Rocks. The day started bright but became more overcast. Entry to Neadon Cleave was by a set of unimproved fields above the woodland. The river edge itself had plenty of tall flowering Bilberry present and the solitary bee *Andrena lapponica* was soon found, but there was no sign of *B. monticola* anywhere in this section.

11.12 We then stopped at a large flowering bush of *Berberis darwinii* growing in a garden above the woodland and which was attracting many bumblebees - still no *B. monticola*, although this species was seen visiting the same plant in highland Scotland some six weeks later.

11.13 Making our way further up the hillside to Manaton Rocks we repeated the search across the open moorland. The Bilberry was much less grazed than it had been above Yarner Wood and we were hopeful of finding *B. monticola*. However, the weather went cold and windy by mid-day and few bumblebees were seen in the hour we spent here. The bumblebee counts for all three sampling sites are presented in table 5.

Species	Neadon Cleave	Berberis (Manaton)	Manaton Rocks
<i>B. hortorum</i>	1	1	0
<i>B. lapidarius</i>	1	3	3
<i>B. lucorum</i>	6	2	4, 1w
<i>B. pascuorum</i>	5	1	0
<i>B. pratorum</i>	1	3w	0
<i>B. terrestris</i>	1	1	0

Table 5. Bumblebees recorded on Manaton sample, all queens, unless noted. Social parasites not recorded.

11.14 While we were searching at Manaton Rocks, Norman contacted us to say that one of his staff had just come back from visiting another area of the moor and that there were many *B. monticola* queens present. We rapidly arranged to make our way to this site and meet Norman there when he had finished his current task.

11.15 On parking near Birch Tor (SX6881) we looked out over a very different environment to that which we had been working (photo 15). This was a much less heavily grazed area than any we had looked at earlier, with tall Heather and Bilberry as well as small lawns containing white clover. We could see a line of flowering Sallow (*Salix ?aurita*) in the middle distance. Mindful of comments made by Gill Nisbet (who has been working on this species around Abernethy, see section 11.19) about the use of Sallow by *B. monticola* we made our way over, in high hopes, despite the dull weather. The Bilberry here was tall and carrying much blossom, but we did not see any *B. monticola* on our way over to the sallows (photo 16).

11.16 On arrival at the Sallow we soon saw *B. monticola* queens working the catkins, and, with considerable gymnastic efforts, were able to capture a number of queens and remove their pollen loads for later analysis. Here we were met by Norman, who told us that most of the queens had been reported from an area just to the north of where we were.

11.17 This was an area of old grouse moor which had lots of tall Bilberry growing among Heather, grass and Bracken (photo 17). The sun had decided to come out again and probably the number of bumblebees had increased in line, but there really were large numbers of *B. monticola* queens (25), all foraging for both nectar and pollen at the Bilberry. *B. lucorum* queens were also present (18) and one *B. jonellus* queen.



Photo 15 (left), 16 (below). Birch Tor was an area of old grouse moor which had plenty of tall, flowering bilberry and stands of Sallows with grassland which included White Clover plants.



Photo 17. The tall Bilberry stands can be easily seen in this close-up view of the habitat.

11.18 In subsequent conversation with Jeremy Field it transpires that he had found the same locality ten years earlier and Norman states that other places on Dartmoor where he has seen good numbers of *B. monticola* have the same tall moorland with Bilberry structure. He comments that these are typical of old grouse-moor areas and less frequent in the more regularly grazed parts of the Moor. It would be very useful to follow the habitat use of this area by *B. monticola* throughout a season.

11.19 Gill Nisbet has been doing this for the *Bombus monticola* living around Abernethy RSPB Reserve as a project funded by The Peoples Trust For Endangered Species. Her interest in this species was aroused during 2001 as a result of conversations with Murdo Macdonald. At the time she thought that queens might be using Sallow in the spring, rather than Bilberry and part of her 2002 project was to follow this idea. A summary of her report is presented here. Full copies of her Report are lodged with BWG, EN, CCW and SNH and these should be consulted for greater detail.

11.20 Gill visited a number of areas where *B. monticola* had been recorded recently at approximately weekly intervals between the end of April and the beginning of October. On each visit she recorded the plants which were being used as forage and collected a number of pollen samples, these latter are included in the 2002 pollen samples analysed by Paul Westrich.

11.21 Her results show that, in the study area at least, there were a small number of core forage plants. Queens were not seen until Bilberry was flowering, even if Sallow was present earlier and the former plant was clearly the favoured forage. This was then followed as favourite (in time sequence) by *Lotus corniculatus*, *Trifolium repens* and, finally, *Erica cinerea*. However, the total range of forage species was much wider than this, with visits to a total of 24 plant species being recorded.

11.22 Gill also comments that *B. monticola* is not strongly associated with Bilberry in woodland situations, being found only in very open woodland situations.

11.23 Thus far all observations of *B. monticola* carried out over a very wide geographic range support the conclusions of Pat Yalden that this bee is indeed associated with tall Bilberry-dominated moorland. The Bilberry forms the dominant nectar and pollen resource at the time the queens emerge and there is a clear succession of preferred forage plants from this time on. This forage succession links with the altitude tolerance of the species to describe its preferred habitat. As in other bumblebee species, the dependence is not absolute, there being a limited menu of preferred plants and a degree of plasticity on the part of the bees, but a continuity of suitable forage resources throughout the season is essential for the maturation of the colony and production of sexuals.

11.24 It would seem that over-grazing of uplands by stock and the consequent reduction in density of flowering Bilberry is a major reason behind declines in this species, predominately by removing essential forage resources for newly emerged queens. Such heavy stock grazing also leads to a severe reduction in the flowering density of other preferred forage plants, such as Bird's-foot Trefoil and White Clover, at later times of the year. This, coupled with the loss of these same plants from meadows at the edges of moorland as a result of agricultural intensification, adds further pressure on the successful maturation of colonies, exacerbating the decline.

12. Further Investigations Regarding the Identity of *B. ruderatus* and Searches for this Species in Previously-known Areas Around Peterborough and Elsewhere.

12.1 The identity and identification of *Bombus ruderatus* has remained a question of some debate throughout the life of the BWG. Whilst several workers, notably Paul Williams and Steven Falk, have always championed the idea of a separate identity of this species from *B. hortorum*, others have not been convinced of the existence of anything more than a gradation of forms with typical '*B. ruderatus*' at one end and typical '*B. hortorum*' at the other.

12.2 Much of this doubt has rested on the inability to find modern populations where these two forms are regularly and reliably distinct, rather than having just isolated individuals which agree with '*B. ruderatus*' amongst a mass of *B. hortorum*. Add to this the claim that some all black '*ruderatus*' are more likely to be black *hortorum* (well documented on the mainland of Europe) and the recipe for confusion is complete.

12.3 BWG has attempted to throw some light on this confusion in the past (BWG Report, 2000). A project undertaken by Paul Williams found morphometric analysis of queens of *hortorum* and *ruderatus* supporting his belief of the separateness of this taxa, but he was unable to extend this to workers and males. A separate project by Paul Westrich looking at a wide range of material from throughout mainland Europe failed to find any consistent taxonomic characters to separate these species, but instead (inevitably) a great deal of confusion in the naming of specimens, with the possibility of a cline of forms spreading across Europe from east to west.

12.4 Both Steve and Paul Williams are emphatic that, whilst they may find no consistent individual taxonomic characters, they can instantly recognise a typical *ruderatus* from its overall appearance. This was demonstrated when Paul Williams rapidly picked out '*ruderatus*' specimens from a long European series which Paul Westrich had used for his analysis.

12.5 In an effort to get further with this problem it was decided to extend a co-operative project into *B. subterraneus* with Dr. Dave Goulson at the University of Southampton. Under this project Dave and his students are to go to New Zealand, where we know that both *B. subterraneus* and *B. ruderatus* (as understood by F. Sladen) were exported at the turn of the Twentieth Century.

12.6 As well as exploring the possibility of this New Zealand stock providing re-introduction material of *B. subterraneus*, it has been agreed that they will also look at *B. ruderatus*. It is hoped to get series of this species from known nests and to compare these series with the known variation in museum specimens in Europe. The possibility of obtaining appropriately killed specimens means that genetic analysis is also a possibility. Such analysis will add a new dimension to our understanding of the problem. Preliminary research, aimed primarily at identifying populations of both species in New Zealand has already been carried out by Dave's contacts in New Zealand. It is hoped that he and his students will be able to undertake the remaining field work this winter (2002/3).

12.7 The situation in the UK took a dramatic turn for the better during 2002. Steve Falk has always insisted that he found typical *B. ruderatus* fairly frequently at a locality known as Stanground Gullet at Peterborough when he lived there in the late 1980s. We have previously not considered the Peterborough area, with its history of long-standing agricultural intensification, as likely to harbour any scarce bumblebee species. At the 2001 Review Meeting it was agreed that we ought to have a look.

12.8 Accordingly, Paul Williams and myself arrived at Stanground just after lunch on 12th June 2002. After rather disappointing results and considerable difficulty in trying to reach the area which Steve had indicated (much of which had been built over anyway), we decided to try looking further east down the Nene, just outside Whittlesea. Paul had a vague recollection of finding *B. ruderatus* in the late 1970s by one such bridge. (Not this one he later realised!)

12.9 As we found a parking place overlooking the banks of the river we realised that there was a race on with an Environment Agency Management Team who were busy cutting the banks, including cutting down the only likely forage plants - Common Comfrey *Symphytum officinale*. They must have thought us mad as we searched the rank vegetation and eventually one of the team came and asked me what we were doing. At this moment Paul found what he was looking for - a clear worker of *B. ruderatus*, as he understood it. When

the significance of this discovery was explained to both men in the team they were very keen to help and gave us a contact number to ask permission for them to leave some stands of Comfrey for the bees. To the great credit of the local Environment Agency Team this was given over the phone there and then.

12.10 After discovering another possible worker (this one was not so clear to Paul - I was not able to comment at this point) on the north-west side of the bridge, we moved to the south-east bank of the river. Here our attention was immediately taken by a small field with a good growth of Comfrey and Yellow Flag (*Iris pseudacorus*) (photo 18).



Photo 18. This small field and the nearby ditches with flowering Comfrey and Yellow Flag provided several examples of *Bombus ruderatus*, including two all black workers.

12.11 Spending about an hour searching the field and its nearby ditches revealed a number of 'good' *B. ruderatus*, Paul was most happy to find two all-black workers amongst these. This was the first time I had ever had been in an area where both clear *B. hortorum* and clear *B. ruderatus* were flying together, and with more than singletons of the '*ruderatus*' present. This met one of my first conditions for considering that they may be separate species. I was still relying on Paul to confirm my determinations, but was beginning to appreciate the assemblage of characters which he was using.

12.12 We were clearly close to, if not within, an RSPB Reserve (Nene Washes). I had previously arranged access permission for any likely sites along the Nene Washes and was able to ring both the local office of EN (Jon Graham) and the local RSPB Warden (Charlie Kitchin) and tell them of our discovery that afternoon.

12.13 Later that night I was able to make a more careful study of the *B. ruderatus* specimens which we had retained from the day and compare them with some of *B. hortorum*. It appeared that the major character Paul was using was the way in which the distribution of the yellow and black banding of the thorax changed between variants of the two species. *B. ruderatus* is often described as having the black band between the yellow bands at the front and back of the thorax parallel-sided. This was clearly not so, as some dark '*ruderatus*' in our sample had black bands which were much wider in the middle than at the ends. What was consistent however, was the fact that the extent of yellow at the front and back of this band remained equal as the extent of black band increased. In *B. hortorum* the back band got narrower before the front one. There was also a general feeling of a shorter and more even pile to the thoracic hairs and one specimen was a most striking mustard yellow with a very distinct black band between the even yellow stripes on the thorax. Re-examination of the description given by Sladen in *The Humble Bee* confirms this character completely.

12.14 The next day we set out to explore the RSPB Reserve at the Ouse Washes, another pre-identified possible locality which Paul had known some twenty years earlier. On the way we stopped at the bridge at Sutton Gault (which was Paul's previously remembered locality). Here the day was cold and very little was flying. Nothing remotely like *B. ruderatus* was seen on the Comfrey and we decided to press on to the Ouse Washes.

12.15. On arrival at the Ouse Washes the day was still cold and overcast, but, after a warm cup of coffee and discussion with Cliff Carson, the RSPB Site Manager, about access arrangements we went back out. The sun was just about to come out and, as we passed a small patch of red clover which I had noticed on our way in, I threw myself and my net over it - sitting on it was the most perfect example of a male *B. ruderatus*! As Paul and Steve had promised, I would know it when I saw it. We tubed it and carried it back to the office in triumph. After showing it round we went out to look for more. Paul soon found another male, an all-black one this time. We photographed both males together, held by Paul (photo 19). The distribution of the yellow and black bands shows up well in the bi-coloured specimen, as does the overall more even hair in the black one.



Photo 19. Males of *Bombus ruderatus*, Ouse Washes RSPB Reserve, 13/6/2002.

12.16 That afternoon we were taken over much of the Reserve by Cliff. We found a number of individuals of *B. ruderatus* and I became quite confident in identifying this species amongst *B. hortorum*. There clearly were difficult cases, but there were also a large number of clear-cut ones. The forage habitat succession being used by *B. ruderatus* at The Ouse Washes appeared to be Yellow Flag, Common Comfrey and Marsh Woundwort *Stachys palustris* - this latter plant was only just coming into flower (photo 20). Cliff informs us that all three plants are very frequent on this area, which occupies well over 10Km², albeit as a relatively thin strip. There were also large stands of Water Mint *Mentha aquatica* in the damp meadows, but this was not yet near flowering.

12.17 The washes are a flood-defence arrangement. Sudden influxes of water are allowed into the Washes to avert flooding elsewhere on the Fens. This is the reason why they have retained a largely unimproved wetland character. But this use also carries a potential danger to the bumblebees on them. What happens when the washes are flooded in the summer, as may occur? Clearly the bumblebees themselves can fly away, but any nests on the low-lying ground would get flooded out.

12.18 It is already known that the major small mammal populations are centred on the walls of the dykes. These walls do not go underwater during summer floods, so the very habitat component which is required as nesting site by the bumblebees, old mouse nests in tunnels, is already situated out of danger. It is highly likely that hibernating queens will also tend to choose the higher ground. This regime of unpredictable flooding helps explain why *B. muscorum* is apparently not present on the Washes, despite the abundant forage resources and apparently suitable vegetation structure. Being a surface-nester in tall vegetation this species is highly vulnerable to catastrophic summer floods.

12.19 Later in the afternoon we returned to the bridge at Sutton Gault as it was on our way back home. This time we looked on the opposite bank of the river where there was a large stand of flowering Musk Thistle *Carduus nutans*. There were many bumblebees visiting these flowers, amongst them several *B. ruderatus* in a variety of colour forms, including several all-black ones.

12.20 The discovery of these localities opened up the possibility of collecting specimens to augment the proposed genetic research on specimens from New Zealand (section 12.6). Unfortunately a planned sampling trip on 1/8/2002 to these localities had to be aborted due to the onset of very heavy and persistent rain which set in on our arrival at site. Peter Hodge did, however, find a very fresh queen clinging to flowering White Dead Nettle *Lamium album* beside the first bridge at Wittlesea and Bryan Pinchen had a bedraggled male from the ditches on the other side of the bridge. Collection of further material for genetic analysis should be carried out as a priority in 2003.

12.21 I alerted both Ted Benton and Claire Carvell of our discovery. Both were able to visit the localities and, using the identification information provided by Paul, to recognise *B. ruderatus* for themselves. Furthermore, both subsequently found new localities for this species; Claire at an experimental plot near Cambridge and Ted on the South Essex coast. I also was able to demonstrate the characters to Peter Harvey on specimens we found near Brightingsea whilst searching for *Odynerus simillima*. This locality is within the area identified by Ted.

12.22 I also had correspondence with Dr. David Bond, who used to research pollination of crops, including Broad Beans. He recorded *B. ruderatus* a number of times in the same general area during the 1960s and 1970s and had specimens confirmed by David Alford. His comments were to the effect that the species 'likes marshy environments - a few Essex rivers, the River Cam near PBI Cambridge.'

12.23 The story does not stop here however. During 2002 I also visited Steven Falk in Warwickshire to see *B. humilis* habitats (section 8). Steve mentioned that he had a few queens of what he considered to be *B. ruderatus* collected by himself whilst he had been in Warwickshire, one of them from the same quarry area which we were looking in for *B. humilis*. Although we were unable to re-find anything remotely like this species in the Southam area we agreed to spend the second day (12/7/2002) I was with him searching for it in other possible localities.

12.24 The first of these localities was an area in the south of Warwickshire, near Ditchford Frary (SP232378). Steve had a queen from here collected at least ten years earlier and had never been back. After asking permission for access from the farm we set out. Beyond a few bees working a stand of Spear Thistle by the farm, there was very little evidence of any bumblebee species, or any suitable forage flowers. We walked on in the general direction which Steve remembered from his earlier visit, getting more and more despondent. We were about to turn round and go back when we noticed a reddish haze in the next field through the trees.

12.25 Arriving in the field we found that it had been planted with a long margin of agricultural red clover (photo 20) on one side - a bumblebee margin from the trial Stewardship Options (WM2)! I did not know that any such margins had been planted outside our research areas and was keen to see what its effect was. Not that this was hard to see, it was heaving with bumblebees of several species, no wonder they were not interested in the poor scraps of forage we had seen so far.

12.26 After about ten minutes wading through the tall clover and marvelling at the number of species and individuals (including fresh queens of *B. lapidarius*!), all busy foraging for both pollen and nectar; I stopped short - something was wrong with the *B. hortorum* in front of me, it didn't look quite right. The bee flew off before I could get a closer look, but I was pretty certain it had been a worker *B. ruderatus*. I shouted to Steve to look carefully at the *hortorum*, in case of *ruderatus* being present, and fairly quickly we were able to each find undoubted workers of *B. ruderatus* (photo 21). These were distributed in two distinct areas of the clover strip, which was over 400m long, we thought that these might correspond with two colonies.

12.27 Subsequently to this Steve has made considerable efforts to make both the landowner and the Countryside Stewardship officer aware of the import of the WM2 strip - it turns out that the new Ecologist/Head of Section in the DEFRA Office is Ian Diack, who helped with developing the trial WM2 mix whilst he was at Reading! We are hoping to follow this development up during 2003.



Photo 20. Ditchford Frary. The clover field where Steve Falk (pictured) and I found *B. ruderatus* in 2002.

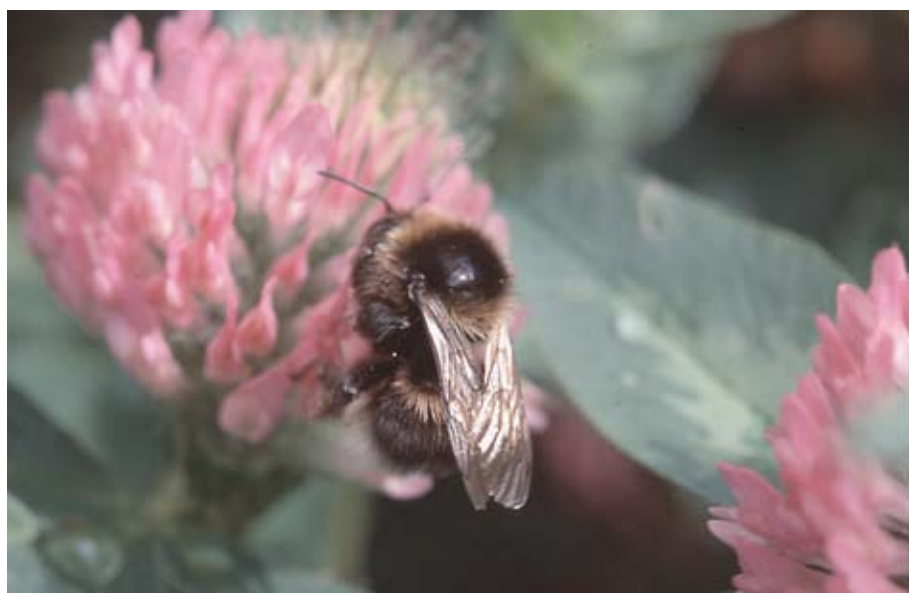


Photo 21. A dark worker of *B. ruderatus* on Red Clover in the field above. Note the way in which the yellow bands (much darkened) are still even on the front and back of the thorax. The short, even hair of the thorax can also be appreciated.

12.28 A final record for *B. ruderatus* in 2002 was the discovery of a worker at Elmley RSPB Reserve by Stuart Roberts noted in section 5.10 above. The male discovered by George Else at Wicken Fen in 2001 also appears to belong to this species.

12.29 We end 2002 in a much better position regarding this problematic species.

- a) We have the ability to recognise it in the field as a distinct form from *B. hortorum*.
- b) We know of localities where both species occur reliably and reasonably frequently together.
- c) We are therefore able to investigate the autecology further, an essential pre-requisite of developing the BAP process, which we had earlier to put on hold.
- d) We should be able to provide a genetic dimension to the argument as to whether these two species are fully separable, or just extremes of a continuous variation.

13. Liaison with Relevant Conservation Bodies, especially Agri-environment Staff and Land-Owners.

13.1 From frequent references throughout this report it should be clear that this has been a very active component of BWG activities throughout 2002. Here I wish to consider further the progress with promoting the establishment of suitable bumblebee habitat within agri-environment schemes, as this requires a little more detail than has been given.

13.2 The consortium considering a bid to DEFRA to develop a landscape scale model of the scale and nature of habitat restoration required for bumblebees met again on 3/5/2002 at the RES, London. We were pleased to welcome new faces from the team led by Andrew Bourke at ZSL who are investigating bumblebee ecology in London (Roselle Chapman) and Scotland (RSPB Project - section 10). Progress on the bid has been steady, but slow. One major constraint to progress has been DEFRA's own financial constraints. However, there were encouraging signs that a preliminary project to explore the idea further would be forthcoming.

13.3 This has subsequently proved to be the case and this project is currently underway at CEH. We are hoping for a go-ahead to bid for a larger project in 2003.

13.4 The meeting also allowed an informal exchange of ideas and results from projects concerned with bumblebee ecology. It was agreed that such an informal forum was very useful to all concerned and Andrew offered to host next year's meeting (25/2/2003) at ZSL.

13.5 Consideration of the appropriateness of the current WM2 trial mix for stewardship has also occupied a lot of time this year, starting with a review meeting with EN, DEFRA ecologists, CEH and the Farmed Environment Company held at Nobel House in London on 9/1/2002. Here it was agreed that, although WM2 was an excellent start, there were problems; both with the longevity of the sown mix and its suitability in all situations. It was agreed that agricultural legume mixes were not suitable for restoration in grassland situations, although perfectly fine - with careful tuning - in arable margin ones. Richard Brown of Emorsgate Seeds was able to offer very valuable advice on Red Clover seed suitable for grassland mixes and its probable availability. He and Marek Nowakowski of Farmed Environment also had very valuable input regarding the use of grass species in both situations and the initial after-care needed to establish the margins.

13.6 This group re-convened at Dungeness/Romney Marsh on 22/7/2002. The aim of this meeting was to review progress in trial areas initiated by EN/BWG/Romney Marsh Countryside Project and we were joined by Jane Reynolds and Owen Leyshon from the Romney Marsh Project as well as Rob Wells of the local DEFRA office. The outcome of the meeting was an agreement that the conditions of WM2 should be reviewed in the light of the information gained about the lack of ten-year longevity of the current mix.

13.7 The issue of cutting regimes for bumblebee conservation margins was also considered. This needs to take into account two factors:

a) If agricultural legume mixes are more suited to being treated as short-term leys than 10-year margins there may be less reason to have an establishment regime of thrice-yearly cutting.

b) As forage needs to be present throughout May to September, management regimes need developing which explicitly allow for this forage availability to be maintained somewhere throughout each farm using the margin mix.

13.8 Following up from these meetings Dave Sheppard (EN) and myself spent two very rewarding days with Marek and others looking at the results of the Farmed Environment Company's Buzz Margin Project. We also spent a very useful time with Unilever Ecologist Jos van Oostrum and Farm Manager Innes McEwan looking at the possibility of a collaborative project for 2003 on the impact of clover margins on bumblebee populations at the Unilever Research Farm in Bedfordshire. It is hoped that this project may be able to start looking at the effect of bumblebee conservation measures on the seed set of field bean crops.

14. A Possible Mechanism for the Ecological Separation of Bumblebee Species by Time of Emergence of Queens and Timing of Initial Forage Abundance.

14.1 Whilst working on Salisbury Plain during April 2002 I was struck by the lack of flowers in the grasslands, yet there was an enormous potential for bumblebee forage flowers (notably legumes) which would clearly come into production during May and June (photos 22, 23, 24). Bryan Pinchen and I had previously remarked on this lack of early flowers when looking for queens of *B. sylvarum* at Tilshead Park, Salisbury Plain at the end of April 1999. Paul Westrich, looking for queens in the German localities which we had been researching during 2001 (2001 Report, section 4) has made similar comments about the lack of flower resources during April in areas where these species occur. Paul Williams has always insisted that Dungeness is a very late place. Other areas which have retained declining species are wetlands, which are also late flowering. I suggest that the timing of first flower flush and the timing of queen emergence is highly significant in the ecology of Bumblebee species.

14.2 We know that many of the bumblebees which are declining are often associated with high-density legume areas. These species also seem to have strong preferences for pollen from flowers with complex parts, including long corollae; hence the tendency for these species to be longer tongued. However, a decline in suitable flowers with which long-tongued bees are associated cannot be all the answer. There are two long-tongued species which have not declined to anything like the same extent - if at all; *B. hortorum* and *B. pascuorum*. Both these species are often found foraging at flowers like Red Clover. There are also two short-tongued species with strong habitat associations which are also declining; *B. monticola* and *B. soroensis*; although these species do not seem to have any strong association with Red Clover, they do forage preferentially at other legumes. Any mechanism for the ecological separation of bumblebee species needs to be able to address these apparent contradictions.

14.2 *Bombus monticola* has been shown

- a) To have a strong association with areas which have a strong representation of tall, heavily flowering Bilberry.
- b) The timing of emergence of queens is strongly correlated with the timing of flowering of Bilberry.
- c) There is a need for a continuity of suitable forage resources, often associated with moorland edges.
- d) Queens and workers are strongly associated with extensive open habitats, rather than woodland ones, despite the presence of flowering Bilberry in both.

14.3 Whilst we have carried out considerable research on *B. monticola* which confirms its rather exact habitat requirements, we have done very little directed research on *B. soroensis*. However, accumulated knowledge of this species suggests the following factors to be relevant:

- a) It is associated with later-flowering grasslands, coastal heath and moorland edges where there is a good continuity of suitable forage resources.
- b) It has very late emerging queens (June to the south of London) and a consequent late development of the colony, the males are amongst the very last bumblebee males to be found.
- c) It is strongly associated with extensive open habitats.

14.5 Similar lists of major factors for *B. humilis*, *B. sylvarum* and *B. muscorum* can be drawn up.

- a) Strong association with areas with later, but abundant, supplies of suitable forage resources, these are largely drawn from a few plant families.
- b) Queens emerge late, early May to the south of London
- b) Timing of emergence of queens is strongly associated with commencement of flushes of the main preferred flower species.
- c) Surviving populations are strongly associated with extensive areas of open habitat, these may be dry grasslands (*B. humilis* and *B. sylvarum*) or wetlands (*B. muscorum* and *B. sylvarum*).



Photos 22, 23. Fox Covert SPTA. The same area photographed at end of April (top), end of May (middle) and end of July (bottom), 2002. The area is almost devoid of flowers early in the year. By the end of May a few forage flowers are starting to show. Throughout June, July and August there is an abundance of suitable forage flowers.

14.6 We have little exact knowledge regarding *B. ruderatus*. The finding of males in June at the Ouse and Nene Washes would tend to argue against a late emergence strategy in this species. However, these could just have been the progeny of failed (queenless nests). Certainly workers and queens were still being found into August. More research into the autecology of this species is required before these questions can be addressed for this species.

14.7 Both *B. pascuorum* and *B. hortorum* have the following characteristics

- a) The queens emerge early, by end of March to the south of London.
- b) Queens and workers are often found in woodland clearings and gardens and large populations are centred in these habitats..
- c) They forage from a relatively wide variety of plant species (this is not as well established as the relative restriction in forage species for the BAP species. We have not concentrated on pollen sampling for these species, hence this statement relies more on general observation).

14.8 In their (at least partial) association with woodland/woodland clearings/garden habitats and early queens these species agree with other still widespread species such as *B. lapidarius*, *B. lucorum*, *B. pratorum* and *B. terrestris*. I also suspect that *B. jonellus* (in the south of England, at least) should belong in the same group - the queens are early emerging and, although the species does very well on heathlands it is found in a very wide range of habitats. The situation in Scotland, where it has late emerging queens, may be a require some refinement of this analysis (see later.)

14.9 These groupings are very broad, there will be overlaps in individual cases, but they represent the majority situation. The argument which follows can be adjusted for regional variation, both in the timing of emergence of bumblebee species and the timing of major floral flushes.

14.10. I suggest that the association of queen emergence and available forage resources results in an effective partition of nest distribution between early and late emerging species. This assumes that queens tend to establish nests in areas where suitable forage is abundant when they are searching for nest sites. Our observations of nest-searching queens of *B. distinguendus* in the Outer Hebrides tend to support this hypothesis, nest searching queens were highly associated with areas of flowering Bird's-foot Trefoil (UK BAP Bumblebee Working Group Report, 1988, section 7). We have not done enough observation of nest-searching queens of other species, although Gill Nesbit's work on *B. monticola* suggests something similar to be happening. Nest establishing queens are assumed to have no knowledge of the future potential of the habitat to support the latter stages of the colony.

14.11 Queens of early emerging species which reach an area of late flower supply in March will have no reason to stay and found a nest, there being no resources to attract them. The majority of early flower resources are associated with woodland/woodland edge habitats where the shelter provided by the trees protects flowers from the effects of frost, as well as there being a large number of flowering trees and shrubs. Early queens will be attracted to these areas (which include gardens). Once the nest is established, there is no reason why later-emerging workers will not fly to subsequently available forage on the previously unavailable open areas, but there will be relatively few nest founded in these areas.

14.12 Late emerging queens, however, are timed with the flower flushes in these later-flowering areas and will tend to stay in these areas to found their nests.

14.13 This mechanism is expected to be 'leaky' as there will odd queens which do not choose their 'typical' habitat.

14.14 This leakage effect can be increased for early emergent species in open grassland environments by an increase in early flower plants, e.g. scrub flowers and dandelions (typical signs of fertiliser application on grassland), or fragmentation of open grasslands by woodlands and hedges.

14.15 Conversely, the leakage of late-emerging species into more woodland edge habitats will be promoted by the extension of available habitat by agricultural practices which mimic the high abundance of suitable late-flowering forage plants within an agricultural landscape, such as the extensive use of legume forage and soil-improver crops as under the conditions of the agricultural revolution of the mid 1700s to mid 1900s.

14.16 As legumes are often dominant in the plant communities of these open landscapes it is no surprise that species which are strongly associated with these areas often seem to specialise to a degree on these plants (BWG Report 2001, section 13). Similar associations might be expected to develop for other plant species. Pollen preference drives the ecology of many solitary bee species and there may be little reason why the situation need be different for bumblebees (apart from the virtual impossibility of becoming totally oligolectic, due to the long life period of colonies requiring a degree of plasticity).

14.17 Species tending to inhabit environments with a greater degree of potential variability in their pollen resources might be expected to have a greater range of potential pollen sources and our experience suggests that this is indeed so. However, some pollens appear to be more suited to the successful development of bumblebee colonies than others and considerable research is need to untangle influences here.

14.18 This hypothesis is relatively readily testable by measurement of nest-searching queen density as well as that of later foraging workers, in different levels of 'late' and 'early' habitats. Hints that there is such a queen gradient were gained during research in southern Germany (BWG Report 2001, section 4). Zones with considerable levels of 'leakage' between early and late flower - flush times would be expected to have a mix of species which reflects the level of leakage - provided that neither overall forage resources, nor nesting sites, are severely limiting. If there were any competition effect between pairs of species these would be expected to be most marked in these situations, especially if the early establishment of nests, and often much larger total nest sizes of many early species, provide a clear advantage.

14.19 Such a mechanism will, if shown to be relevant, not be the only factor which affects the success of individual species. However, if it is shown to be an important factor it has major implications for the nature of habitat conservation for different bumblebee species.

14.20 The situation of *B. jonellus* in southern Britain is interesting with regard this postulated mechanism. *B. jonellus* is a very early emerging species, with a very short life cycle in the south. It is often found collecting pollen from Gorse and Sallow, both frequent and often abundant plants on heathlands, but also present in other habitats. It is possible that there are sufficient resources from these two plants to allow the full development of a colony to the production of queens by early May. Queens from these colonies, or a proportion of them, will then be establishing new nests as the heather flush starts on the heathland, providing another long-lasting flower flush for the successful development of a second colony in the year. The mechanism above would explain the observed success of the species when associated with heathlands, but does not restrict it to them, which is just the situation observed.

14.20 How the telescoping of seasons towards the north (and with increasing altitude) affects the available flower flushes and the timing of queen emergence in this species (and *B. pratorum*) would be a worthwhile investigation. Would queens transposed from south to north still try to emerge early? Are there consistent differences in genomes between different 'emergence lines'?

14.21 *B. monticola*, with its queen emergence closely timed with the main flower flush of Bilberry (and possibly other ericaceous plants elsewhere in its range?) fits well with the overall mechanism. How does its queen emergence dates compare with those of *B. lucorum* and *B. jonellus* in the same environment?

14.22 Working on *B. distinguendus* on the Machair habitats of South Uist, Lynn Hughes noted that many *B. lucorum* queens seemed to remain on the Machair until they died, without founding nests. She commented that they seemed much less able to find suitable forage plants, being poorly adapted to foraging at many of the dominant late-flowering plants. (The Great Yellow Bumblebee, *Bombus distinguendus* (Morawitz): Aspects of Habitat Use, Phenology and Conservation on the Machair of the Outer Hebrides, UK. MSc. Thesis, UCL, 1998 and pers. comm.). Our observations in the same areas support the notion that *B. lucorum* workers are more frequent away from Machair habitats. Whether these queens observed on the Machair were the same individuals, or ones which drifted there having failed to found nests elsewhere is not known, perhaps these were parasitised individuals. Could it be that differences in queen emergence times and synchronisation with dominant flower flushes affect the ability of different species to successfully found nests?

15. Future Programme

15.1 It is fitting that this report should end with speculation concerning future directions for research in bumblebee ecology and habitat management. This report appears to mark the end of co-ordinated research on these bumblebee species under the auspices of the BWG, the last source of funding for the group having come to an end.

15.2 It will not be the end of all research, several projects nurtured by the group and its associates have developed their own life and, hopefully, funding:

a) Research concerned with establishing and monitoring agri-environment prescriptions which will help restore foraging habitat.

b) Research concerned with establishing the population dynamics, colonisation range and density of *Bombus distinguendus* in Scotland.

c) Habitat management to provide continuity of bumblebee habitat within flood defence management in northern Kent.

d) Consideration of the provision of suitable habitat under grazing management projects on Salisbury Plain.

e) Research concerned with the restoration of bumblebee habitat on Dungeness/Romney Marsh.

f) A project to map the distribution/ density and foraging habits of bumblebee species throughout the UK.

g) Production of a leaflet promoting the conservation of bumblebees in gardens.

h) Production of a Field Guide to Bumblebees.

15.3 A number of other small projects will inevitably continue in a quiet fashion due to the enthusiasm and personal dedication of individuals. This same degree of personal commitment will inevitably be called upon by the projects above when specific advice or knowledge is required; hopefully we will be able to provide some level of input.

15.4 However, other important areas will be left with no way of moving them forward, including:

a) Development of the elucidation of the status and autecology of *B. ruderatus*.

b) Consideration of the possibility of re-introducing *B. subterraneus*, after suitable habitat restoration.

c) Support for individual projects to conserve specific populations of threatened bumblebees.

d) Autecological research on a further five species of bumblebee whose declining status fully merits inclusion in the UK BAP.

e) The consistent educational, lobbying and political work needed to maintain public and official awareness of the urgent need for the conservation of all our bumblebee species.

f) A co-ordinating thread between all projects concerned with bumblebee conservation and facilitation of networking between researchers.

15.5 Thus, the Biodiversity Action Plan Bumblebee Working Group will continue in name and spirit. Its effectiveness, however, may have to be judged largely by the first five years of its short life.

16. Acknowledgements

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