ENGLISH NATURE

Report Number
512

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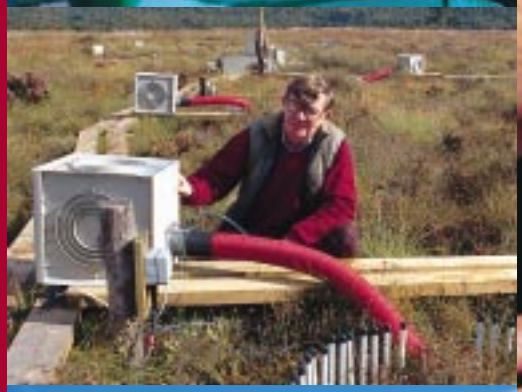
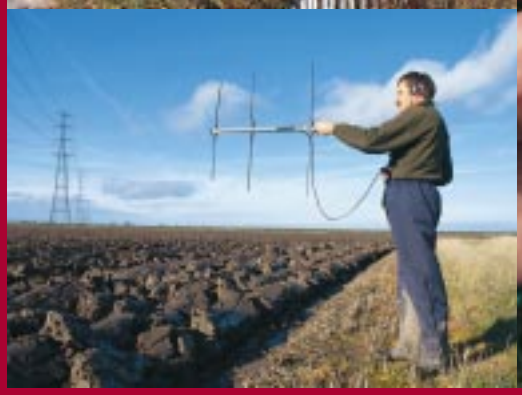
English Nature Research Reports





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April 2003

ISSN 0967-876X

Acknowledgements

Thanks are due to Jon Webb for initiating this project and Dave Sheppard for help in its progression.

Each draft species table was circulated amongst a number of invertebrate specialists for their reactions and additional data. Comments on the Coleoptera table were received from Jonty Denton, Tony Drane, Andrew Duff, Andy Foster, Peter Hodge, Pete Kirby, Derek Lott, Mike Morris; Hemiptera from Jonty Denton, Pete Kirby and Alan Stewart; Hymenoptera from Michael Archer, Graham Collins, Mike Edwards, and Andy Foster; spiders from Peter Harvey, David Nellist and Rowley Snazell; moths from Andy Foster and Mark Parsons.

Summary

This report brings together a considerable amount of information on the species composition of the invertebrate fauna of lowland calcareous grasslands, and is aimed at helping field workers and site managers to obtain a broader understanding of the extent and importance of the fauna. It concentrates on the species most closely associated with the habitat type and provides preliminary assessments of their habitat fidelity, the importance of habitat continuity, and their microhabitat preferences.

Many factors influence the composition of the fauna of calcareous grasslands. The three key influences are climate, soil and management history, and these combine in a variously unique way on each defined site. Each of these key features also has influence at different scales.

These factors combine to provide a habitat type of unique species composition and one of the most species-rich grassland types in Britain – potentially **the** most species-rich.

Very short swards tend to favour open ground species including predators and foliage feeders, and - where the short sward is maintained by large herbivores - dung fauna. Taller flowery swards, maintained by periodic grazing followed by relaxation of grazing pressure, tend to favour plant-feeders associated with flowers, fruits and buds. Denser, coarser grasslands with few flowers but abundant litter favour decomposer species, as well as provide cover for roosting. All sward types are valuable for species of conservation importance, and some important species actually require more than one type per site or even detailed mosaics. With many insect species the requirement is for a mosaic of features rather than one single feature alone, and often the site needs to be in a complex landscape with additional features available within easy flying distance. The importance of developing trees and shrubs, scrub and woodland within or close by cannot be overstated.

The various sampling techniques available are discussed and a species recording programme suggested. The best approach to species recording is really for an experienced recorder to make a series of visits across the season under good recording conditions, preferably supplemented with some trapping work.

The species assemblage of calcareous grassland is described on an order by order basis, and provisional listings of the specialist spiders (70 species), bugs (69 Heteroptera plus 39 Auchenorhyncha), larger moths (31 species), bees, wasps and ants (79 species) and beetles (250 species) in tabular format. These tables consider the degree of habitat fidelity and

habitat continuity shown by each species. Information on the known vegetation structural requirements and other important features are outlined.

Relationships between the fauna and the different NVC communities are considered although this is as yet a very neglected aspect of calcareous grasslands.

Finally, an outline is provided to various approaches to the use of the species tables in site assessment for nature conservation, including the Index of Ecological Continuity, Species Quality Index, and – for bees and wasps - Cleptoparasite Load and Aerial Nester Frequency. An important conclusion is the need to assess site quality using as many taxonomic groupings as possible in order to cover all habitat requirement variables.

Contents

1. Introduction

1.1 UK Biodiversity Action Plan

1.1.1 Definition

The Lowland Calcareous Grassland Habitat Action Plan (HAP) defines this habitat in the following terms:

"Lowland calcareous grasslands are developed on shallow lime-rich soils generally overlying limestone rocks, including chalk" "They are typically managed as components of pastoral or mixed farming systems, supporting sheep, cattle or sometimes horses; a few examples are cut for hay." (www.ukbap.org.uk)

1.1.2 National Vegetation Classification types

It goes on to explain the vegetation type in terms of the National Vegetation Classification (Rodwell, 1992): "The definition of calcareous grasslands covers a range of plant communities in which lime-loving plants are characteristic. In the context of this Action Plan, lowland types are defined as the first nine calcareous grassland National Vegetation Classification communities, CG1 to CG9. With the exception of CG9, *Sesleria albicans - Galium sterneri* grassland, which straddles both lowlands and uplands, these communities are largely restricted to the warmer and drier climates of the southern and eastern areas of the United Kingdom. Lowland sub-communities of CG9 occur in the more clement conditions around Morecambe Bay in Cumbria, while upland sub-communities occupy colder and wetter localities in the Pennines.

Within Britain, lowland calcareous grasslands of these NVC types are believed to be confined to England and Wales.

Lowland calcareous grassland is included within the *Festuco-Brometalia* grassland identified in Annex 1 of the EC Habitats Directive as of Community interest. The habitat is a priority type if important orchid populations are present. Lowland calcareous grassland sites will form part of the Natura 2000 network.

Many sand dune systems contain biological communities with broad similarities to those of lowland calcareous grasslands. An important influence in this respect is the amount of fragmented shell from marine molluscs which may be present, and which provides a source of free calcium carbonate in the substrate. The "calcareous grasslands" on such dunes may support many species in common with the calcareous grasslands covered by the HAP. The unique grasslands of the Breck region of East Anglia also support many species in common. Communities unique to sand dunes or the Breck are not covered by the present report.

Scrub is often a component of calcareous grassland and can have both positive and negative impacts on the communities present. In particular it can be important in providing shelter for invertebrates and some species appear to be dependent on scrub edge conditions. Scrub is also an important habitat type in its own right; however, the communities of scrub *per se* are not covered by the present report.

1.1.3 Favourable condition and condition monitoring

The objectives of the HAP are phrased in terms of:

- rehabilitation management for all significant stands in unfavourable condition;
- achieving favourable status for all significant stands of lowland calcareous grassland.

Definitions of unfavourable condition and favourable status need to fully acknowledge the conservation requirements of the invertebrate communities which may be present. The present report aims to draw attention to key features of lowland calcareous grasslands which are important to the conservation of their specialist invertebrate fauna.

1.1.4 The Habitat Action Plan

The proposed actions of the HAP include:

- encourage, develop and disseminate best practice for unimproved calcareous grassland management, in particular the integration of conservation management into agricultural practice (Action 5.3.1);
- review research needs into the conservation and restoration management of the habitat and the integration of this with agriculture, to identify significant gaps in knowledge. Commission and undertake new research as appropriate. (Action 5.5.4);
- encourage and support conservation studies on scarce animal and plant taxa associated with unimproved calcareous grasslands with particular relevance to amelioration of damaging impacts from habitat depletion and fragmentation. (Action 5.5.6).

This new report is intended as a contribution to these actions.

1.2 Specific objectives of this report

Although there is a substantial amount of information available (both published and unpublished) concerning the invertebrate fauna of lowland calcareous grassland – especially its responses to different nature conservation management regimes - this information has never been brought together to provide an overall picture of the specialist fauna within the UK.

This current project aims to bring together much of the available information to help field workers and managers alike to understand the importance of such faunas.

The project also aims to show what features of grassland are of particular importance by providing information on rarity, fidelity, continuity and microhabitat preference.

2. The invertebrates of calcareous grasslands

2.1 Characteristics of the fauna

The invertebrate fauna of lowland calcareous grasslands has been most extensively studied by E. Duffey in the 1960s and 1970s (Duffey, 1962, 1978, etc) and M.G. Morris from the mid 1960s into the 1990s (many papers; see References section), and, more recently by C.W.D. Gibson and V. K. Brown (eg Gibson *et al*, 1992). More general reviews have been provided by Richards (1964), Duffey *et al* (1974) and Hillier *et al* (1990). Lack (1982) has considered the relationships between the flowers and their pollinators.

Many factors influence the composition of the fauna of calcareous grasslands. The three key influences are climate, soil and management history, and these combine in a variously unique way on each defined site and generally within sites. Each of these key features also has influence at different scales:

- climate varies according to the region of the country, but also with land form, especially aspect and shelter. The degree of exposure to strong sunshine, wind, and frost impose further variation upon the local temperature and precipitation patterns.
- earth science aspects include the influence of bedding planes, jointing and erosion features, such as accumulations of rock rubble, as well as soil depth and the effects of any deposits such as loess or more recent wind-blown materials which may mask the influence of the bedrock and affect the drainage;
- the continuous history of a site as a grassland may be complex, with fluctuations in grazing intensity, duration, season, and type of grazing animal; the grassland may be long-established or, at the other extreme, only recently created. These features may have operated locally within the site or across the whole site. The behaviour of the grazing animals will also create and/or maintain local patterns.

These key features will also have indirect impacts on the fauna. The local climate will affect the pace and timing of plant growth, flowering and seed-set, as well as competition between plant individuals and species. The processes of soil formation and development will affect the fauna through the balance of water and nutrients. The grazing fluctuations influence sward height and composition as well as the presence and composition of trees and shrubs. Trees and shrubs - both within the grassland and adjoining it – contribute to shelter and local microclimate. In many cases the fauna will be dependent on the presence of both the grassland and the trees and shrubs.

These factors combine to provide a habitat type of unique species composition and one of the most species-rich grassland types in Britain – potentially **the** most species-rich. Curry (1994) comments that base-rich temperate grasslands with abundant earthworms tend to support the highest faunal biomass of all the world's grasslands, the biomass often exceeding 100g fresh mass per square metre.

Some of the more important features of calcareous grasslands for invertebrates are as follows:

- floral species –richness.
- habitat structure or architecture;

- temperature regimes;
- friable soils, for burrowing;
- high concentrations of certain nutrients in soils and surface material, especially calcium carbonate.

More information on these aspects may be found in Kirby (1992).

Very short swards tend to favour open ground species including predators and foliage feeders, and, if the short sward is maintained by large herbivores, dung fauna. Taller flowery swards, maintained by periodic grazing followed by relaxation of grazing pressure, tend to favour plant-feeders associated with flowers, fruits and buds. Denser, coarser grasslands with few flowers but abundant litter favour decomposer species, as well as provide cover for roosting. All sward types are valuable for important species, and some important species actually require more than one type or even detailed mosaics.

South-facing slopes are important because they intercept much greater amounts of solar radiation compared with other aspects or even level ground. Species near the northern edge of their range are often confined to calcareous hillsides on account of the thermal properties of the rock rather than for any other reason.

Often the most obvious reason for the presence of a particular species is not actually the full reason. A good case in point is small blue butterfly *Cupido minimus*, the larvae of which develop in the flower heads of kidney vetch, but the butterfly is actually more or less confined to sites with high calcium carbonate in the soils and absent from most coastal grasslands even when the food plant is present in abundance. Equally, since the larvae require the development of sufficient flower heads of kidney vetch to maintain a viable population, the presence or absence of the species will reflect the characteristics of the grazing practices in recent years.

Although it is well known that the invertebrate communities of calcareous grasslands show variation in response to differences in environmental factors such as climate, rock and soil type, floristics and vegetation structure, such variation cannot be fully assessed at present because the communities themselves have not yet been fully described and classified.

With many insect species the requirement is for a mosaic of features rather than one single feature alone. Bumblebees provide a particularly complex example, requiring:

- forage areas;
- nesting areas;
- mating areas;
- hibernation areas.

These features may not all occur within one particular area of calcareous grassland. The nest of a particular bee colony may be in one patch within the landscape while foraging may occur in one or more other patches. Bees and wasps provide a special case where it is habitat availability at landscape level is more important than at site level (see 2.4.11 below).

Tussocky areas are known to be important structural components of grassland for spiders (Cherrett, 1964) and other invertebrates (Luff, 1966). Litter layers below the plants stems important for many species, eg money spiders (Duffey, 1962). Other species live in the upper parts of the vegetation

The major source of information on the habitat requirements of most invertebrates remains anecdotal. Valuable though this is, it has severe limitations. Systematic investigations of the habitat have been carried out to some extent. An early example is the fieldwork in 1968 and 1969 by the Nature Conservancy which led to the publication of *A Nature Conservation Review* (Ratcliffe, 1977). Standard vacuum net (Morris, 1969) samples were taken from a number of key lowland calcareous grassland sites and three groups – Heteroptera (plant bugs), Auchenorhyncha (leafhoppers and planthoppers) and Curculionoidea (weevils) were chosen to represent the whole fauna. The samples were compared with those taken from a reference site (Barton Hills, Bedfordshire) where the fauna was well known.

This early work has been followed up to a considerable extent by M.G. Morris in particular, covering Hemiptera and Coleoptera (many papers; see References section), and, more recently by C.W.D. Gibson and V. K. Brown (eg Gibson *et al*, 1992). Detailed species research has been concentrated on butterflies (recently summarised in Asher *et al*, 2001) and increasingly on moths. It is beyond the scope of the present report to review all of this work in detail.

2.2 Sampling methods

Quantitative methods available for sampling grassland invertebrates are:

- quadrat sampling using vacuum samplers or hand search;
- cutting soil cores.

Species are often present at low densities however and the probability of detection using standardised quantitative sampling techniques can be relatively low. Other techniques will be needed for species recording purposes:

- pitfall trapping can be very useful in recording the more active species;
- targeted vacuum sampling;
- malaise traps;
- emergence traps;
- light traps;
- water traps;
- hand netting;
- direct capture by hand or via a pooter.

Details of these and other techniques may be found in Southwood (1978) and Clements (1982) – the latter focuses solely on grassland techniques.

"Watching" may be the best overall technique for compiling a site inventory and for locating key areas, eg nesting banks for bees and wasps.

Rearing may also be necessary, eg for stem-nesting bees.

2.3 Survey programme

A survey programme should ideally cover the full seasonal variation in invertebrate activity. This would start in early spring (March/April) to cover the early mining bees which forage at blackthorn and sallow blossom, and extend into the autumn for species associated with fungal fruiting. Certain groups – notably spiders and bugs - are best surveyed in the latter half of the season, from July onwards, although key species would be missed if only that period were to be covered. Invertebrate life cycles come in various forms, but the commonest are:

- spring breeding and adult over-wintering, so the more readily identifiable adults are available for recording spring and autumn, but only the immature stages are present during summer period;
- summer breeding, whereby adults are available for part of summer period at least, but only immature stages at other times of year.

A minimum of one visit per month between April and October is advisable, and - if at all possible - coinciding with extended periods of calm, fine, sunny weather.

2.4 Structure of the lists of species characteristic of calcareous grasslands

Section 2.5 includes information on the main groups of invertebrates which may be found on calcareous grasslands. For many of the larger groups a table of the calcareous grassland species has been compiled which provides information on their biology and ecology, and gives an estimate of the extent to which they are associated with calcareous grasslands and with long-established grasslands. Before those sections some introductory information is provided to explain the reasoning behind some of the table columns.

2.4.1 Explanation of column headings

Column headings in the table are based on those used by Lott (2002).

Habitat fidelity

The following habitat fidelity classes are used:

High: Species routinely recorded from calcareous grasslands. They may also be recorded to a greater or lesser degree from other open habitats on freely-draining soils, but it is likely that they are mainly dependent on calcareous grasslands to sustain viable populations.

Moderate: Species routinely recorded from calcareous grasslands, but also from semi-natural open habitats on freely-draining soils over all or part of their geographical area of distribution.

Low: Species frequently recorded in numbers from calcareous grasslands, but predominantly associated with other types of open habitats over all their British area of distribution.

The classification of species into fidelity classes is based on literature records and personal experience of the author and the various invertebrate experts who were consulted. It is not based on objective criteria and should be regarded as indicative rather than an authoritative ecological classification.

Continuity

Grasslands have in the past been regarded as cultural artefacts and their communities therefore not truly "natural". Bush & Flenley (1987) demonstrated evidence for persistence of chalk grassland throughout the pre-boreal and boreal periods at a site in Yorkshire. However the validity of regarding grasslands as ancient habitats and part of the original post-glacial vegetation cover of Britain has received new and strong support from the work of Vera (2000). The natural forest vegetation of Britain may now be viewed as a dynamic mosaic of open and closed canopy habitats, with grasslands a characteristic feature of the mosaic of tree and shrub density. Grasslands may now be regarded as habitat types as long-established in Britain as woodlands.

Habitat continuity is known to be a factor of considerable importance in species-richness in woodland and especially wood-pasture communities. It is basically related to mobility, in that species which are relatively immobile are relatively poor at colonising sites with suitable habitat for them, the result being that they are effectively confined to sites which have always contained sufficient habitat to maintain viable populations of the species concerned and from which the probability of them reaching and colonising other areas is low. Species of medium colonising ability are more likely to be able to colonise suitable habitat a relatively short distance away from suitable breeding habitat, whereas species of high colonising ability are capable of crossing large expanses of unsuitable habitat in search of new sites.

All British species are of course mobile to some extent – all managed to colonise or re-colonise Britain following the last glaciation. However, habitat fragmentation and isolation has increasingly imposed constraints of the ability of species to colonise sites and for populations to intermix.

Habitat recreation projects – either by scrub clearance or from intensive farmland – initially attract pioneer species characteristic of ephemeral or disturbed habitats. As time progresses colonisation proceeds. However, the more isolated the site from existing long-established habitat then the lower the probability of it being colonised by the less mobile species. The concept of reversibility does not apply – once old grasslands are lost their characteristics are not readily recreated within human lifetimes. Newly created grasslands become something different, of their own distinctive character, with their species composition a clear indicator of their history.

Little knowledge is actually available on species mobility in calcareous grasslands – or elsewhere - and a practical way forward has had to be developed. In the case of flightless species, these are assumed to be good indicators of habitat continuity unless there is good evidence otherwise.

It should be noted however that the possession of full wings does not necessarily imply that an insect is able to use them for active flight. The subject of flight capability in ground beetles, for instance, is a complex one. Certain species, eg *Nebria brevicollis*, are fully winged and have function flight musculature primarily during the period between eclosion from the pupal stage and the first summer period of aestivation. Older individuals therefore still possess full wings but the flight musculature will have become re-absorbed in the majority of individuals and are no longer functional (see Alexander, 1986, for example). In other species the wing cases are fused together, eg *Pterostichus madidus*. The latter species is nonetheless highly mobile since it is capable of inhabiting most lowland situations and so barriers to movement tend to be geographic features, notably rivers, but these may still be crossed passively in flood debris.

The concept of continuity has a resonance with specialists in beetles, bugs, grasshoppers, molluscs and spiders and is clearly meaningful in these orders. But it is regarded as irrelevant to certain specialists in bees and wasps. Clearly bees and wasps are highly mobile species which are reliant on the presence of suitable habitat at landscape level rather than smaller scale.

Reliable data on continuity is difficult to obtain. Detailed site histories are rarely available for lowland calcareous grasslands. The experience of recorders is of course subjective but is in most cases all the evidence that is currently available. The continuity gradings presented in this report should be regarded as provisional at this stage.

Climate change will also impact on continuity through its influence on species mobility. Restricted mobility in many cases will be partly due to the availability of favourable conditions for flight activity. With changing temperature and humidity regimes, formerly relatively immobile species may become increasingly able to colonise sites, and vice versa. Increased windiness will also impact on the distances over which invertebrates may be carried.

There is obviously a link between continuity and rarity, in that the ranges and patterns of distribution of the more immobile species will have become increasingly fragmented and localised in response to deterioration in habitat quantity and quality. But the overlap is far from complete. Many highly mobile species, for instance, are rare due to limited availability of habitat, notably amongst wetland species.

Structure of habitat

Few of the species concerned have been subject to detailed studies of their habitat requirements and the information provided is taken largely as stated in the listed sources without any attempt to further classify or categorise. In many cases the text records personal experiences of the species concerned.

Status

The national conservation status indicated is taken from the Recorder biological recording software package. This consists of provisional red data book (RDB) listings and different categories of national scarcity (NS). A review of these gradings is urgently needed in the light of new information and improved understanding of the species concerned.

Priority Species identified under the UK Biodiversity Action Plan are also highlighted.

Literature references

References used to establish the calcareous grassland affinities of species are given here together with other references to detailed treatments of individual species' habitats. A complete literature review has not been undertaken.

Synonyms

Synonyms in general usage are listed and are mainly from relatively recent changes or where key texts are now quite old and using superseded nomenclature.

2.5 The species assemblages

2.5.1 Molluscs

Molluscs are an invertebrate group with a very obvious link to calcareous habitats, with their need for a source of calcium carbonate for shell formation. However, the freely-draining nature of calcareous soils also makes them particularly dry situations for such a generally moisture-loving group. The dry calcareous grasslands do not therefore support high species-richness, although the species which can exploit these conditions may occur in some abundance and the species composition is of considerable nature conservation interest. The best introduction to the habitats of land molluscs is still Boycott (1934) while Kerney & Stubbs (1980) provide a more up-to-date discussion of the conservation importance of the group. The main identification guide is Kerney & Cameron (1979) and the most up-to-date information on distribution is Kerney (1999).

A group of medium-sized lime-loving snails are characterised by their relatively thick whitish or black and white shells which help them to tolerate the intense sunlight and heat to which they are often subjected. These are striped snail *Cernuella virgata*, heath snail *Helicella itala*, wrinkled snail *Candidula intersecta* and the similar *C. gigaxii*, and are widespread across the downlands of southern and eastern Britain. Carthusian snail *Monacha cartusiana* has a more restricted range in the south-east and tends to favour taller swards, while point snail *Cochlicella acuta* is a maritime species. All may also be found in calcareous sand dune grasslands.

These species live exposed and unprotected within short swards. They make little attempt to burrow into the turf or get into any shelter, and under the hottest conditions, escape from the overheated ground by ascending the stalks of any available plants.

Two other species are also characteristic of short swards - large chrysalis snail *Abida secale* (Nationally Scarce) and moss chrysalis snail *Pupilla muscorum* - but are smaller and are able to make use of the cover provided within short or open swards to avoid the hottest and driest conditions. Stones and rock rubble also provide retreats well-used by these species – they provide places with a relatively high humidity to escape drought and for egg-laying. *Pupilla* has been shown to need vegetation shorter than 10cm high (Cameron & Morgan-Huws, 1975). These two species are also widespread across southern Britain, with more localised

populations further north. *Pupilla* also occurs in calcareous sand dune grasslands but *Abida* does not.

Round-mouthed snail, or land winkle, *Pomatia elegans*, and the tiny blind snail *Cecilioides acicula* also require a high lime content and are primarily soil-living species. They need a loose friable soil in which to burrow. Shade and shelter are important for *Pomatias* and it is not normally found on the more open downs. *Cecilioides*, in contrast, favours un-wooded sites.

Another adaptation to living in relatively hot and dry conditions is breeding during the autumn and winter months, enabling the eggs and young to avoid the most extreme conditions, and, as the xerophiles are commonly resistant to cold and hardly hibernate, the young can grow during the cooler months. *Pupilla* is unusual in being viviparous (Boycott, 1934). The above species all normally have annual life cycles, with a life span of 9-15 months. The larger snails do live much longer, however. Roman snail *Helix pomatia* is a lime-requiring species which occurs on some downlands and individuals have been recorded living for 10-15 years.

In addition to these species there are a range of snails and slugs which occur in dry calcareous grasslands but are much less confined to them. These are often found in greater abundance on north-facing hillsides, unlike the true downland species which are often absent from the cooler and moister slopes. The most characteristic is ribbed grass snail *Vallonia costata*, and is mostly known from dry places. The more catholic species include hairy snail *Trichia hispida*, eccentric grass snail *Vallonia excentrica*, smooth grass snail *Vallonia pulchella*, the whorl snail *Vertigo pygmaea*, netted slug *Deroceras reticulata* and pellucid glass snail *Vitrina pellucida*.

The normal food of most molluscs is the decayed remains of vascular plants, fungi, lichens and algae. The partly digested plant material of rabbit and sheep dung is attractive to molluscs for this reason. Live vegetation is much more rarely eaten and by a restricted range of species, but particularly by the commoner slug species. Most wild plant species have some natural protection from mollusc grazing, notably hairs, oxalate crystals and other chemical compounds in the sap – cultivated plants have generally had these defensive characters selected out and hence are much more vulnerable. The downland specialists are primarily vegetarian but some of the more widespread species are more omnivorous, feeding on other molluscs, earthworms and other invertebrates.

The generalist feeding habits of molluscs mean that food is seldom limiting on their distribution or abundance. Rather it is the structural, moisture, chemical and land-use history aspects of the environment which determines the faunal composition. Dew can be important on dry calcareous grasslands as a source of moisture – its quantity is dependent on local topography.

Although certain species favour the dry environment of calcareous grasslands, moisture is still very important. Snails and slugs move on a film of mucus and movement therefore consumes moisture, which needs to be replaced by feeding and drinking. Activity tends therefore to be greatest when humidity is highest, especially at night and during wet weather. Under dry conditions the molluscs first seek out retreats and then enter periods of inactivity, making their location for recording purposes difficult.

The mobility of molluscs is often assumed to be low since slugs and snails appear to be restricted to a very slow pace through their habitats, especially with their need to maintain body moisture and consequent inactivity under relatively dry conditions.

However some species are capable of rapid dispersal through the countryside. Girdled snail *Hygromia cinctella* is a good example of a species of well-drained, base-rich soils, which is currently spreading rapidly. It is a common Mediterranean species, accidentally introduced into the Paignton, Devon, area where it was first noted in 1950. Within the past 10-15 years it has spread widely across the south west and south of England and has already reached the West Midlands (Kerney, 1999). The rapid spread is believed to have been facilitated through garden centres and the great expansion of the garden trade in recent decades, the snails being transported amongst plants, furniture and construction materials. Other snail species have been noted adhering to sheep wool, etc, and so being transported from area to area along with livestock.

Of the calcareous grassland specialists, banded snail *Cernuella virgata*, wrinkled snail *Candidula intersecta* and *C. gigaxii* appear able to colonise suitable habitat relatively quickly and rapidly colonise downland re-creation sites. *C. gigaxii* may actually prefer disturbed soils (Willing, 1993)..

At the opposite extreme are a few species which are confined to calcareous grasslands and which appear to be very poor colonists. The sensitivity of these species to disturbance and their relatively poor mobility makes the molluscs as a whole particularly good for assessing the naturalness and long term stability of sites and hence their nature conservation importance.

The key species of lowland calcareous grasslands with high habitat continuity are:

- large chrysalis snail *Abida secale*;
- moss chrysalis snail *Pupilla muscorum*;
- heath snail *Helicella itala*;
- lapidary snail *Helicigona lapicida* (favours rocky situations, with deep crevices).

Three further species are extremely localised and known from very few sites:

- cylindrical whorl snail *Truncatellina cylindrica* (eastern);
- British whorl snail *Trancatellina callicratis* (southern coast);
- Carthusian snail *Monacha cartusiana* (confined to far south-east, especially coastal sites).

The most important considerations for land managers are:

- management stability:
  - old grassland is better than reverted ploughed land or land cleared of scrub;
  - grazing pressure does not have to be relaxed for very long before a massive change in fauna occurs;

- the use of pesticides, herbicides, veterinary drugs, etc, may directly kill molluscs or adversely change their habitat;
- soil compaction from heavy trampling and vehicle use causes damage to soil structure and hence also to natural drainage, with serious consequences for molluscs;
- habitats mosaics support the widest variety of species;
- heavy grazing by sheep can be damaging, as they have been reported to selectively eat heath snail *Helicella itala*, for instance;
- excessive clearance of scrub destroys shelter and increases desiccation from wind;
- debris of various sorts provide valuable moist retreats, and so the removal of fallen trunks and branches, for example, may reduce snail populations;
- grassland fires are very damaging;
- successful re-introduction of species such as heath snail *Helicella itala* have not yet been demonstrated.

2.5.2 Millipedes

A number of millipede species appear to have some specific association with calcareous soils in Britain but none can be considered to be calcareous grassland specialists. Most tend to be associated with woodland habitats.

Most millipedes feed on dead vegetation which has been on the ground for some time and has undergone some microbial decomposition, such as plant litter (Blower, 1985). They are therefore involved in the natural recycling of that material back into the soil. Millipedes do feed on living plant material on occasion, however, particularly the delicate rootlets of seedlings. Some occasionally feed on dead animal matter.

The majority of species live on the soil surface and within litter layers above. They also burrow into the soil when the need arises – for moulting, egg-laying, avoidance of summer droughts and winter cold. Some are more subterranean in habit. Surface active species make use of debris as refuges when inactive, eg moving beneath rocks, logs, etc. As they lack a waterproof coating they need to confine their activity to humid conditions.

Millipedes are long-lived animals in comparison to most other terrestrial invertebrates. The common pill millipede *Glomeris marginata* takes several years to mature and can live for up to eleven years. Their longevity may relate to the poor quality of their food (Hopkin & Read, 1992).

Millipedes have rather limited powers of dispersal, although passive transport through human activity is undoubtedly an important consideration today. Active dispersal is primarily by walking. Some species are great wanderers while others tend to remain in their optimum habitat. Activity tends to be under moist conditions and so largely at night.

The species most likely to be found in calcareous grasslands are the very widespread *Cylindroiulus caeruleocinctus*, the blind *Blaniulus guttulatus* and the small flatback *Brachydesmus superus*. Open swards with bare chalk or limestone exposed may also have bristly millipede *Polyxenus lagurus* which favours the open rock habitat, feeding on debris

amongst the encrusting lichens and using the humid environment beneath marginal vegetation mats for shelter under drier conditions.

The main identification key is Blower (1985), preliminary distribution maps are available (British Myriapod Group, 1988), and there is a general book available on their biology (Hopkin & Read, 1992).

2.5.3 Centipedes

Centipedes are active predators, feeding on live prey – a wide variety of other invertebrates. They have powerful poison-claws with which they are able to grasp, paralyse and/or kill active prey. As with millipedes and woodlice, they do not have the waxy coating that insects have, and need to remain in moist situations. They therefore tend to be active at night and avoid extremes of heat and cold. This makes calcareous grasslands, and especially short swards, a very specialist habitat for them and few species are normally present.

Temperature and humidity is more suitable for them in spring and autumn. In periods of summer drought and winter cold, centipedes are found in the moister and sheltered environments beneath stones, in decaying wood, and deep in crevices in the soil.

The main identification work (Eason, 1964) is now very out of date. A provisional distribution atlas is available (Barber & Keay, 1988).

2.5.4 Woodlice

The commonest woodlouse on calcareous grasslands is usually the very widespread *Philoscia muscorum*, but other widespread species may also occur, especially the common pill woodlouse *Armadillidium vulgare* and the small *Trichoniscus pusillus*. The other two most widespread species *Oniscus asellus* and *Porcellio scaber* may also be present, especially if there are open rocky or stony areas present. The ant guest woodlouse *Platyarthrus hoffmannseggi* is another widespread species but is most often found on calcareous grasslands, living in the nests of a wide variety of ant species.

Additional species may be present, depending on where in England and Wales the site is situated, and these may be considered to add quality to the fauna:

- *Trichoniscoides sarsi*, a soil species, the few British records (south and east) all being from grassland and screes, particularly on chalk;
- *Armadillidium nasatum*, a natural constituent of calcareous or coastal grassland in the south-west, but in more disturbed habitats elsewhere;
- *Armadillidium pictum*, from base-rich rocky situations in western Britain, as well as ancient wood pastures;
- *Armadillidium pulchellum*, with strong populations in the rocky limestone grasslands of the Peak District, Yorkshire Dales and elsewhere in the north and west; also in certain ancient wood pastures and heathlands;
- *Porcellio dilatatus* known from a few calcareous grassland sites in central southern England, but also in derelict buildings, etc;
- *Porcellio spinicornis*, in limestone rock rubble and drystone walls.

Amongst these additional species, it is suggested that only *Armadillidium pulchellum* should perhaps be regarded as an indicator species of high quality calcareous grassland.

The only general account of British woodlice is Sutton (1972). The most up to date identification key is Hopkin (1991), and distribution maps with some information on habitats is also available (Harding & Sutton, 1985).

2.5.5 Spiders

The spider species of calcareous grasslands are relatively well-known, particularly through the work of Merrett and Duffey (1962). Merrett produced the first attempt at definition of the spider fauna of the habitat (in Ratcliffe, 1977). As with so many invertebrate groups, many of the characteristic species are common to both calcareous grasslands and acidic heathlands, emphasising the importance of dry ground on freely-draining soils rather than the availability of calcium carbonate. However, knowledge of the autecology of the spiders concerned is very sparse.

Research on grassland spider communities has been developing over the last 10-15 years (eg Rushton & Eyre, 1989, 1992)

Spiders capture live insects and other arthropods for food. Many are active predators running down or ambushing their prey. Others spin webs to ensnare their prey. The prey may be immobilised not only by silk but also by poison injected from the fangs which are used to bite and crush.

Mobility is normally by wandering, but some spiders also have the capacity to travel by air. Strands of silk may be produced and used as a kite to carry the spider into the air – commonly referred to as ballooning. This aerial dispersal is most effectively carried out when warm days follow a cold spell and air currents are rising (Roberts, 1995). Young spiders of many species can do this as well as adult spiders of smaller species.

With such a large and diverse group of invertebrates a table has been compiled which lists the associated species (Table 1). The key habitat requirements on calcareous grassland sites are:

- diverse vegetation structure and especially mosaics of different structures;
- areas of sparsely-vegetated or bare ground, both as heat traps, and as arenas for hunting and chasing prey;
- microclimate.

Richter (1971) has sown that humidity and wind conditions influenced dispersal patterns in juvenile spiders and Rushton *et al* (1989) and Rushton & Eyre (1989) both concluded that external colonization sources are important in determining between year differences in the species composition of managed grasslands.

Rushton & Eyre (1992) report that in most cases the importance of land management on spider communities has been directly related to its effects on vegetation structure. Short intensively used grasslands have fewer spider species than long under-utilized grasslands because the diversity and number of sites suitable for web construction is lower in short

grassland. However, the short sward conditions can be important for specialists requiring relatively higher temperatures and open areas for hunting prey.

Many management factors that influence structure have been shown to influence spider communities: cutting (Rushton, 1988), burning (Haskins & Shaddy, 1986), fertilizer use (Kajak, 1978) and complete sward destruction (Duffey, 1978; Rushton *et al*, 1989).

There are, however, other non-vegetation mediated aspects of management which can be important. The use of biocides has obvious direct effects on spider communities in agricultural systems, whilst other management practices may have more subtle effects. Rushton & Eyre (1989), for instance, showed that the way in which intensively grazed pasture was utilized influenced the communities present, with silage production favouring ground web producing species like *Milleriana inerrans*.

Rushton & Eyre (1992) also report that descriptive discriminant analyses to suggest that after the management and vegetation variables, soil water content and site altitude were the next most important variables influencing spider community composition. They go on to suggest that it should be possible to predict the type of spider community present on a grassland on the basis of these four variables.

The current species identification works are Roberts (1993 & 1995) and provisional distribution maps are now available (Harvey *et al*, 2002).

2.5.6 Harvestmen

Like spiders, harvestmen feed on a wide variety of other invertebrates. They scavenge dead and even faecal material, as well as take live prey.

A few species appear to have some association with calcareous grasslands, although none are specific to them. The first three are western European species:

- *Anelasmocephalus cambridgei* is sometimes frequent in chalk grasslands, living amongst the grass litter and moss;
- *Homalenotus quadridentatus* occurs in similar situations;
- *Paroligolophus meadii* is also a ground living species which is regularly present in calcareous grasslands – this a rare species of the extreme Atlantic zone of western Europe;
- *Opilio saxatilis*, mainly ground living and in dry situations, including chalk grassland;
- *Trogulus tricarinatus*, mainly a species of calcareous woodlands but it does occur in scrub and open grasslands, especially in taller swards with well-developed litter layers.

The identification guide is Hillyard & Sankey (1989) and provisional distribution maps are available (Sankey, 1988).

2.5.7 Orthoptera (Grasshoppers & Crickets)

The British Orthoptera are only a small group of species and, while a high proportion of them may be found on calcareous grasslands, very few may be considered to be characteristic of this type of grassland.

The two key species are: rufous grasshopper *Gomphocerippus rufus* and stripe-winged grasshopper *Stenobothrus lineatus*. The former favours medium length grassland in warm sheltered situations on calcareous soils, and generally where there is much woody growth providing the shelter. The latter favours warm dry places, generally where the turf is broken, and occurs in heathlands and coastal sand dunes as well as calcareous grasslands. Both are regarded as good indicators of old species-rich turf on calcareous hillsides.

Two further localised grasshopper species may also be present on calcareous grasslands. Woodland grasshopper *Omocestus rufipes* may be present on the more heavily wooded grassland areas, while mottled grasshopper *Myrmeleotettix maculatus* may be present in areas of more open and generally rocky turf.

The Wart-biter *Decticus verrucivorus* is the most strongly associated of the bush-crickets, and favours grassland mosaics. The adults are associated mostly with tussocky areas, generally tor-grass, while the immature stages favour finer swards with good flowering.

The key publication for identification, ecology and distribution is Marshall & Haes (1988).

2.5.8 Hemiptera (true bugs)

The true bugs have piercing and sucking mouthparts, and most feed on plant sap. Some also, or exclusively, feed on other arthropods. Lifestyles and habitats are very variable. An introduction to the group is provided by Dolling (1991).

The body form is compact and the central nervous system is greatly concentrated, allowing a rapidity of response and degree of behavioural complexity more comparable with the Coleoptera, Diptera and Hymenoptera than with the invertebrates covered in the preceding sections.

Identification guides that cover the whole order are non-existent. The true bugs are normally classified into three major groupings: Heteroptera (plantbugs), Auchenorhyncha (leafhoppers and planthoppers) and Sternorhyncha (aphids, whiteflies, scales, etc). Only the first two are sufficiently well-known in native vegetation for the characteristic fauna of calcareous grasslands to be identified, although the Auchenorhyncha are much less well known in comparison with Heteroptera.

A large number of species are involved and these are detailed in Table 2. Calcareous grassland faunas have been studied my a number of workers: Auchenorhyncha (Cook, 1996 & 1997; Hawes & Stewart, 1997; Morris, 1971,1972; Thompson, 1983) and Heteroptera (Morris, 1969, 1973b). Grassland Auchenorhyncha – being predominantly grass-feeding species - are greatly influenced by the vertical structure of the vegetation. Taller grasslands possess greater stratification and hence a wider range of niches. Short grasslands nonetheless have their own characteristic assemblages of species. A general relationship between the height of the vegetation and the abundance and species-richness of Auchenorhyncha has been

demonstrated for chalk grasslands (Morris, 1971a) and for Carboniferous Limestone grasslands (Morris, 1974).

The main identification to Heteroptera remains Southwood & Leston (1959) although this is now very out of date. Auchenorhyncha are covered by a series of Handbooks published by the Royal Entomological Society (Le Quesne, 1960, 1965, 1969, and Le Quesne & Payne, 1981). No provisional distribution maps are available.

2.5.9 Lepidoptera

The habitat associations of the larger moths are relatively well-known and it is relatively straightforward to produce a list of species which are characteristic of lowland calcareous grasslands. John Heath produced one for Ratcliffe (1977) but a more up to date one –based on improved knowledge - has been created specifically for the current report – see Table 3. The relative importance of site features for the individual species is however more difficult to discern from the literature. The emphasis in the listing is very much based on larval foodplants.

The main guides are Skinner (1984) for the adult stages and Porter (1997) for the larval stages. The incomplete series *The Moths and Butterflies of Great Britain and Ireland* also covers some of the families.

The rest of the moths are in general much less well known, and especially from the point of view of ecological relationships. Although a provisional listing is feasible, it was decided to omit them from this first review of the fauna due to the poor state of ecological knowledge.

Butterflies are unusual in being very well-studied invertebrates and the literature has recently been summarised by Asher *et al* (2001). Ecological studies of the various calcareous grassland species are extensive. With butterflies being so well studied and having such an extensive literature of their own it was decided to exclude them from the present report.

2.5.10 Diptera

The two-winged flies comprise a large and diverse group with an incredible range of breeding strategies. A wide variety of Diptera may be found on calcareous grasslands and some are characteristic of the habitat. A full review of the order has not been undertaken, however, as ecological knowledge is notably incomplete in large sections of the fauna. Some better known families are considered in brief here.

The most intensively studied flies are the hoverflies (Syrphidae), but few appear to be specific to calcareous grasslands. While many of the downlands are known to be rich in species, this appears to reflect the diverse structure of scrubby woodland edge and glade conditions rather than open grassland conditions – it is the open mosaic of vegetation heights and structures that is more important than any individual vegetation type component. Stubbs and Falk (2002) provide a brief overview of the dry grassland fauna and identify the rare *Microdon devius* as the only speciality of the habitat. This species is dependent on yellow meadow ant *Lasius flavus*, the larvae living within their nest mounds feeding on the eggs and larvae of the ant. Other typical species are the more widespread *Platycheirus manicatus*, *Paragus haemorrhous* and *Pipizella viduata*. Amongst the scarcer and more interesting hoverflies which are often present on calcareous grasslands where there is shelter from scrub

or woodland, and where there are plenty of tall flowers, are various *Chrysotoxum* species – *C. cautum*, *C. elegans*, *C. festivum* and *C. verralli*. These all also appear to have larvae associated with ants of the genus *Lasius*. Stubbs & Falk (2002) is the most up to date guide to the family and distribution maps are available (Ball & Morris, 2000).

Stubbs and Drake (2001) provides a guide to some of the larger and most popular flies of the Brachycera grouping of families. They point out that lowland calcareous grasslands have an important fauna and pick out a number of specialists:

- the uncommon hunchback fly *Paracrocera orbiculus* (Acroceridae)), with larvae internal parasitoids of gnaphosid and lycosid spiders;
- the scarce snipefly *Symphoromyia immaculata* (Rhagionidae), more or less confined to dry calcareous grasslands, especially the warmest areas and away from districts with late frosts, favouring moderately long but not dense swards;
- the scarce and little known horsefly *Tabanus glaucopis* (Tabanidae);

and a number of robberflies (Asilidae):

- *Dioctria atricapilla*, which favours taller, but open structured swards, and is also found in neutral meadow grasslands, preying upon other flies and smaller wasps;
- *Leptarthrus brevirostris*, a species of ancient semi-natural grasslands on freely-draining soils, and confined to the moorland grasslands of northern and western Britain as well as lowland calcareous ones, usually those dominated by upright brome;
- *Machimus atricapillus*, a more widespread species present on most lowland calcareous grasslands preying on various other flies and occasionally other types of insect;
- *Leptogaster cylindrica*, a species of taller and denser but not too coarse grasslands, preying upon small flies and other invertebrates;
- *Leptogaster guttiventris*, a scarcer and little known species, probably favouring scrubbier sites than *L. cylindrica*;

as well as the rarer:

- *Leptarthrus vitripennis*, only recently recognised in Britain and best known along the North Downs;
- *Machimus rusticus*, confined to a small number of lowland calcareous or base-rich grasslands;
- hornet robberfly *Asilus crabroniformis*, a very localised species of downs and heaths with livestock grazing, preying upon large insects such as grasshoppers, bees, wasps and dung beetles, while the larvae prey upon invertebrates in the soil beneath cow pats or horse or rabbit dung.

A more restricted version of this fauna occurs on neutral dry grasslands.

Robber flies are very much a warmth-loving group and this explains their strong association with calcareous grassland hillsides.

A few other species also merit some mention.

Bee-flies (Bombylidae) require hot sunny conditions and are parasitoids of mining bees and wasps, and so are often a feature of calcareous grassland hillsides. The very local dotted bee-fly *Bombylius discolor* is often recorded on calcareous grassland sites, probably associated with *Andrena* spp bees, as well as the much more widespread *B. major*. The very rare *Villa cingulata* is particularly associated with certain calcareous grassland systems, but its ecology is virtually unknown.

The rare and little known snipefly *Rhagio strigosus* is associated with scrubby calcareous grasslands in the North Downs and Chilterns.

Stilettoflies (Therevidae) have very active eel-like larvae which live in warm friable soils and prey upon soil invertebrates. The widespread *Thereva nobilitata* occurs in calcareous grasslands to some extent while the scarcer *T. plebejus* may also be present more locally. The latter has been associated with more disturbed situations, but this can involve natural land-slippage or loose rubbly slopes as well as human activity.

Distribution maps are available for a selection only of the species (Drake, 1991).

Wasp flies (Conopidae) are internal parasitoids of aculeates and the species-richness of aculeate communities on calcareous grasslands is reflected in a relatively species-rich conopid fauna. The small dark species are the species most strongly associated with the habitat: *Thecophora atra*, *T. fulvipes*, *Zodion cinereum* and *Z. notatum*. Smith (1969) is the main published guide but keys and other information have also been produced by the Conopid Recording Scheme (Dipterists Forum).

The acalypterate families include many species associated with calcareous grassland. The picture-winged species are the best known.

Calcareous grasslands where flowering and seed-set is possible – either through little or no grazing during the high summer period, or through a hay-cutting management regime - may support a good range of fruit flies (Tephritidae). Few are actually strongly associated with the habitat type *per se*, however, the species composition reflecting much more the abundance and diversity of Asteraceae (Compositae) rather than the calcareous grassland itself.

Knapweed flowering and seed-set is especially important as the two species support a wide range of fruit flies:

- common knapweed supports the very widespread *Urophora jaceana* and *Chaetostomella cylindrica*, as well as the local *U. quadrifasciata* and *Chaetorellia jaceae*, the Nationally Scarce *Acanthiophilus helianthi*, and the Red Data Book *Acinia corniculata* in the developing seed heads;
- greater knapweed supports the local *Terellia colon*, the Nationally Scarce *Urophora cuspidata*, and the Red Data Book *Chaetorellia loricata* in the developing seed heads, while the stem developing *Terellia plagiata* has been found at just one site.

Calcareous grassland thistles are also important:

- musk thistle supports the widespread *Terellia serratulae*, the local *Tephritis hyoscyami*, and the Nationally Scarce *Urophora solstitialis* in the developing seed heads;
- woolly thistle supports the Nationally Scarce *Terellia longicauda*.

Amongst the yellow Asteraceae, mouse-ear hawkweed supports the Nationally Scarce *Noeeta pupillata* and *Tephritis ruralis*, cat's-ear the widespread *Tephritis vespertina*, and hawkbits the Nationally Scarce *Tephritis leontodontis.*

Saw-wort supports the Red Data Book *Urophora spoliata* and *Terellia vectensis*, on southern downlands with large stands of its food plant saw-wort, the larvae developing in the seed heads.

A guide to the Tephritidae is available (White, 1988) as are distribution maps (Clemons, 1996).

Snail-killing flies (Sciomyzidae) are mainly associated with damper habitats but a few specialise in drier habitats and the calcareous grasslands with their abundant snail populations provide a large host resource which a few species are able to exploit: *Coremacera marginata* is one of the more familiar species of the habitat together with *Euthycera fumigata*, *Limnia unguicornis*, *Pherbellia cinerella* and *Trypetoptera punctulata*, but none of these are confined to calcareous grasslands. *Pherbellia knutsoni* is a scarcer species which favours calcareous grasslands. The fly larvae are parasitoids of snails or slugs, feeding within the living host for a considerable part of their development. The main guide in general use is Rozkosny (1984) and distribution maps are available (Ball & McLean, 1986).

Other calcareous grassland acalyptrates include:

- *Geomyza breviseta* (Opomyzidae), a rare species with larvae feeding within grass stems and hence favouring taller grasslands (Drake, 1993);
- *G. venusta*, a Nationally Scarce species with larvae feeding in stems of upright brome and overwintering within the shoots (Drake, 1993);
- the widespread *Herina germinationis* (Ulidiidae), the larvae probably develop in decaying grass litter.

Calcareous grasslands are particularly rich in another important group of flies, the Tachinidae (Wainwright, 1940). This is a family of parasitoid flies, their larvae developing within other arthropods, and predominantly other insects (Belshaw, 1993). The specialists include *Exorista tubulosa* (hosts unknown), *Meigenia majuscula* (on leaf beetles Chrysomelidae), *Gonia capidata* (on certain noctuid moth larvae), *G. picea* (associated with long grass on chalk, developing in larvae of certain grass-feeding noctuid moths), *Zophomyia temula* (hosts unknown), *Neaera laticornis* (with the tortricid moth *Eucosma hohenwartiana* on greater knapweed), *Demoticus plebejus* (hosts unknown but probably moth species), *Bithia modesta* (on clearwing moths), *Solieria fenestrata* (hosts unknown), *S. inanis* (hosts unknown but

probably moth species), *S. pacifica* (hosts Lepidoptera including small tortoiseshell butterfly, and *Gymnosoma rotundatum* (hosts various shield bugs, Pentatomidae).

2.5.11 Hymenoptera

Hymenoptera are another large and diverse group of insects, of variable popularity amongst entomologists and of very variable knowledge of relationships with lowland calcareous grasslands. The aculeates are the best known grouping by far and Table 4 presents a provisional listing of calcareous grassland species.

The problem with associating any aculeate bee and wasp species with any habitat relates to their requirements of pollen and nectar resources, which usually are flowers in open habitats, and of aerial nesters which usually require either dry dead wood or hollow plant stems in sunny situations.

Pollen is a source of protein and is needed for the food store laid down for bee larvae to feed on – species are often very selective on which plant species are used as a supply of pollen. Nectar is an energy food for the adult insects and species tend to be less specialist in the flowers selected. Extra-floral nectaries and honeydew may also be exploited by some species.

Bees and wasps tend to be highly mobile species which operate more at landscape than site level. The concept of continuity probably has little meaning. An individual area of calcareous grassland may supply only part of their habitat requirements – sunny banks for nest sites or areas of flowers for gathering pollen and/or nectar for instance - and it is the overall habitat mosaic within the local landscape continuum that may be more important.

Bumblebees are associated with taller swards of unimproved grasslands although the detail of the ecological relationships is poorly understood at present. Knowledge of relationships with vegetation structure is steadily building up.

Ants as a group favour warm dry situations, and that is the key reason why calcareous grasslands are rich in species and why it is the broken or rocky swards which are most favoured. The more restricted species found in this situation tend to be the most heat-demanding species. A characteristic feature of many long-established calcareous grasslands will be the anthills of yellow meadow ant *Lasius flavus*, although this species cannot be considered as having any particular association with the habitat other than as a grassland, and is not therefore included in Table 4.

Amongst the sawflies (Symphyta) there are notably few species which can be considered as specialists of calcareous grasslands. *Rhogogaster chambersi* larvae feed on fairy flax and are widespread in the habitat, and *Tenthredo amoena* – larvae on perforate St John's-wort – is regularly present. A few other species are mostly found in the habitat: *Tenthredo distingenda*, *Pachynematus calcicola* and – to a lesser extent – *Tenthredo zona* and *T. marginella*.

2.5.12 Coleoptera

The beetles are a very diverse group of insects and it is beyond the scope of this report to review the full range of guides required as sources for identification, ecology and distribution. The basic identification book remains Joy (1932) but a guide to the species

recognised since that date as occurring in Britain is now also available (Hodge & Jones, 1995). The beetle fauna is diverse in size, structure, behaviour and ecology.

Most adult beetles of grassland are more or less active and free-living amongst the vegetation of the ground zone and field layer. Beetle larvae have more varied habits and include inactive forms feeding within plant tissues as leaf-miners or stem or root borers. Others live within the upper layers of the soil feeding on plant roots or are predators. Soil-living forms also include species which feed on subterranean fungi, either the mycelium or the fruiting bodies, eg truffles.

Table 5 presents a provisional listing of the species which are most strongly associated with, and dependent upon, lowland calcareous grassland.

2.6 Invertebrate communities and the NVC

The relationship between the different NVC types and the invertebrate communities of calcareous grasslands has received little attention from invertebrate ecologists. This in part reflects the recognition that habitat structure is of much greater importance than floristic composition *per se*, but also the lack of familiarity with the NVC on the part of invertebrate ecologists and entomologists in general. Whatever the cause, the result has been notably slow progress in reconciling developments in plant ecology with invertebrate ecology in this habitat type.

In the absence of any detailed studies, a preliminary attempt is made here to identify the characteristic features of the different lowland calcareous grassland NVC types in terms of their invertebrate communities.

CG1 *Festuca ovina - Carlina vulgaris* grassland:

- a characteristically short and open tussocky turf, interrupted by fractured rock outcrops and small patches of bare soil;
- distinctive for abundant growth of the woody stemmed wild thyme and rock-rose species, as well as salad burnet;
- mouse-ear hawkweed and common bird's-foot-trefoil often abundant;
- frequent ephemerals, notably carline thistle, but also common centaury, yellow-wort and thyme-leaved sandwort;
- extensive patches of moss on otherwise bare ground;
- on steep and rocky, though stable slopes over hard limestones, with southerly or westerly aspect;
- basically the hot dry rocky slopes of sites in Wales (Great Orme, Gower); Mendip; Purbeck & Isle of Wight;
- good areas for the hot rocky ground specialities,

o notably spiders:

  - *Episinus truncatus* is a feature of this community in Wales (Alexander & Fowles, 1996) although its habitat structural requirements are met in lowland heathland situations in southern England;

        - the RDB spider *Callilepis nocturna* occurs in this situation on the Isle of Wight (Alexander, 1999).
    - and seed bugs (Lygaeidae), including:
        - the Nationally Scarce *Heterogaster artemisiae* on thyme;
    - and also other species such as:
        - the RDB stonecrop bug *Chlamydatus evanescens*;
        - the Nationally Scarce rock-rose pollen beetle *Meligethes brevis*.

CG2 *Festuca ovina – Avenula pratensis* grassland

- typically comprises rich and intimate mixtures of grasses and broad-leaved herbs in a continuous closed sward;
- under heavy sheep or rabbit grazing, occurs as even expanses of very short, tight and springy turf, with poor growth of plant species but very species-rich;
- glaucous sedge often abundant;
- salad burnet, ribwort plantain, bird's-foot trefoil, rough hawkbit, small scabious, self-heal, harebell and lady's bedstraw frequent;
- burnet-saxifrage, dropwort, knapweed, cowslip, milkwort, etc, present;
- common rock-rose and wild thyme locally abundant;
- small and scattered patches of bare soil, with fairy flax, autumn gentian, etc;
- the major grassland type for stemless thistle, squinancywort, horseshoe vetch, and sainfoin;
- rare plants include bastard toadflax and round-headed rampion;
- relatively warm and dry, lowland temperate climate;
- very widespread across lowland England and Wales;
- this is the prime habitat for many classic downland invertebrates.

CG3 *Bromus erectus* grassland

- upright brome with more than 10% cover, with it coarse, bulky foliage and accumulating litter;
- most frequent broad-leaved plants are salad burnet, glaucous sedge, ribwort plantain, stemless thistle and common bird's-foot-trefoil;
- reduced frequency of wild thyme, mouse-ear hawkweed, rock-rose, squinancywort, quaking grass, small scabious, harebell, fairy flax, autumn gentian;
- feature of lightly grazed or ungrazed grasslands - held at low levels by heavy grazing and can expand rapidly in response to relaxation of grazing pressure;
- very widespread across lowland England and Wales, and especially frequent in North and South Downs, Wiltshire, Cotswolds and Magnesian Limestone;
- the invertebrate associations are unclear, but Stubbs and Drake (2002) regard the localised robber fly *Leptarthrus brevirostris* as a typical element of upright brome

dominated swards and also associate the scarce snipefly *Symphoromyia immaculata* with patches of this grassland type.

CG4 *Brachypodium pinnatum* grassland

- swards with cover of tor-grass in excess of 10%, and often rank;
- cool and damp enough to exclude upright brome;
- associated with absence of grazing, or relaxation in grazing;
- occurs locally over the North and South Downs, and more commonly in Dorset; more frequent in Cotswolds and very characteristic of the Yorkshire Wolds;
- important habitat for specialist feeders on tor-grass:
  - the leafhoppers *Adarrus multinotatus* and *Ribautodelphax pungens*;
  - the beetle *Phalacrum fimetarius* feeds specifically on smutted plants of tor-grass;
  - the bug *Ischnodemus quadratus* is confined in Britain to tor-grass stands at Folkestone Warren.

CG5 *Bromus erectus – Brachypodium pinnatum* grassland

- mosaics of upright brome and tor grass;
- glaucous sedge, sheep's fescue and quaking grass can be locally abundant, making up the remainder of the sward and giving an overall grassy feel to the vegetation;
- broad-leaved herbs present, and sometimes locally abundant, include mouse-ear hawkweed, wild thyme, common rock-rose and bird's-foot trefoil;
- grazing absent or reduced;
- most frequent on Cotswold scarp, with more isolated occurrences on the southern Chalk and Magnesian Limestone;
- the invertebrate associations are unclear.

CG6 *Avenula pubescens* grassland

- dominated by various mixtures of red fescue and generally smaller amounts of meadow and downy oat-grasses, producing a markedly rank character;
- small quantities of dandelion and bird's-foot-trefoil, scattered glaucous sedge, rough hawkbit, ribwort plantain, salad burnet and stemless thistle;
- moister and more neutral soils on flat or gently-sloping sites where there is sometimes a history of ploughing but little or no grazing;
- widely scattered across lowland England;
- the invertebrate associations are unclear.

CG7 *Festuca ovina – Hieraceum pilosella – Thymus praecox/ pulegioides* grassland

- mouse-ear hawkweed abundant, thyme locally prominent, but rock-rose scarce;

- rough hawkbit, self-heal, dandelion, stemless thistle, salad burnet and bird's-foot-trefoil but little or no glaucous sedge or small scabious;
- open texture, providing patches of bare ground, exploited by ragwort and occasionally silverweed;
- thin, stony, very free-draining and impoverished soils in hot dry situations;
- scattered over the Chalk of south-east England, with outliers on south-facing slopes on the Yorkshire Wolds, and Carboniferous Limestone of Derbyshire and the Mendips;
- the invertebrate associations are unclear.

CG8 *Sesleria albicans – Scabiosa columbaria* grassland

- generally closed swards in which blue moor-grass is the most abundant grass;
- glaucous sedge and sheep's fescue very common;
- rich in broad-leaved herbs such as thyme and rock-rose, with salad burnet, ribwort plantain, bird's-foot-trefoil, harebell, fairy flax, plus small scabious, lady's bedstraw, rough hawkbit, kidney vetch, etc;
- restricted to Magnesian Limestone in the cool dry climate of lowland Durham;
- the invertebrate fauna is little studied.

CG9 *Sesleria albicans – Galium sterneri* grassland

- conspicuous presence of blue moor-grass, with sheep's fescue and crested hair-grass;
- sedges prominent, especially glaucous sedge;
- thyme and rock-rose feature, but poor in mouse-ear hawkweed;
- Limestone bedstraw characteristic, plus bird's-foot-trefoil, but broad-leaved herbs generally few and sparse;
- largely restricted to Morecambe Bay area, to the Craven district of North Yorkshire and the Upper Teesdale region;
- the classic specialist invertebrate of this type is the Nationally Scarce moth least minor *Phothedes captiuncula*.

Ideally a proper study of the how the invertebrate communities vary with the NVC communities should be carried out, to determine to what extent the vegetation community determines the character of the invertebrate fauna.

3. Use of invertebrate assemblages in site assessment for conservation

Each individual area of calcareous grassland will be more or less unique, having its own individual influences from climate, soils and history; comparisons between sites - for the purposes of nature conservation evaluation of site quality and management needs - therefore become complex. No one site is likely to support a complete assemblage of characteristic

calcareous grassland invertebrates. Each individual assemblage will reflect local conditions, past and present.

Changes to site management practices will favour some species and compromise others. For highly mobile species this need not be a serious issue, but the less mobile species once lost are not easy to recover. The most species-rich sites tend to be those with the stabler histories.

There are a number of options for developing systems for relative site assessment and it is hoped that the present report will stimulate further discussion and some trialling of various approaches. The three columns in the tables – habitat fidelity, continuity, and species status – provide scope for different approaches.

Habitat fidelity helps to identify which species should be the priorities for conservation within calcareous grasslands. High fidelity species occur primarily in calcareous grasslands and are therefore strongly dependent on conservation of their habitat within them. Low fidelity species can be conserved in other habitat types and may not be a priority in calcareous grasslands. Sites with a large number of high fidelity species or with a large proportion of them may be considered to have high quality for nature conservation.

Continuity is a particularly important concept as it identifies sites which have species which are dependent on conservation at site level, and which once lost, may be difficult to recover other than by re-establishment projects. It therefore is especially important in the identification of site quality for nature conservation and site management priorities. As with fidelity, sites with a large number of high continuity species or with a large proportion of them may be considered to have high quality for nature conservation.

Species status is perhaps more straightforward. Conservation of rare species is a common pursuit in nature conservation, although of course knowledge of rarity does not assist knowledge of conservation requirements in the way that fidelity and continuity do.

These three attributes of species can all be used to develop statistics which then may inform and aid decisions on site protection and site management.

The “high”, “moderate” and “low” categories of fidelity and continuity can be allocated individual scores and these may then be summed for each recorded site. This type of approach has been used to develop an Index of Ecological Continuity for wood-decay beetle faunas (Alexander, 1988, Harding & Alexander, 1994) based on an original proposal for use with epiphytic lichens (Rose, 1976). The IEC system scores 3 for “high”, 2 for “moderate” and 1 for “low”, the simple numeric scale acknowledging the subjectivity of the system while still rewarding the presence of higher quality species. The summed scores for a single site is referred to as the IEC and informs any site comparison. IEC values for whole suites of sites nationally can then be used to suggest values for sites of local, regional, national or European importance for the fauna.

An alternative approach is to focus solely on species status and develop rarity statistics. This has been also been used to assess sites for wood-decay beetle faunas (Fowles *et al*, 1999). The scoring in this “Species Quality Index” approach is not a simple numeric progression: score 32 for each RDB1 and 2 species, 24 for RDB3 and I Indeterminate, 16 for each Nationally Scarce A and RDBK Insufficiently Known, 8 for each Nationally Scarce B, 4 for each very local species or of uncertain status, 2 for local status and 1 for common or

widespread species. These are then summed to calculate a Species Quality Score, which is then divided by the total number of species and multiplied by 100 to produce the Site Quality Index.

These approaches have yet to be field-trialled on calcareous grassland invertebrates.

As already mentioned, neither habitat fidelity not site continuity have been considered to be helpful concepts when dealing with the highly mobile bees and wasps (and probably butterflies too). Archer (2001, 2002a,b, c) has therefore developed a series of different approaches tailor made for the group. "Species Quality" is comparable to that described above, although he has introduced a regional element, but he has also developed the concepts of "Cleptoparasite Load" and "Aerial Nester Frequency".

The cleptoparasite load (CL) is the perecentage of aculeate species that are cleptoparasitic (or parasitoids) on other host aculeates. The aerial-nester frequency (AF) is the percentage of host aculeate species that have aerial nest sites. Aerial nesters mainly use old beetle burrows in dead wood and central stem cavities such as dead bramble. Subterranean nesters nest in the soil, usually in burrows dug by themselves, but sometimes holes and crevices are used after being altered.

The value of focussing on agreed lists of characteristic species – as proposed in the following Tables – helps to eliminate chance finds of species which are merely passing through a site or vagrants. The occasional highly mobile Nationally Scarce or Red Data Book species which does not breed on site may be encountered during species-recording. Equally a species characteristic of a neighbouring different habitat type which overwinters or otherwise strays onto site, but does not breed there, might be encountered. These would potentially affect site assessment if based solely on the full species list and the representation of Nationally Scarce or Red Data Book species – as the case with scores derived from the old Invertebrate Site Register system. The agreed lists will provide a more reliable basis for site assessment.

Another consideration is the importance of using more than one taxonomic group in any assessment, due to their varying requirements; preferably many groups should be used in order to cover as many habitat requirement variables as possible. One group alone can give misleading results. Vascular plants and butterflies provide many examples of where this mistake has occurred, whereby site assessment has missed areas of considerable importance for other invertebrate groups – wood pastures are a classic example of a habitat type with low interest for vascular plants and butterflies and which have been a Cinderella habitat in the conservation movement as a result.

Emberson (1985) provides an interesting example of the selection of a notably poorly appreciated group - soil mites, Mesostigmata – as an indicator group of site value; he has demonstrated quite different results from those arising from the use of vascular plants. He stresses that assessments of conservation value of areas based on plant studies alone may be poor indicators of conservation value for other organisms. Few could reasonably argue against his conclusion.

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Table 1. The spiders of lowland calcareous grasslands

Species	Fidelity	Continuity	Structure of habitat	Food	Status	Synonyms	Literature References
Atypidae – Purse-web Spiders							
Atypus affinis Eichwald	Moderate	High	Friable substrate for constructing underground web. Slope with sunny aspect. Relatively undisturbed and protected areas for web sites, such as edge of scrub or rock outcrops, or lower edge to ant hills. Light grazing only.	Beetles, bees, flies, earwigs and woodlice.	Very local		Harvey *et al* (2002); Merrett (1977)
Theridiidae – Comb-footed Spiders							
Episinus truncatus Latreille	Moderate	Probably high	Bushy common rock-rose – or plants of similar structure - on open rocky slopes, for web construction.	General predator?	NS(B)		Alexander & Fowles (1996); Harvey *et al* (2002)
Dipoena prona (Menge)	Moderate	Probably high	Thinly vegetated soils, with stony ground for web construction	Ants?	NS(B)		Harvey *et al* (2002)
Linyphiidae – Money Spiders							
Ceratinella scabrosa (O.P.-Cambridge)	Moderate	High	Debris of various sorts – grass litter, loose rocks – or ant hills	Probably specialise on springtails	Very local		Harvey *et al* (2002)
Walckenaeria incisa (O.P.-Cambridge)	Low	Unknown	Little information available but likely to be favoured by the presence of sparsely-vegetated ground.	Probably specialise on springtails	NS(B)		Harvey *et al* (2002); Merrett (1977)
Entelecara flavipes (Blackwall)	Moderate	Probably high	Good aerial structure is likely to be important	Probably specialise on springtails	Very local		Harvey *et al* (2002); Merrett (1977)
Metopobactrus prominulus (O.P.-Cambridge)	Moderate	Unknown	Grass litter and moss	Probably specialise on springtails	Local		Harvey *et al* (2002); Merrett (1977)

Species	Fidelity	Continuity	Structure of habitat	Food	Status	Synonyms	Literature References
Gonatium paradoxum (L.Koch)	Low	Probably high	Mossy sward	Probably specialise on springtails	RDB2		Harvey *et al* (2002)
Pelecopsis parallela (Simon)	Low	Probably relatively low	Moss, detritus and/or loose rocks	Probably specialise on springtails	Local		Harvey *et al* (2002)
Pelecopsis nemoralioides (O.P.-Cambridge)	Low	Probably high	Steep slopes with sunny aspect	Probably specialise on springtails	Very local		Harvey *et al* (2002)
Pelecopsis radicicola (L. Koch)	Moderate	Probably high	Tussocky grassland	Probably specialise on springtails	RDB3		Harvey *et al* (2002); Merrett (1977)
Trichoncus saxicola (O.P.-Cambridge)	Moderate	Probably high	Fairly tall grassland	Probably specialise on springtails	NS(B)		Harvey *et al* (2002); Merrett (1977)
Ceratinopsis stativa (Simon)	Moderate	High	Tussocky areas	Probably specialise on springtails	Local		Harvey *et al* (2002); Merrett (1977)
Troxochrus scabriculus (Westring)	Low	Unknown	Tussocky areas	Probably specialise on springtails	Local		Harvey *et al* (2002)
Tapinocyba praecox (O.P.-Cambridge)	Low	Low	Low vegetation and leaf litter	Probably specialise on springtails	Local		Harvey *et al* (2002); Merrett (1977)
Tapinocyboides pygmaeus (Menge)	Moderate	Almost certainly high	Tussocky areas, with small mammal runs or soil cracks for web construction.	Probably specialise on springtails	RDB3		Harvey *et al* (2002); Merrett (1977)
Micrargus subaequalis (Westring)	Moderate	Low	Medium to tall grass swards	Probably specialise on springtails	Local		Harvey *et al* (2002); Merrett (1977)
*Micrargus laudatus (*O.P.-Cambridge*)*	Low	Probably high	Short stony sward	Probably specialise on springtails	NS(B)		Harvey *et al* (2002)
Diplocephalus cristatus (Blackwall)	Moderate	Low	Low sward for construction of sheet web	Probably specialise on springtails	Widespread		Harvey *et al* (2002); Merrett (1977)
Panamomops sulcifrons (Wider)	Moderate	Medium?	Information not available	Probably specialise on springtails	Local		Harvey *et al* (2002); Merrett (1977)

Species	Fidelity	Continuity	Structure of habitat	Food	Status	Synonyms	Literature References
Typhochrestus digitatus (O.P.-Cambridge)	Moderate	Probably high	Bare or sparely-vegetated ground, where sheet-web can be constructed over depressions in the soil surface or against stones.	Probably specialise on springtails	Local		Harvey *et al* (2002))
Typhochrestus simoni Lessert	Moderate	Almost certainly high	Short grazed or lichen-rich open sward	Probably specialise on springtails	RDB2		Harvey *et al* (2002))
Wiehlea calcarifera (Simon)	Low	Almost certainly high	Well-drained slopes with coarse friable substrate for burrowing	Probably specialise on springtails	NS(A)		Harvey *et al* (2002); Merrett (1977)
Jacksonella falconeri (Jackson)	Low	Unknown	Well-drained slopes, with open stony areas within sward, and friable substrate for burrowing	Probably specialise on springtails	Very local		Harvey *et al* (2002); Merrett (1977)
Meioneta mollis (O.P.-Cambridge)	Low	Unknown	Information not available	Probably specialise on springtails	Very local		Harvey *et al* (2002)
Meioneta simplicitarsis (Simon)	Moderate	Probably high	Taller tussocky swards	Probably specialise on springtails	NS(A)		Harvey *et al* (2002)
Syedra gracilis (Menge)	Moderate	Unknown	Tall grass	Probably specialise on springtails	NS(B)		Harvey *et al* (2002)
Centromerus incilium (L.Koch)	Moderate	Relatively low	Sward height not important	Probably specialise on springtails	NS(B)		Harvey *et al* (2002); Merrett (1977)
Centromerus serratus (O.P.-Cambridge)	Low	Probably high	Grass litter and moss	Probably specialise on springtails	NS(B)		Harvey *et al* (2002)
Bathyphantes parvulus (Westring)	Low	Unknown	Information not available	Probably specialise on springtails	Widespread		Harvey *et al* (2002); Merrett (1977)
Diplostyla concolor (Wider)	Low	Unknown	Appears to require patchy debris, such as stones, pieces of wood, etc.	Probably specialise on springtails	Widespread		Harvey *et al* (2002); Merrett (1977)
Araneidae – Orb-Web Spiders							
Hypsosinga albovittata (Westring)	Low	Almost certainly High	Taller swards for orb-web construction	General predator?	Very local		Harvey *et al* (2002)

Species	Fidelity	Continuity	Structure of habitat	Food	Status	Synonyms	Literature References
Hypsosinga pygmaea (Sundevall)	Moderate	Probably high or depends on structure	Low vegetation but sufficiently structured to provide for orb web construction.	General predator?	Local		Harvey *et al* (2002); Merrett (1977)
Hypsosinga sanguinea (C.L.Koch)	Low	Probably high	Tall swards	General predator?	NS(B)		Harvey *et al* (2002)
Cercidia prominens (Westring)	Moderate	Probably high	Sparse vegetation	General predator?	Local		Harvey *et al* (2002); Merrett (1977)
Lycosidae – Wolf Spiders							
Pardosa monticola (Clerck)	Moderate	High	Open short vegetation	General predator?	Local		Harvey *et al* (2002)
Pardosa hortensis (Thorell)	Low	Unknown	Sparsely-vegetated ground	General predator?	Very local		Harvey *et al* (2002); Merrett (1977)
Xerolycosa nemoralis (Westring)	Moderate	In general Probably high, but can move into suitable habitat	Short stony swards with sparsely-vegetated areas	General predator?	NS(B)		Harvey *et al* (2002); Merrett (1977)
Alopecosa cuneata (Clerck)	Moderate	High	Areas of sparesely-vegetated ground, short turf and lichen heath.	General predator?	Local		Harvey *et al* (2002); Merrett (1977)
Alopecosa barbipes (Sundevall)	Moderate	High	Areas of sparesely-vegetated ground, short turf and lichen heath.	General predator?	Local	*A. accentuata*	Harvey *et al* (2002); Merrett (1977)
Trochosa robusta (Simon)	High	Almost certainly high	Stony swards	General predator?	NS(B)		Harvey *et al* (2002); Merrett (1977)
Pirara uliginosus (Thorell)	Moderate	Probably high	Information not available	General predator?	Local		Harvey *et al* (2002)

Species	Fidelity	Continuity	Structure of habitat	Food	Status	Synonyms	Literature References
Hahniidae							
Hahnia nava (Blackwall)	Low	Unknown	Short but open swards with sufficient structure for web construction, eg mossy patches, stones, soil crevices	General predator?	Local		Harvey *et al* (2002); Merrett (1977)
Liocranidae							
Agroeca inopina O.P.-Cambridge	Low	Unknown	Tussocky sward	General predator?	Local		Harvey *et al* (2002)
Scotina palliardii (L.Koch)	Moderate	Almost certainly high	Probably needs areas of taller vegetation	General predator?	NS(A)		Harvey *et al* (2002)
Phrurolithus minimus C.L.Koch	Moderate	Probably high	Stony, sparsely-vegetated areas	General predator?	Very local		Harvey *et al* (2002); Merrett (1977)
Clubionidae							
Clubiona neglecta O.P.-Cambridge	Low	Unknown	Sparsely-vegetated ground amongst short vegetation	General predator?	Local		Harvey *et al* (2002); Merrett (1977)
Gnaphosidae							
Phaeocedus braccatus (L.Koch)	High	Probably high	Sparsely-vegetated areas or loose stones	General predator?	NS(B)		Harvey *et al* (2002); Merrett (1977)
Zelotes latreillei (Simon)	Low	Unknown. Probably reasonably low	Short vegetation or loose stones, wooden debris, etc.	General predator?	Local		Harvey *et al* (2002)
Zelotes petrensis (C.L.Koch)	Low	Almost certainly High	Dry stony hillsides	General predator?	NS(A)		Harvey *et al* (2002)
Trachyzelotes pedestris (C.L.Koch)	High	Probably high	Fairly open swards with loose stones	General predator?	NS(B)		Harvey *et al* (2002); Merrett (1977)

Species	Fidelity	Continuity	Structure of habitat	Food	Status	Synonyms	Literature References
Drassyllus pusillus (C.L.Koch)	Moderate	Seems to be able to colonise suitable habitat; probably low	Stones or woody debris, or tussocky sward	General predator?	Local		Harvey *et al* (2002)
Drassyllus praeficus (L.Koch)	Moderate	Probably high	Loose stones, etc.	General predator?	NS(B)		Harvey *et al* (2002); Merrett (1977)
Gnaphosa lugubris (C.L.Koch)	Moderate	Almost certainly High	Dry stony areas, especially hillsides	General predator?	NS(A)		Harvey *et al* (2002); Harvey (pers. comm.)
Micaria romana L.Koch	Moderate	Almost certainly High	Short swards in warm sunny situations	Probably ants	NS(B)	*M. scintillans*	Harvey *et al* (2002); Merrett (1977)
Thomisidae – Crab Spiders							
Xysticus erraticus (Blackwall)	Low	Almost certainly High	Shorter swards	General predator?	Local		Harvey *et al* (2002); Merrett (1977)
Xysticus bifasciatus C.L.Koch	Moderate	Almost certainly High	Low vegetation, with stones	General predator?	Very local		Harvey *et al* (2002); Merrett (1977)
Xysticus acerbus Thorell	Moderate	Almost certainly High	Information not available	General predator?	NS(A)		Harvey *et al* (2002)
Xysticus robustus (Hahn)	Moderate	Almost certainly High	Stony, sparsely-vegetated areas among older taller vegetation	General predator?	NS(A)		Harvey *et al* (2002)
Ozyptila blackwalli Simon	Moderate	Almost certainly High	Short swards and stones	General predator?	NS(B)		Harvey *et al* (2002)
Ozyptila nigrita (Thorell)	High	Almost certainly high	Very closely grazed sward and/or with open stony areas	General predator?	NS(B)		Harvey *et al* (2002); Merrett (1977)

Species	Fidelity	Continuity	Structure of habitat	Food	Status	Synonyms	Literature References
Ozyptila pullata (Thorell)	High	Almost certainly High	Short swards	General predator?	One locality		Harvey *et al* (2002)
Ozyptila atomaria (Panzer)	Moderate	High	Well-developed litter layer	Soft-bodied prey	Local		Harvey *et al* (2002)
Ozyptila brevipes (Hahn)	Low	Unknown	Information not available	General predator?	Local		Harvey *et al* (2002); Merrett (1977)
Salticidae – Jumping Spiders							
Heliophanus flavipes (Hahn)	Low	Unknown	Mosaic of vegetation structures, eg sparsely-vegetated ground within short turf, or bushy ares	General predator?	Local		Harvey *et al* (2002); Merrett (1977)
Bianor aurocinctus (Ohlert)	Low	Unknown	Sparsely-vegetated ground amongst short vegetation	General predator?	NS(A)	*B. aenescens*	Harvey *et al* (2002); Merrett (1977)
Talavera aequipes (O.P.-Cambridge)	Low	Moderate	Warm open sunny situations, such as short turf, stony banks, etc.	General predator?	Local		Harvey *et al* (2002)
Talavera thorelli (Kulczyński)	High	Almost certainly High	Steep south-facing slopes	General predator?	Not yet assessed, probably RDBK		Harvey *et al* (2002); Snazell (1995)
Aelurillus v-insignitus (Clerck)	Moderate	Almost certainly High	Short stony swards	General predator?	NS(B)		Harvey *et al* (2002)
Myrmarachne formicaria (De Geer)	Low	Almost certainly High	Open grass or stony ground	Probably ants	NS(B)		Harvey *et al* (2002)

Table 2. The bugs of lowland calcareous grasslands

Species	Fidelity	Continuity	Structure of habitat	Food	Status	Synonyms	Literature References
HETEROPTERA							
Cydnidae – Shield bugs (in part)							
Legnotus limbosus (Geoffroy)	Low	Low	Dry flowery banks with large stands of foodplants; sward structure less important	Bedstraws, especially lady's bedstraw	Local		Southwood & Leston (1959)
Canthophorus impressus Horváth	High	High	Short turf, ideally with some bare or disturbed ground, and large populations of bastard toadflax	Bastard toadflax	NS	*Sehirus dubius* (Scopoli)	Kirby (1992); Nau (2002); Southwood & Leston (1959)
Sehirus luctuosus (Mulsant & Rey)	Low	Low	Sparsely-vegetated patches	Forget-me-nots	Local		Southwood & Leston (1959)
Thyreocoris scarabaeoides (Linnaeus)	Moderate	Moderate	Open sward on friable soil, with sunny aspect, and good supply of violets; favoured by trampling or rabbit grazing	Violets & possibly other plants	Local		Kirby (1992); Southwood & Leston (1959)
Scutelleridae – Shield bugs (in part)							
Eurygaster maura (Linnaeus) European tortoise bug	Moderate	Moderate	Favours sunny slopes, although also uses level ground; moderately high sward.	Polyphagous on grasses	NS		Kirby (1992); Southwood & Leston (1959)
Pentatomidae – Shield bugs (in part)							
Podops inuncta (Fabricius) European turtlebug	Moderate	Low	Short swards or sparsely-vegetated ground	Not known	Local		Southwood & Leston (1959)
Sciocoris cursitans (Fabricius)	Moderate	Moderate	Open sward with sunny aspect; fairly low vegetation	Host-plants not identified, possibly wood sage, plantain or storksbill	NS		Kirby (1992); Southwood & Leston (1959)
Coreidae – Squash Bugs							
Syromastus rhombeus (Linnaeus)	Low	Low	Open sward with sunny aspect	Spurreys, sand-worts & other Caryophyllaceae	Local		Southwood & Leston (1959)

Species	Fidelity	Continuity	Structure of habitat	Food	Status	Synonyms	Literature References
Bathysolen nubilus (Fallén)	Low	Low	Sparse vegetation cover; friable soil; sunny aspect	Black medick & perhaps other Fabaceae (Leguminosae)	NS		Kirby (1992); Southwood & Leston (1959)
Coriomerus denticulatus (Scopoli)	Low	Low	Sparsely-vegetated areas in old pits and disturbed ground, where black medick spreads over the ground	Black medick, hare's foot trefoil & melilots	Local		Southwood & Leston (1959)
Ceraleptus lividus Stein	Low	Low	Sparsely-vegetated areas	Red clover, hare's foot trefoil and hop trefoil	Local		Southwood & Leston (1959)
Lygaeidae – Ground Bugs or Seed Bugs							
Cymus claviculus (Fallén)	Low	Moderate	Sedge rich swards	Sedges	Local		
Cymus glandicolor Hahn	Low	Moderate	Sedge rich swards	Sedges, including glaucous sedge	Local		Southwood & Leston (1959)
Ischnodemus quadratus Fieber	High	High	Dense tor grass	Grasses	RDB1 – Folkestone Warren		Kirby (1992); Southwood & Leston (1959)
Macroplax preyssleri (Fieber)	High	High	Relatively short grassland with sparsely-vegetated or bare areas, on sunny hillsides; with large stands of rock-rose. Light grazing beneficial but heavy grazing detrimental.	Common rock-rose and white rock-rose	RDB3		Kirby (1992); Southwood & Leston (1959)
Heterogaster artemisiae Schilling	Moderate	High	Areas with broken or partly bare ground or scree, or edges of tracks, with large clumps of thyme over bare ground or rocks	Thyme	NS		Kirby (1992); Southwood & Leston (1959)
Tropistethus holosericeus	Moderate	Moderate	Open sunny situations, with short and sparse vegetation, plus coarser vegetation close by for over-wintering	Probably a seed-feeder	NS		Kirby (1992); Southwood & Leston (1959)

Species	Fidelity	Continuity	Structure of habitat	Food	Status	Synonyms	Literature References
Lasiosomus enervis (Herrich-Schaeffer)	Low	Moderate	Fairly moist microclimate in sheltered or sunny situations, eg tussocky or mossy grass with dense litter at the foot of hillsides	Polyphagous seed-feeder, including. selfheal, black medick and grasses	NS		Kirby (1992); Southwood & Leston (1959)
Acompus rufipes (Wolff)	Moderate	High	Food plant has tall growing habit and is therefore very vulnerable to cutting or heavy grazing in summer; good flowering and seed-set essential as oviposits on the fruits.	Valerian (calc grasslands) & marsh valerian (bogs & fens)	Very local		Morris (1979)
Stygnocoris rusticus (Fallén)	Low	Low	Low flowery vegetation, usually patchy, or near transitions, eg path-sides or scrub margins	Polyphagous	Widespread		Southwood & Leston (1959)
Drymus pilipes Fieber	Moderate	Moderate	Moss amongst low grasses or stones; especially at scrub margins	Probably seed feeder.	NS		Kirby (1992); Southwood & Leston (1959)
Drymus pilicornis (Mulsant)	High	Moderate	Dense moss amongst grasses at the margins of scrub	Probably seed feeder.	NS		Kirby (1992); Southwood & Leston (1959)
Drymus latus Douglas & Scott	Low	Low	Patches of tall grasses	Probably seed feeder.	NS		Kirby (1992); Southwood & Leston (1959)
Drymus pumilio Puton	Moderate	Low	Patches of damper moss growing amongst grasses, etc	Probably seed feeder.	NS		Kirby (1992); Southwood & Leston (1959)
Eremocoris podagricus (Fabricius)	Moderate	Moderate	Leaf litter & other debris beneath scrub, either bare ground or grassy	Not known	Local		Southwood & Leston (1959)
Scolopostethus puberulus Horvath	Moderate	Moderate	Damp mossy places within the grassland, usually where partially shaded by trees or shrubs		Local		Southwood & Leston (1959)

Species	Fidelity	Continuity	Structure of habitat	Food	Status	Synonyms	Literature References
Notochilus limbatus (Fieber)	Low	High	Abundant ant colonies in sheltered situations	Probably a seed-feeder	RDB3	Taphropeltus limbatus	Kirby (1992); Southwood & Leston (1959)
Taphropeltus contractus (Herrich-Schaeffer)	Low	Low	Sparsely-vegetated ground with low spreading plants and dead leaves	Not known	Local		Southwood & Leston (1959)
Taphropeltus hamulatus (Thomson)	Moderate	High	Moss in areas with loose chalk fragments and flints, although occurs at lower densities in coarser vegetation	Probably seed-feeding	NS		Kirby (1992); Southwood & Leston (1959)
Trapezonotus arenarius (Linnaeus)	Low	Low	Sparsely-vegetated areas	Seeds	Widespread		Southwood & Leston (1959)
Megalonotus chiragra (Fabricius)	Low	Low	Sparsely-vegetated areas	Seeds	Widespread		
Megalonotus praetextatus (Herrich-Schaeffer)	Low	Low	Open areas with stony ground; usually on south-facing slopes	Seeds, probably storksbill and other plants	NS		Southwood & Leston (1959)
Megalonotus emarginatus (Rey)	Low	Low	Sparsely-vegetated areas	Seeds	Probably widespread		Aukema & Nau (1992)
Graptopeltus lynceus (Fabricius)	Low	High	Dry open sunny situations, generally with sparsely-vegetated and disturbed ground, especially from rabbits; stunted host plants best; stabler areas with tussocky vegetation for overwintering.	Boraginaceae especially viper's-bugloss – feed on flowers and developing seeds	NS		Kirby (1992); Southwood & Leston (1959)
Raglius alboacuminatus (Goeze)	Low	Low	Warm, sheltered situations, with densely tufted plants growing in ground partly bare or covered with thin leaf litter	Black horehound & possibly others; probably seed-feeder	NS		Kirby (1992); Southwood & Leston (1959)
Berytinidae – Stilt Bugs							
Berytinus clavipes (Fabricius)	Moderate	Moderate	Short swards with sparse areas	Restharrow	Local		Southwood & Leston (1959)
Berytinus crassipes (Herrich-Schäffer)	Low	Moderate	Sparse areas, including anthills	Chickweeds and other plants	Local		Southwood & Leston (1959)

Species	Fidelity	Continuity	Structure of habitat	Food	Status	Synonyms	Literature References
Berytinus hirticornis (Brullé)	Moderate	Low	Mosaic of tall flowering grasses and bare ground	Grasses, including cock's-foot and possibly false oat-grass, feeding on stem & leaves, and also opportunistic carnivore	NS		Kirby (1992); Southwood & Leston (1959)
Berytinus minor (Herrich-Schäffer)	Low	Moderate	Mats of white clover and restharrow, and other Fabaceae (Leguminosae)	omnivorous	Local		Southwood & Leston (1959)
Berytinus montivagus			Mats of low growing Fabaceae				
Berytinus signoreti (Fieber)	Moderate	Low	Mats of common bird's-foot-trefoil	Fabaceae	Local		Southwood & Leston (1959)
Gampsocoris punctipes (Germar)	Low	Low	Bushy growths of restharrow	restharrow	Local		Southwood & Leston (1959)
Tingidae – Lace Bugs							
Campylosteira verna (Fallén)	Moderate	Low	Open rocky or stony areas		Local		Southwood & Leston (1959)
Acalypta carinata (Panzer)	Moderate	Low	Tallish grasses with a good moss layer beneath		Local		Southwood & Leston (1959)
Acalypta parvula (Fallén)	Low	Low	Short mossy turf where moss becomes droughted in summer	Mosses	Widespread		Southwood & Leston (1959)
Kalama tricornis (Schrank)	Moderate	Moderate	Low-growing vegetation	unknown	Local	*Dictyonota tricornis*	Southwood & Leston (1959)
Tingis reticulata (Herrich-Schaeffer)	Moderate	Unknown	Large stands of bugle; ungrazed or lightly grazed	Bugle	NS		Kirby (1992); Southwood & Leston (1959)
Catoplatus fabricii (Stal)	Moderate	Moderate	Low or sparse sward with large stands of flowering ox-eye daisy, with south-facing aspect	Ox-eye daisy	NS		Kirby (1992); Southwood & Leston (1959)
Agramma laeta (Fallén)	Low	Moderate	Short open conditions with stands of sedges	Sedges, woodrushes and rushes	Local		Morris (1990a); Southwood & Leston (1959)

Species	Fidelity	Continuity	Structure of habitat	Food	Status	Synonyms	Literature References
Nabidae – Damsel Bugs							
Stalia boops (Schiödte)	Moderate	Moderate	Tussocky grasses	Other insects	Local		Southwood & Leston (1959)
Miridae – Plant Bugs							
Hoplomachus thunbergi (Fallén)	Moderate	Low	Dense patches of mouse-ear hawkweed, with good flowering, especially on low banks with relatively short turf	Mouse-ear hawkweed	Local		Southwood & Leston (1959)
Tinicephalus hortulanus (Meyer-Dür)	High	Moderate	Sward with good growth of rock-rose	Common rock-rose	Local		Southwood & Leston (1959)
Macrotylus paykulli (Fallén)	Low	Low	Sizeable stands of restharrow	Restharrow	Local		Southwood & Leston (1959)
Chlamydatus pullus (Reuter)	Low	Moderate	Sparsely-vegetated ground	Fabaceae (Leguminosae)	Local		Southwood & Leston (1959)
Chlamydatus saltitans (Fallén)	Low	Low	Sparsely-vegetated ground	White clover, black medick, etc	Local		Southwood & Leston (1959)
Chlamydatus evanescens (Boheman)	High	High	Open steep hillsides with exposed rock and scree, and sunny aspect; good growth of stonecrops	Stonecrops	RDB3		Kirby (1992); Southwood & Leston (1959)
Hallodapus montandoni (Reuter)	Moderate	Low	Areas of sparse vegetation with large ant populations	Ants	RDB3		Kirby (1992); Southwood & Leston (1959)
Systellonotus triguttatus (Linnaeus)	Moderate	High	Short sparse vegetation, with ants	Partly phytophagous & partly predacious: young buds, shoots & unripe fruits; aphids, dead ants.	NS		Kirby (1992); Southwood & Leston (1959)
Dicyphus annulatus (Wolff, J.F.)	Low	Low	Good development of restharrow	Restharrow	Local		Southwood & Leston (1959)
Halticus apterus (Linnaeus)	Moderate	Moderate	Medium height flower-rich swards	Bedstraws and Fabaceae (Leguminosae)	Local		Southwood & Leston (1959)

Species	Fidelity	Continuity	Structure of habitat	Food	Status	Synonyms	Literature References
Halticus luteicollis (Panzer)	Moderate	Moderate	Short swards with lady's bedstraw, or scrub margins with hedge bedstraw	Bedstraws	Local		Southwood & Leston (1959)
Strongylocoris leucocephalus (Linnaeus)	Moderate	Moderate	Dry banks	Common rock-rose, harebell & lady's bedstraw	Local		Southwood & Leston (1959)
Pachytomella parallela (Meyer-Dür)	Low	Moderate	Short or open swards	Tormentil and cinquefoils	Local		Southwood & Leston (1959)
Orthocephalus coriaceus (Fabricius)	Low	Low	Short to moderate height swards with open structure & usually some bare ground	Bedstraws, yarrow, knapweed, etc	Local		Southwood & Leston (1959)
Orthocephalus saltator (Hahn)	Low	Low	Short to moderate height swards with open structure & usually some bare ground	Various Asteraceae (Compositae)	Local		Southwood & Leston (1959)
Heterocordylus genistae (Scopoli)	Moderate	Moderate	Moderate swards with stands of dyer's greenweed	Dyer's greenweed and aphids	Local		Southwood & Leston (1959)
Polymerus unifasciatus (Fabricius)	Moderate	Low	Good growth of bedstraws	Lady's bedstraw & other bedstraws	Local		Southwood & Leston (1959)
Charagochilus gyllenhali (Fallén)	Moderate	Low	Good growth of bedstraws	Bedstraws	Local		Southwood & Leston (1959)
Calocoris roseomaculatus (De Geer)	Low	Low	Sward with diverse aerial structure and good development of broad-leaved herbs	Flowers and unripe fruits of Asteraceae (Compositae) and Fabaceae (Leguminosae). Salad burnet major food on downs.	Local		Southwood & Leston (1959)
Placochilus seladonicus (Fallén)	Moderate	Low	Tall grassy vegetation with flowering field scabious	Field scabious – nymphs and adults can be found on leaves and stems but prefer flower heads or flower buds	RDBK		Kirby (1992); Nau (1994)

Species	Fidelity	Continuity	Structure of habitat	Food	Status	Synonyms	Literature References
AUCHENORHYNCHA							
Cercopidae – Froghoppers							
Neophilaenus exclamationis (Thunberg)	Moderate	Low	Intermediate swards, not too short or too dense.	Grasses	Local		Le Quesne (1965)
Cicadellidae – Leafhoppers							
Ulopa trivia Germar	Moderate	High	Tolerant of a wide rage of vegetation structure, although not in very rank or overgrown sites	Not known, probably either lady's bedstraw or ribwort plantain	NS		Kirby (1992); Morris (1972)
Batracomorphus irroratus Lewis	High	Unknown	Good development of bushy rock-rose	Common rock-rose	Local		Le Quesne (1965)
Hephathus nanus (Herrich-Schaeffer)	Moderate	Unknown	Short sward	Information not available	NS		Kirby (1992)
Agallia brachyptera (Boheman)	Moderate	Low	Low or sparse vegetation, especially early successional after a disturbance	Variety of broad-leaved herbs, including sorrel, trefoils, & yarrow	NS		Kirby (1992)
Agallia ribauti Ossiannilsson	Moderate	Unknown	Information not available	Information not available	Local		Le Quesne (1965)
Aphrodes bicinctus (Schrank)	High	Unknown	Information not available	Information not available	Local		
Doratura stylata (Boheman)	Low	Unknown	Information not available	Red fescue & perhaps other grasses	Widespread		Cook (1997); Le Quesne (1969)
Recilia coronifera (Marshall)	Moderate	Unknown	Short sward	Favours *Holcus*	Local		Le Quesne (1969); Morris (1981, 1883)
Turrutus socialis (Flor)	High	High	Found in swards of various heights according to situation; high humidity or shelter may be more important sward height	Various grasses - red fescue, tor grass, downy oat-grass	Local		Cook (1997); Le Quesne (1969); Morris (1990d); Thompson (1983)
Adarrus multinotatus (Bohemann)	Moderate	Unknown	Taller sward	Tor-grass	Local		Cook (1997); Le Quesne (1969)
Jassargus flori (Fieber)	Low	Unknown	Information not available	Information not available	Local		Le Quesne (1969)

Species	Fidelity	Continuity	Structure of habitat	Food	Status	Synonyms	Literature References
Arthaldeus striifrons (Kirschbaum)	Moderate	Unknown	Information not available	Information not available	Local		Le Quesne (1969)
Psammotettix albomarginatus Wagner	Moderate	Unknown	Information not available	Possibly *Agrostis*	NS		Kirby (1992)
Psammotettix cephalotes (Herrich-Schaeffer)	High	Unknown	Short sward	Information not available	Local		Le Quesne (1969)
Rhytistylus proceps (Kirschbaum)	High	Unknown	Taller swards, with dead flowering stems of sheep's-fescue	Sheep's-fescue	Local		Cook (1997); Le Quesne (1969)
Euscelis venosus (Kirschbaum)	High	Unknown	Rank swards	Not known	RDBK		Hawes & Stewart (1997); Kirby (1992); Le Quesne (1969)
Euscelidius variegatus (Kirschbaum)	Low	Unknown	Information not available	Not known, either grasses or clover	NS		Kirby (1992)
Paluda adumbrata Sahlberg, C.	Moderate	Unknown	Information not available	Information not available	Local		Le Quesne (1969)
Mocydia crocea (Herrich-Schaeffer)	Moderate to low	Unknown	Medium to tall swards	Tor-grass and upright brome	Widespread		Cook (1997); Le Quesne (1969); Morris (1981a)
Mocydiopsis attenuata (Germar)	High	Unknown	Information not available	Information not available	Local		Le Quesne (1969)
Macrosteles quadripunctulatus (Kirschbaum)	Low	Low	Short, open, and quite sparse vegetation	Probably certain grasses	NS		Kirby (1992)
Typhlocybinae							
Emelyanoviana contraria (Ribaut)	Unknown	Unknown	Upland sites	Common rock-rose	NS		Kirby (1992)
Emelyanoviana mollicula (Boheman)	High	Unknown	Information not available	Reared from betony; also associated with *Primula*, *Plantago*, *Calamintha* & *Verbascum*	Local		Le Quesne & Payne (1981)
Eupteryx atropunctata (Goeze)	Low	Unknown		Polyphagous on labiates	Local		Morris (1972); Stewart (1988)

Species	Fidelity	Continuity	Structure of habitat	Food	Status	Synonyms	Literature References
Eupteryx notata Curtis	High	Unknown	Short sward, rich in broad-leaved herb species	Polyphagous, primarily among Lamiaceae (Labiatae) and Asteraceae (Compositae)	Local		Le Quesne & Payne (1981); Stewart (1988)
Eupteryx origani (Zakhvatkin)	High	Unknown		Marjoram	Local		Le Quesne & Payne (1981); Stewart (1988)
Arboridia parvula (Boheman)	Moderate	Unknown	Short sward	Probably rock-rose	Local		Le Quesne & Payne (1981)
Zygina hyperici (herrich-Schaeffer)	Moderate	Unknown	Tall stands of St John's wort	St John's worts spp, especially perforate	Local		Le Quesne & Payne (1981)
Cixiidae							
Trigonocranus emmeae Fieber	Moderate	Unknown	Not known	Not known, nymphs probably root-feeders	NS		Kirby (1992)
Delphacidae – Planthoppers							
Asiraca clavicornis (Fabricius)	Moderate	Low	Open sunny situations, sward height not important	Information not available	NS		Kirby (1992)
Kelisia guttula (Germar)	Moderate	Unknown	Dry hillsides with luxuriant stands of sedges	Sedges	Local		Le Quesne (1960)
Kelisia guttulifera (Kirschbaum)	Moderate	Unknown	Lightly wooded hillsides	Sedges	Local		Le Quesne (1960)
Kelisia vittipennis (Sahlberg)	Moderate	Low	Information not available	Sedges	Local		Brown *et al* (1992); Le Quesne (1960)
Anakelisia perspicillata (Boheman)	Moderate	Unknown	Information not available	Sedges	Local		Le Quesne (1960)
Eurysa douglasi (Scott)	High	High	Dense tussocky tor grass on hillsides	Information not available	NS		Kirby (1992)
Ribautodelphax imitans (Ribaut)	Moderate	High	Information not available	Probably tall fescue	RDBK		Kirby (1992)
Ribautodelphax pungens (Ribaut)	High	High	Information not available	Tor grass	NS		Kirby (1992)
Tettigometridae							

Species	Fidelity	Continuity	Structure of habitat	Food	Status	Synonyms	Literature References
Tettigometra impressopunctata Dufour	High	High	Fairly short or thin grassy vegetation in sheltered hollows on south-facing slopes; with thyme and other low calcicoles present. May be a need for tussocky vegetation or thick moss nearby to provide suitable hibernation sites.	Unknown	NS		Kirby (1992)

Table 3. The larger moths of lowland calcareous grasslands

Species	Fidelity	Continuity	Structure of habitat	Food	Status	Synonyms	Literature References
Adscita statices Linnaeus The Forester	Low	High	Open grassland with well-developed sward and good flowering and seed-set	Larvae on common sorrel & sheep's sorrel. Adult nectars to a variety of flowers.	Very local		Porter (1997); Skinner (1984); Waring (2001)
Adscita geryon Hübner Cistus Forester	High	High	Open grassland with good flowering	Larvae on common rock-rose. Adult nectars at a variety of calcareous grassland flowers.	NS(B)		Porter (1997); Skinner (1984)
Jordanita globulariae Hübner Scarce Forester	High	High	Open grassland with good flowering; a layer of plant litter probably important for larval overwintering	Larvae on the foliage of common knapweed & greater knapweed. Adult nectars at knapweed, salad burnet & other downland flowers.	NS(A)	*Adscita globulariae*	Porter (1997); Skinner (1984); Waring (2001)
Zygaena trifolii palustrella Five-spot Burnet– downland race	Moderate	High	Open grassland with good flowering	Larvae on bird's-foot-trefoil	Local		
Pyropteron chrysidiformis Esper Fiery Clearwing	Moderate	High	Unknown	Larvae in crowns and roots of dock and sorrel.	RDB1; Priority Species (BAP)	*Bembecia chrysidiformis*	Porter (1997); Skinner (1984)
Bembecia ischneumoniformis D. & S. Six-belted Clearwing	High	High	Sparsely vegetated areas with plentiful kidney vetch	Larvae feed in the roots of bird's-foot-trefoil and kidney vetch	NS(B)	*Bembecia scopigera* Scopoli	Porter (1997); Skinner (1984)
Aplasta ononaria Fuessly Rest Harrow	Low	Moderate	Unknown	Larva on common restharrow	RDB3		Porter (1997); Skinner (1984)
Scopula ornata Scopoli Lace Border	High	Unknown	Unknown	Larvae on thyme & marjoram	NS(A)		Porter (1997); Skinner (1984)

Species	Fidelity	Continuity	Structure of habitat	Food	Status	Synonyms	Literature References
Idaea dilutaria Hübner Silky Wave	High	High	Open exposed rock faces with bushy growth of common rock-rose; usually in well-sheltered situations such as clearings amongst low scrub	Larvae on withered and decaying leaves of common rock-rose	RDB2; Priority Species (BAP)		Porter (1997); Skinner (1984)
Idaea degeneraria Hübner Portland Ribbon Wave	High	Unknown	Rough grassy slopes with sheltering scrub	Not known	RDB3		Skinner (1984)
Phibalapteryx virgata Hufnagel Oblique Striped	Low	Unknown	Unknown	Larvae on lady's bedstraw	NS(B)		Porter (1997); Skinner (1984)
Scotopteryx bipunctaria Prout Chalk Carpet	High	High	Unknown	Larvae on bird's-foot trefoil and other trefoils and clovers	NS(B); Priority Species (BAP)		Porter (1997); Skinner (1984)
Catarhoe rubidata Denis & Schiffermüller Ruddy Carpet	Low	Unknown	Unknown	Larvae on hedge and lady's bedstraw	NS(B)		Porter (1997); Skinner (1984)
Catarhoe cuculata Hufnagel Royal Mantle	Moderate	Unknown	Unknown	Larvae on hedge and lady's bedstraw	Local		Porter (1997); Skinner (1984)
Epirrhoe rivata Hübner Wood Carpet	Low	Unknown	Unknown	Larvae on hedge and lady's bedstraw	Local		Porter (1997); Skinner (1984)
Eupithecia subumbrata Denis & Schiffermüller Shaded Pug	Low	Unknown	Open flowery swards	Larvae on flowers of field scabious, hawksbeards, ragwort, St John's-wort, etc	Local		Porter (1997); Skinner (1984)
Eupithecia pimpinellata Hübner Pimpinel Pug	Moderate	Unknown	Open flowery swards	Larvae on ripening seed capsules of burnet-saxifrage	Local		Porter (1997); Skinner (1984)
Gnophos obscurata Denis & Schiffermüller The Annulet	Moderate	Unknown	Unknown	Larvae on a wide variety of plants, including. bird's-foot-trefoil, common rock-rose and salad burnet.	Local		Porter (1997); Skinner (1984)

Species	Fidelity	Continuity	Structure of habitat	Food	Status	Synonyms	Literature References
Siona lineata Scopoli Black-veined Moth	High	High	Coarse tor-grass dominated swards, 10-25cm in height in June, with marjoram present in every other pace when walking through the sward. Grass tussocks needed for larval cocoons.	Marjoram	RDB1; Priority Species (BAP)		Porter (1997); Skinner (1984); Waring (2001)
Aspitates gilvaria Denis & Schiffermüller Straw Belle	High	High	Mosaic of turf heights: short turf, sparsely-vegetated ground or path edges for larval development; long turf for adult roosting.	Larvae on thyme, cinquefoil, wild parsnip, etc.	RDB3; Priority Species (BAP)		Porter (1997); Skinner (1984)
Hemaris tityus Linnaeus Narrow-bordered bee hawk	Low	High	Open flowery grassland	Larvae on devil's-bit scabious. and occasionally small scabious	NS(B); Priority Species (BAP)		
Setina irrorella Linnaeus Dew Moth	Moderate	Unknown	Areas of broken soil with stones, chalk fragments, etc	Larvae on various lichens on rocky ground	NS(A)		Porter (1997); Skinner (1984)
Parasemia plantaginis Linnaeus Wood Tiger	Moderate	Moderate	Lightly grazed open hillsides	Larvae on wide variety of broad-leaved herbs, including plantain and dandelion.	Local		Porter (1997); Skinner (1984)
Agrotis cinerea Denis & Schiffermüller Light Feathered Rustic	Moderate	Unknown	Unknown	Larvae on wild thyme and other low plants. Adults visit flowers of red valerian.	NS(B)		Porter (1997); Skinner (1984)
Polia bombycina Hufnagel Pale Shining Brown	Moderate	Unknown	Unknown	Unknown	NS(B); Priority Species (BAP)		Skinner (1984)

Species	Fidelity	Continuity	Structure of habitat	Food	Status	Synonyms	Literature References
Pachetra sagittigera Turner Feathered Ear	High	Unknown	Unknown	Various grasses, possibly preferring meadow-grass	Probably extinct		Skinner (1984)
Heliophobus reticulata Haworth Bordered Gothic	Moderate	Moderate	Unknown	Larval food plant unknown. Adults visit flowers of red valerian, campions, viper's-bugloss and wood sage.	NS(A); Priority Species (BAP)		Porter (1997); Skinner (1984)
Shargacucullia lychnitis Rambur Striped Lychnis	Moderate	Moderate	Soil disturbance to encourage development of dark mullein	Larvae on dark mullein, mainly on flowers.	NS(A); Priority Species (BAP)	*Cucullia lychnitis*	Porter (1997); Skinner (1984)
Apamea sublustris Reddish Light Arches	Moderate	Moderate	Unknown	Unknown, although grass roots suspected	Local		
Photheades captiuncula Stainton Least Minor	Moderate	High	Unknown	Larvae in the stems of glaucous sedge.	RDB3		Porter (1997); Skinner (1984)
Acontia luctuosa Denis & Schiffermüller The Four-spotted	Moderate	Moderate	Unknown	Larvae on field bindweed	NS(A); Priority Species (BAP)	*Tyta luctuosa*	Porter (1997); Skinner (1984)

Table 4. The bees wasps & ants of lowland calcareous grasslands

Species	Fidelity	Continuity	Structure of habitat	Food	Status	Synonyms	Literature References
Myrmica hirsuta Elmes A guest ant	Moderate	Unknown	Short-cropped turf on hillsides with sunny aspect	Omnivore; social parasite of *Myrmica sabuleti*	RDBK		Falk (1991)
Myrmica sabuleti Meinert A red ant	Moderate	Unknown	Short dropped or open sward with sunny aspect; stony areas for nesting.	Omnivore	Local		Bolton & Collingwood (1975)
Myrmica speciodes Bondroit A red ant	Low	Unknown	Bare or sparsely-vegetated areas on hillsides with sunny aspect & good shelter	Omnivore	RDB3		Falk (1991)
Ponera coarctata (Latreille) An ant	Low	Unknown	Loose stones on superficial clay deposits for nesting	Omnivore	NS(B)		Falk (1991)
Solenopsis fugax (Latreille) An ant	Low	Unknown	Sparsely-vegetated areas on hillsides with sunny aspect	A thief ant: robs and eats broods of larger ants such as *Lasius* or *Formica* spp; also known to tend root aphids	RDB3		Falk (1991)
Myrmecina graminicola (Latreille) An ant	Moderate	Unknown	Stony ground for nesting. Sunny aspect.	Omnivore	Local		Bolton & Collingwood (1975)
Lasius alienus (Förster)	Moderate	Unknown	Sparsely-vegetated or stony ground, usually on sunny hillsides	Omnivore	Local		
Formica cunicularia Latreille An ant	Low	Unknown	Open stony ground for nesting. Sunny aspect.	Omnivore	Local		Bolton & Collingwood (1975)
Chrysis viridula Linnaeus A ruby-tailed wasp	Moderate	Low	Sparsely-vegetated swards, combining bare ground for host nesting and well-developed species-rich grassland for host prey	Parasitoid of larvae of mason wasps of genus *Odynerus;* visits flowers of umbellifers	Local		Edwards (1998); Morgan (1984)

Species	Fidelity	Continuity	Structure of habitat	Food	Status	Synonyms	Literature References
Chrysogona gracillima (Foerster) A ruby-tailed wasp	Low	Low?	Scrubby areas or scattered trees; hosts nest in old fence posts, old stumps, dead branches and old stems, eg bramble	Parasitoid of larvae of other aculeates	RDB2		Falk (1991)
Chrysura radians (Harris) A ruby-tailed wasp	Moderate	Low	Open sunny situations with availability of dead wood for host nesting	Parasitoid of larvae of *Osmia* bees	NS(A)		Edwards & Telfer (2002); Falk (1991)
Cleptes nitidulus (Fabricius) A ruby-tailed wasp	Low	Low?	Scrubby areas	Parasitoid of sawfly cocoons; adults visit flowers of wild carrot and hogweed	NS(A)		Falk (1991)
Mutilla europaea Linnaeus The Large Velvet Ant	Low	Moderate?	Wide variety of open flowery habitats	Parasitoid of bumble bees; males attracted to blossom of bramble, wild carrot, Angelica, scabious & yarrow	NS(B)		Falk (1991)
Tiphia minuta Van der Linden The Small Tiphia	Moderate	Low	Areas kept open by livestock grazing	Larvae believed to be parasitoids of dung beetle larvae	NS(B)		Falk (1991)
Aporus unicolor Spinola A spider-hunting wasp	Moderate	Moderate	Well-grazed areas, with warm south-facing banks for the host spider & flowering umbellifers for adult wasps	Parasitoid of purse-web spider *Atypus affinis*; adults visit wild carrot, wild parsnip, etc	NS(A)	Pompilus unicolor	Falk (1991)
Arachnospila minutula (Dahlbom) A spider-hunting wasp	Moderate	Moderate	Sparsely-vegetated areas in warm sunny situations	Poorly known; once recorded with a wolf spider (Lycosidae); adults visit flowers of wild carrot & wild parsnip	NS(B)		Falk (1991)
Priocnemis agilis (Schuckard) A spider-hunting wasp	Low	Moderate	Open grassy situations on sunny banks; natural cavities probably needed for nest sites	Spider prey poorly known; adults favour blossom of wild carrot	NS(B)		Falk (1991)

Species	Fidelity	Continuity	Structure of habitat	Food	Status	Synonyms	Literature References
Priocnemis coriacea Dahlbom A spider-hunting wasp	Moderate	Moderate	Open situations on sunny banks; natural cavities probably needed for nest sites	Spider prey not known; adults visit spurge flowers	NS(A)		Edwards & Telfer (2002); Falk (1991)
Priocnemis hyalinata (Fabricius) A spider-hunting wasp	Moderate	Unknown	Open bushy situations on sunny banks; natural cavities probably needed for nest sites	Poorly known; once recorded with a wolf spider (Lycosidae)	NS(B)	*P. femoralis* & *P. notatulus* (these also include *P. fennica*)	Falk (1991)
Microdynerus exilis (Herrich-Schaeffer) A mason wasp	Moderate	Low	Dead or dying trees, old fence posts and old stems, eg bramble, needed for nesting; in open sunny situations	Adults visit flowers of hawk's-beard, hogweed and mayweed; nests stocked with weevil larvae for brood to feed upon.	NS(B)		Archer (2000); Falk (1991)
Crossocerus exiguus (Van der Linden) A solitary wasp	Low	Moderate	Short-cropped sward; sparsely-vegetated ground or vertical banks in warm sunny situations needed for nesting	Aphids and small flies for larvae in nests	RDB3		Falk (1991)
Ectemnius borealis (Zetterstedt) A solitary wasp	Moderate	Moderate	Dead or dying trees, stumps, & old fence posts needed for nesting; in open sunny situations in vicinity of tall flowery areas, eg umbellifers	Probably medium-sized flies, eg hoverflies for larvae in nests; adults visit blossom of hogweed, wild parsnip, etc	RDB3	*E. nigrinus* (Herrich-Schaeffer)	Falk (1991)
Passaloecus monilicornis Dahlbom A solitary wasp	Moderate	Unknown	Dead wood in sunny situations for nesting	Aphids for larvae in nests; adults may visit honeydew	Local		Edwards & Telfer (2002)
Hylaeus cornutus Curtis A yellow-faced bee	Moderate	Moderate	Bramble and tall herbs with pithy stems in warm sunny situations, as nest sites, eg bramble or sorrel. Flowery grassland for adult nectaring.	Adults visit a wide range of flowers, incl. field scabious, ox-eye daisy, yarrow, wild carrot.	NS(A)		Edwards & Telfer (2001); Falk (1991)

Species	Fidelity	Continuity	Structure of habitat	Food	Status	Synonyms	Literature References
Hylaeus signatus (Panzer) A yellow-faced bee	Low	Low	Dead woody stems of bramble or rose in warm sunny situations, for nest sites, although will also use vertical banks of dry friable material. Flowery grasslands for adult nectaring.	*Reseda* flowers essential as source of pollen, although adults also nectar at a wider variety of flowers.	NS(B)		Falk (1991)
Andrena alfkenella Perkins A mining bee	Low	Moderate	Areas of bare soil or sparsely-vegetated ground for nesting, in warm sunny situations. Tall flowery grasslands for adult nectaring.	Adults visit flowers of a wide variety of herbs and shrubs, although particularly umbellifers for the second brood in late summer.	RDB3		Falk (1991)
Andrena bucephala Stephens A mining bee	Low	Low	Grassy south-facing slopes & banks for nesting, especially where sheltered by scrub.	Spring-flowering shrubs for nectar.	NS(B)		Falk (1991)
Andrena cineraria (Linnaeus) Grey Mining Bee	Moderate	Low	Open sunny situations; friable chalk for nesting; flowery grassland for pollen & nectar.	Pollen from variety of flowers including. buttercups and grasses. Even wider range for nectar.	Local		Edwards & Telfer (2002)
Andrena falsifica Perkins A mining bee	Low	Moderate	Sparsely-vegetated ground on south-facing slopes for nesting. Low growing broad-leaved herbs for adult nectaring.	Flowers visited include speedwell, daisy and tormentil.	NS(A)		Falk (1991)
Andrena fulvago (Christ) A mining bee	High	High	Small yellow composites for pollen, plus short-cropped or sparsely-vegetated areas in warm sunny situations for nesting.	Yellow composites such as cat's-ear, oxtongue, mouse-ear hawkweed, hawk's-beard & dandelions.	NS(A)		Falk (1991)

Species	Fidelity	Continuity	Structure of habitat	Food	Status	Synonyms	Literature References
Andrena hattorfiana (Fabricius)	Moderate	High	Warm sunny situations which combine exposed earth along paths for nest sites, with grasslands rich in flowering field scabious, although small scabious may be used at some sites.	Field scabious is key source of pollen; other flowering herbs used for nectar as well.	RDB3, but needs down-grading		Edwards & Telfer (2001); Falk (1991)
Andrean lathyri Alfken A mining bee	Moderate	Unknown	Bare soil of banks and slopes, in warm sunny situations for nesting. Good flowering of Fabaceae (Leguminosae).	Visits flowers of vetches	RDB1; Priority Species (BAP)		Edwards & Telfer (2002); Falk (1991)
Andrena lepida Schenck A mining bee	High	High	Bare or sparsely-vegetated ground for nest sites, in warm sunny situations. Flowery grasslands for nectar and pollen.	Flowers of umbellifers such as hogweed for summer brood; spring brood uses a wider variety of flowers.	RDB1		Falk (1991)
Andrena marginata Fabricius A mining bee	Moderate	High	Areas of short turf or exposed soil in warm sunny situations required for nest sites. Adults require scabious flowers/	Scabious species for pollen; other flowers visited for nectar.	NS(A)		Falk (1991)
Andrena minutuloides Perkins A mining bee	Moderate	High	Bare or sparsely-vegetated ground for nest sites, in warm sunny situations. Flowery grasslands for nectar and pollen.	Wide variety of flowers visited by spring brood; second brood favours white umbellifers.	NS(A)		Falk (1991)

Species	Fidelity	Continuity	Structure of habitat	Food	Status	Synonyms	Literature References
Andrena nitidiusculus Schenck A mining bee	Moderate	Moderate	Warm sunny situations with bare soil or short-cropped vegetation for nest sites. Umbellifer flowers as a pollen source, and a wider variety of flowers for nectaring.	Pollen from wild carrot, hogweed, wild parsnip and hedge parsley.			Falk (1991)
Andrena ocreata (Christ) A mining bee	Low	Moderate	Patches of bare or sparsely-vegetated ground in sunny situations for nesting. Legume flowers for pollen.	Pollen collection only noted from gorse in Britain; nectars at wide variety of flowering herbs, shrubs and trees.	NS(B)		Falk (1991)
Andrena pilipes Fabricius A mining bee	Low	Moderate	Patches of bare or sparsely-vegetated ground in sunny situations for nesting. Flowering shrubs and tall herbs needed for pollen.	Sallow, blackthorn and *Brassica* spp used for pollen by spring brood, while second brood uses bramble & thistles. Other flowers also used for nectar.	NS(B)		Falk (1991)
Andrena polita Smith A mining bee	High	Unknown	Flowery grasslands on south-facing slopes.	Yellow composites probably main pollen sources, but may visit wider range of flowers for nectar.	RDB1		Falk (1991)
Andrena simillima Smith A mining bee	Low	High	Patches of bare or sparsely-vegetated ground in sunny situations for nesting, close to rather rank or scrubby grassland for nectaring.	Flowers visited include bramble, marjoram, hemp agrimony, knapweed, creeping thistle and ragwort	RDB2		Falk (1991)

Species	Fidelity	Continuity	Structure of habitat	Food	Status	Synonyms	Literature References
Andrena tibialis (Kirby) A mining bee	Low	Moderate	Bare or sparsely-vegetated ground in sunny situations for nesting, including. banks, slopes and footpaths. Flowery areas for pollen and nectar – herbs, shrubs and/or trees.	Pollen from sallows, buttercup, sycamore, blackthorn, etc.	NS(A)		Falk (1991)
Andrena varians (Rossius) A mining bee	Low	Moderate	The only downland record was from short rabbit-grazed turf. Spring flowering Rosaceous trees and shrubs for pollen.	Blackthorn, pear and probably apple used for pollen. Wide range of other flowers also visited.	NS(B)		Falk (1991)
Halictus eurygnathus Bluethren A mining bee	High	High	Short turf or bare and sparsely-vegetated soil in warm sunny situations for nest sites. Flowery grassland close by.	Nectar gathered from knapweeds	RDB1, possibly extinct		Falk (1991)
Halictus maculatus Smith A mining bee	Moderate	Moderate	Short turf or bare and sparsely-vegetated soil in warm sunny situations for nest sites. Flowery grassland close by.	Wide variety of flowers probably used.	RDB1		Falk (1991)
Lasioglossum fulvicorne (Kirby)	High	Low			Widespread		Falk (1991)
Lasioglossum laevigatum (Kirby)	Moderate	Low	Flowery grassland	Visits a wide range of flowers for pollen & nectar	Local		Edwards & Telfer (2002)
Lasioglossum morio (Fabricius) Brassy Mining Bee	Moderate	Low			Widespread		Falk (1991)
Lasioglossum pauperatum (Brullé) A mining bee	Low	Moderate	Bare and sparsely-vegetated soil in warm sunny situations for nest sites. Flowery grassland close by.	Visits flowers of viper's-bugloss, ragwort and other yellow composites	RDB3		Falk (1991)

Species	Fidelity	Continuity	Structure of habitat	Food	Status	Synonyms	Literature References
Lasioglossum pauxillum (Schenck) A mining bee	Low	Moderate	Bare and sparsely-vegetated soil in warm sunny situations for nest sites. Flowery grassland close by, possibly preferring coarser swards.	Visits flowers of bramble, hogweed, fleabane, dandelions, and germander speedwell	NS(A)		Falk (1991)
Lasioglossum quadrinotatum (Kirby) A mining bee	Low	Moderate	Bare and sparsely-vegetated soil in warm sunny situations for nest sites. Tall flowery grassland close by.	Visits flowers of lesser celandine, spurges, germander speedwell, tansy and smooth sowthistle	NS(A)		Falk (1991)
Lasioglossum xanthopus (Kirby) A mining bee	Moderate	Moderate	Bare and sparsely-vegetated soil in warm sunny situations for nest sites. Flowery grassland close by.	Visits flowers of a wide range of broadleaved herbs as well as bramble.	NS(B)		Edwards & Telfer (2001); Falk (1991)
Sphecodes crassus Thomson A cuckoo bee	Low	?	Patches of bare soil or short-cropped turf in warm sunny situations for host nest sites. Flowery grassland needed for nectaring.	Cleptoparasite of various *Lasioglossum* mining bees. Visit flowers such as hogweed, yarrow, creeping thistle and Angelica.	NS(B)		Falk (1991)
Sphecodes ephippius (Linnaeus)	Low	Low	Warm sunny situations for host nesting, such as short downland turf or bare ground	Cleptoparasite of *Lasioglossum* or *Halictus* bees	Widespread		
Sphecodes ferruginatus Hagens A cuckoo bee	Moderate	High	Bare and sparsely-vegetated ground or short turf in warm sunny situations for host nest sites. Flowery grassland close by.	Cleptoparasite principally of the mining bees *Lasioglossum fulvicorne* & *L. fratellum* Visit flowers such as fennel and wild carrot.	NS(B)		Falk (1991)

Species	Fidelity	Continuity	Structure of habitat	Food	Status	Synonyms	Literature References
Sphecodes miniatus Hagens A cuckoo bee	Low	?	Bare and sparsely-vegetated ground or short turf in warm sunny situations for host nest sites. Flowery grassland close by.	Cleptoparasite of *Lasioglossum nitidiusculum* and other mining bees. Visit flowers such as oxtongue and probably other composites as well as umbellifers.	NS(B)	S. dimidiatus	Falk (1991)
Sphecodes niger Sichel A cuckoo bee	Moderate	Moderate	Bare and sparsely-vegetated ground or short turf in warm sunny situations for host nest sites. Flowery grassland close by.	Cleptoparasite of *Lasioglossum* mining bees, probably mainly *L. morio*. Visits flowers of various composites and umbellifers.	RDB3		Falk (1991)
Sphecodes reticulatus Thomson A cuckoo bee	Low	Unknown	Patches of bare or sparsely-vegetated ground in warm sunny situations for host nest sites. Tall coarse flowery grassland close by.	Cleptoparasite of mining bees, *Lasioglossum* as well as *Andrena* spp. Visits flowers of a variety of umbellifers and composites.	NS(A)		Falk (1991)
Sphecodes rubicundus (Hagens) A cuckoo bee	Low	Moderate	Close-cropped turf in warm sunny situations for host nesting. Taller grassland with good flowering close by for nectaring.	Cleptoparasite of *Andrena* mining bees, mainly *A. labialis* – this host forages exclusively on legumes. Cuckoo visits flowers of spurge, umbellifers, etc	NS(A)		Falk (1991)
Sphecodes spinulosus Hagen A cuckoo bee	Moderate	Unknown	Bare soil or short turf in warm sunny situations for host nesting. Taller flowery grassland close by for nectaring.	Cleptoparasite of *Lasioglossum xanthopus*; cuckoos visit flowers of spurges, wild carrot, etc.	RDB2		Edwards & Telfer (2001); Falk (1991)

Species	Fidelity	Continuity	Structure of habitat	Food	Status	Synonyms	Literature References
Melitta dimidiata Morawitz A mining bee	High	Moderate	Large stands of sainfoin. Warm sunny spots with short turf or sparse vegetation for nesting.	Pollen and nectar from sainfoin.	RDB1, but needs down-grading		Edwards (1998); Falk (1991)
Melitta haemorrhoidalis (Fabricius) A mining bee	High	Moderate	Short sward flowery grassland with sheltered sunny banks of sparsely-vegetated ground for nesting.	Bellflowers for pollen & nectar.	Very local; needs up-grading to NS.		Edwards (1998)
Melitta tricincta (Kirby) A mining bee	Moderate	Moderate	Large stands of red Bartsia. Warm sunny spots with a short turf or sparse vegetation for nesting.	Pollen and nectar from red Bartsia	NS(B)		Falk (1991)
Chelostoma campanularum (Kirby) Harebell Carpenter Bee	Moderate	Moderate	Timber and fence posts for nesting	Pollen from bellflowers	Local		
Coelioxys quadridentata (Linnaeus) A cuckoo bee	Low	Moderate	Requirements of the various hosts encompass a wide variety of structures.	Cleptoparasite of *Anthophora* bees. Cuckoo visits a wide variety of flowering herbs especially those of short sward grasslands.	RDB3		Falk (1991)
Osmia aurulenta (Panzer) A mason bee	Low	Moderate	Warm sunny areas on moderately grazed south-facing slopes. Empty snail shells for nesting.	Pollen collection observed from bird's-foot-trefoil; nectar from a wider range of flowers.	NS(B)		Edwards (1998)
Osmia bicolor (Schrank) The Two-coloured Mason Bee	High	High	Warm sunny areas on moderately grazed south-facing slopes. Empty snail shells for nesting.	Horseshoe vetch and bird's-foot-trefoil flowers for pollen; wider variety for nectar.	NS(B)		Edwards (1998); Falk (1991)

Species	Fidelity	Continuity	Structure of habitat	Food	Status	Synonyms	Literature References
Stelis ornatula (Klug) A cuckoo bee	Moderate	Unknown	Scrubby grassland for stems for host nesting – bramble, rose & ragwort used, close to flowery swards	Cleptoparasite of the bee *Hoplitis clavicentris*; visits flowers of cinquefoils, bird's-foot-trefoil, hawk's-beard, etc	RDB3		Edwards (1998); Falk (1991)
Stelis phaeoptera (Kirby) A cuckoo bee	Moderate	Unknown	Scrubby areas of deadwood in open sunny situations for host nesting, close to flowery swards.	Cleptoparasite of *Osmia* bees; visit flowers of bird's-foot-trefoil, speedwell, thistles, hawkweed and field scabious	RDB2		Edwards (1998); Falk (1991)
Nomada argentata Herrich-Schaeffer A nomad bee	High	Moderate	Areas of short or sparsely-vegetated turf in warm sunny situations for host nesting. Good flowering of scabious.	Cleptoparasite of the mining bee *Andrena marginata*. Scabious flowers needed by host and parasite.	RDB3		Edwards & Telfer (2001); Falk (1991)
Nomada armata Herrich-Schaeffer A nomad bee	High	Moderate	Areas of short or sparsely-vegetated turf in warm sunny situations for host nesting. Good flowering of scabious.	Cleptoparasite of the mining bee *Andrena hattorfiana*. Scabious flowers needed by host and parasite, especially field scabious.	RDB1, but needs down-grading; Priority Species (BAP)		Edwards & Telfer (2001); Falk (1991)
Nomada errans Lepeletier A nomad bee	Moderate	Low	Dry bare earth for host nesting, in warm and sunny situations. Good flowering of wild carrot for host.	Cleptoparasite of the bee *Andrena nitidiuscula*; visits flowers of carrot, ragwort and yarrow	RDB1; Priority Species (BAP)		Edwards & Telfer (2002); Falk (1991)
Nomada flavopicta (Kirby) A nomad bee	Low	Moderate	Flower-rich situations, especially with *Trifolium repens* and other leguminous flowers, with areas of short turf or bare soil for host nesting. Warm sunny situations.	Cleptoparasite of *Melitta* mining bees, especially *M. leporina*. Cuckoo visits wide range of flowers of open and scrubby grassland.	NS(B)		Falk (1991)

Species	Fidelity	Continuity	Structure of habitat	Food	Status	Synonyms	Literature References
Nomada hirtipes Perez A nomad bee	Low	Moderate	South-facing banks for host nesting. Spring-flowering shrubs & trees for host.	Cleptoparasite of mining bee *Andrena bucephala*. Cuckoo visits variety of flowers, including dandelions	RDB3		Falk (1991)
Nomada signata Jurinep A nomad bee	Low	Unknown	Warm sunny situations, with trampled paths, short-cropped or sparsely-vegetated areas for host nesting. Spring flowering shrubs for host nectaring.	Cleptoparasite of mining bee *Andrena fulva*. Cuckoo visits flowers of sallow, wood spurge & dandelions.	RDB2		Falk (1991)
Ceratina cyanea Kirby The Blue Carpenter Bee	Moderate	Low	Warm & sunny, scrubby situations, with broken dead stems of bramble or rose for nest sites. Short flowery grassland for pollen and nectar.	Pollen from a wide variety of short grassland flowers.	RDB3		Falk (1991)
Bombus cullumanus Kirby Cullum's Bumblebee	High	Moderate	Large areas of flower-rich open grassland.	Visits flowers of marjoram, musk thistle, stemless thistle, knapweed and white clover.	RDB1, probably extinct		Falk (1991)
Bombus humilis Illiger	Moderate	Low	Large areas of tall, open, grassland with high densities of perennial plants such as Fabaceae, Lamiaceae and Scrophulariaceae. Areas of taller grassland needed for nesting.	Strong preference for pollen from Fabaceae, Lamiaceae and Scrophulariaceae. Nectar gathered from a wider variety of flowers.	Very local; Priority Species (BAP)		Edwards & Telfer (2002)

Species	Fidelity	Continuity	Structure of habitat	Food	Status	Synonyms	Literature References
Bombus ruderatus Fabricius The Large Garden Bumblebee	Moderate	Low	Large areas of open, flower-rich grassland on relatively dry soils. Coarser patches may be needed for nesting.	Visits flowers with a long corolla tube, especially toadflax, white dead-nettle, woundworts and red clover	NS(B); Priority Species (BAP)		
Bombus sylvarum Linnaeus The Shrill Carder Bumblebee	Low	Moderate	Large areas of open, flower-rich grassland. Coarser patches may be needed for nesting.	Favours flowers of white deadnettle, *w*oundworts, black horehound, red Bartsia , field scabious, thistles, knapweeds and tall melilot.	NS(B), but needs up-grading; Priority Species (BAP)		Edwards & Telfer (2001); Falk (1991)

Table 5. The beetles of lowland calcareous grasslands

Species	Fidelity	Continuity	Structure of habitat	Food	Status	Synonyms	Literature References
Carabidae – Ground Beetles							
Cicindela campestris Linnaeus	Low	Low	High proportion of dry open ground, locally at least	Carnivore	Widespread		Luff (1998)
Leistus spinibarbis (Fabricius)	Low	Low	Dry open ground	Carnivore	Widespread (E & Wales)		Luff (1998)
Olisthopus rotundatus (Paykull)	Low	Low	Dry open ground	Carnivore	Widespread		Luff (1998)
Amara curta Dejean	Moderate	Moderate	Sparsely-vegetated dry open ground, often with rock rubble	Plant-feeding adults but larvae carnivores	NS(B)		Luff (1998)
Amara equestris (Duftschmidt)	Low	Low	Sparsely-vegetated dry open ground	Plant-feeding adults but larvae carnivores	NS(B)		Luff (1998)
Amara nitida (Sturm)	Low	Low	Sparsely-vegetated dry open ground	Plant-feeding adults but larvae carnivores	NS(A)		Luff (1998)
Amara praetermissa (Sahlberg)	Low	Low	Sparsely-vegetated dry open ground	Plant-feeding adults but larvae carnivores	NS(B)		Luff (1998)
Harpalus ardosiacus Lutschnik	Moderate	Low	Sparsely-vegetated dry open ground, usually broken, with crevices; more on chalky clays	Plant-feeding larvae; adults omnivores	NS(B)		Luff (1998)
Harpalus attenuatus Stephens	Low	Low	Sparsely-vegetated dry open ground	Plant-feeding larvae; adults omnivores	Very local		Luff (1998)
Harpalus azureus (Fabricius)	Moderate	Moderate	Sparsely-vegetated dry open ground	Plant-feeding larvae; adults omnivores	NS(B)		Luff (1998)

Species	Fidelity	Continuity	Structure of habitat	Food	Status	Synonyms	Literature References
Harpalus dimidiatus (Rossi)	Moderate	Moderate	Sparsely-vegetated dry open ground	Plant-feeding larvae; adults omnivores	NS(A); Priority Species (BAP)		Luff (1998)
Harpalus honestus (Duftschmid)	High	Moderate	Sparsely-vegetated dry open ground and short swards	Plant-feeding larvae; adults omnivores	RDB1		Luff (1998)
Harpalus melleti Heer	Moderate	Low	Sparsely-vegetated dry open ground	Plant-feeding larvae; adults omnivores	NS(A)		Luff (1998)
Harpalus obscurus (Fabricius)	High	?	Sparsely vegetated dry open ground (e.g. old limestone quarries in Northants)	Plant-feeding larvae; adults omnivores	RDB1; Priority Species (BAP)		Luff (1998)
Harpalus parallelus Dejean	High	?	Sparsely-vegetated dry open ground	Plant-feeding larvae; adults omnivores	RDB3; Priority Species (BAP)		Luff (1998)
Harpalus punctatulus (Duftschmid)	Moderate	Low	Sparsely-vegetated dry open ground	Plant-feeding larvae; adults omnivores	NS(A); Priority Species (BAP)		Luff (1998)
Harpalus puncticollis (Paykull)	Moderate	Low	Sparsely-vegetated dry open ground	Plant-feeding larvae; adults omnivores	RDB3		Luff (1998)
Harpalus rupicola Sturm	Moderate	Low	Sparsely-vegetated dry open ground, usually with tall vegetation	Plant-feeding larvae; adults omnivores	NS(B)		Luff (1998)
Harpalus sabulicola (Panzer)	Moderate	Low	Sparsely-vegetated dry open ground	Plant-feeding larvae; adults omnivores	RDB3		Luff (1998)

Species	Fidelity	Continuity	Structure of habitat	Food	Status	Synonyms	Literature References
Harpalus schaubergerianus Puel	Moderate	Low	Sparsely-vegetated dry open ground	Plant-feeding larvae; adults omnivores	Very local		Luff (1998)
Licinus depressus (Paykull)	High	High	Sparsely-vegetated dry open ground, generally with loose rock debris	Molluscs	NS(B)		Luff (1998)
Licinus punctatulus (Fabricius)	High	High	Sparsely-vegetated dry open ground, generally with loose rock debris	Molluscs	NS(A)		Luff (1998)
Panagaeus bipustulatus (Fabricius)	Moderate	Low	Sparsely-vegetated dry open ground, usually short vegetation		NS(B)		Luff (1998)
Callistus lunatus (Fabricius)	High	Low	Well-developed & species-rich vegetation		RDB1		Luff (1998)
Lebia chlorocephala (Hoffmannsegg)	Moderate	Low	Well-developed & species-rich vegetation (inc. wood margins & hedges on calcareous substrate)	Larvae ectoparasitic on *Chrysolina* leaf beetle pupae	NS(B)		Luff (1998)
Lebia cruxminor (Linnaeus)	Low	Low	Well-developed & species-rich vegetation	Larvae probably ectoparasitic on *Galeruca tanaceti* leaf beetle pupae	RDB1		Luff (1998)
Lebia cyanocephala Linnaeus	Low	Moderate	Sparely-vegetated dry open ground, amongst such plants as Asteraceae (Compositae)	Larvae carnivorous	RDB1		Luff (1998)
Cymindis axillaris (Fabricius)	High	Low	Sparely-vegetated dry open ground		NS(A)		Luff (1998)
Brachinus crepitans Linnaeus)	Moderate	Low	Dry open ground, usually very broken, with many crevices	Larvae ectoparasitic on the pupae of other beetles	NS(B)		Luff (1998)

Species	Fidelity	Continuity	Structure of habitat	Food	Status	Synonyms	Literature References
Leiodidae							
Colon rufescens Kraatz	High	?	Short to medium sward	Fungi/mould at the roots of dead grass	RDBI		Allen (1989); Hyman (1994); Joy (1910)
Leiodes gallica (Reitter)	Moderate	?	Short downland turf	Subterranean fungi	RDBK		Cooter (1989 & 1996); Hyman (1994)
Leiodes gyllenhali (Stephens)	Moderate	?	In more sheltered situations such as woodland rides & glades	Subterranean fungi	RDBK	L. parvula	Cooter (1996); Hyman (1994)
Leiodes lunicollis (Rye)	Moderate	?	Xerophilous, short swards	Subterranean fungi	RDBK		Cooter (1996); Hyman (1994)
Leiodes rugosa Stephens	Moderate	?	Ranker vegetation with scrub	Subterranean fungi	NS		Cooter (1989); Hyman (1994)
Agaricophagus cephalotes Schmidt, W.L.E.							
Ptomaphagus varicornis (Rosenhauer)	Moderate	?	Well-developed litter and moss layers in sward	Decaying vegetation?	RDBK		Hyman (1994) Walker (1910); Last (1946); Donisthorpe (1946)
Silphidae							
Silpha laevigata Fabricius	Moderate	?	Short to medium sward with calcareous rubble & litter	Molluscs	Local		Airy Shaw
Silpha obscura Linnaeus	Low	Low	Short to medium sward with calcareous rubble & litter	Omnivorous	RDB2		Hyman (1992& 1994) Balduf (1935)
Silpha tristis Illiger	Moderate	Low	Various heights and densities	Omnivorous	Local		

Species	Fidelity	Continuity	Structure of habitat	Food	Status	Synonyms	Literature References
Scydmaenidae							
Euconnus denticornis (Müller & Kunze)	Moderate	?	Well-developed litter and moss layers in sward	Mites	RDBI		Hyman (1994)
Neuraphes carinatus (Mulsant)	High	?	Well-developed litter and moss layers in sward	Mites	RDBI		Hyman (1994)
Stenichnus pusillus (Müller & Kunze)	Moderate	?	Well-developed litter and moss layers in sward	Mites	NS		Hyman (1994)
Staphylinidae							
Platystethus capito Heer	High	Unknown	Slightly moist banks or relatively open areas where vegetation is sparse, for burrow construction	Adults and larvae appear to be saprophagous	Very local		Hammond (1971)
Stenus asphaltinus Erichson	Moderate	Unknown	Well-developed litter beneath turf	Predatory on soft-bodied insects	RDBI		Good & Giller (1991); Hyman (1994)
Stenus ater Mannerheim	Moderate	Unknown	Well-developed litter beneath turf	Predatory on soft-bodied insects	NS(B)		Good & Giller (1991); Hyman (1994)
Stenus ochropus Kiesenwetter	High	Unknown		Predatory on soft-bodied insects	Local		Good & Giller (1991);
Scopaeus sulcicollis (Stephens)	Moderate	High	Prefers uncovered soil on warm slopes; under stones on dry chalky ground		Local		Allen (1968); Good & Wistow (1997)
Astenus procerus (Gravenhorst)	Moderate	Unknown	Well-developed litter and moss layers in sward		RDBK		Hyman (1994)
Rugilus similis (Erichson)	Moderate	Unknown			NS		Hyman (1994)
Rugilus subtilis (Erichson)	Moderate	Unknown			RDBI		Hyman (1994)
Platydracus latebricola (Gravenhorst)	Moderate	Unknown	Xerophilic	Predatory on invertebrates	NS(B)		Good & Giller (1991); Hyman (1994)
Staphylinus fuscatus Gravenhorst	Moderate	Unknown		Predatory on invertebrates	Local		Good & Giller (1991);

Species	Fidelity	Continuity	Structure of habitat	Food	Status	Synonyms	Literature References
Staphylinus nero Faldermann	Moderate	Unknown	Rather dry soil and high insolation	Predatory on invertebrates	Local		Allen (1998); Good & Giller (1991)
Tasgius pedator (Gravenhorst)	High	Unknown	Dry open ground, usually very broken, with many crevices	Predatory on invertebrates	NS(A)	*Ocypus pedator*	Good & Giller (1991); Hyman (1994)
Cousya nitidiventris (Fagel)	Low	Unknown		Predatory on invertebrates	RDBK	*Ocypus nitidiventris*	Good & Giller (1991); Hyman (1994)
Philonthus coprophilus Jarrige	Low	Unknown		Predatory on invertebrates	RDBI		Good & Giller (1991); Hyman (1994)
Mycetoporus piceolus Rey	Moderate	Unknown			NS		Hyman (1994)
Sepedophilus immaculatus (Stephens)	Moderate	Unknown	Short open turf	Mycetophagous	Local		Reid (1990)
Tachyporus quadriscopulatus Pandellé	High	Unknown	Upland Carboniferous limestone	Predatory on arthropods, and possibly also feeds on fungal material	RDBK		Good & Giller (1991); Hyman (1994)
Brachida exigua (Heer)	Moderate	Unknown	Warm south-facing slope, with a moist litter layer provided by tor grass		RDBI		Welch (1989)
Borboropora kraatzi Fuss	Moderate	Unknown	Subterranean?		RDBK		Hyman (1994)
Dacrila pruinosa (Kraatz)	High	Unknown	Sparsely-vegetated areas		RDBI		Hyman (1994)
Alaobia scapularis Sahlberg, C.R.	Low	Unknown	Xerophilic		NS		Hyman (1994)
Atheta pervagata Benick	Moderate	Unknown	Subterranean?	Probably predatory on soil invertebrates such as springtails, mites and enchytraeid worms	RDBK		Good & Giller (1991); Hyman (1994)
Alevonota aurantiaca Fauvel	Moderate	Unknown	Subterranean?		RDBI		Hyman (1994)
Alevonota gracilenta (Erichson)	Low	Unknown	Well-developed litter and moss layers in sward		RDBK		Hyman (1994)

Species	Fidelity	Continuity	Structure of habitat	Food	Status	Synonyms	Literature References
Homoeusa acuminata (Märkel)	Low	Unknown	Associated with runs and nests of *Lasius* spp of ant.		RDBK		Hyman (1994)
Pselaphinae							
Claviger longicornis Müller	High	Unknown	Nests of *Lasius* spp ants	Mites	RDB1		Hyman (1994); Pearce (1957)
Claviger testaceus Preyssler	Moderate	Unknown	Nests of *Lasius flavus* and other *Lasius* spp.	Mites	NS		Hyman (1994); Pearce (1957)
Tychobythinus glabratus (Rye)	High	Unknown	Nests of *Ponera coarctata* and occasionally *Lasius flavus* ants	Mites	RDBI	*Bythinopsis glabrata* (Rye)	Hyman (1994); Pearce (1957)
Geotrupidae							
Geotrupes pyrenaeus (Charpentier)	Low	Moderate	Depth of soil suitable for shallow burrowing	Livestock dung	NS(A)		Hyman (1994); Jessop (1986)
Odontaeus armiger (Scopoli)	Moderate	Unknown	Deep soils	Develops in subterranean fungi	NS(A)		Hyman (1992); Jessop (1986)
Scarabaeidae							
Copris lunaris (Linnaeus)	Moderate	Unknown		Cattle or horse dung	RDB1		Hyman (1992); Jessop (1986)
Amphimallon ochraceus (Knoch)	Moderate	High	Long undisturbed turf	Larvae root-feeders	NS(A)		Hyman (1992); Jessop (1986)
Omaloplia ruricola (Fabricius)	High	High		Larvae root feeders, possibly associated with ants	NS(B)		Hyman (1992); Jessop (1986)
Euheptaulacus villosus Gyllenhal	Moderate	Moderate	Sparse open swards with areas of bare substrate	Vegetable matter & dung	NS(A)		Hyman (1992); Jessop (1986)
Aphodius consputus Creutzer	Low	Unknown		Livestock dung	RDB3		Hyman (1992); Jessop (1986)
Aphodius distinctus (Müller)	Low	Unknown		Horse dung & decomposing vegetable matter	NS(B)		Hyman (1992); Jessop (1986)
Aphodius paykulli Bedel	Low	Unknown		Livestock dung	NS(B)		Hyman (1992); Jessop (1986)

Species	Fidelity	Continuity	Structure of habitat	Food	Status	Synonyms	Literature References
Aphodius porcus (Fabricius)	Low	Unknown		A cuckoo parasite in burrows of *Geotrupes stercorarius* beneath horse & cattle dung	NS(B)		Hyman (1992); Jessop (1986)
Aphodius putridus (Fourcroy)	Moderate	Unknown	Dry pastures	Dung & vegetable debris	NS(B)		Hyman (1992); Jessop (1986)
Aphodius quadrimaculatus (Linnaeus)	Low	Unknown	Dry pastures	Livestock dung, generally sheep	RDB1		Hyman (1992); Jessop (1986)
Aphodius sordidus (Fabricius)	Moderate	Unknown	Dry pastures	Livestock dung	NS(A)		Hyman (1992); Jessop (1986)
Aphodius subterraneus (Linnaeus)	Low	Unknown		Dung, debris, compost & carrion	RDB1		Hyman (1992); Jessop (1986)
Dascillidae							
Dascillus cervinus (Linnaeus)	Low	Low		Larvae feed on roots of orchids and grasses; adults on pollen and nectar	Local		
Byrrhidae							
Chaetophora spinosa (Rossi)	High	High	Sparsely vegetated dry open sward with mosses	Probably feeds on mosses	Very local	*Syncalypta spinosa* (Rossi)	Johnson (1978)
Curimopsis maritima (Marsham)	Moderate	High	Sparsely vegetated dry open sward		Very local	*Syncalypta striatopunctata* Steffahny	Johnson (1978)
Buprestidae							
Aphanisticus pusillus (Olivier)	Moderate	High	Short to moderate height sward, but not rank; adult hibernates in plant debris on soil surface.	Larvae feed within mines in leaf blades of sedges	NS(B)		Alexander (2000, 2003); Bílý (1982); Levey (1977)

Species	Fidelity	Continuity	Structure of habitat	Food	Status	Synonyms	Literature References
Trachys scrobiculatus Kiesenwetter	High	High	Sizeable patches of the food-plant on thin soils and in open swards. Grazing usually heavy and by rabbits, deer, etc, which selectively avoid ground ivy, with consequence that it develops relatively good aerial structure for the situation.	Larvae feed within blister mines on leaves of ground ivy where it grows in situations exposed to full sunshine	NS(A)		Alexander (2003); Bílý (1982); Levey (1977)
Trachys troglodytes Gyllenhal	Moderate	High	Short to moderate height sward, but not rank; adult hibernates in plant debris on soil surface.	Larvae feed within blister mines on leaves of basal rosette of devil's-bit scabious	Very local		Alexander (1989, 2003); Bílý (1982); Levey (1977)
Elateridae							
Agrypnus murinus (Linnaeus)	Moderate	High	Short to medium sward	Larvae feed on roots of various plants, predatory in later stages	Local		
Prosternon tessellatum (Linnaeus)	Low	Low	Open grasslands	Larvae root-feeding	Local		
Adrastus rachifer (Fourcroy)	High	Moderate	Rank vegetation, including field margins	Larvae probably root-feeding	RDB3		Hyman (1992)
Drilidae							
Drilus flavescens (Fourcroy)	High	Moderate	Moderately rank grassland with larger snail species; in open grassland, woodland rides and glades, as well as grass verges	Snails, particularly *Helix aspersa*, *Cepaea nemoralis*, and medium sized species	NS(A), but needs down-grading		Alexander (field observations); Hyman (1992)

Species	Fidelity	Continuity	Structure of habitat	Food	Status	Synonyms	Literature References
Lampyridae							
Lampyris noctiluca (Linnaeus)	Moderate	High	Short to medium sward; also woodland ride edges, field margins, etc.	Larvae feed on snails. Adults may also feed on snails but less so than larvae	Local		Tyler (2002)
Melyridae							
Psilothrix viridicoeruleus Fourcroy	Low	Unknown	Good flowering of broadleaved herbs; generally coastal	Adults feed on pollen	Local		
Nitidulidae							
Meligethes bidens Brisout	High	Unknown	Good flowering of wild basil	Larvae feed on developing fruit buds of wild basil; adults feed on pollen.	Local		Kirk-Spriggs (1996)
Meligethes bidentatus Brisout	Low	Moderate	Good flowering of dyer's greenweed; short to medium swards	Larvae feed on developing fruit buds; adults feed on pollen.	RDBK		Hyman (1994); Kirk-Spriggs (1996)
Meligethes brevis Sturm	High	Unknown	Good flowering of hoary rock-rose (North Wales) and common rock-rose (Yorkshire)	Larvae feed on developing fruit buds; adults feed on pollen.	RDBK		Hyman (1994); Kirk-Spriggs (1996)
Meligethes erichsoni Brisout	High	Unknown	Short turf with good flowering of horseshoe vetch	Larvae feed on developing fruit buds; adults feed on pollen.	NS		Hyman (1994); Kirk-Spriggs (1996)
Meligethes lugubris Sturm	Low	Unknown	Good flowering of thyme. Short sward with bare patches and stones	Larvae feed on developing fruit buds; adults feed on pollen.	NS		Hyman (1994); Kirk-Spriggs (1996)

Species	Fidelity	Continuity	Structure of habitat	Food	Status	Synonyms	Literature References
Meligethes planiusculus (Heer)	Moderate	Unknown	Good flowering of viper's-bugloss	Larvae feed on developing fruit buds; adults feed on pollen.	Local		Kirk-Spriggs (1996)
Meligethes solidus (Kugelann)	High	Unknown	Good flowering of common rock-rose	Larvae feed on developing fruit buds; adults feed on pollen.	NS		Hyman (1994); Kirk-Spriggs (1996)
Meligethes subrugosus (Gyllenhal)	Low	Unknown	Good flowering of sheep's-bit and possibly clustered bellflower	Larvae feed on developing fruit buds; adults feed on pollen.	NS		Hyman (1994); Kirk-Spriggs (1996)
Meligethes umbrosus Sturm	Moderate	Unknown	Good flowering of selfheal	Larvae feed on developing fruit buds; adults feed on pollen.	NS		Hyman (1994); Kirk-Spriggs (1996)
Cryptophagidae							
Micrambe lindbergorum (Bruce)	Moderate	Unknown	Good flowering, especially of dyers greenweed. Short to medium sward.	Cryptophagids are mould feeders – could be a smut or rust on dyer's greenweed?	RDBK		Hyman (1994)
Phalacridae							
Phalacrus fimetarius (Fabricius)	High	Unknown	Medium to tall grassland	On smutted plants of tor-grass	Local	*Phalacrus brisouti* Rye	Thompson (1958)
Coccinellidae							
Scymnus femoralis (Gyllenhal)	Moderate	Unknown	Short sward	Carnivore	NS(B)		Hyman (1992); Majerus (1994)
Scymnus schmidti Fuersch	Moderate	Unknown	Short sward	Carnivore	NS(B)		Hyman (1992); Majerus (1994)

Species	Fidelity	Continuity	Structure of habitat	Food	Status	Synonyms	Literature References
Endomychidae							
Lycoperdina bovistae (Fabricius)	Low	?	Short to medium sward, often with bare sandy/calcareous soils	Puff-ball fungi *Lycoperdon* spp	RDB3		Hyman (1992)
Tenebrionidae							
Opatrum sabulosum (Linnaeus)	Moderate	High	Moderately open vegetation	Omnivorous scavenger	NS(B)		Brendell (1975); Hyman (1992)
Mordellidae							
Mordellistena brevicauda (Boheman)	High	?	Good flowering and persistence of tall stems	Larvae develop in pith stems of various tall plants	RDBK		Hyman (1992)
Mordellistena parvula (Gyllenhal)	Moderate	?	Good flowering and persistence of tall stems	Larvae develop in pith stems of various tall plants, possibly mainly mugwort but also yarrow	RDBK		Hyman (1992)
Mordellistena pseudopumila Ermisch	Low	?	Good flowering and persistence of tall stems	Larvae develop in pith stems of various tall plants	RDBK		Hyman (1992)
Meloidae							
Meloe rugosus Marsham	Moderate	High	Sparely-vegetated to short sward	Larvae parasitic on *Anthophora* and *Osmia* bees	RDB3		Hyman (1992)
Bruchidae - Seed Beetles							
Bruchidius cisti (Fabricius)	High	Low	Short to medium sward	Larvae develop in seeds of common bird's-foot-trefoil; adults feed at rock-rose blossom	Local		Cox (2001)

Species	Fidelity	Continuity	Structure of habitat	Food	Status	Synonyms	Literature References
Bruchidius olivaceus (Germar)	High	?	Good flowering and seed-set of sainfoin; seed-heads left to stand through the winter	Larvae develop in seed pods of sainfoin, probably over-wintering in the pods	RDB1		Cox (2001); Hyman (1992)
Chrysomelidae							
Clytra laeviuscula Ratzeburg	Unknown	Unknown	Scrubby grasslands	Larvae develop in ants nests	Extinct		Hyman (1992)
Cryptocephalus aureolus Suffrian	Moderate	Moderate	Lightly grazed sward with good flowering of hawkweeds and other yellow flowers	Larvae feed on foliage of hawkweed & possibly rock-rose; adults feed on pollen	NS(B) – needs down-grading		Cox (1976); Hyman (1992)
Cryptocephalus bilineatus (Linnaeus)	High	High	Open grassland with good population of kidney vetch	Kidney vetch	NS(B)		Hyman (1992)
Cryptocephalus bipunctatus (Linnaeus)	Moderate	High	Developing open scrub within sward	Foliage of woody shrubs growing in open sunny situations	NS(B)		Hyman (1992)
Cryptocephalus coryli (Linnaeus)	High	High	Developing open scrub within sward	Foliage of open grown young hazel on warm dry sunny slopes	RDB1; Priority Species (BAP)		Cox (1976); Hyman (1992)
Cryptocephalus fulvus Goeze	Moderate	Low	Sparely vegetated to short sward	Lamiaceae, Asteraceae, Salicacaea Fabaceae, Apiaceae	Local		
Cryptocephalus hypochaeridis (Linnaeus)	Moderate	Low	Short to medium sward	Larvae feed on foliage of hawkweed; adults feed on pollen	Local		Cox (1976)

Species	Fidelity	Continuity	Structure of habitat	Food	Status	Synonyms	Literature References
Cryptocephalus moraei (Linnaeus)	Low	Low	Short to medium sward, also quite bare ground and ride verges etc	Perforate St John's-wort	Local		Cox (1976)
Cryptocephalus nitidulus Fabricius	High	High	Developing open scrub within sward	Foliage of open grown young birch on warm dry sunny slopes	RDB1; Priority Species (BAP)		Cox (1976); Hyman (1992)
Cryptocephalus primarius Harold	High	High	Developing open scrub within sward	Common rock-rose	RDB1; Priority Species (BAP)		Hyman (1992)
Timarcha goettingensis (Linnaeus)	Moderate	High	Short to medium sward	Bedstraws	Very local		
Timarcha tenebricosa (Fabricius)	Low	Moderate	Short to medium sward	Goosegrass species	Local		
Chrysolina haemoptera (Linnaeus)	Moderate	High	Sparsely vegetated ground rich in broad-leaved herb species; sward height moderately short	Plantains	NS(B)		Hyman (1992)
Chrysolina hyperici (Forster)	Low	Low	Tall flowering St John's worts Short to medium sward, also quite bare ground and woodland ride verges etc	St John's-worts; larvae feed on stem and leaves; adults on leaves and flowers	Local		Cox (1976)
Chrysolina marginata (Linnaeus)	Low	Moderate	Short sward grasslands with yarrow plentiful	Primarily yarrow	NS(A)		Hyman (1992)
Chrysolina violacea (Müller)	Moderate	Moderate	Short to medium sward grasslands; also woodland rides and field/road verges	Ground ivy	NS(B)		Hyman (1992)
Galeruca tanaceti (Linnaeus)	Moderate	Low	Short to medium sward; also field margins and waste ground	Scabiouses, knapweed, yarrow, thyme, etc	Very local		Cox (1976)
Sermylassa halensis (Linnaeus)	Moderate	Low	Short to medium grassland, including woodland wides	Lady's & heath bedstraws	Local		
Phyllotreta nodicornis (Marsham)	Low	Low	Short to medium sward	*Reseda* spp	Local		

Species	Fidelity	Continuity	Structure of habitat	Food	Status	Synonyms	Literature References
Aphthona atrovirens Foerster	High	Low			Local	A. atratula	Cox (1976)
Aphthona herbigrada (Curtis)	High	Low	Short to medium sward; flower rich	Common rock-rose	Local		Cox (1976)
Longitarsus anchusae (Paykull)	Moderate	Low	Short to medium sward	Viper's bugloss, comfrey and hound's-tongue	NS(B)		Hyman (1992)
Longitarsus ballotae (Marsham)	Moderate	Low	Rank grassland	Black horehound and white horehound	NS(B)		Hyman (1992)
Longitarsus curtus (Allard)	Moderate	Low		Viper's bugloss, comfrey and hound's-tongue	NS(A)		Hyman (1992)
Longitarsus dorsalis (Fabricius)	Moderate	Low	Favours short sward and sparsely-vegetated ground, especially areas heavily grazed by rabbits	Ragwort	NS(B)		Hyman (1992)
Longitarsus exoletus (Linnaeus)	Moderate	Low	Short to medium swards	Viper's-bugloss mainly	Local		Cox (1976)
Longitarsus fowleri Allen	High	High	Short sward; warm south-facing slopes	Thyme and ground ivy	NS(A)		Cox (1976)
Longitarsus lycopi (Foudras)	Moderate	?	Short to medium sward, incl. woodland rides	Calamint, selfheal and gypsywort	NS(B)		Hyman (1992)
Longitarsus nasturtii (Fabricius)	Low	Low		Viper's bugloss, comfrey and hound's-tongue	NS(B)		Hyman (1992)
Longitarsus nigrofasciatus (Goeze)	High	Low	Short to medium sward	Figworts & mulleins	NS(A)		Hyman (1992)
Longitarsus obliteratus (Rosenhauer)	High	Moderate	Short to medium sward	Marjoram	Very local		
Longitarsus quadriguttatus (Pontoppidan)	Moderate	Low	Short to medium sward	Hound's-tongue	NS(A)		Hyman (1992)
Longitarsus suturalis (Marsham)	High	Low	Disturbed ground	Gromwell	NS(B)		Hyman (1992)
Longitarsus tabidus (Fabricius)	High	Low	Disturbed ground	Mulleins	NS(B)		Hyman (1992)

Species	Fidelity	Continuity	Structure of habitat	Food	Status	Synonyms	Literature References
Altica pusilla Duftschmid	High	Low	Open grasslands, moderate sward height	Salad Burnet	Local		
Mantura matthewsi (Curtis)	High	Moderate	Short to medium sward with abundant bushy rock-rose	Common rock-rose, larvae leaf-miners	Very local		
Apteropeda globosa (Illiger)	Low	Low	Sward tall enough for good lateral development of labiates and other herbs	Various labiates, including selfheal, germander, speedwell & possibly also plantain and ground ivy; larvae mining leaves	NS(B)		Hyman (1992)
Cassida prasina Illiger	High	High	Short to moderate height swards	Adults and larvae on yarrow	NS(B)	*C. sanguinolenta* Müller	Hyman (1992)
Pilemostoma fastuosa (Schaller)	High	High	Short sward	Ploughman's spikenard - larvae feeding on foliage	NS(A)		Hyman (1992)
Apionidae							
Perapion sedi Germar	Low	Low	Short sward and rubble-strewn ground	Larvae mine leaves & stems of stonecrops	NS(B)		Morris (1990)
Exapion difficile Herbst	Low	Low	Good flowering of dyer's greenweed	Larvae develop in pods of dyer's greenweed	NS(A)		Morris (1990)
Thymapion atomarium Kirby	Moderate	Low	Short swards	Larvae develop in stem galls on thyme	Very local		Morris (1990)
Thymapion cineraceum Wencker	High	Low	Short swards	Larvae probably develop in rootstock of selfheal	NS(A)		Morris (1990)

Species	Fidelity	Continuity	Structure of habitat	Food	Status	Synonyms	Literature References
Thymapion flavimanum Gyllenhal	High	Low	Open grasslands with foodplant	Larvae develop in lower stems of wild marjoram	NS(A)		Morris (1990)
Diplapion stolidum Germar	Moderate	Low	Short to medium sward; often on disturbed ground e.g. disused quarries and road cuttings	Larvae develop in either stems or root-stocks of ox-eye daisy	NS(B)		Morris (1990)
Pseudotrichapion astragali (Paykull)	Moderate	Low	Good flowering of wild liquorice, usually in short to medium grassland; also in grassy woodland rides	Larvae develop in flower buds of wild liquorice	NS(A)		Morris (1990)
Eutrichapion intermedium Eppelsheim	High	Low	Tall growth of sainfoin	Larvae develop in stems of sainfoin	NS(A)		Morris (1990)
Eutrichapion ononis Kirby	Moderate	Low	Good flowering of restharrows	Larvae feed on unripe seeds in pods	Local		Morris (1990)
Eutrichapion reflexum Gyllenhal	High	Low	Good flowering of sainfoin	Larvae may develop in galls in the inflorescences of sainfoin	NS(A)		Morris (1990)
Eutrichapion waltoni Stephens	High	Low	Large stands of horseshoe vetch in short sward	Larvae feed in stems of horseshoe vetch	Very local		Morris (1990)
Protapion filirostre Kirby	Moderate	Low	Good flowering of medicks	Larvae develop in buds of medicks	NS(B)		Morris (1990)
Protapion ononicola Bach	Moderate	Low	Good flowering and seed-set of restharrows	Larvae develop in fruits of restharrows	Local		Morris (1990)
Curculionidae							
Otiorhynchus ligustici (Linnaeus)	Moderate	Moderate	Sparsely-vegetated, open grassy situations, particularly on seacliffs	Preference for kidney vetch; root-feeding larvae	RDB2		Hyman (1992); Morris (1997)

Species	Fidelity	Continuity	Structure of habitat	Food	Status	Synonyms	Literature References
Otiorhynchus ovatus (Linnaeus)	Low	Moderate	Open sparsely-vegetated ground	Polyphagous; root-feeding larvae	Local		Morris (1997)
Otiorhynchus desertus Rosenhauer	Low	Moderate	Denser vegetation than that favoured by *O. ovatus*	Polyphagous; root-feeding larvae	NS(B)		Hyman (1992); Morris (1997)
Otiorhynchus rugifrons (Gyllenhal)	Low	Moderate	Open rocky places	Polyphagous; root-feeding larvae	Local		Morris (1997)
Otiorhynchus raucus (Fabricius)	Moderate	Moderate	Open and sparsely-vegetated	Polyphagous; root-feeding larvae	NS(B)		Hyman (1992); Morris (1997)
Otiorhynchus clavipes (Bonsdorff)	Low	Low	Generally favours taller vegetation	Polyphagous; root-feeding larvae	Local		Morris (1997)
Otiorhynchus rugosostriatus (Goeze)	Low	Low	Short to medium sward	Polyphagous; root-feeding larvae	Local		Morris (1997)
Otiorhynchus ligneus (Olivier)	Low	Moderate	Short sward to sparsely-vegetated ground	Polyphagous; root-feeding larvae	Local		Morris (1997)
Caenopsis waltoni (Boheman)	Low	Moderate	Present in wide spectrum of vegetation density	Polyphagous; root-feeding larvae	Very local		Morris (1997)
Trachyphloeus alternans Gyllenhal	Moderate	High	Sparsely-vegetated areas	Polyphagous; root-feeding larvae	NS(B)		Hyman (1992); Morris (1997)
Trachyphloeus angustisetulus Hansen	Low	High	Sparsely-vegetated areas	Polyphagous; root-feeding larvae	Very local		Morris (1997)
Trachyphloeus aristatus (Gyllenhal)	Moderate	High	Sparsely-vegetated areas	Probably polyphagous; root-feeding larvae	NS(B)		Hyman (1992); Morris (1997)
Trachyphloeus asperatus Boheman	Moderate	High	Sparsely-vegetated areas	Probably polyphagous; root-feeding larvae	NS(B)		Hyman (1992); Morris (1997)
Trachyphloeus bifoveolatus (Beck)	Low	High	Sparsely-vegetated areas	Polyphagous; root-feeding larvae	Very local		Morris (1997)
Trachyphloeus digitalis (Gyllenhal)	High	High	Open vegetation	Probably polyphagous; root-feeding larvae	NS(A)		Hyman (1992); Morris (1997)
Trachyphloeus scabriculus (Linnaeus)	Moderate	High	Open vegetation	Polyphagous; root-feeding larvae	Very local		Morris (1997)

Species	Fidelity	Continuity	Structure of habitat	Food	Status	Synonyms	Literature References
Trachyphloeus spinimanus Germar	High	High	Open vegetation	Polyphagous; root-feeding larvae	NS(B)		Hyman (1992); Morris (1997)
Phyllobius viridicollis (Fabricius)	Moderate	Low	More densely vegetated and coarser areas	Polyphagous; root-feeding larvae	Local		Morris (1997)
Phyllobius viridiaeris Laicharting	Low	Low	Medium to long grassland	Polyphagous; root-feeding larvae	Widespread		Morris (1997)
Strophosoma faber (Herbst)	Moderate	High	Open vegetation	Polyphagous; root-feeding larvae	NS(B)		Hyman (1992); Morris (1997)
Strophosoma nebulosum (Stephens)	Low	Moderate	Sparsely-vegetated areas	Polyphagous; root-feeding larvae	Local		Morris (1997)
Barynotus obscurus (Fabricius)	Low	Moderate	Open vegetation	Polyphagous; root-feeding larvae	Local		Morris (1997)
Brachysomus echinatus (Bonsdorff)	Low	High	Relatively coarse, with accumulations of grass litter in sward	Polyphagous; root-feeding larvae	NS(B)		Hyman (1992)
Brachysomus hirtus (Boheman)	Moderate	High	Relatively coarse, with accumulations of grass litter and/or moss in sward	Polyphagous; root-feeding larvae	RDB3		Hyman (1992)
Sitona humeralis Stephens	Low	Low	Short to medium swards; range of grassy habitats	Mainly medicks; larvae probably feed on nitrifying root nodules	Widespread		Morris (1997)
Sitona macularius (Marsham)	Low	Low		Pea family, especially sanfoin, vetches, medicks & trefoils.; larvae probably feed on nitrifying root nodules	NS(B)		Hyman (1992); Morris (1997)
Sitona ononidis Sharp	Moderate	Low	Short to medium sward	Restharrows; larvae probably feed on nitrifying root nodules	NS(B)		Hyman (1992); Morris (1997)

Species	Fidelity	Continuity	Structure of habitat	Food	Status	Synonyms	Literature References
Sitona sulcifrons Thunberg	Low	Low	Wide range of sward types, from short to medium coarse grassland	Mainly trefoils, especially red clover; larvae probably feed on nitrifying root nodules	Local		Morris (1997)
Sitona waterhousei Walton	Low	Low	Tall bushy stands of bird's-foot-trefoil; in short to medium sward, and sparsely vegetated habitats	Bird's-foot-trefoils; larvae probably feed on nitrifying root nodules	NS(B)		Hyman (1992); Morris (1997)
Larinus planus (Fabricius)	Low	Moderate	Open grassland	Various thistles; larvae in flower-heads	NS(B)		Morris(2002)
Rhinocyllus conicus (Frölich)	Moderate	Moderate	Open grassland	Various thistles; larvae in flower-heads	NS(A)		Hyman (1992); Morris(2002)
Hypera arator (Linnaeus)	Low	Low	Open grassland and sparsely-vegetated areas	Caryophyllaceae	Widespread		Morris(2002)
Hypera dauci (Olivier)	Low	High	Large plants of common stork's-bill in open vegetation	Larvae feed on foliage of stork's-bill	NS(B)		Hyman (1992); Morris(2002)
Hypera duversipunctata (Schrank)	Low	High		Caryophyllaceae	RDB3		Morris(2002)
Hypera fuscocinerea (Marsham)	Moderate	?		Medicks	NS(B)		Morris(2002)
Hypera meles (Fabricius)	Low	Low		Trefoils, especially red and white clover	Local		Morris(2002)
Hypera nigrirostris (Fabricius)	Low	Low		Red clover	Widespread		Morris(2002)
Hypera ononidis Chevrolat	Moderate	?		Restharrow	Local		Morris(2002)
Hypera pastinacae (Rossi)	Low	?		Wild carrot; larvae in umbels	RDB1 – Folkestone Cliffs		Morris(2002)

Species	Fidelity	Continuity	Structure of habitat	Food	Status	Synonyms	Literature References
Hypera plantaginis (Degeer)	Low	Low		Bird's-foot-trefoil; larvae on flowers as well as foliage	Widespread		Morris(2002)
Hypera postica (Gyllenhal)	Moderate	Low	Short to moderate height swards	Wide range of Fabaceae (Leguminosae), but mostly on medick	Widespread		Morris(2002)
Hypera punctata (Fabricius)	Low	Low	Open grassland situations	Red and white clover, and other *Trifolium* spp	Widespread		Morris(2002)
Hypera suspiciosa	Low	Low	Luxuriant growth of Fabaceae (Leguminosae)	On various Fabaceae (Leguminosae)	Local		Morris(2002)
Hypera venusta (Fabricius)	Low	Low		Kidney vetch, dwarf gorse, etc	Widespread		Morris(2002)
Limobius borealis (Paykull)	High	Low	Luxuriant growth of crane's-bills spp in open vegetation	Crane's-bills	NS(A)		Hyman (1992); Morris (2002)
Cionus nigritarsis Reitter	Moderate	Low	Disturbed ground and rank grassland; also woodland verges	Dark mullein and other mulleins	NS(A)		Hyman (1992); Morris (2002)
Leiosoma troglodytes Rye	High	Moderate	Short to medium sward	Found at roots of grass, foodplant not known; others in genus feed on *Ranunculus* spp; larvae in roots.	RDB2	*L. pyrenaeum*	Hyman (1992); Morris (2002)
Orthochaetes insignis (Aubé)	Moderate	High	Open and short sward; sparsely vegetated areas	Larvae leaf-miners on a wide variety of broad-leaved herbs, including ox-eye daisy	NS(B)		Hyman (1992); Morris (2002)

Species	Fidelity	Continuity	Structure of habitat	Food	Status	Synonyms	Literature References
Orthochaetes setiger (Beck)	Moderate	High	Open and short swards; also along woodland edges and rides	Larvae leaf-miners on a wide variety of broad-leaved herbs, including. knapweed	NS(B)		Hyman (1992); Morris (2002)
Smicronyx reichi (Gyllenhal)	High	High	Short to medium sward, and especially sparsely-vegetated areas	Common centaury and possibly yellow-wort & autumn gentian; larvae in seed-heads.	RDB3		Hyman (1992); Morris (2002)
Neophytobius quadrinodosus (Gyllenhal)	Moderate	Low		Larvae probably feed on foliage of sorrels or knotgrass	NS(A)	Phyobius quadrinodosus (Gyllenhal)	Hyman (1992); Morris (1991)
Microplontus campestris (Gyllenhal)	Moderate	Low		Ox-eye daisy	NS(B)	*Ceutorhynchus campestris* Gyllenhal	Hyman (1992); Morris (1991)
Hadroplontus trimaculatus (Fabricius)	Moderate	Low	Disturbed ground and short sward areas	Musk thistle	NS(B)	*Ceutorhynchus trimaculatus* (Fabricius)	Hyman (1992); Morris (1991)
Mogulones euphorbiae (Brisout)	Moderate	Low	Short to mediun swards	Ground ivy, viper's-bugloss, ragwort & speedwell	NS(A)	*Ceutorhynchus euphorbiae* Brisout	Hyman (1992); Morris (1991)
Mogulones geographicus (Goeze)	Moderate	Low	Sparely vegetated to short / medium sward	Viper's-bugloss, larvae in roots	NS(B)	*Ceutorhynchus geographicus* (Goeze)	Hyman (1992); Morris (1991)
Glocianus moelleri (Thomson)	High	Low		Possibly hawkweed & hawkbit	RDBK	*Ceutorhynchus moelleri* Thomson	Hyman (1992); Morris (1991)
Glocianus pilosellus (Gyllenhal)	Moderate	Low	Sparely vegetated	Lesser dandelion, larvae probably in capitula	RDB2	*Ceutorhynchus pilosellus* Gyllenhal	Hyman (1992); Morris (1991)

Species	Fidelity	Continuity	Structure of habitat	Food	Status	Synonyms	Literature References
Ceutorhynchus atomus Boheman	Moderate	Low	Disturbed or sparsely-vegetated ground	Thale cress & other crucifers	NS(A)		Hyman (1992); Morris (1991)
Ceutorhynchus resedae (Marsham)	Low	Low	Disturbed ground	Weld & possibly mignonette	NS(B)		Hyman (1992); Morris (1991)
Ceutorhynchus syrites Germar	Moderate	Low	Disturbed ground	Various Cruciferae	RDB1		Hyman (1992); Morris (1991)
Ceutorhynchus unguicularis Thomson	Moderate	Low	Short sward	Hairy rock-cress	RDB3		Hyman (1992); Morris (1991)
Calosirus terminatus (Herbst)	Low	Low	Short to medium sward	Wild carrot	NS(B)	*Ceutorhynchus terminatus* (Herbst)	Hyman (1992); Morris (1991)
Baris picicornis (Marsham)	High	Low	Short sward, generally well trampled or droughted grassland, with food-plant stressed	Wild mignonette, larvae in stems	NS(B)		Hyman (1992)
Tychius junceus (Reich)	High	Moderate		Black medick	Local	T. haematopus	
Tychius lineatulus Stephens	Low	Low	Disturbed areas	Zigzag clover, red clover, kidney vetch	NS(A)		Hyman (1992)
Tychius meliloti Stephens	Low			Melilot	Local		
Tychius polylineatus (Germar)	High	High	Short to medium sward	Red clover & possibly common bird's-foot-trefoil; larvae in galla	RDBK		Hyman (1992)
Tychius pusillus Germar	Low	Low	Disturbed areas with good flowering and seed-set of lesser trefoil	Lesser trefoil and possibly other clover species; larvae in seed-heads	NS(B)		Hyman (1992)
Tychius schneideri (Herbst)	Moderate	High	Short to medium sward, sometimes patchily vegetated waste ground	Kidney vetch; larvae in developing seeds	NS(B)		Hyman (1992)

Species	Fidelity	Continuity	Structure of habitat	Food	Status	Synonyms	Literature References
Tychius squamulatus Gyllenhal	Moderate	High	Short to medium sward, sometimes patchily vegetated waste ground	Common bird's-foot-trefoil; larvae feed in seed pods	NS(B)	*T. flavicollis*	Hyman (1992)
Tychius stephensi Gyllenhal	Moderate	High	Short to medium sward, sometimes patchily vegetated waste ground		Local	*T. tomentosus*	
Tychius tibialis Boheman	Low	Low		Probably hop trefoil and knotted clover	NS(A)		Hyman (1992)
Sibinia primitus (Herbst)	Moderate	High	Open vegetation	Pearlworts	NS(B)		Hyman (1992)
Miarus campanulae (Linnaeus)	High	Low	Short to medium swards	Clustered bellflower & occasionally harebell; larvae gall ovaries; adults feed on pollen	Very local		
Miarus graminis (Gyllenhal)	High	Low	Short to medium swards	Bellflowers especially clustered	NS(B)		Hyman (1992)
Miarus plantarum (Germar)	Moderate	Low	Short to medium swards	Bellflowers & rampion	RDBK		Hyman (1992)
Mecinus circulatus (Marsham)	Moderate	Low	Short swards and sparsely-vegetated areas	Ribwort plantain & buck's-horn plantain; larvae burrow in stem	NS(B)		Hyman (1992)
Gymnetron collinum (Gyllenhal)	Moderate	Low	Disturbed ground	Common toadflax; larvae in galls on roots	NS(A)		Hyman (1992)
Gymnetron melanarium (Germar)	Moderate	Low	Large bushy flowering clumps of germander speedwell, usually in short to medium height swards	Germander speedwell	NS(B)		Hyman (1992)
Gymnetron pascuorum (Gyllenhal)	Low	Low	Short to medium sward		Local		

Species	Fidelity	Continuity	Structure of habitat	Food	Status	Synonyms	Literature References
Rhynchaenus pratensis (Germar)	Moderate	Low	Short to medium sward; flower rich	Larvae leaf-miners on common knapweed and small scabious	NS(B)		Hyman (1992); Morris (1993) *Scherf 1964)*

Glossary of terms

Cleptoparasite	species which lay their eggs in the nests of other species and their larvae feed on the food stores laid down by the host for its own larvae.
Omnivorous	feeding on a wide range of material: animal, plant, live, dead.
Parasitoid	species which lay their eggs in the nests of other species and their larvae feed on the mature larvae of the host.
Phytophagous	feeding on plant material.
Polyphagous	Feeding on many different plant species, not specialising to any particular extent.

Scientific names of plants named in text

Names from Dony *et al* (1986)

Bartsia, Red	*Odontites verna*	Horehound, Black	*Ballota nigra*
Basil, Wild	*Clinopodium vulgare*	Horehound, White	*Marrubium vulgare*
Bastard-toadflax	*Thesium humifusum*	Hound's-tongue, Common	*Cynoglossum officinale*
Hedge-bedstraw	*Galium mollugo*	Knapweed, Common	*Centaurea nigra*
Bedstraw, Lady's	*Galium verum*	Knapweed, Greater	*Centaurea scabiosa*
Bedstraw, Limestone	*Galium sterneri*	Liquorice, Wild	*Astragalus glycophyllus*
Bellflower, Clustered	*Campanula glomerata*	Marjoram	*Origanum vulgare*
Bindweed, Field	*Convolvulus arvensis*	Medick, Black	*Medicago lupulina*
Bird's-foot-trefoil, Common	*Lotus corniculatus*	Melilot, Tall	*Melilotus altissima*
Brome, Upright	*Bromus erectus*	Mignonette, Wild	*Reseda lutea*
Burnet, Salad	*Sanguisorba minor*	Milkworts	*Polygala* spp
Burnet-saxifrage	*Pimpinella saxifraga*	Moor-grass, Blue	*Sesleria albicans*
Calamint, Common	*Calamintha ascendens*	Mugworts	*Artemisia* spp
Carrot, Wild	*Daucus carota*	Mullein, Dark	*Verbascum nigrum*
Cat's-ear	*Hypochoeris radicata*	Oat-grass, Downy	*Avenula pubescens*
Celandine, Lesser	*Ranunculus ficaria*	Oat-grass, False	*Arrhenatherum elatius*
Centaury, Common	*Centaurium erythraea*	Oat-grass, Meadow	*Avenula pratensis*
Chickweeds	*Stellaria* spp	Oxtongue	*Picris* spp
Cinquefoils	*Potentilla* spp	Parsnip, Wild	*Pastinaca sativa*
Clover, Hare's-foot	*Trifolium arvense*	Pearlworts	*Sagina* spp
Clover, Knotted	*Trifolium striatum*	Plantain, Buck's-horn	*Plantago coronopus*
Clover, Red	*Trifolium pratense*	Plantain, Ribwort	*Plantago lanceolata*
Clover, White	*Trifolium repens*	Ploughman's-spikenard	*Inula conyza*;
Clover, Zigzag	*Trifolium medium*	Quaking-grass	*Briza media*
Cock's-foot	*Dactylis glomerata*	Ragwort, Common	*Senecio jacobaea*
Cowslip	*Primula veris*	Rampion, Round-headed	*Phyteuma orbiculare*
Crane's-bills	*Geranium* spp	Restharrows	*Ononis* spp
Cress, Thale	*Arabidopsis thaliana*	Rock-cress, Hairy	*Arabis hirsuta*
Daisy	*Bellis perennis*	Rock-rose, Common	*Helianthemum nummularium*
Daisy, oxeye	*Leucanthemum vulgare*	Rock-rose, Hoary	*Helianthemum canum*
Dandelions	*Taraxacum* spp	Rock-rose, White	*Helianthemum apenninum*
Dandelion, Lesser	*Taraxacum laevigatum*	Sainfoin	*Onobrychis viciifolia*
Dead-nettle, White	*Lamium album*	St John's-wort, Perforate	*Hypericum perforatum*
Docks	*Rumex* spp	Sandwort, Thyme-leaved	*Arenaria serpyllifolia*
Dropwort	*Filipendula vulgaris*	Saw-wort	*Serratula tinctoria*
Fescue, Red	*Festuca rubra*	Scabious, Devils'-bit	*Succisa pratensis*
Fescue, Sheep's	*Festuca ovina*	Scabious, Field	*Knautia arvensis*
Fescue, tall	*Festuca arundinacea*	Small Scabious	*Scabiosa columbaria*
Flax, Fairy	*Linum catharticum*	Sedge, Glaucous	*Carex flacca*
Forget-me-nots	*Myosotis* spp	Selfheal	*Prunella vulgaris*
Gentian, Autumn	*Gentianella amarella*	Sheep's-bit	*Jasione montana*
Greenweed, Dyer's	*Genista tinctoria*	Sorrel, Common	*Rumex acetosa*
Gromwell, Common	*Lithospermum officinale*	Sorrel, Sheep's	*Rumex acetosella*
Ground-ivy	*Glechoma hederacea*	Sow-thistle, Smooth	*Sonchus oleraceus*
Hair-grass, Crested	*Koeleria macrantha*	Speedwells	*Veronica* spp
Harebell	*Campanula rotundifolia*	Speedwell, Germander	*Veronica chamaedrys*
Hawkbits	*Leontodon* spp	Squinancywort	*Asperula cynanthica*
Hawkbit, Rough	*Leontodon hispidus*	Stork's-bills	*Erodium* spp.
Hawk's-beards	*Crepis* spp	Thistle, Carline	*Carlina vulgaris*
Hawkweed	*Hieraceum* spp	Thistle, Creeping	*Cirsium arvense*
Hawkweed, Mouse-ear	*Hieraceum pilosella*	Thistle, Musk	*Carduus nutans*
Hedge-parsley	*Torilis* spp	Thistle, Dwarf or Stemless	*Cirsium acaule*
Hemp-agrimony	*Eupatorium cannabinum*	Thistle, Woolly	*Cirsium eriophorum*
Hogweed	*Heracleum sphondylium*	Thyme, Wild	*Thymus praecox*

Toadflax	*Linaria vulgaris*		
Tor-grass	*Brachypodium pinnatum*		
Tormentil	*Potentilla erecta*		
Trefoil, Hop	*Trifolium campestre*		
Trefoil, Lesser	*Trifolium dubium*		
Valerian, Common	*Valeriana officinalis*		
Valerian, Red	*Centranthus ruber*		
Vetch, Horseshoe	*Hippocrepis comosa*		
Vetch, Kidney	*Anthyllis vulneraria*		
Violets	*Viola* spp		
Viper's Bugloss	*Echium vulgare*		
Weld	*Reseda luteola*		
Wood-sage	*Teucrium scorodonia*		
Woundworts	*Stachys* spp		
Yarrow	*Achillea millefolium*		
Yellow-wort	*Blackstonia perfoliata*		

ENGLISH NATURE

English Nature is the Government agency that champions the conservation of wildlife and geology throughout England.

This is one of a range of publications published by:
External Relations Team
English Nature
Northminster House
Peterborough PE1 1UA

www.english-nature.org.uk

Cover printed on Character Express, post consumer waste paper, ECF.

ISSN 0967-876X

Cover designed and printed by Status Design & Advertising, 2M, 5M, 5M.

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Peter Wakely/English Nature 17,396
Middle left: Co_2 experiment at Roudsea Wood and Mosses NNR, Lancashire.
Peter Wakely/English Nature 21,792
Bottom left: Radio tracking a hare on Pawlett Hams, Somerset.
Paul Glendell/English Nature 23,020
Main: Identifying moths caught in a moth trap at Ham Wall NNR, Somerset.
Paul Glendell/English Nature 24,888