

## Chapter (non-refereed)

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# What do we know about insects in Scottish woods?

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## 1 Introduction

Although this symposium is primarily concerned with woodlands in the Scottish uplands, I have, by necessity, had to take a wider overview of insects in Scottish woodlands as a whole. However, information from the Forestry Commission (FC) (1985) and from Davies (1985) shows that over the past 65 years the land under trees in Scotland has risen from 3% to 14%, mostly in the uplands, which is a loosely defined area comprising about 42% of Scotland. Almost without exception, this planting has involved conifers. Indeed, broadleaved woodlands probably occupy no more than 10% of the 1 Mha of commercial and 'unproductive' woodland in Scotland. Clearly, in any examination of the insects occurring in Scottish woodlands, those of the conifer plantations should take precedence. Although rides, streamsides and clearings within forests are refuges for many insect species, these sites have been discussed elsewhere during this symposium (Young 1986), and I shall not consider them further.

Apart from the small band of dedicated FC staff, most entomologists visiting or resident in Scotland have largely ignored the coniferous plantations. Instead, they seek out the relict areas of 'Caledonian' pine forest or concentrate on the deciduous woodlands, especially the birchwoods (*Betula* spp.) of the Highlands. In both these ecotypes, their quest is for species of insects with distributions in Britain restricted to the Highland forests. Such species may have an arctic-alpine distribution in continental Europe. Most entomologists give only a cursory inspection of the outer margins of the dark serried ranks of Sitka spruce (*Picea sitchensis*) and lodgepole pine (*Pinus contorta*) plantations, whilst the attention of the FC entomologists is usually only attracted when a particular insect species reaches epidemic proportions. It will, therefore, come as no surprise to learn that our knowledge of the entomology of Scottish upland forests is somewhat scanty. That which does exist is largely scattered through the literature and is difficult to find and abstract. My intention here is to provide an introduction to the major sources of information in this field, without too much specific detail.

## 2 Broadleaved woodlands

In Scotland, broadleaved woodlands are typical of the central lowlands and the coastal fringe, especially on the west coast. Crowson (1962, 1964) made a particular study of the Coleoptera of oakwoods (*Quercus* spp.) within easy reach from Glasgow, and recorded a number of species with a very restricted

distribution in Scotland. In the 1960s and early 1970s, teams of entomologists, funded by the Nature Conservancy and Shell Chemical Company, surveyed several areas of Scotland, paying particular attention to National Nature Reserves (NNRs). The resulting lengthy species lists are not suitable for publication and most now reside in various Nature Conservancy Council files. However, accounts of one such survey have been published for the Isle of Rhum (Steel & Woodroffe 1969; Wormell 1982). Despite the small size and recent origin of woodland of both deciduous and coniferous species, the accounts contain reference to many woodland insects. Woodroffe (1974) also compared Hemiptera found on Rhum with those collected in other surveys based on Speyside, Deeside, and at Invernaver, but interpretation of the species list requires a previous knowledge of the biology of this group of insects.

Regrettably, most insects found in Scottish broadleaved woodlands are, with very few exceptions, much more abundant in the woods of England and Wales. Many species of insect appear to have spread into Scotland along the milder coastal regions, so that broadleaved trees in Caithness, Sutherland and even on the Orkneys have what can be regarded as a diluted southern fauna, with the addition of a few northern elements. However, our present knowledge of the insect fauna of the western oak/birch woodlands is very limited, and many such woods are either totally unknown entomologically or such information as does exist resides in private collections and notebooks. It is mainly in the central Highlands where the insect fauna differs markedly. I have previously described typical examples from a wide range of habitats (Welch 1974, 1981) and will not consider Scottish broadleaved woodlands further here.

## 3 Coniferous woodlands

In 1974, the Nature Conservancy set up a Native Pinewoods Discussion Group as a forum for owners, managers and scientists concerned with the conservation and study of native pinewoods (*Pinus* spp.) in Scotland. This initiative culminated in a symposium volume in which Hunter (1977) provided an excellent review of the 'ecology of pinewood beetles'. He lists 129 species of Coleoptera associated with pine, of which 4 are of doubtful status. Of the remainder, 105 are known to occur in Scotland, and 44 of these have a geographic range lying mainly within the relict Caledonian forests. Hunter mentions an additional 6 species which occur both in pine and in association with other trees. Although relying heavily on published records, much of this account is based on his own experience

in the field. Not only is this the most comprehensive record of any group of pine insects in Britain, but it is rare among published accounts in distinguishing the Scottish element of the fauna. Speight (1985) argues the absence of Caledonian pine insects in Ireland as evidence for the extinction there of Scots pine (*Pinus sylvestris*), and for its present fauna having been acquired since its reintroduction by man.

The Lepidoptera of the Cairngorms NNR were surveyed by MacAlpine (1979a, b) and most of his trapping sites were in pine forest. His published lists contain 393 species but, unfortunately, for most he provides only locality and date of collection. For only 4 species is pine mentioned as the host plant, although the knowledgeable reader will recognize a number of other species associated with pine, and a few known to feed on species of spruce (*Picea* spp.). Many other lists of Lepidoptera have been published for Scottish counties or localities but, often for brevity, data on habitat or host plant are lacking. Such lists usually presume that the reader possesses that information. It will always be the case that the 'expert' can read more into a simple list than the novice, which is no help to the latter.

It can be seen that even for the 2 best studied insect groups, the Lepidoptera and Coleoptera, data are poor. Information on the other Orders is even more sparse. Crooke (1957) reviewed 27 species of conifer-feeding sawflies (Hymenoptera: Symphyta), and, in recent years, Liston has published on Scottish species but, although several are pests of conifers, very few of his papers concern this element of the fauna (Liston 1981). Among a list of 66 conifer forest insects, Speight (1985) included 35 species of Symphyta. Of these, the larvae of 4 species of wood wasp in the family Siricidae are recorded feeding on a wide range of tree hosts. Eleven species in the families Diprionidae, Pamphilidae and Xyelidae have foliage-feeding larvae which prefer pine as their plant host. A further 11 species, almost exclusively Tenthredinidae, feed on spruce, but 9 of these also feed on fir (*Abies* spp.). Eight species are recorded from larch (*Larix* spp.). Published accounts of other groups such as Homoptera and Diptera are few and far between. However, in his list of conifer insects, Speight includes 20 species of hoverfly (Diptera: Syrphidae), 3 of which have saproxylic larvae, whilst the remainder feed on aphids and related plant bugs. Eight species are listed exclusively from pine, but such predators generally have less specific relationships with their host plants.

### 3.1 Colonization of conifers by native and introduced insects

Hunter (1977) comments that 'it would be difficult to assemble separate British lists of beetles for species of *Pinus*, and it is doubtful if such lists would differ'. However, Speight (1985) considers that 'in Great Britain it is possible to differentiate between the faunas of indigenous *P. sylvestris* forest ("Caledonian" pine forest) and commercial *Pinus* plantations (includ-

ing plantations of *P. sylvestris*)' (cf Welch 1974, 1981). He further remarks that, although the saproxylic species associated with European pines are well represented in Britain, those species 'exclusive to one or another of the introduced genera of conifers are generally lacking'. The inference is that colonization by those insects which feed on the foliage and shoots is much more rapid than colonization by species feeding on the woody tissues and associated saprophytic fungi. This hypothesis is supported by the fact that most of the 'Urwaldtiere', or ancient forest indicator species, fall into this latter group. One would expect, therefore, that the colonization of introduced conifers will be by the true phytophages. The primary hindrance to the accumulation of such data is the reluctance, or inability, of most entomologists to record the host tree beyond the generic level. This reluctance is true for both coniferous and broadleaved species, but is particularly true for introduced conifers. Not surprisingly, such information as does exist stems almost entirely from publications by FC staff, not least because they can identify the tree species concerned.

Crooke (1957) listed 9 species of sawfly feeding on spruce and 7 on larch. He noted that, like their hosts, all were introductions into Britain. Furthermore, Japanese larch (*Larix leptolepis*) and hybrid larch (*L. eurolepis*) appeared to be more attractive to the larch sawflies than European larch (*L. decidua*), and *Neodiprion sertifer* readily transferred from its usual host, Scots pine, to lodgepole pine. When present in high densities, this insect was also capable of feeding on Sitka spruce.

Winter (1983) provides data for several species of lepidopterous larvae feeding on both native and introduced conifers. Under pine, he distinguishes Scots pine, lodgepole pine, Corsican pine, (*P. nigra*) and Monterey pine (*P. radiata*), whilst under spruce he includes Norway and Sitka spruce, together with 2 records for oriental spruce (*P. orientalis*) and one for Serbian spruce (*P. omorika*). In an FC Booklet, presently in preparation, Bevan gives some information on the preferred or alternative hosts of a number of insect species. However, it is among the Homoptera, with their more intimate relationship with their host plant, that specific differences are best observed. Carter (1983) provides a useful summary of the occurrence of 13 adelgid and 35 aphid species on 18 species of conifer in Britain. He comments that only one adelgid is native to Britain, and among the aphids it is probable that only 4 of the 22 species of *Cinara* (Lachnidae) are native. Parthogenetic, winged, female aphids are among the first phytophagous insects to colonize exotic tree species. Most have spread to Britain from Europe, although 2 polyphagous species, one the ubiquitous bean aphid (*Aphis fabae*), now feed on young seedling conifers throughout Britain. Adelgids are more catholic in their choice of host. Those of European origin may form galls on Asiatic and American spruces, but adelgids introduced from North





Plate 1. Cultivation of deep peat moorland by double mouldboard plough at Naver Forest, Sutherland (Photograph Forestry Commission)



Plate 2. Shrub layer of juniper and well-developed ground layer of tussocky heather and bilberry in an opening of the old, native pine forest of Glen Tanar (Photograph N Picozzi)





Plate 3. Fifth instar pine beauty moth larva (Photograph R Parks)



Plate 4. Defoliation caused by pine beauty moth larvae at Rimsdale, near Tongue, Sutherland (Photograph R Parks)





Plate 5. Birchwood at Dunbeath, Caithness. Stable core on cliff, with some expansion over old pasture (Photograph G F Peterken)



Plate 6. Russel Ashwood showing the dramatic regeneration within an enclosure. c1973 (Photograph G F Peterken)





Plate 7. Management of native pinewoods must be carefully planned to benefit wildlife such as capercaillie and these golden eagles (Photograph N Picozzi)



Plate 8. A family group of red deer in pre-thicket Sitka spruce. Red deer are now resident, often at high densities, in most forestry plantations in Scotland (Photograph M D C Hinge)



# GROUPS OF LAND CLASSES

|       |       |
|-------|-------|
| 1-4   | 17-20 |
| 5-8   | 21-24 |
| 9-12  | 25-28 |
| 13-16 | 29-32 |

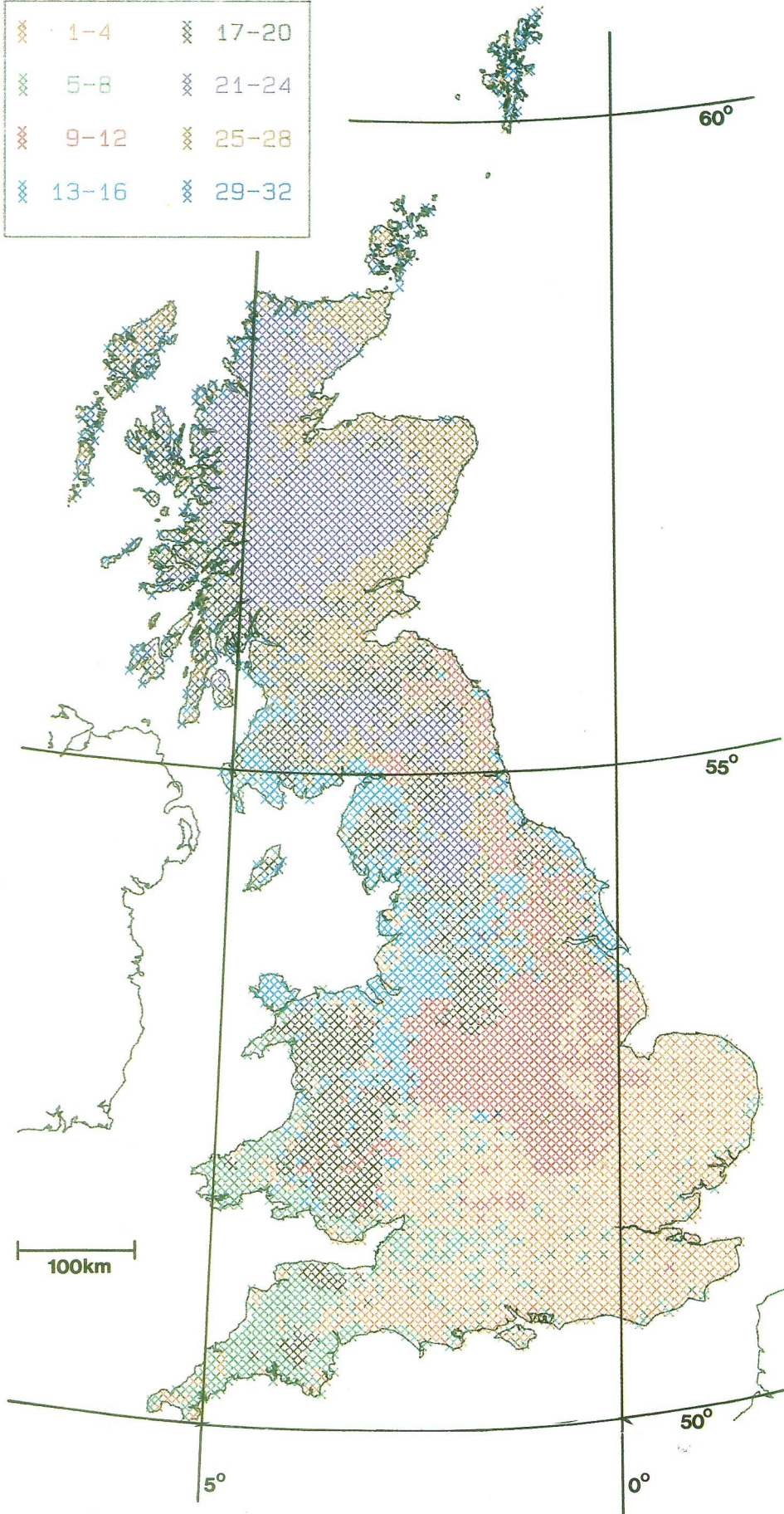


Plate 9. Map showing the distribution in the UK of 32 land classes characterized by Bunce *et al.* (1982) (source: Bunce & Last 1981)

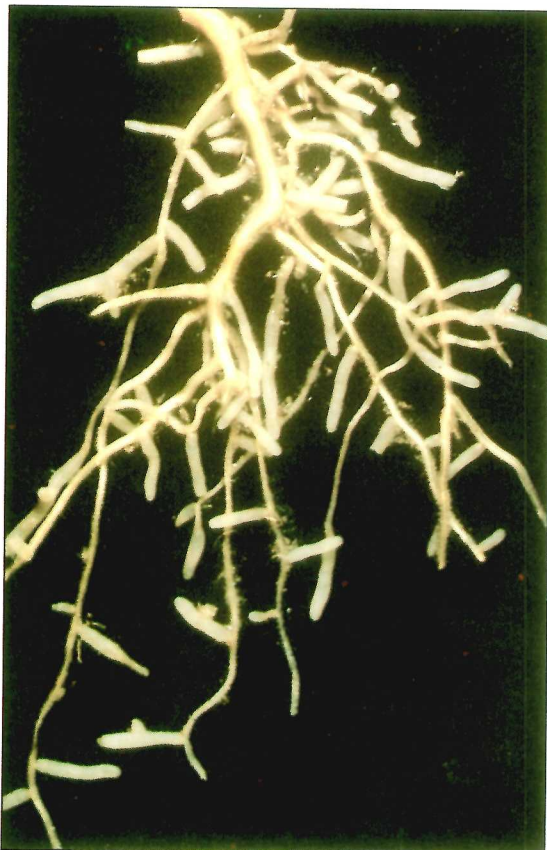




A1



B1



A2



B2

Plate 10. Fruitbodies and mycorrhizas formed by species of *Laccaria* (early state) and *Leccinum* (late-stage) with birch (A1 *Laccaria proxima* and A2 *Laccaria*-type; B1 *Leccinum roseofracta* and B2 *Leccinum*-type) (Photograph A1 A2, A Crossley; B1 B2, V Fleming)



America almost exclusively gall only American species of spruce.

Perhaps the most interesting tree colonists are those insects which have previously not had a conifer as a host plant. As early as 1933, larvae of the bilberry tortrix (*Aphelia viburnana*) and the narrow-winged pug (*Eupethecia nanata*) had been recorded severely damaging young plantations of various conifers after exhausting their normal food plants, bilberry (*Vaccinium*), heath (*Erica*) and heather (*Calluna vulgaris*) in Cornwall and parts of Wales (Crystal 1937). Styles (1959, 1961) was the first to compile lists of Lepidoptera reared on unusual food plants based on FC field survey notes and record cards. As more and more previously treeless upland areas were being planted, mainly with introduced conifers, so such unusual records increased. Several species of Lepidoptera appear to have found the young succulent shoots of these conifers a readily acceptable alternative to the grasses, heather and other moorland plants on which they normally fed. Between 1968 and 1970, Winter (1974) investigated the causes of post-planting losses in recently afforested areas, including 18 forests in Scotland. He provided the first records for 24 species of lepidopterous larvae feeding on conifers, of which Sitka spruce was the most common new host. Some woodland species such as the winter moth (*Operophtera brumata*) and dotted border (*Agriopsis marginaria*) were being increasingly found adapting to moorland conditions, feeding on heather (Wormell 1977). These events were unusual enough in that both species have flightless females and rely for dispersal upon aeronauting first instar larvae. However, once established in such areas, remote from deciduous woodland, the winter moth proved capable of a further change of food plant and became a pest of young Sitka spruce. More recently in south-east Scotland, and in the absence of heather and bog myrtle (*Myrica gale*), winter moth is behaving as a primary pest of plantations 8–12 years old (Stoakley 1985). Early plantings of larch on areas of purple moor-grass (*Molinia caerulea*) have suffered ring-barking by the clay-coloured weevil (*Otiorhynchus singularis*).

Foresters have always kept a watchful eye on the dangers of introduced pests. The large larch bark beetle (*Ips cembrae*), which was first recorded on larch in northern Scotland in 1955, has since spread south as far as Peebles and has been found on windblown Sitka spruce. Another long-expected arrival from northern Europe was the great spruce bark beetle (*Dendroctonus micans*), albeit at present confined to England and Wales. Although only discovered in 1982, by counting the annual rings of the tissues occluded following attack, it was clear that this beetle had been in the UK since about 1973 (Bevan & King 1983). Bevan (1986), aware of such dangers, regards the white pine weevil (*Pissodes strobi*) and 3 species each of the scolytids *Dendroctonus* and *Ips* as having a 'high quarantine hazard risk'. One of these species is the

8-toothed spruce bark beetle (*Ips typographus*). Although it has been recorded regularly since 1849, breeding in Britain is not proven (Winter 1985). Winter (1983) also lists some Scolytidae and Cerambycidae known only as non-breeding introductions in spruce and pine.

Many species of Lepidoptera are widespread and of common occurrence in low numbers on pine in Britain, but only rarely reach pest proportions. However, lodgepole pine has proved to be unusually susceptible to attack by species such as the pine shoot moth (*Rhyacionia buoliana*), larch bud moth (*Zeiraphera diniana*), pine looper (*Bupalus piniaria*), and the pine beauty moth (*Panolis flammea*). An intensive study of the pine beauty moth has revealed differences in larval behaviour from that reported for this species on the continent (Bevan 1986). This is quite a common, although not well-documented, phenomenon. Many species of phytophagous insect may behave differently on the same host plants in Britain and on the continent. Even pest species, which have been the subjects of prolonged research in continental Europe, may behave quite differently in Britain. Hunter (1977) points out that 77 of the species of beetle which he lists for Scots pine are considered in Finland to be associated with spruce. In 17 of these species, this association is thought to be especially close. He mentions 6 pine species which have been found on spruce in Britain and states 'no doubt many others are capable of the same transition'.

### 3.2 Numbers of insect species on 4 conifer genera

Southwood (1961) was the first person to assemble data concerning the number of insect species associated with their host trees in Britain. Insect data were taken from only 3 Orders, Hemiptera, Lepidoptera and Coleoptera. In addition to the native Scots pine and European larch, an introduction since 1629, Southwood included Norway spruce (*Picea abies*) and species of fir (*Abies* spp. (*alba*)) on the strength of there having been native trees in Britain before the last glacial phase, noting their reintroduction in the 16th and 17th centuries respectively. However, in updating this information (Kennedy & Southwood 1984), he retains spruce but inexplicably drops fir; otherwise, the same tree hosts are used but coverage of insect orders is greatly improved, with the resulting increase in numbers of associated insect species.

Exactly what comprises an 'associated insect' is still a matter for considerable discussion, and even personal interpretation. In Table 1, I have attempted to compile lists of the numbers of insects attributed to 4 conifer genera by various authors. Comparison of the 2 lists by Southwood and Kennedy shows how the data have been improved since the much-quoted 1961 paper. In each case, the records are referable to a single host species. I have included Hunter's comprehensive Coleoptera list for Scots pine for comparison, and the list prepared for Carlisle and Brown (1968) by O W



Table 1. Numbers of insect and mite species associated with 4 genera of conifers in Britain

| Host         | <i>Pinus</i>                                |           |                  |                |          |                            |         | <i>Picea</i> |           |                  |                            |         | <i>Abies</i> |           |                            |         | <i>Larix</i> |           |                  |                            |         |           |
|--------------|---|-----------|------------------|----------------|----------|----------------------------|---------|--------------|-----------|------------------|----------------------------|---------|--------------|-----------|----------------------------|---------|--------------|-----------|------------------|----------------------------|---------|-----------|
|              | Reference*<br>(author's initials<br>& date) | TRES 1961 | CEJK & TRES 1984 | AC & AHFB 1968 | FAH 1977 | TGW 1978-83<br>JHS 1959-61 | DB 1985 | PIDB 1985    | TRES 1961 | CEJK & TRES 1984 | TGW 1979-83<br>JHS 1959-61 | DB 1985 | PIDB 1985    | TRES 1961 | TGW 1979-83<br>JHS 1959-61 | DB 1985 | PIDB 1985    | TRES 1961 | CEJK & TRES 1984 | TGW 1979-83<br>JHS 1959-61 | DB 1985 | PIDB 1985 |
| Acarina      |   | 0         | 1                | 0              | —        | 1                          | 1       | 2            | 0         | 0                | 2                          | 3       | 2            | 0         | 0                          | 0       | 2            | 0         | 1                | 0                          | 0       | 2         |
| Heteroptera  |   | 15        | 15               | 10             | —        | 1                          | —       | 23           | 9         | 9                | 0                          | —       | 14           | 5         | 0                          | —       | 8            | 3         | 3                | 0                          | 0       | 7         |
| Homoptera    |   | 3         | 10               | 8              | —        | 16                         | 8       | 21           | 1         | 14               | 18                         | 10      | 22           | 0         | 7                          | 3       | 9            | 0         | 6                | 7                          | 3       | 6         |
| Thysanoptera |   | 0         | 5                | 0              | —        | 0                          | —       | 5            | 0         | 1                | 1                          | —       | 0            | 0         | 0                          | —       | 0            | 0         | 0                | 0                          | 0       | 0         |
| Lepidoptera  |   | 38        | 41               | 28             | —        | 41                         | 12      | 56           | 19        | 22               | 58                         | 7       | 36           | 3         | 17                         | 0       | 25           | 12        | 16               | 39                         | 3       | 28        |
| Diptera      |   | 0         | 2                | 2              | —        | 3                          | 2       | 10           | 0         | 3                | 1                          | 0       | 5            | 0         | 0                          | 0       | 8            | 0         | 1                | 1                          | 1       | 5         |
| Hymenoptera  |   | 0         | 11               | 12             | —        | 12                         | 3       | 20           | 0         | 10               | 13                         | 6       | 22           | 0         | 2                          | 1       | 19           | 0         | 5                | 8                          | 6       | 13        |
| Coleoptera   |   | 35        | 87               | 32             | 131      | 30                         | 16      | 126          | 8         | 11               | 15                         | 12      | 77           | 8         | 5                          | 1       | 52           | 2         | 6                | 4                          | 2       | 39        |
| Total        |   | 91        | 172              | 92             | (131)    | 104                        | 42      | 263          | 37        | 70               | 108                        | 38      | 178          | 16        | 31                         | 16      | 123          | 17        | 38               | 59                         | 15      | 100       |

\*DB 1985 = D Bevan's MS for Forestry Commission Booklet  
PIDB = ITE's phytophagous insect data bank (see text)

Richards. When I compared the lists of Styles (1959, 1961) with that of Winter (1974, 1983), I found numerous inconsistencies. In his 1983 FC Booklet, Winter includes only some, but not all, of Styles' records and also omits some from his own earlier publication. I have, therefore, combined all these records into a single column entry for all 4 tree hosts. I have taken the liberty of abstracting details from Bevan's forthcoming Booklet as it is hoped that this will become widely used by practising foresters when available. His selection of insect species is based not only on those known to feed directly upon their host, but upon those species for which the Entomology Branch of the FC had received most enquiries over the years. It is, therefore, biased towards pests and the more obvious species. This and the remaining lists include the combined records of insects from a number of different tree species within each genus. For example, of the 94 insect species listed from spruce by Winter (1983), 19 were recorded from Norway spruce and 29 from Sitka spruce. Among those from non-specific spruces are 5 Coleoptera not yet known to breed in Britain. Similarly, a further 3 are included in his list for pines. I should remind you that Bevan's list also includes 5 spruce and 2 pine insects of similar status.

The last columns for each tree genus in Table 1 contain data from the Institute of Terrestrial Ecology's Phytophagous Insect Data Bank (PIDB). The data included here are a very small part of the mammoth undertaking by Dr Lena K Ward and D F Spalding to abstract important published literature containing references to the relationships between insects in Britain and their recorded plant hosts. Many of the records are taken from European sources which must be treated with caution when considering the British fauna. However, in many cases, although an insect may be well known from a particular host in Britain, the only published

account so far abstracted (and possibly the only such reference) is from a continental reference. Table 1 provides the non-specialist with some indication of the range and accessibility of data on insects and their tree hosts. All numbers given in Table 1 relate to Britain as a whole, and many species included may not occur in Scotland.

#### 4 Conclusions and recommendations

I hope that I have demonstrated the scattered nature of the available published data on woodland and forest insects. Much more information may exist in an unpublished form, so that the combined personal knowledge of various specialist entomologists, foresters and ecologists will vastly exceed this summary. In my opinion, the root of the problem lies in our lack of knowledge of the ecology of introduced tree species. This is true for broadleaved as well as coniferous species. There appear to be 3 major areas where more information is urgently needed and where future work could be directed. These are as follows.

##### 4.1 Mapping introduced trees

Most county floras and plant mapping schemes ignore introduced trees, although occasionally they are included for counties where they regenerate naturally. We need to know more about their distribution in Britain. Jeffers (1972) provides some useful 10 km distribution maps for Scots pine, Corsican pine, lodgepole pine, Norway spruce and Douglas fir, but Sitka spruce is notable by its absence. If it has not already been done, a start could be made by bringing together planting records for this (and other) species from all the FC Conservancies. Hopefully, this compilation could include not only plantings on land owned by the FC, but also for grant-aided schemes in private woodlands. This information, in turn, could possibly be supplemented by data from the Kew Index of Living Collections, which already contains the computerized



records of trees at Kew, Wakehurst Place, and 53 National Trust properties. Once such base maps are available, there will be an incentive for others to add to them.

#### 4.2 Recording insects on introduced trees

There is nothing better guaranteed to promote a flow of information than the production of a 'definitive' list of insect species. We should consider publishing lists of those insects which are currently known to occur on such trees as Sitka spruce. We should not then just sit back and await the anticipated flood of 'additional' records, but should consider implementing an active survey programme in order to understand better which insects are able to utilize these vast new man-made habitats, and to encourage other people to do likewise.

#### 4.3 Colonization from Caledonian pinewoods into plantations

Many of the native pinewood areas identified by Steven and Carlisle (1959) were small relict populations which had survived at the heads of glens or in locations which became isolated by adjacent felling and forest clearance. As a result, many of the rare insects associated with them have survived in isolated pockets throughout the Highlands. Increasingly, these areas have become caught up in the approaching legions of commercial plantations so that they may now be contiguous with, or relatively close to, young conifers of various species. I can only reiterate Hunter's (1977) comment that 'the ability of relict pinewood species to colonise plantations has (still) not yet received sufficient attention'. He also saw the need for monitoring the development of the beetle fauna in a number of new pine plantations within the Caledonian forest area. Ten years have passed since that symposium, and the plea for more detailed information in this field is as real today as it was then.

#### 5 Summary

A brief background is given to our present state of knowledge of forest entomology in Scotland, which explains how entomologists have largely ignored recent conifer plantations in favour of relict 'Caledonian' pinewoods and broadleaved woodlands. The insect fauna of the latter is regarded as being essentially a diluted southern fauna with some additional northern elements.

Some examples are given of the types of insect species lists prepared by individuals and teams of entomologists. The acceptability of such lists for publication and the interpretation of their contents are discussed.

Introduced conifers are typically colonized by insects which have either transferred from a native tree, or have themselves become established by accidental introduction or natural immigration. Some immigrant pests from continental Europe and North America are considered, and the susceptibility of certain introduced tree hosts to native insects is discussed. Particular

attention is also paid to the increasing ability of certain insects to transfer to conifers from unrelated native host plants.

Data on the numbers of insect species associated with 4 conifer genera, *Pinus*, *Picea*, *Abies* and *Larix*, are presented, combining records from various sources. Caution is stressed when continental insect host data are used.

Recommendations are made for the distributional mapping of introduced trees in Britain, and the recording of the insects associated with them. It is also suggested that the movement of insects between Caledonian pinewood relicts and conifer plantations be investigated.

#### 6 Acknowledgements

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#### 7 References

- Bevan, D.** 1986. *Forest insects*. (Forestry Commission booklet.) London: HMSO. In press.
- Bevan, D. & King, C.J.** 1983. *Dendroctonus micans* Kug. – a new pest of spruce in UK. *Commonw. Forest. Rev.*, **62**, 41–51.
- Carlisle, A. & Brown, A.H.F.** 1968. *Pinus sylvestris* L. (Biological flora of the British Isles, no. 109.) *J. Ecol.*, **56**, 269–307.
- Carter, C.I.** 1983. Some new aphid arrivals to Britain's forests. *Proc. Trans. Br. ent. nat. Hist. Soc.*, **16**, 81–87.
- Carter, C.I. & Nichols, J.F.A.** 1985. Host plant susceptibility and choice by conifer aphids. In: *Site characteristics and population dynamics of lepidopteran and hymenopteran forest pests*, edited by D. Bevan & J.T. Stoakley, 94–99. (Forestry Commission research and development paper no. 135.) London: HMSO.
- Crooke, M.** 1957. A brief review of the British conifer feeding sawflies. *Z. angew. Entomol.*, **41**, 179–183.
- Crowson, R.A.** 1962. Observations on Coleoptera in Scottish oak woods. *Glasg. Nat.*, **18**, 177–195.
- Crowson, R.A.** 1964. Additional records of Coleoptera from Scottish oak woods. *Glasg. Nat.*, **18**, 371–375.
- Crystal, R.N.** 1937. *Insects of the British woodlands*. London: Warne.
- Davies, E.J.M.** 1985. *Forestry in Scotland*. Edinburgh: Forestry Commission.
- Forestry Commission.** 1985. *Forestry facts and figures 1984–85*. Edinburgh: FC.
- Hunter, F.A.** 1977. Ecology of pinewood beetles. In: *Native pinewoods of Scotland*, edited by R.G.H. Bunce & J.N.R. Jeffers, 42–55. Cambridge: Institute of Terrestrial Ecology.
- Jeffers, J.N.R.** 1972. Conifers and nature conservation. In: *Conifers of the British Isles*, 59–73. London: Royal Horticultural Society.
- Kennedy, C.E.J. & Southwood, T.R.E.** 1984. The numbers of species of insects associated with British trees: a re-analysis. *J. Anim. Ecol.*, **53**, 455–478.
- Liston, A.D.** 1981. Notes on little known British *Pristophora* Lat. (Hym., Tenthredinidae) of the *abietina* group. *Entomologist's mon. Mag.*, **117**, 73–75.

- MacAlpine, E.A.M.** 1979a. The Lepidoptera of the Cairngorms National Nature Reserve. *Entomologist's Rec. J. Var.*, **91**, 1–6, 65–70, 213–216, 241–244.
- MacAlpine, E.A.M.** 1979b. The Macrolepidoptera of Inverness-shire – Newtonmore District, Supplement 10. *Entomologist's Rec. J. Var.*, **91**, 157.
- Southwood, T.R.E.** 1961. The number of species of insect associated with various trees. *J. Anim. Ecol.*, **30**, 1–8.
- Speight, M.C.D.** 1985. The extinction of indigenous *Pinus sylvestris* in Ireland: relevant faunal data. *Ir. Nat. J.*, **21**, 449–453.
- Steel, W.O. & Woodroffe, G.E.** 1969. The entomology of the Isle of Rhum National Nature Reserve. *Trans. Soc. Br. Ent.*, **18**, 91–167.
- Steven, H.M. & Carlisle, A.** 1959. *The native pinewoods of Scotland*. Edinburgh: Oliver & Boyd.
- Stoakley, J.T.** 1985. Outbreaks of winter moth, *Operophtera brumata* L. (Lep., Geometridae) in young plantations of Sitka spruce in Scotland. *Z. angew. Entomol.*, **99**, 153–160.
- Styles, J.H.** 1959. Notes on some Microlepidoptera. *Entomologist's Gaz.*, **10**, 43–44.
- Styles, J.H.** 1961. Additions to the list of foodplants of Lepidoptera larvae, not recorded in 'Larval food plants' by P.B.M. Allan, and 'The caterpillars of the British moths' by W.J. Stokoe. *Entomologist*, **94**, 86–88.
- Welch, R.C.** 1974. Insects and other invertebrates. In: *The Cairngorms, their natural history and scenery*, edited by D. Nethersole-Thompson & A. Watson, Appendix 2, 257–285. London: Collins.
- Welch, R.C.** 1981. The modern story – insects. In: *The Cairngorms, their natural history and scenery*, edited by D. Nethersole-Thompson & A. Watson, 281–283. 2nd ed. Perth: Melvin Press.
- Winter, T.G.** 1979. New host plant records of Lepidoptera associated with conifer afforestation in Britain. *Entomologist's Gaz.*, **25**, 247–258.
- Winter, T.G.** 1983. *A catalogue of phytophagous insects and mites on trees in Great Britain*. (Forestry Commission booklet no. 53.) Edinburgh: Forestry Commission.
- Winter, T.G.** 1985. Is *Ips typographus* (Linnaeus) (Coleoptera: Scolytidae) a British insect? *Entomologist's Gaz.*, **36**, 153–160.
- Woodroffe, G.E.** 1974. Hemiptera from Rhum, the Cairngorms, Deeside and Invernaver. *Glasg. Nat.*, **19**, 101–114.
- Wormell, P.** 1977. Woodland insect population changes on the Isle of Rhum in relation to forest history and woodland restoration. *Scott. For.*, **31**, 13–36.
- Wormell, P.** 1982. The entomology of the Isle of Rhum National Nature Reserve. *Biol. J. Linn. Soc.*, **18**, 291–401.
- Young, M.R.** 1986. The effects of commercial forestry on woodland Lepidoptera. In: *Trees and wildlife in the Scottish uplands*, edited by D. Jenkins, 88–94. (ITE symposium no. 17.) Abbots Ripton: Institute of Terrestrial Ecology.