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Survey
OF
Forest Insect Conditions
IN THE
British Isles.
1919.

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An investigation into the Forest Insect Conditions in the United Kingdom was commenced by direction of the Interim Forest Authority in May, 1919. Mr. J. W. Munro, the Commission's Entomologist, has been responsible for the field work and the preparation of this Report, which was submitted by Mr. R. L. Robinson, Technical Commissioner, for publication as Bulletin No. 2, and approved by the Commission on Feb. 24th, 1920.

FORESTRY COMMISSION,
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May, 1920.

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A SURVEY OF FOREST INSECT CONDITIONS IN THE BRITISH ISLES, 1919.

Introductory.

In consequence of the heavy fellings made in coniferous woods during the war, and of the impossibility of clearing the ground promptly owing to shortage of labour, conditions favourable to the increase of harmful forest insects were brought about. The problems so created were referred to in the Final Report of the Forestry Sub-Committee on Reconstruction (Cd. 8881, pp. 53-54), and the need for early attention being given to them was expressed.

A survey was accordingly started in May, 1919, by the Interim Forest Authority, in order to ascertain the forest insect conditions in the British Isles, with special reference to felled areas and recently formed plantations. The main object of the survey was to determine the location, extent, and nature of the chief forest insect outbreaks and to decide what control measures were likely to prove most useful against them. The survey was concluded in September, 1919.

The districts inspected were the South, North-west, and North-east of England; North Wales; the South, Central, East and North-west of Scotland; and the Southern Midlands of Ireland.

Observations were made on sixty-two felled areas, of which seventeen were in England, six in Wales, thirty-three in Scotland, and six in Ireland. See map.

Method of Inspection.

The general method of survey was to inspect the most important felled areas in a given district. The felled area was first traversed, and a general idea obtained of the age and condition of the stumps and slash (branches and twigs) as affording breeding ground for insects. At the same time flying or crawling adult insects were collected. A number of stumps throughout the area were then examined. The roots were bared of soil, and the bark prised off from the stumps and roots. By this means the bark-dwelling insects and their eggs and larvæ were exposed. Where no adults were present, such insects as the pine weevils and Longicorn beetles were identified by their larvæ and the bark-beetles by the nature of their egg galleries. The slash was also barked and examined, and the insects identified in the same manner. The abundance or scarcity of each insect, the stage of its life-history, and its habitat were noted.

Young plantations and standing woods next received attention. In the former dead and sickly plants were examined, and, if necessary, dug up for examination of the roots. In older woods the condition of the crowns of the trees, viewed from a short distance, afforded a good indication as to the prevalence of the pine shoot beetle, and the presence of fallen pine shoots in the wood itself supplemented this evidence. Wherever possible a number of dead, dying and suppressed trees were examined, felling being resorted to if

necessary for proper examination. In addition to these observations, outbreaks of injurious insects not connected with fellings were looked for and noted. A collection of injurious forest insects and their work was made, and observations relating to their distribution and habits were recorded.

The survey was confined to insect conditions as affecting conifers, with special reference to Scots pine, larch, spruce and Douglas fir.

Summary of Observations.

Lists of the chief injurious insects, roughly in order of importance, which were found to be associated with felled areas, and the damage which they cause, are given on pp. 7-8. These insects are described and illustrated on pp. 17-34.

The following insects were observed in young coniferous plantations :—

Large Larch Sawfly, *Nematus erichsoni* Hart.

Pine Sawflies, *Lophyrus pini* L. and *L. rufus* Rtzb.

Pine Bud and Shoot Moths, *Tortrix (Retinia) turionana* Hb. ; *T. buoliana* Schiff ; *T. resinella* L.

Larch Mining Moth, *Coleophora laricella* Hb.

Larch Shoot Moth, *Argyresthia atmoriella* Banks.

Spruce Gall Aphis, *Chermes abietis* Kaltb.

Spruce-Larch Aphids, *Chermes viridis* Rtzb. and *C. strobilobius* Kaltb.

Spruce-Silver Fir Aphids, *Dreyfusia nuesslini* Rtzb. and *D. piceæ* Rtzb.

Pine Aphis, *Chermes (Pineus) pini* Koch.

Considered as a whole, the forest insect conditions, as indicated by the survey, show that, with the exception of Ireland, our coniferous woods are in an unhealthy state. The worst forest insect enemies are those which inhabit the Scots pine, especially *M. piniperda* and *H. abietis*. The universal abundance of these two pests is undoubtedly largely due to the extensive pine fellings occasioned by the recent war, but lack of proper management, and especially neglect of thinning operations in Scots pine woods, has also favoured the increase of *M. piniperda*.

Conditions in England.

The New Forest.

The extensive fellings of Scots pine which have taken place throughout the New Forest have produced outbreaks of pine-dwelling insects, of which *M. piniperda* was the most injurious. The effects of its work in the pine shoots were everywhere evident, and in some places it was also killing standing trees by cutting its egg galleries in them. Trees on the margins of felled areas or along rides and roadways suffered most from the beetle's attacks. The worst outbreaks occurred around Brockenhurst and at Highland Water Inclosure, where several hundred acres of Scots pine were felled and the felled timber was left lying two years and upwards on the ground. In this last area *M. piniperda* attacks had been especially severe, and the mis-shapen spire-like crowns produced by them were visible a long distance off.

INSECTS ASSOCIATED WITH FELLEED AREAS.

Name of Insect.	Breeding-ground.	Species attacked.	Damage done.
Large Pine Weevil (<i>Hylebius abietis</i> L.)	Stumps and roots of Scots pine, Corsican pine, Weymouth pine, spruce and rarely larch.	All conifers.	Adults gnaw and kill young plants.
Pine Shoot Beetle (<i>Myelophilius piniperda</i> L.) Lesser Pine Shoot Beetle (<i>M. minor</i> Hart.)	Dying stems and logs of Scots pine, Corsican pine, Weymouth pine, spruce and occasionally larch. (<i>M. minor</i> is confined to Scots pine).	Scots pine, Weymouth pine, Corsican pine.	Adults bore in leading shoots. Larvæ tunnel in bark and cambium.
Black Pine Beetles. <i>Hylastes ater</i> Payk. and <i>H. opacus</i> . Er.	Stumps and roots of Scots pine. <i>H. opacus</i> also breeds in young conifers, namely, Scots pine, Corsican pine and larch.	All conifers.	Adults tunnel in the bark below soil level and kill young plants.
Two-toothed Pine Beetle. <i>Pityogenes bidentatus</i> Hbst.	Slash of Scots pine, Corsican pine, Weymouth pine, spruce and larch. Also on sickly conifers of all species from 10-25 years old.	All conifers.	Adults kill young plants and trees by cutting their egg-galleries under the bark.
Smaller Banded Pine Weevil. <i>Pissodes notatus</i> . F.	Tops and stems of dying trees in polewoods of Scots pine and spruce and in stems of young plants.	Scots pine, Weymouth pine, Corsican pine, spruce and probably other conifers.	Larvæ tunnel under the bark killing young plants and suppressed poles. Adults gnaw the bark of branches and twigs of various conifers.

Name of Insect.	Breeding-ground.	Species attacked.	Damage done.
Toothed Pine Beetles. <i>Tomicus laricis</i> F. and <i>T. acuminatus</i> . Gyll.	Tops and branches (slash) and on dying branches and tops of pines ; rarely on larch, spruce and Douglas fir.	Pines chiefly.	Adults kill off sickly stems by cutting their egg-galleries in the bark.
Brown Pine Beetle. <i>Hylurgops (Hylastes) palliatus</i> . Gyll.	Felled dying and sickly stems of Scots pine, spruce and occasionally larch, also on the slash of these trees.	Scots pine and other pines, spruce and larch.	Adults and larvæ kill sickly trees by tunnelling in the cambium.
Larger Banded Pine Weevil. <i>Pissodes pini</i> . L.	Felled, dying and sickly stems of Scots pine, especially pines girdled by squirrels or injured by snow and wind break.	Scots pine and probably other pines and spruce.	Larvæ kill injured or dying trees.
Spruce Plantation Beetle. <i>Pityogenes chalcographus</i> . L.	Found only in Central Perthshire on fallen and sickly stems and poles of spruce.	Spruce.	Adults kill young plants and trees by cutting their egg-galleries under the bark.
Black Spruce Bark-beetle. <i>Hylastes cunicularius</i> Er.	Stumps and roots of felled spruce.	All conifers.	Adults kill and attack young plants by tunnelling in the bark below the root-collar.
Ambrosia Beetle. <i>Trypodendron lineatum</i> Ol.	Felled stems and stumps of spruce, Scots pine and larch.	Spruce, Scots pine, larch.	Adults bore deep in sapwood spoiling the timber by their borings.

In Hawkhill Inclosure, near Brockenhurst, where Scots pine woods 40-50 years old had been felled in strips or grids, and the areas replanted two years later, two species of bark-beetles have proved very destructive, namely, *Pityogenes bidentatus* and *Hylastes opacus*. These beetles have attacked the newly-formed Scots and Corsican pine plantations, which it is feared will be totally destroyed.

P. bidentatus attacked the stem of the young plants just below the branch whorls. *H. opacus* attacked the plants just at or below soil level. Both beetles in many instances were found on the same plant. It should be observed that a prolonged drought favoured these attacks.

Tomicus laricis and *Hylurgops palliatus* occurred in great numbers on fallen pine stems and slash throughout the New Forest, but were only of secondary importance.

Hylobius abietis, although it occurred throughout the forest and was found breeding in various localities, had done very little damage to young plantations. This is almost certainly due to its having been controlled in past years by persistent trapping and collecting.

All over the forest, and especially in the more open heath lands, *Tortrix buoliana* was abundant, and was causing malformation of the crowns and leaders of Scots pine of five years old and upwards.

Bagshot—Ascot Woods.

Scots pine forms the greater part of the large stretch of Crown woodlands here, and extensive fellings of this species have been made.

The Paschal Woods, consisting of Scots and Weymouth pines in the pole stage, were suffering from severe *Myelophilus* attacks. Their condition was due to the adjoining roadway having been used as a dump for Scots pine stems felled in the vicinity. These stems were infested by the beetles and served as a breeding-ground and centre of dispersal. In these woods *Myelophilus* was not only boring in the shoots, but was also killing suppressed trees by cutting its egg galleries under the bark.

In the Surreyhill area where two compartments had been felled, and in one of which stems and slash were still lying, *Hylobius abietis* and *Myelophilus piniperda* occurred in hundreds. One compartment had been partly replanted and in places was covered with self-sown pines, some of which have been stripped bare of bark and needles by *Hylobius*. On one pine sixteen weevils were found feeding.

The Bark-beetles *Tomicus laricis* and *Hylurgops palliatus* occurred in large numbers on the stems and slash in these areas, while *Hylastes ater* and *H. opacus* were abundant on the stumps and roots. In the felled areas near the Upper and Lower Star Posts the conditions were similar to those just described.

At Swinley an aphid (*Chermes* sp.) was causing the young shoots of ten-year-old Douglas firs to wilt. Japanese and European larch were badly attacked, especially along the borders of the plantation, by *Coleophora laricella* and *Argyresthia atmoriella*. Both side shoots and leaders were killed by this last insect.

Cumberland.

On the Netherby Estate (Longtown) considerable fellings of Scots pine have been made, but owing to the rapid removal of the felled timber no serious outbreaks of insects affecting the neighbouring woods need be feared. *H. abietis* and *M. piniperda* were, however, fairly numerous, and the first of these, unless checked by trapping, may cause considerable loss in any new plantations which may be formed.

On the Cliburn Estate, the insect conditions were bad. This area consists for the greater part of pure Scots pine woods 60-70 years old.

It extends probably to three hundred acres, and the felled areas it includes were littered with stems and slash.

H. abietis was not abundant, but three kinds of bark-beetles were causing serious damage in the standing woods, some of which are especially well grown and valuable. The worst enemy of these was *M. piniperda*. Accompanying it were *Tomicus acuminatus* and *Hylurgops palliatus*. Normally both the latter species are of secondary importance, but owing to the abundance of breeding material available, and their consequent increase in numbers, they have undoubtedly here acquired a primary significance.

Myelophilus, appearing earlier in the spring than *T. acuminatus* and *H. palliatus*, had bred in the fallen logs and brushwood. These logs had thereby been rendered suitable as breeding ground for the two latter species, which had utilised them and compelled the summer's brood of *Myelophilus* to seek fresh breeding ground. The result was that *Myelophilus* had attacked living timber, and had again been followed by the summer broods of *T. acuminatus* and *H. palliatus*. All three species, therefore, were to be found on living timber, and will probably continue their depredations. The conditions on this area illustrate in a striking way the various stages of the bark-beetle invasion, and they also show how certain injurious species, which are normally of minor importance, may assume a very important rôle. So far, fortunately, the conditions just described are confined to the standing woods immediately adjoining the felled areas.

Westmorland.

At Bassenthwaite Lake, a considerable felling of Scots pine and larch has been made, but as no *Hylobius* larvæ or adults were found on the stumps and all the stems have been barked or removed on felling and all slash burned, the risk of damage from insect pests has been greatly reduced.

Northumberland.

At Dipton Wood, near Hexham, a severe outbreak of *Myelophilus piniperda* was observed, together with large numbers of *Hylobius abietis*. *Tomicus acuminatus* and *H. palliatus* were here of no importance. The conditions around Hexham appear to apply generally to Northumberland.

Conditions in Wales.

North Wales.

The prevailing conifer in North Wales is the larch, and, except on a limited area on Gwydyr estate, near Llanrwst, few injurious pine insects occur. On this estate *Hylobius* had destroyed forty acres of pine, spruce, and larch, planted in the spring of 1919 on the site of a Scots pine wood felled during 1918.

In Ghelli plantation a number of seventy-year-old larch trees had been defoliated, and in some cases killed, by *Coleophora laricella*. In some places the moths were so abundant as to cause the larch stems to appear grey in colour. *Argyresthia atmoriella* also occurred.

At High Park *Trypodendron lineatum* was abundant in felled larch stems, but had not penetrated beyond the sapwood.

Conditions in Scotland.

Peeblesshire.

The distinctive feature of the conditions in Peeblesshire was the prevalence of *Hylobius* and *Hylastes ater*. These two insects have caused

serious damage to young coniferous plantations on Darnhall, Cringletie, and Dawyck Estates.

Myelophilus piniperda occurred in numbers throughout the district, and where squirrels were numerous *Pissodes pini* and *Hylurgops palliatus* were common. All three insects were causing appreciable loss in these woodlands.

Perthshire.

On the Dupplin Estates *Hylobius* has proved very destructive in new plantations, but the older woodlands are in a healthy condition.

On the Mansfield Estates at Lynedoch, near Methven, extensive fellings of Scots pine have been made, and in Drumhuich and Drumvaich Woods fires have done considerable damage. These two factors have produced extensive breeding grounds for *Hylobius* and *Myelophilus*, both of which may be expected to inflict losses in young plantations and standing woods. *Myelophilus* injury was already apparent in the standing woods. At Taymount similar conditions prevailed.

At Dunkeld, on the Atholl Estates, several hundred acres of pine and larch have been felled, together with small groups of spruce. *Hylobius* and *Myelophilus piniperda* are undoubtedly the most serious pests to be feared, but the variety of injurious forest insects found in this locality deserves notice. Both species of *Myelophilus* (*M. piniperda* and *M. minor*) occurred, although the proportion of the latter species as compared with *piniperda* was low. *M. minor* is the more destructive of the two species considered individually. Felled and suppressed spruce harboured *Pityogenes chalcographus* and spruce stumps and logs contained *Trypodendron lineatum* in hundreds. Dying branches of silver fir harboured the bark-beetle *Cryphalus abietis*, while felled and suppressed Douglas firs were attacked by *Pityogenes bidentatus* and *Tomicus acuminatus*. In one Scots pine pole wood a tiny Bark-beetle *Pityophthorus* sp. occurred in large numbers on the twigs, causing the needles to turn yellow. *Hylastes ater* and *Hylurgops palliatus* were found everywhere on Scots pine stumps. The occurrence of so many Bark-beetles in one locality is interesting and affords an idea of the number of species which, given favourable conditions, might prove harmful.

Forfarshire.

At Montreathmont Muir, near Auldbar (Auldbar Estate), *Myelophilus piniperda* was found in large numbers breeding in Scots pine, larch, and spruce logs, and attacking standing timber. *M. minor* also occurred, but in limited numbers. *Pissodes pini* was unusually abundant, and was found injuring pine and spruce branches in much the same way as *Hylobius* gnaws young conifers. *M. piniperda* was more numerous here than in any other locality visited.

Aberdeenshire

In the neighbourhood of Aberdeen, on Countesswells Estate, extensive fellings have resulted in the increase in numbers of most of the pine insects, particularly of *Myelophilus* and *Hylobius*.

On Deeside, around Aboyne (Balfour and Ballogie Estates), *Myelophilus*, especially, was injurious. Both species, *piniperda* and *minor*, occurred, and the abundance of the latter species was a feature of the conditions in the upper Dee valley.

At Kincardine O'Neill *Hylastes cunicularius* occurred on spruce stumps and roots.

Morayshire.

The outstanding feature of the insect conditions in the Morayshire woodlands was the prevalence of *Hylobius*. At Altyre, 150 acres of recently planted pine, larch and spruce have been completely destroyed by this weevil, and it is evident that future plantations will suffer the same fate unless the weevil is controlled by assiduous trapping and collecting.

On the Altyre and Darnaway Estates Scots pine plantations of five years and upwards suffered considerably from the attacks of *Pissodes notatus*. *Myelophilus piniperda* was everywhere abundant, but no *M. minor* was observed. On the felled Scots pine areas on the Culbin Sands no *Hylobius* was found, although its associate, *Hylastes ater* occurred in numbers.

Inverness-shire.

Extensive pine fellings have caused a considerable increase in the numbers of *Myelophilus* and *Hylobius*, and around Beauly, on the Beaufort Estates, the insect conditions approximate to those described for Montreathmont Muir, Forfarshire. Sporadic outbreaks of the Large Larch Sawfly occurred in the young larch plantations, but these were kept under control by hand-picking the larvæ. The Vapourer Moth, *Orgyia antiqua* was, here and there, injurious to the larch and birch woods.

Conditions in Ireland.

The woodlands visited at Abbeyleix, Queen's County, and Drum, Tipperary County, which Mr. A. C. Forbes considers typical of Irish woodlands, were particularly free from insect damage. This is undoubtedly due to the mixed nature of the woods, and especially to the absence of extensive tracts of Scots pine. *M. piniperda* and *Hylobius* occurred, but not in sufficient numbers to prove very harmful. Here and there *Coleophora laricella* and *Argyresthia atmoriella* cause slight injury to larch.

The Relation of Felled Areas of Different Species to the Prevalence of Forest Insect Pests.

In the general review above it will be observed that forest insect conditions are invariably worst in those localities where more or less extensive fellings of Scots pine have taken place. The reason for this is that the Scots pine in this country supports under normal conditions, more kinds of injurious forest insects than all our other conifers together. Just as unhealthy, dirty animals harbour and spread vermin and disease, so do unhealthy, badly-kept woodlands and uncleared felled areas; and in this respect the Scots pine felling with its stumps, stems and slash affords a breeding-ground for insects exactly comparable to a very unhealthy Scots pine wood. Unfortunately, *H. abietis* and *Hylastes*, while breeding on Scots pine, attack nearly all other conifers, though they do not breed on them to any extent.

Felled areas of pure spruce harbour few insect enemies of young plantations. *H. abietis* is occasionally found in such areas but not in great numbers, and *Hylastes cunicularius* is, so far as is known at present, confined to certain districts.

Felled areas of pure larch do not afford breeding-ground for injurious insects to any extent under present conditions, and the same is true of Douglas fir fellings.

It should be noted that wherever Scots pine occurs in admixture with other conifers, fellings on such areas will affect surrounding woods in varying degrees according to the proportion of Scots pine present. Fellings of mixed woods of Scots pine and spruce may affect surrounding woods as much as pure pine fellings.

This is due to the large number of insects which a small number of Scots pine stumps and stems with their slash can support. Where spruce and Scots pine occur together *Hylobius*, *Myelophilus*, *Pityogenes bidentatus* and *Hylurgops palliatus* not infrequently adopt the spruce as a breeding-ground when the Scots pine has been fully utilised for that purpose.

It must be remembered that a relatively low proportion of Scots pine in an area may provide breeding-ground for *Hylobius* in sufficient numbers to cause great damage to the young crop.

Some Biological Considerations.

Our most serious pests in coniferous woods are the pine weevils and the bark-beetles, insects which belong to the group of beetles known as the *Rhynchophora* or snouted beetles. The weevils belong to the family *Curculionidæ* of this group; the bark-beetles to the family *Scolytidæ* (*Ipidæ*). The members of the two families are characterised by two main features, namely, that the head is prolonged before the eyes into a more or less well-marked snout or proboscis, and that the antennæ are elbowed or geniculate. These features are especially noticeable in the pine weevils, *Hylobius* and *Pissodes*; in the bark-beetles the snout is much less evident although it nevertheless exists. One important difference between the weevils and the bark-beetles lies in their manner of egg-laying. The weevils deposit their eggs in their host by gnawing a hole for the purpose from outside; the bark-beetles tunnel into their host and deposit their eggs in well-defined tunnels or egg-galleries. In our British bark-beetles, the form of their egg-galleries is peculiar to each species. (Contrast text figs. 4 and 6 on pp. 21 and 22.). In their biology the weevils and bark-beetles have many points in common. Von Oppen (1883), MacDougall (1896-98), and Nusslin (1897) have shown that our pine weevils (genera *Hylobius* and *Pissodes*) are remarkably long-lived; that they do not, like many insects, die after their first egg-laying, but may pair again and produce another brood. More recently Knoche (1900, 1904), Fuchs (1907), and Hennings (1908) have shown the same to be true of many bark-beetles. The pine weevils and many of the bark-beetles cannot commence egg-laying as soon as they "emerge" or change from the pupal state and become apparently adult insects. For example, MacDougall has shown that *Pissodes notatus* may attain its adult state in July and yet lay no eggs until the following spring. Fuchs and Hennings have shown the same to be true of the pine-shoot beetle *Myelophilus*.

These features in the biology of weevils and bark-beetles have a distinct bearing on forestry. The large pine weevil *Hylobius*, when it appears as a "perfect" beetle in spring is still sexually immature, and in order to mature its reproductive organs it commences feeding. It feeds as the forester knows only too well, on recently planted conifers. This feeding, or "frass" as it is often termed, goes on throughout the summer until the cold weather sets in, when the weevil seeks its winter quarters. When it appears again in spring, it proceeds to egg-laying. After egg-laying, the reproductive organs are reduced and the weevil restores them by feeding once more, and it is these prolonged feeding periods which render the weevil so injurious a pest.

In most, if not all, of our British pine-dwelling bark-beetles the same habits are found, but it is interesting to note that the "feeding" is not always of equal economic importance. In the pine-shoot beetles (*Myelophilus*) and the root-feeding bark-beetles (*Hylastes*) the feeding takes place in the pine shoots and on the roots of recently-planted conifers respectively, and the beetles of both these genera are serious forest pests. In the toothed bark-beetles (*Tomicus*), however, the feeding takes place on the stems and limbs of older trees, and is of relatively small importance. Occasionally, however, the long branching egg-galleries of these beetles cause considerable damage. (Text, fig. 10, p. 27.)

One important biological feature of the bark-beetles deserves mention. Hennings (1908) has shown that the European bark-beetles may be divided into two biological groups, viz., those whose life-history being unaffected by weather conditions invariably produce only one brood in the year, and those which, under favourable conditions (warm and moderately dry) may produce two broods in the year. Observations made during the survey confirm Hennings' experimental observations and indicate that the majority, if not all, of our pine bark-beetles belong to the second group, and are more prolific and, therefore, more injurious in favourable, sunny seasons. It was also evident that beetles of the genera *Myelophilus*, *Hylastes*, and *Pityogenes* are more prolific in the South of England than in the North of Scotland. This is important, because it shows that control measures against these beetles must be varied according to local conditions.

It is interesting to note that the beetles of the genera *Pissodes* and *Tomicus* are, so far as our present knowledge goes, entirely absent from Ireland. Johnson and Halbert (1902) ascribe this to the extirpation of the primæval Scots pine of Ireland, and state that there is good ground for the belief that such species as *Hylobius abietis* and *Myelophilus piniperda* have been reintroduced into Ireland from Britain.

With regard to *Tomicus laricis* and *T. acuminatus*, it should be observed that the former is the common English species south of Northumberland and Cumberland. North of this and throughout Scotland, *T. acuminatus* is the common species.

Forest Practice in Relation to Insect Attacks.

The methods of planting and the correct choice of species for different conditions have a direct bearing on the prevalence of insect pests and the losses caused by them in young plantations. It has repeatedly been observed during the survey that well-rooted plants not only resist, but overcome, the attacks of *Hylobius*, *Hylastes*, and *Pityogenes bidentatus* better than plants that are poorly rooted or that have been notched in. Not only is this true of recently-formed plantations, but it is equally true of older plantations and pole woods. Badly planted and sickly plantations become further weakened by the above mentioned pests. When they reach larger growth coniferous plantations are still injured by *P. bidentatus* and they may later be further injured by *Myelophilus*; by *Pissodes notatus*; by pine and spruce Tortrix moths; by *Coleophora laricella* (this moth attacks Douglas fir and hemlocks as well as larch); by *Chermes* and even by *Hylurgops palliatus* and *Tomicus*. In fact, their whole existence during the first thirty years may be a continual struggle against insect injuries, often accompanied by fungus diseases. The same is true of trees planted in unsuitable soil.

Dense soil vegetation in newly-formed plantations favours insect attacks, especially of *Hylobius*. This is probably due in part to the

difficulty which the young plants have in becoming established, but it is also due to the shelter which the herbage affords *Hylobius*, which has a dislike for bare soil. Careful planting with well-rooted plants, combined with choice of the right species, are measures which of themselves will reduce insect injuries in young plantations.

Proper cleaning and thinning of woods are most important factors in insect control. Dying, suppressed and fallen branches, and dying and sickly stems, all serve as breeding ground for insects. Such branches and trees are for the most part removed in thinning operations, but it is essential to see, if they are not removed, that they are rendered useless as breeding ground for bark-beetles by removal and burning of the bark. The effects of careless or neglected thinnings are to be seen in most pine woods in Britain. "Beetle-trees," *i.e.*, trees serving as breeding places for the pine-shoot beetle, are only too familiar in our woods, and their location is easily traced by the numbers of fallen pine shoots in their vicinity. As a matter of fact, the presence of such shoots on the forest floor ought to warn the forester that "beetle-trees" exist in his woods, and cause him to locate and remove, or bark, them at the earliest opportunity. Regular thinning of woods, especially of older pole woods, is one of the best protective measures the forester has against bark-beetle enemies.

The length of rotation in coniferous woods has a bearing on the prevalence of insect pests. Over-mature trees or trees which, owing to poor soil conditions, are growing very slowly, often suffer from insect attacks which they resisted while in full vigour of growth. These attacks are unimportant for the trees attacked, but the latter may serve as breeding-ground and centres of infestation for insect enemies which may spread to younger woods where their attacks become serious. Over-mature larch woods or larch woods on unsuitable soils often harbour *Coleophora laricella*, which spreads to other younger larch plantations. A clear case of this was seen in Ladywell Wood, on the Atholl Estates, Dunkeld. Over-mature and "back-going" pines are especially liable to serve as centres of bark-beetle infestation.

The time of felling and the period elapsing between the felling and the removal of the timber and slash is, in Scots pine woods, the most important factor governing the prevalence of forest insect pests at the present time. Timber, if felled in winter and removed or barked in May, will have no detrimental effect on insect conditions. Timber felled in winter, and left lying unbarked through the summer and for longer periods, causes greater increase in the forest insect pests in a district than any other factor. Dumps of unbarked pine timber are a frequent source of danger to adjacent coniferous woods.

From the above statements it is clear that a little forethought on the part of the management may do much to control insect attacks. In this connection it is desired to urge the importance of dealing with forest areas on a well-considered scheme of management or working plan. The compilation of a working plan entails at least a description of the individual sub-division of the forest, and in making such descriptions the possibility of attacks by insects such as the pine beetle may be foreseen. In the case of that insect preventive measures consist in timely thinnings and the setting of trap trees. Again, in arranging the order of fellings it may be possible by careful distribution to avoid a series of areas through which weevils will find it possible to migrate. In the case of Scots pine fellings it will be perfectly clear that weevils will occur in large numbers and steps may accordingly be taken to trap them well in advance of planting operations. In mixed crops of larch and Scots pine it may be

possible to remove the pine four or five years in advance of the larch and thus to proceed immediately after the final felling to replant with much less fear of weevil attack.

Summary and Conclusion.

The preliminary survey of forest insect conditions in Great Britain and Ireland shows that our coniferous woods generally are in an unhealthy condition. Scots pine woods, and young coniferous plantations on the site of or near felled areas of Scots pine are suffering most. Pure larch, spruce, Douglas fir and Corsican pine woods are comparatively free of injurious insects and do not form centres of dispersal. The most injurious insects are *Hylobius abietis*; *Myelophilus piniperda*; *Pityogenes bidentatus*; and *Hylastes ater* and *Hylastes opacus*. Some secondary enemies (e.g., *T. acuminatus*) have in certain localities become of primary importance.

Attention should be given in the first place to *Hylobius abietis* and *Myelophilus piniperda*. The survey indicates that the former can best be controlled by trapping the adults, and that the latter can be controlled by means of trap-trees. Further information with regard to the best means of trapping *Hylobius*, and to the most suitable time for setting and barking trap stems for *Myelophilus*, in different localities is desirable.

It is also a question whether Scots pine is not planted too extensively, both pure and in mixture with other coniferous species. From the entomological point of view this is undoubtedly the case and statistics as to the rate of growth of timber support the contention.

Fortunately, there are no signs in this country of the severe outbreaks of lepidopterous insects like the Nun and Gipsy Moths, so familiar in Central Europe and America, but the Large Larch Sawfly, *Nematus erichsoni*, and the Pine Sawflies, *Lophyrus*, must be carefully watched for and their outbreaks controlled as early as possible.

With the exception of the Douglas Fir Seedfly, *Megastigmus spermotrophus*, there is no evidence of imported insects causing serious loss to foresters in this country.

APPENDIX.

Description of the More Important Insects found in Felled Pine Areas.

The Large Pine Weevil, *Hylobius abietis*, L.

Hylobius is among the largest of our British weevils ($\frac{1}{4}$ – $\frac{1}{2}$ in.). Colour, dull; brown to black. In fresh (recently emerged) specimens, the sides and front of the thorax are clothed with fine yellow scales, the wing-covers having groups or flecks, of larger yellow scales, which in some specimens form irregular bands. In older specimens the scales on the wing-covers only may remain. (Text fig. 1.)

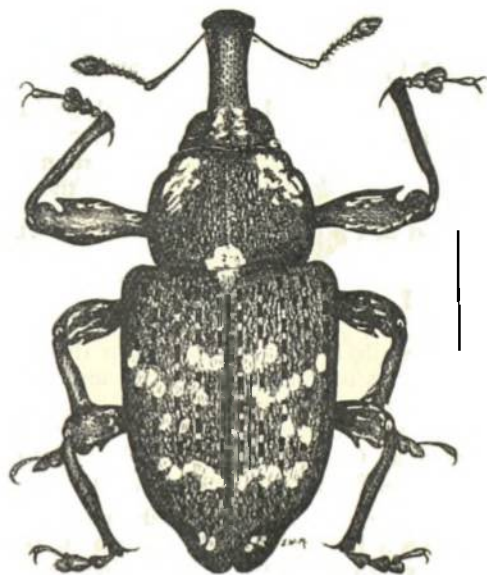


FIG. 1.—LARGE PINE WEEVIL (*Hylobius abietis*) MAGNIFIED.
The line to the right shows natural size.

Hylobius has been observed throughout Great Britain and in Ireland, and is everywhere causing serious injury to young coniferous plantations. It is especially abundant in the great pine districts of Scotland from Perthshire to Inverness-shire, and in Strathspey and Moray is so numerous as to be found on the roads and even in houses. It is undoubtedly the most serious insect pest of the forester in this country at the present time.

Unfortunately, its life-history and habits do not appear to be so well understood as might be expected from its prevalence and the loss it causes. It is essentially a ground insect, spending the greater part of its life on, or even in, the soil and herbage in felled areas and young plantations. The weevil's chief breeding-ground is the Scots pine stump and roots, and the great majority of its eggs are deposited *below* soil level. So, too, the larval and pupal stages of the insect's life are spent in the stump and roots underground, and it is on this account that the "weevil" is so difficult an insect to combat.

In our present state of knowledge the only sure and reliable means the forester has against *Hylobius* is to trap and collect the adults, and if landowners and foresters throughout the country were to unite in con-

ducting a systematic and continued campaign against the weevil by this means, there is reason to believe that in a few years' time *Hylobius* would cease to be the menace it now is to all attempts at replanting, and would become of relatively small importance as a forest pest.*

The Lesser or Banded Pine Weevils, *Pissodes notatus* and *P. pini*.

The weevils of the genera *Hylobius* and *Pissodes* are at first glance somewhat similar in general appearance, but the following characters serve to distinguish them :—

Character.	<i>Hylobius</i> .	<i>Pissodes</i> .
Size	Larger ($\frac{1}{3}$ - $\frac{1}{2}$ in.) ...	Smaller ($\frac{1}{4}$ - $\frac{1}{3}$ in.).
Colour	Brown to black, flecked with yellowish scales.	Reddish-brown to brown-black. Yellowish scales forming distinct bands on the wing-covers.
Antennæ	Inserted at tip of snout	Inserted about middle of snout.
Femora	Toothed	Not toothed.

The lesser Pine Weevils are injurious both in the larval and adult stages. They are enemies of older plantations and pole woods, but, except where they are unusually abundant, are of secondary importance, attacking young trees and poles which have already been reduced in vitality by such agents as fungi, fire, snowbreak, and squirrel damage. *Pissodes pini* especially is frequently associated with squirrel damage.

The two species of *Pissodes* are much alike in general appearance, but may be distinguished by the characters given in the table below. The colour is red-brown to dark brown, the wing-covers showing two distinct bands of scales. (Text Fig. 2.)

Character.	<i>P. pini</i> L.	<i>P. notatus</i> P.
Size	Larger ($\frac{1}{4}$ - $\frac{1}{3}$ in.) ...	Smaller ($\frac{1}{6}$ - $\frac{1}{3}$ in.).
Bands on wing-covers	<div> <div></div> <div>Anterior bands meeting in the middle</div> <div>Colour of bands yellowish</div> </div>	<div> <div></div> <div>Anterior bands not meeting in middle.</div> <div>Colour of bands yellowish and white.</div> </div>
Rows of punctures on wing-covers	Larger and more distinct	Smaller and less distinct.
Corners of thorax	Less prominent	More prominent.

The species have a similar life-history, although their habitats are usually different, *P. pini* preferring pole-woods and *P. notatus* young plantations of 2 to 10 years' standing. Like *Hylobius*, the weevils of the genus *Pissodes* have a long adult life, and are to be found throughout

* Reference may be made to Leaflet No. 1 of the Forestry Commission (Pine Weevil).

all the warm months of the year. The life-cycle from egg to egg commonly occupies a year.

The female lays her eggs in punctures made in the bark and the grubs tunnel between the bark and the wood, often causing radiating galleries. These galleries end in the pupal chamber or bed, which, in *P. notatus*, consists of a hollow in the sapwood roofed with chips and fibres, in *P. pini*, of a tunnel in the sapwood blocked at both ends with fibres.

Pissodes pini (Text fig. 2) lays its eggs on Scots pine, and occasionally on spruce trees. It does not confine itself to any particular region of the tree, but may be found breeding on the roots, stem and crown. It is most injurious in the larval stage.

Preventive measures consist in regular thinnings and barkings of thinnings within three months of felling. Trees injured by snow, wind, or squirrel damage should be removed as far as the canopy will admit.

Pissodes pini is easily trapped. Billets or logs of recently cut pine should be laid on the ground from April to September throughout in-

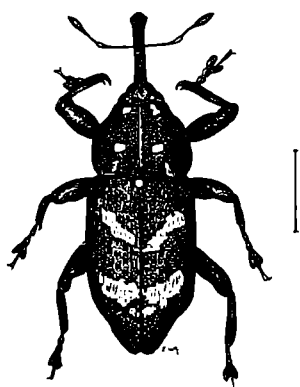


FIG. 2.—BANDED PINE WEEVIL (*Pissodes pini*) MAGNIFIED.
The line to the right shows natural size.

festated areas. These should be removed and barked every three months, the bark being burned.

The favourite breeding grounds of *Pissodes notatus* are pine plantations of two to ten years' standing. Scots pine is its usual host, but Austrian and Weymouth pine are also attacked. Pines growing in unsuitable soil are especially liable to attack, and striking evidence of this was seen in the New Forest. The weevil lays its eggs on the pine plants between the root-collar and the first whorl of branches, and in older plants right up the stem. Occasionally the larvæ are found on the roots.

P. notatus is harmful both in the larval and adult stages. The larva mines the bark of the stem and roots girdling them and killing the plant. (Text fig. 3.) The adult gnaws the young shoots of pine in the same manner as *Hylobius* gnaws the stem.

Where infestation is not severe, uprooting and burning of infested plants will usually check the outbreak. If the infestation is severe and the beetles numerous, these may be collected by hand as for *Hylobius*.

In older plantations trap-trees, either sickly suppressed trees of two to four inches in diameter or trees weakened artificially by partial girdling,

may be left standing and examined every three months. Trap-logs, preferably thin-barked "tops," may be laid on the ground throughout the infected area and barked every two or three months. Such traps should be prepared in early spring and used throughout the warmer months until October.

The Pine-shoot Beetle, *Myelophilus piniperda*.

Myelophilus piniperda (Plate 1, Fig. 1) measures $1/6$ - $1/5$ inch in length. It is cylindrical in shape and dull brown or black in colour with

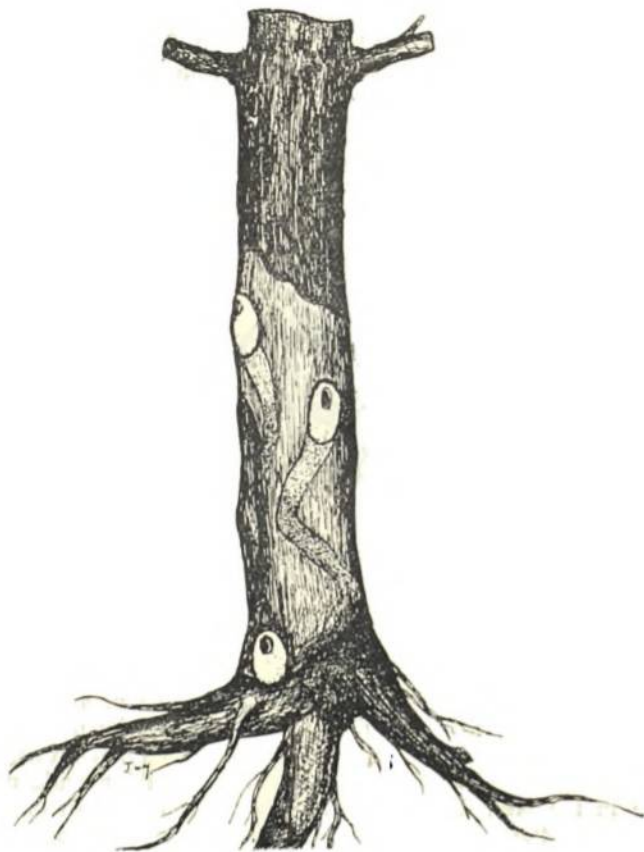


FIG. 3.—WORK OF *P. notatus* ON SCOTS PINE.

the thorax glossy black. On the wing covers are rows of punctures, and between these rows a series of tubercles bearing fine hairs. In the second row of these tubercles from the junction of the wing cases, the tubercles cease before the apex or declivity of the wing-covers, a character which distinguishes the species from the rarer northern, *Myelophilus minor*.

M. Piniperda is the earliest of our Bark-beetles to appear in spring. On leaving their winter quarters, in the pine shoots or under the bark of logs and dead trees, the females cut their egg-galleries (Text

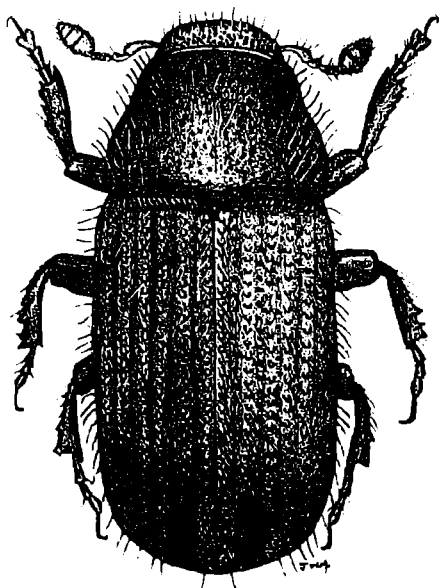


FIG. 1. PINE-SHOOT BEETLE.
(*Myeloophilus piniperda*).

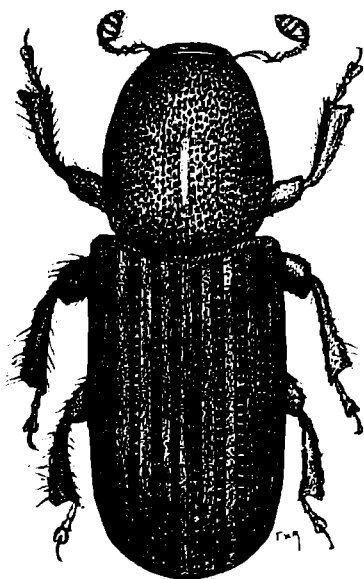


FIG. 3. BLACK PINE BEETLE.
(*Hylastes ater*).

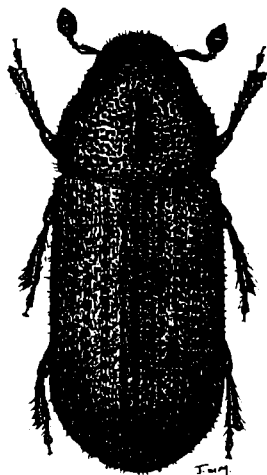


FIG. 2. BROWN PINE BEETLE.
(*Hylurgops palliatus*).

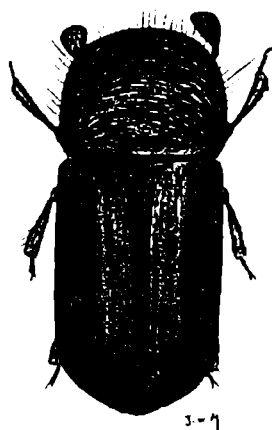


FIG. 4. AMBROSIA BEETLE.
(*Trypodendron lineatum*).

The above figures are all drawn to the same scale magnified about 12 times.

fig. 4) and deposit their eggs in Scots pine stems in March and April. The first brood become adult beetles and emerge in May and June. The parent beetles may lay the eggs of a second brood in August and September, and in very favourable seasons the beetles of the first brood may also proceed to egg-laying about that time. In such seasons three broods and two generations occur in the year, but normally two broods and one generation occur.

Emerging from their breeding ground the beetles bore in the last year's shoots of Scots pine causing them to wither or drop off. (Text

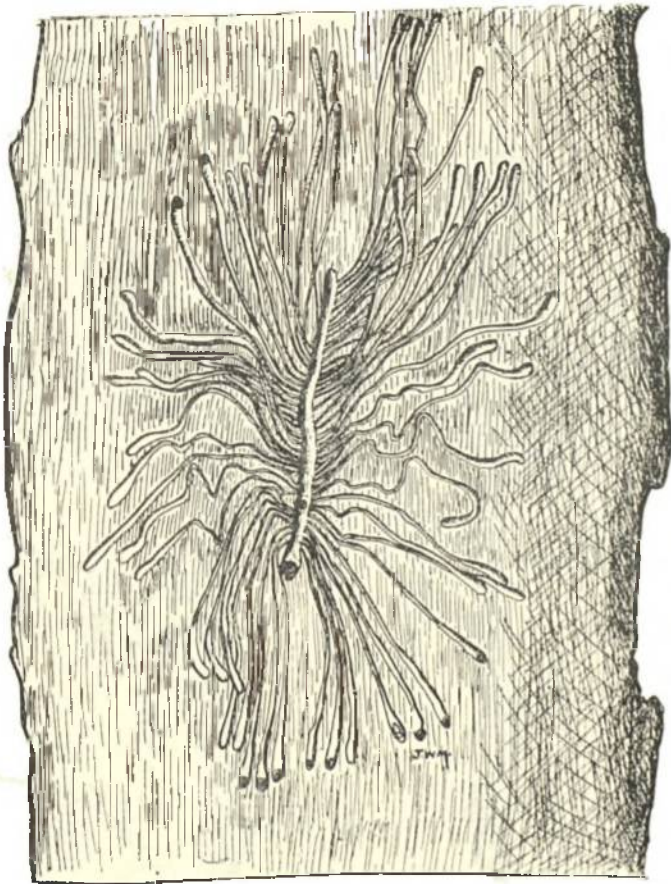


FIG. 4.—BROOD TUNNELS OF COMMON PINE-SHOOT BEETLE (*M. piniperda*).

fig. 5.) This produces a spire-like crown, and severe attacks, involving repeated loss of the leading shoot, kill the tree.

The real danger arising from the undue prevalence of *M. Piniperda* will only be fully apparent when the felling still proceeding in all parts of the country ceases. When that happens the beetles, deprived of felled stems and logs to breed in, will, if numerous, be compelled to attack green, standing timber, unless control measures against them are instituted.

The best means of controlling this beetle are by careful thinning and cleaning of all pine woods. Stems felled during the winter should be barked in May or early June and the slash burned up before that date.

This will destroy the spring broods before they emerge. Where attacks are severe, trap-stems, consisting of felled pines, should be laid. These should be felled in December and barked in May or June to catch the first brood, and felled in July and barked in December for the autumn broods.

The lesser Pine-shoot Beetle, *Myelophilus minor*, causes similar damage to that caused by *M. piniperda*. *M. minor*, however, cuts horizontal egg-galleries (Text fig. 6), and is, on that account, more injurious as a breeding insect. It is distinctly local in its distribution, having been



FIG. 5.—PINE SHOOT BORED BY COMMON PINE-SHOOT BEETLE; CUT OPEN TO SHOW TUNNEL.

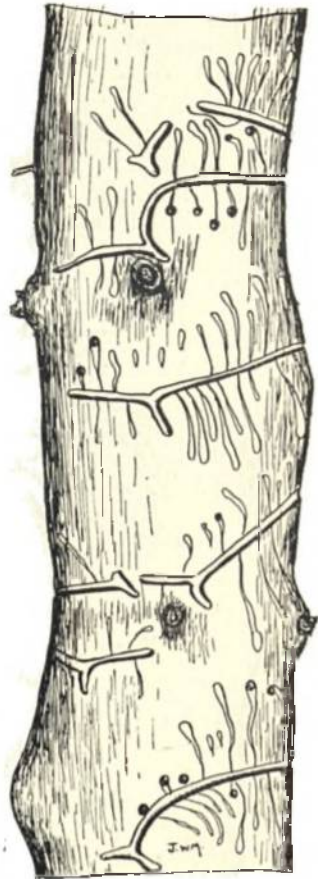


FIG. 6.—BROOD TUNNELS OF LESSER PINE-SHOOT BEETLE (*Myelophilus minor*).

observed during the survey only in Scotland (Perthshire, Forfarshire, Kincardineshire and Aberdeenshire). It occurs in its greatest numbers in Upper Deeside (Aberdeen and Kincardineshire). Its life-history is similar to that of *M. piniperda*, and the same control measures apply to both, although *M. minor* is later in appearing in spring than the former.

The Black Pine Beetle, *Hylastes ater*.

This beetle measures $1/6$ - $1/5$ inch long and may readily be recognised by its long, narrow shape, glossy thorax and black wing-covers.

The thorax is elongate and narrowly oval. The wing-covers show rows of punctures. (Plate 1, fig. 3.)

H. ater, which is essentially an enemy of young coniferous plantations, was, until recently, generally considered of secondary forest importance. It has, however, proved in certain districts a forest pest of the first rank, and there is good reason to suppose that formerly its injuries were attributed to *Hylobius*, with which it is often associated. It is certain that *H. ater* has increased in numbers in recent years and that it must be reckoned with in forming new coniferous plantations wherever extensive pine felling have occurred.

Hylastes ater breeds in the stumps and roots of felled Scots pine, in the roots of dead or dying standing pines, and occasionally in larch. The beetles emerge from their winter quarters (stumps and roots) and proceed

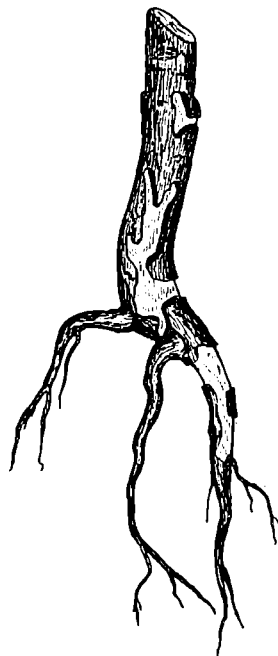


FIG. 7.—PORTION OF SCOTS PINE PLANT SHOWING INJURY BY BLACK PINE BEETLE (*Hylastes ater*). THE UNSHADED PORTIONS HAVE BEEN EATEN AWAY.

to egg-laying in April and May. The first brood issue in July and August, and then feed in the roots and lower stems of recently planted conifers of all species. The parent beetles may lay the eggs of a second brood in September and October, and in the South of England the beetles of the spring brood may proceed to egg-laying along with their parents in the autumn.

H. ater is very often associated with *Hylobius*, both in its breeding and feeding grounds. *Hylastes*, however, invariably works below soil level, gnawing and tunnelling below the bark of the roots (Text fig. 7).

The only means of controlling *Hylastes ater* are to uproot and burn all attacked plants and to trap the beetles on emergence by means of trap logs or stakes. These consist of logs of recently cut Scots pine, four feet long and two to four inches in diameter, partly buried, on the slant, in the soil. Such traps should be prepared in February and March and re-

moved and barked in the end of June. A second series should be laid in June and barked in November. These traps should be laid both in the felled area and in the plantations it is desired to protect.

The smaller or Dull Black Pine Beetle, *H. opacus*, causes similar damage to that of *H. ater*. It is, however, more restricted in its distribution, not having been observed in the survey north of the Tyne. It occurred in Tipperary Co. in Ireland.

H. opacus, as its name implies, is dull or dingy black in colour, and smaller than *H. ater*. It has proved very injurious in the New Forest. The same control measures apply to it as have been recommended for *H. ater*.

A third pine beetle, *Hylastes* (*H. angustatus*), a small elongate, narrow species, was observed in the New Forest and in the Ascot and Bagshot Woods. It is probably of minor importance.

The Brown Pine Beetle, *Hylurgops* (*Hylastes*) *palliatu*s.

(Plate I., Fig. 2.)

This beetle is closely related to the Black Pine Beetles described above, and was until recently classed in the genus *Hylastes*. It differs from the latter in having the thorax broader than long and narrowed in front, and in certain other structural details; but the chief justification for separating it from the *Hylastes* beetles proper is that it is not a soil dweller, but breeds in the stems and branches of Scots pine and other conifers and is rarely an enemy of young plantations. Normally, *Hylurgops* is a secondary pest following *Myelophilus*.

The beetles issue from their winter quarters under the bark of Scots pine and other conifers, in April and May and proceed to egg-laying. They cut their egg-tunnels in the bark of the stems and larger branches of felled and dead Scots pine, spruce and larch. Owing, however, to the prevalence of Scots pine woods, this tree is the beetles' more common host in this country. The first brood emerges in July and August, and the eggs of a second brood, and also of a third brood and second generation, may be laid in September and October.

The damage done by *H. palliatu*s is caused by its cutting or boring its egg-tunnels under the bark of sickly trees and by the borings of the larva. Unlike the Bark-beetles so far described, it often remains tunnelling in the bark of its native host after reaching the adult state, only leaving it when fully mature, when it seeks a fresh stem to breed in.

In Cumberland and Northumberland *H. palliatu*s has attained primary importance as an associate of *M. piniperda*.

The control of *H. palliatu*s depends almost wholly on clean forestry methods. Trap trees do not always give results, as the beetle shows a dislike for fresh felled timber, and prefers stems felled some time, removal of dead and dying stems and regular thinnings in pine and spruce woods being the best safeguard against it.

The Plantation or Two-toothed Pine Beetle, *Pityogenes bidentatus*.

Pityogenes bidentatus is a small beetle (1-10th to 1-8th inch long). It varies in colour from reddish brown to black. The thorax is almost

black in mature specimens. The male beetle has the tips of the wing covers armed with two hooked teeth, which render the species easily recognisable when examined with a pocket lens. (Plate II., Fig. 7.)

P. bidentatus is an enemy of young plantations and pole-woods, and next to *Myelophilus* is probably our most common Bark-beetle. It is widely distributed throughout Great Britain, and occurs in some districts in Ireland (Queen's County and Tipperary). It has increased greatly in numbers in the past five years, and in certain localities has caused considerable loss, notably in Hawkhill Inclosure, in the New Forest, and in the Bagshot district, in Surrey.

P. bidentatus is polygamous, one male pairing with four or five females. This polygamy produces a star-shaped brood-gallery, consisting of a central pairing chamber, from which radiate four or five egg-tunnels (Text Fig. 8). The beetles breed in the slash of felled pines and in the less healthy plants and poles in coniferous planta-

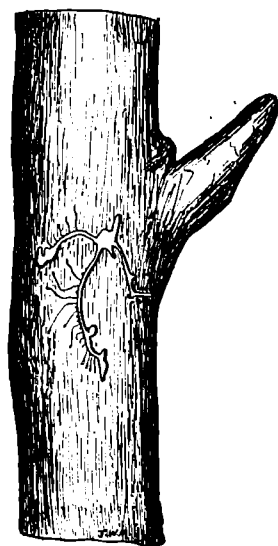


FIG. 8.—BROOD TUNNELS OF TWO-TOOTHED PINE BEETLE (*Pityogenes bidentatus*).

tions. Scots pine, Corsican pine, Weymouth pine, spruce, larch, Douglas fir, and silver fir are all liable to attack by the beetle.

The damage caused by *P. bidentatus* is due to the destruction of the cambium by the insects cutting their egg-tunnels under the bark. As the beetles are highly prolific and always numerous where they occur, they rapidly encircle the young stem, causing cessation of the sap flow and death. The stem is almost invariably attacked in the region of the branch whorls. Plants of five to twenty-five years of age are attacked, and occasionally "*bidentatus*" is a nursery pest.

The beetles issue in April and May, and proceed to egg-laying, the first brood emerging in June and July. The eggs of a second brood are laid in August and September, and in the North of Scotland even in October in mild weather. Two generations in the year are not uncommon.

The best control measures against this beetle consist in burning of all slash, and in the removal and burning of attacked plants. In pole-woods, where attacked stems may be saleable as stakes

or poles, the bark should be removed from them and burned. These operations can best be carried out in the winter. Owing to the usual density of the plantations attacked by *P. bidentatus*, the use of trap trees is not always practicable.

A second member of the genus *Pityogenes*, *P. quadridens*, occurs in the north of Scotland, where it plays a similar role to *P. bidentatus*, and in some localities, *e.g.*, Deeside and Morayshire, replaces it. It is a smaller beetle, very similar to "*bidentatus*," but the male bears a second and smaller tooth on each wing-cover. The same control measures apply to both species.

The Large Toothed Pine Beetles, *Tomicus laricis* and *Tomicus acuminatus*.

These beetles are normally of secondary importance, but they have greatly increased in numbers during recent years owing to the abundant

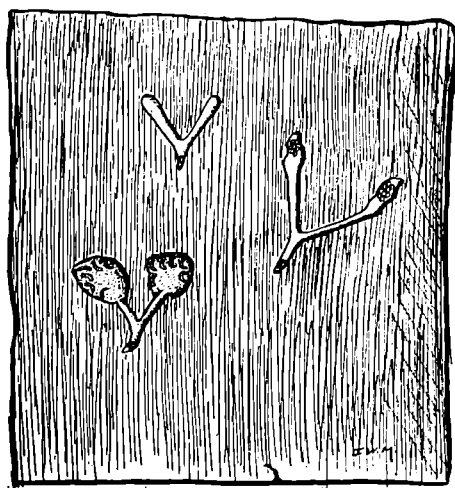


FIG. 9.—BROOD TUNNELS OF *Tomicus laricis*. THE EGGS ARE LAID IN CLUSTERS AND NO LARVAL GALLERIES ARE FORMED. CONTRAST WITH FIG. 10.

breeding ground provided for them by extensive pine fellings. The two beetles are at first glance readily confused owing to their somewhat similar appearance. They may be distinguished, however, by two main features. In *Tomicus laricis* the wing-covers are about one and a half times as long as the thorax, and the apical excavation of the wing-covers is abrupt and steep. (Plate II., Figs. 6 and 9.) In *T. acuminatus* the wing-covers are only a little longer than the thorax, are narrowed towards the apex, and have the apical excavation gradual. (Plate II., Figs. 5 and 8.)

The Toothed Bark-beetles may be recognised from the other Bark-beetles, which they approach in size, by the head being hidden by the thorax, which is large and subglobular. From *Pityogenes* they may be recognised by their greater size and subglobular thorax. Both beetles, when mature, are brown in colour.

T. laricis is peculiar among our pine Bark-beetles in that it lays its eggs in clusters or groups. (Text Fig. 9.) Its biology is still obscure.

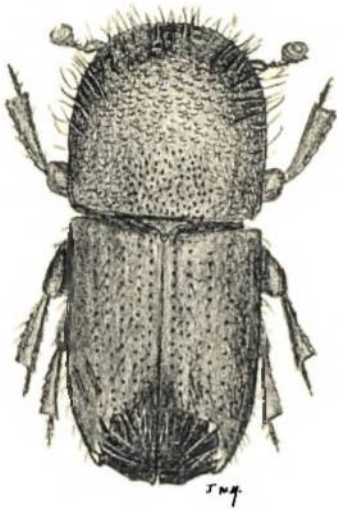


FIG. 5. TOOTHED PINE BEETLE.
(*Tomicus acuminatus*).

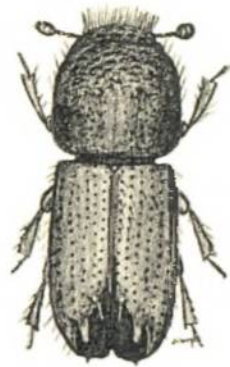


FIG. 7. TWO-TOOTHED PINE BEETLE.
(*Pityogenes bidentatus*).

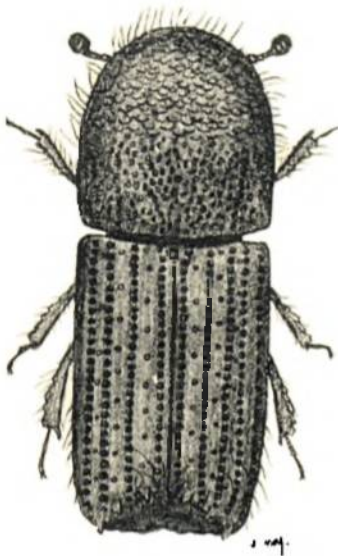


FIG. 6. TOOTHED PINE BEETLE.
(*Tomicus laricis*).

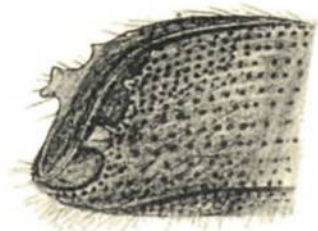


FIG. 8. APICES OF WING-COVERS OF
T. acuminatus.

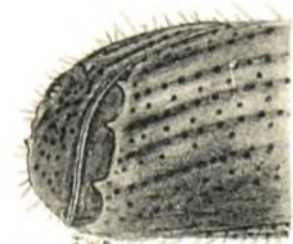


FIG. 9. APICES OF WING-COVERS OF
T. laricis.

The above figures are all drawn to the same scale magnified about 12 times.

T. acuminatus is a polygamous species, and its brood galleries (Text Fig. 10) somewhat resemble those of *P. bidentatus*. They may be distinguished by the larger brood-chamber, and wider egg-tunnels, and especially by the distance between the egg-niches in the egg-tunnels. The life-history of this species has not yet been studied under British climatic and forest conditions, but observations on it made during the survey indicate that there are two broods in the year. Clean forestry methods and burning of all slash are the best means of controlling these beetles.

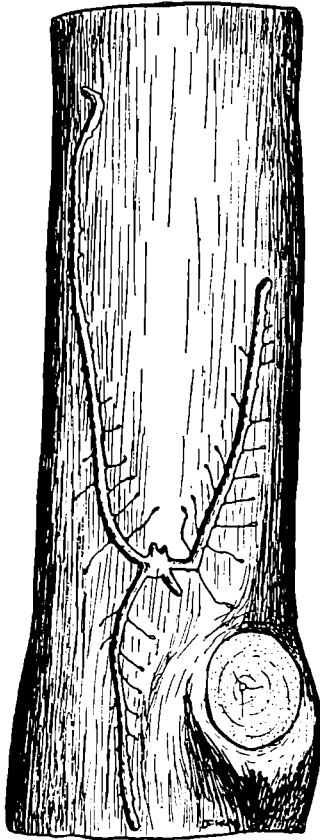


FIG. 10.—BROOD TUNNELS OF *Tomicus acuminatus*. NOTE THE DISTANCE BETWEEN THE LARVAL TUNNELS AND COMPARE WITH FIGS. 8 AND 9.

The Pith Pine Beetles, *Pityophthorus Lichtensteinii* and *P. pubescens*, have been observed in various localities, but, except at Dunkeld, Perthshire, cannot be said to be of any real importance. They tunnel in the bark and pith of the smaller pine twigs.

Insects Associated with Felled Spruce Areas.

The Black Spruce Bark-beetle, *Hylastes cunicularius* has been observed only in Peeblesshire, Aberdeenshire and Kincardineshire, where it causes damage in young plantations similar to that caused by *H. ater*, which it somewhat resembles both in appearance and life-history. It is, however, a more stoutly built insect, and its thorax is distinctly oval

and markedly rounded at the sides. It breeds in the stumps and roots of Norway and Sitka spruce.

The "Ambrosia" Beetle, *Trypodendron lineatum*, (Plate I., Fig. 4) breeds on fallen spruce logs and on spruce stumps. It rarely penetrates beyond the sapwood, in which it makes curious ladder-like brood-tunnels. (Text Fig. 11.) It is injurious only when occurring in large numbers. This species also attacks Scots pine and larch.

The Spruce Plantation Beetle, *Pityogenes chalcographus*, was observed at Dunkeld, Perthshire, breeding in fallen spruce stems and on suppressed trees of six years old and upwards. This species has not hitherto been recorded as breeding in Britain. *P. chalcographus* differs from *P. bidentatus* in general shape and colour. The wing-covers are longer in proportion to the thorax than in *bidentatus*, and bear three tubercles on the apical declivity. The colour of the wing-covers in mature specimens is brighter and redder in *chalcographus* than in *bidentatus*. The species is polygamous and probably resembles *P. bidentatus* in its

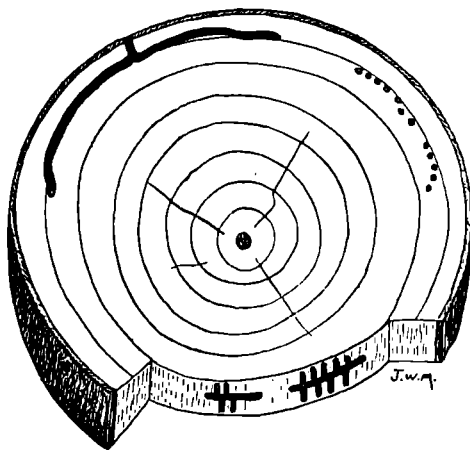


FIG. 11.—BROOD TUNNELS OF **Ambrosia** BEETLE (*Trypodendron lineatum*).

biology. The same preventive and control measures apply to *chalcographus* as have been recommended for *bidentatus*.

The Bark-beetle *Dryocates autographus* was observed on fallen stems and stumps of spruce in Perthshire and Peeblesshire. Little is known of the species in Britain. In Central Europe it is only of secondary importance.

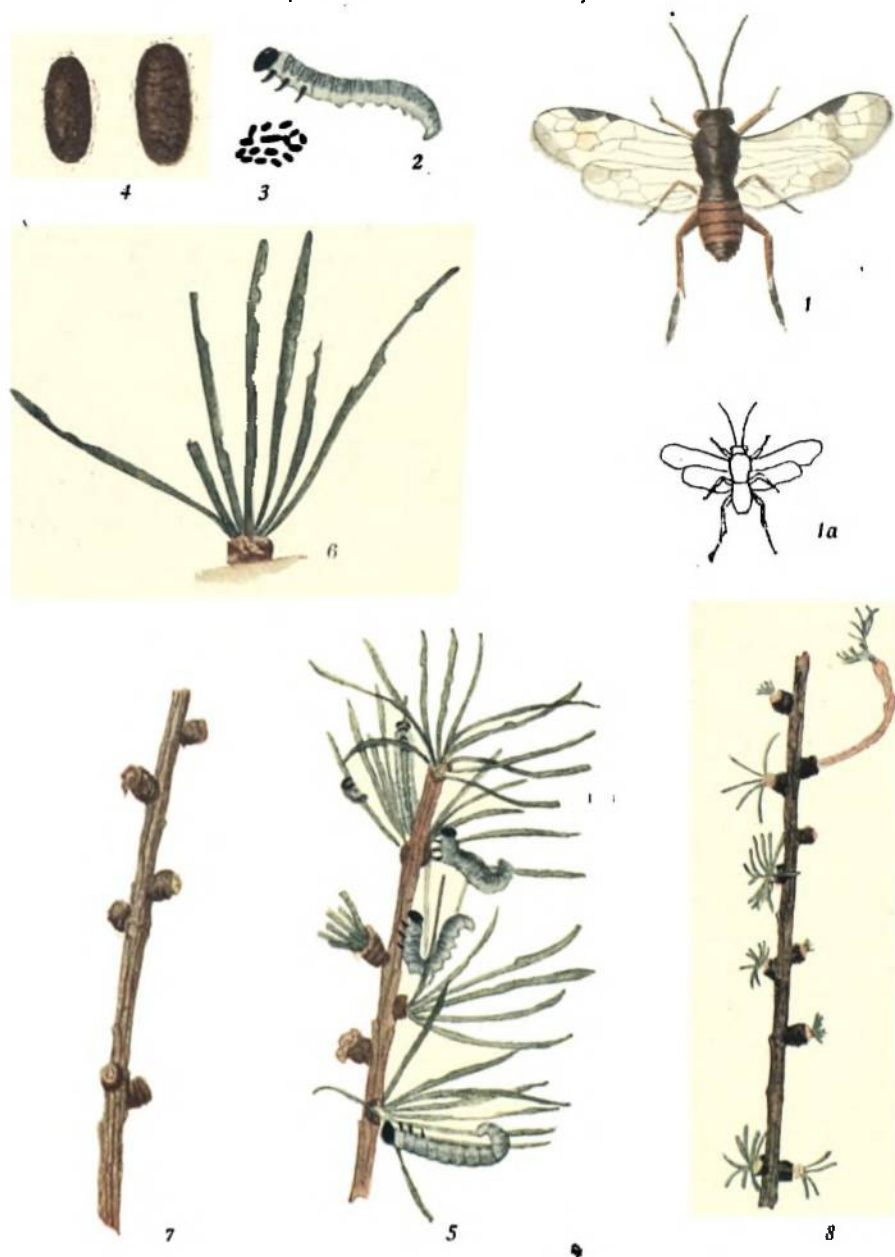
Injurious Insects Found in Standing Woods.

The following notes on insects observed in young and established coniferous plantations may be of interest.

The Large Larch Sawfly, *Nematus Erichsoni*, was observed during the survey in Perthshire (Lynedoch Estate), and Inverness-shire (Beaully Estate). It is known to occur throughout Britain and Ireland and sporadic outbreaks of it are not unusual. The severe outbreak of this insect which occurred in the Lake District (Thirlmere) in 1906 showed how serious a pest it can be. It has been more studied probably than any other forest pest in Britain.

N. Erichsoni measures up to $\frac{3}{8}$ inch, or a little over in length, and in spread of wings just less than an inch. The ground colour is black.

PLATE III.
THE LARGE LARCH SAWFLY
(*Nematus Erichsoni*).



Description of Figures :—Fig. 1, *Nematus Erichsoni* (magnified) ; Fig. 1A, *Nematus Erichsoni* (natural size) ; Fig. 2, Larva ; Fig. 3, Excrement of larva ; Fig. 4, Two cocoons, each magnified $1\frac{1}{2}$ times ; Fig. 5, Larvæ on twig of larch ; on one of the needles a moulted skin is seen ; Fig. 6, Some injured leaves magnified ; Fig. 7, Larch twig defoliated by the larvæ. Fig. 8, Larch twig, drawn in September, that had been defoliated and now putting out new leaves. Figs. 1 and 1A after Packard, all the others drawn from nature. (Reproduced by permission from *The Journal of the Board of Agriculture*, October 1906.)

The head and thorax are black ; the first joint of the abdomen is black ; then follow joints coloured red ; the end of the abdomen again being black. The mouth parts, the two front pairs of legs, except at the part next to the thorax, and the upper parts of the femora of the hind legs, are reddish or reddish yellow. The antennæ are nine-jointed, somewhat thick and taper towards the apex.

The full-grown caterpillar of *N. Erichsoni* measures about three-quarters of an inch in length. It has a round black head with a tiny eye on each side. On the upper surface, all down the back, the colour is grey-green ; the sides are lighter and the under surface is yellowish green. The legs number twenty, *viz.*, three pairs of thoracic legs, which are jointed and black in colour, and seven pairs of abdominal legs, which are pad-like and similar in colour to the underside of the body. (See Plate III.)

It is especially desirable that all outbreaks of *nematus erichsoni*, however small, should be reported, that they may be dealt with at once. In

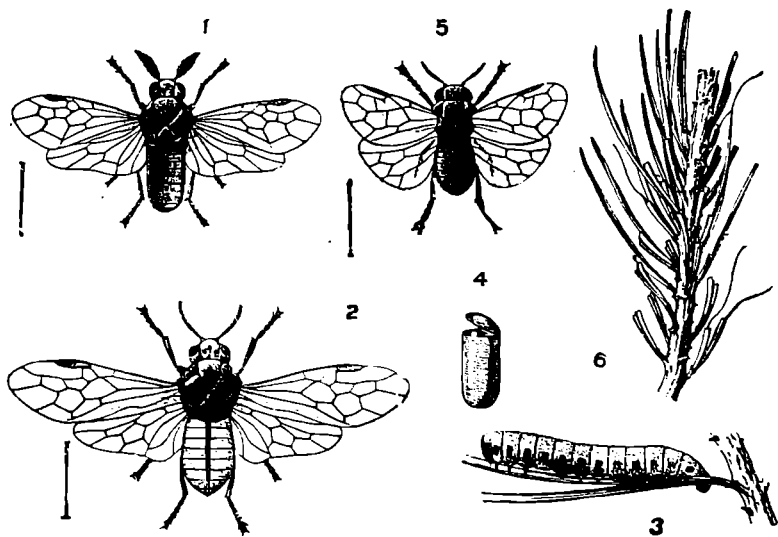


FIG. 12.

1, *Lophyrus pini*. Male ; 2, Female ; 3, Larva ; 4, Cocoon ; 5, *Lophyrus rufus* ; 6, Pine shoot attacked by Sawfly larvæ. Lines show natural size of 1, 2, and 5.

young plantations hand picking or crushing the larvæ or false-caterpillars is highly effective as a control measure.

Two species of Pine Sawfly, *Lophyrus pini* and *Lophyrus rufus* (Text Fig. 12), have been observed during the survey. Neither species, however, was observed in large numbers. The habits and life-histories of these insects have been worked out by MacDougall and are dealt with in leaflet No. 103 of the Board of Agriculture and Fisheries.

Lophyrus pini is nearly three-fifths of an inch across the wings in the male and about four-fifths in the female. The male is black, with the apex of the abdomen reddish, and with white spots on the underside of the first segment. In the female the body is dull yellow, with three dark

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areas on the thorax, and the middle of the abdomen black. The legs are yellow and the wings have dusky borders, which are, however, not so noticeable in the fore-wings of the male. The sexes can most easily be distinguished by the double comb-like antennæ of the male, those of the female being bristle-like.

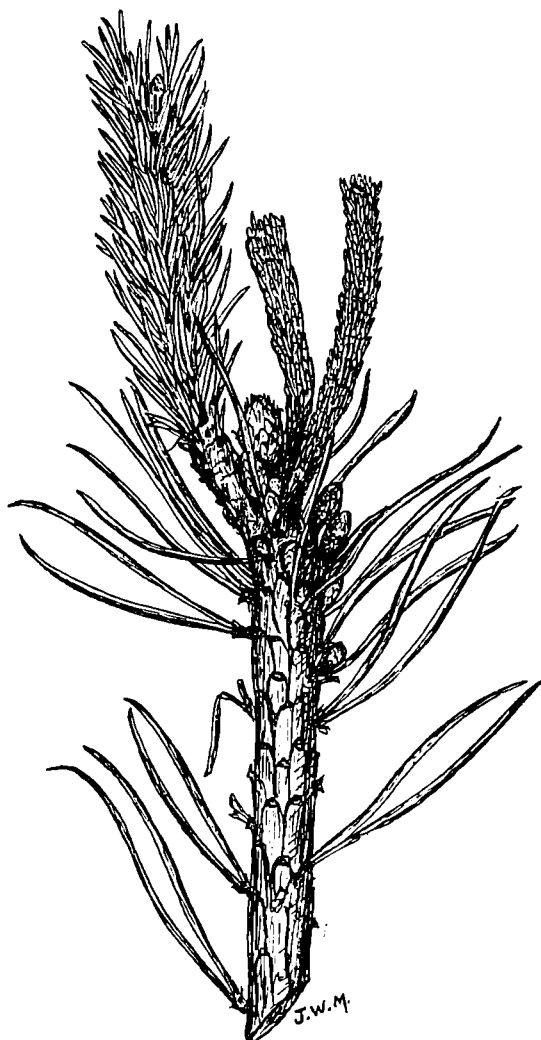


FIG. 13.—PINE SHOOT DAMAGED BY *Tortrix buoliana*.

The leading (central) bud and one lateral bud have been killed. Two side buds have developed a little and have then been killed—a third side shoot is still alive. Note the number of buds developing—a factor which ultimately produces a form of witch's broom.

Lophyrus rufus is glossy black in the male, with first abdominal ring, and the feet (except the claws) red. The female is larger, reddish-brown in colour, with black spots on the thorax and yellow to reddish-brown legs.

The larvæ or false-caterpillars of *L. pini* and *L. rufus* may be distinguished as follows:—

	<i>L. pini.</i>	<i>L. rufus.</i>
Head ...	Dark brown ...	Black.
Abdominal legs.	Yellow with a brown line at base.	Pale green.
Length when full grown.	About 1 inch	About 1 inch.

The *Lophyrus* caterpillars have twenty-two legs, three pairs of jointed thoracic legs and eight pairs of abdominal pad-like legs or sucker-feet.

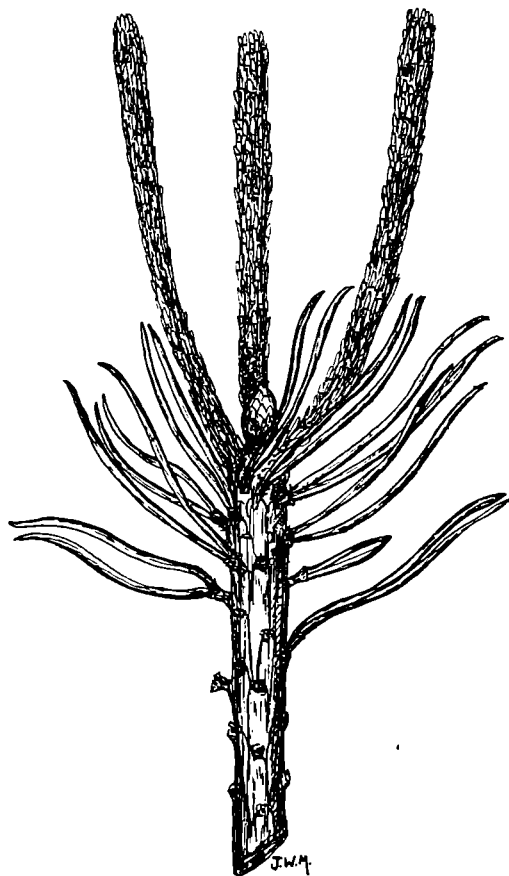


FIG. 14.—PINE SHOOT DAMAGED BY *Tortrix turionana*.

The (centre) leading bud has been killed and three side shoots are competing for leadership.

The Pine Tortrix Moths, *Tortrix (Retinia)* spp., attack Scots pine trees of five to twelve years of age in various districts. Three species are commonly destructive, attacking the buds or shoots.

They are small moths not exceeding $\frac{3}{4}$ inch in wing expanse. *T. buoliana* has yellowish-red fore-wings, with silvery transverse markings. *T. turionana* has brownish-grey forewings, with irregular blue-grey markings, and *T. resinella* has dark-brown fore-wings, with silvery-blue markings.

T. buoliana (Pine shoot Moth) is the most injurious ; its larva destroys both buds and shoots. *T. turionana* (Pine bud Moth) destroys the leading bud. *T. resinella* (Resin-gall Moth) forms a resinous gall around the shoot and causes death of the shoot or twigs above the gall by gnawing into the shoot. (See Text Figs. 13, 14, 15.) It is doubtful whether any practical measures can be devised against these moths, and it is probable that in many cases their presence is an indication of poor soil quality.

The Larch Mining Moth, *Coleophora laricella*, has been observed throughout Britain and Ireland. It caused considerable injury to young (7 year old) larch at Swinley, Surrey, and in Ghelli Plantation on Gwydyr Estate, Wales, it had completely defoliated 60-year-old larch trees.



FIG. 15.—PINE SHOOT DAMAGED BY *Tortrix resinella*.

The portion of the shoot above the resin-gall has been killed.



FIG. 16.—LARCH NEEDLES INJURED BY *Coleophora laricella* and showing "sacs" attached to the needles.

Coleophora laricella is a small moth measuring about $\frac{3}{8}$ inch in wing-expanse. Both fore and hind wings are grey in colour, with dark-grey fringes. The larva mines the larch needles and encloses itself in a sac formed of a mined needle. These cases or sacs are readily seen in spring contrasting with the bright green of the young needles, and their presence often affords the first indication of an attack. (Text Fig. 16.)

The encouragement of insectivorous birds, especially tomtits, and the removal of weakly branches in young plantations, are the best means of controlling this moth.

The Larch Shoot Moth, *Argyresthia atmoriella*, occurred frequently along with *Coleophora laricella*, and in young plantations proved more injurious than the latter.

A. atmoriella measures about one-fifth inch in length and about $\frac{3}{8}$ inch in spread of wings. Its general appearance when magnified is shown in the accompanying figure. The colour is leaden grey, the forewings having a distinct metallic gloss, while the hind wings are darker and without the gloss. (See Text Figs. 17 and 18.) For a fuller account of this moth see Leaflet No. 208 of the Board of Agriculture and Fisheries.

The Nursery Pine Chermes, *Chermes pini*, has been observed on recently-planted pines in many districts. It is probably not seriously harmful, but it certainly reduces the vitality of attacked plants at a time when they are prone to weevil and bark-beetle attacks and are

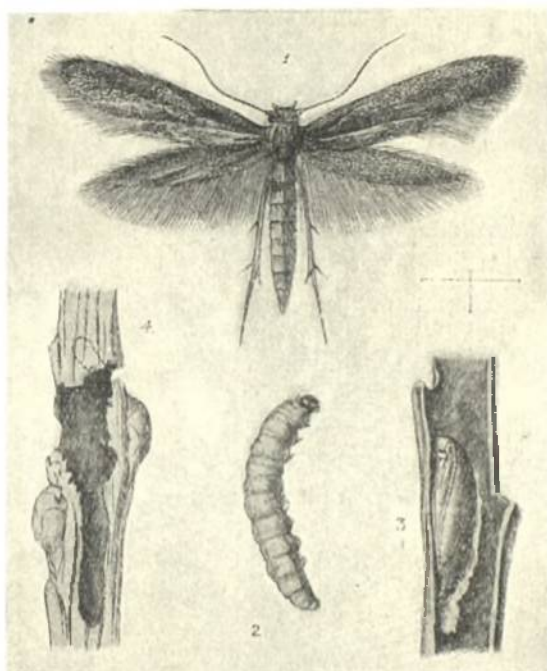


FIG. 17.—LARCH-SHOOT MOTH (*Argyresthia atmoriella*).

1. Moth (magnified). 2. Larva (much magnified). 3. Pupa. 4. Form of Burrow.

accommodating themselves to new soil conditions. The aphid should be controlled in the nursery, either by fumigating the plants with Hydrocyanic acid gas or by spraying them with some nicotine spray prior to distribution.

Two Spruce Aphids (*Chermesidae*) are widely distributed throughout Britain and Ireland, namely, the Common Spruce Gall Aphid, *Chermes abietis* Kaltb (*viridis* Rtzb) and the lesser Spruce Gall Aphid, *Chermes (Cnaphalodes) strobilobius* Kaltb. The work of these two species is readily distinguishable. The first causes the formation of a larger gall which does not usually prevent the development or growth of the shoot on which it is situated. The second causes the formation of a smaller and harder

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gall which arrests the growth of the affected shoot and is, therefore, always found at the tip of the twig.

The biology of the *Chermesidae* is complicated. Steven (1917) has worked out the life-histories of the more important British species.

The injury these insects do is two-fold. The gall-formation they cause undoubtedly reduces increment, and in some localities spruce is often badly dwarfed and even killed by the continual destruction of the

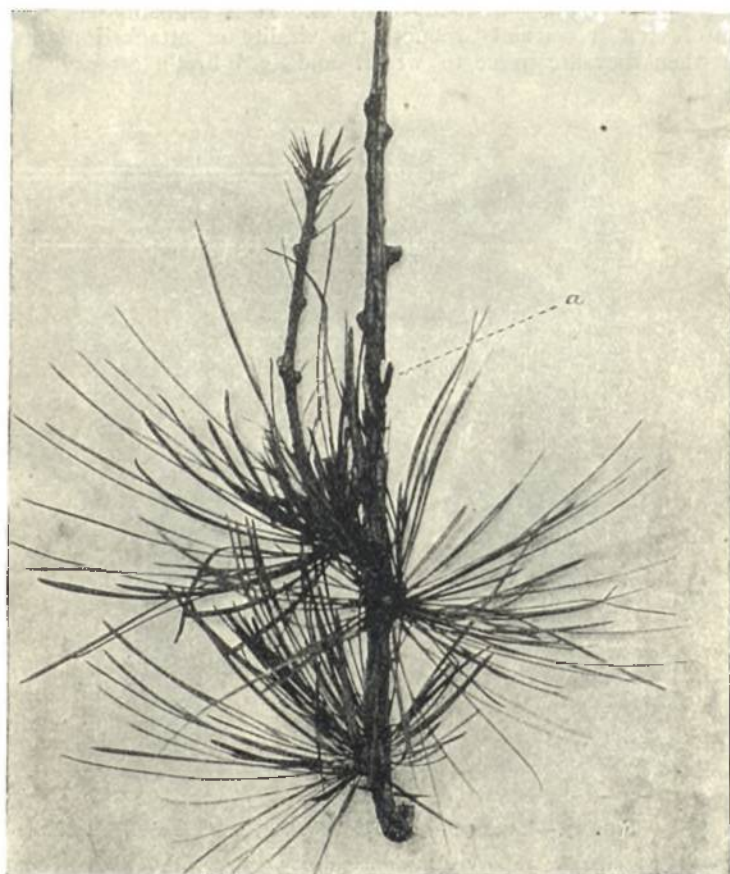


FIG. 18.—Branch of Larch attacked by Larch-Shoot Moth.

(a) Portion tunnelled by Larva.

young shoots. The Spruce Aphids, moreover, are the progenitors of the so-called Larch and Pine Aphids which cause the familiar knee-bends in the needles of larch and pine and the woolly patches on larch twigs and stems. All these injuries, small, it may be, when considered individually, are collectively of importance, and these aphids must rank as considerable pests of spruce in this country. Unfortunately satisfactory and practicable control measures against these pests have still to be devised.

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References to Literature.

- Fowler, W. W. (1895) British Coleoptera, Vol. V. London.
- Fuchs, G. (1907) ... Über die Fortpflanzungsverhältnisse der rindenbrutenden Borkenkäfer. Munich.
- Gillanders, A. T. (1912) Forest Entomology. Edinburgh.
- Hennings, C. (1908) ... Experimentell-biologische Studien an Borkenkäfern. Natw. Zeitschrift f. Forst und Landwirtschaft.
- Johnson, W. F., and Halbert, J. N. (1902) A List of the Beetles of Ireland. Proceedings Royal Irish Academy, Dublin.
- Knoche, E. (1900) Ueber Borkenkäfer Biologie u. Borkenkäfer Vertilgung. Forstw. Zentralblatt. B. XXX.
- MacDougall, R. S. (1896) The Biology of *Pissodes*. Proceedings Royal Society, Edinburgh. Vol. XXIII.
- MacDougall, R. S. (1898) Ueber Biologie u. Generation von *Pissodes notatus*. Forstl.-naturw. Zeitschrift. Heft. 5.
- Munro, J. W. (1916) Various Notes on Scolytidae. Scottish Naturalist, Edinburgh.
- Munro, J. W. (1917) The Genus *Hylastes* Er. and its importance in Forestry. Proc. Roy. Phys. Soc., Edinburgh. Vol. XX., Pt. 3.
- Nusslin, O. (1897) Über Generation und Fortpflanzung der *Pissodes*-Arten. Forstl.-naturw. Zeitschrift. Heft 6.
- Nusslin, O. (1913) Leitfaden der Forstinsektenkunde. 2nd Edn. Berlin.
- Steven, H. M. (1917) Contributions to the knowledge of the Family Chermesidae. Proc. Royal Soc., Edinburgh. Vol. XXXVII., Pt. III.

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