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BULLETIN No. 8

# BRITISH BARK-BEETLES

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BY

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LONDON

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# FOREWORD

This Bulletin deals with a group of insects which is closely connected with forestry practice. It is the outcome of several years' work and of first-hand study of the bark-beetles both in the laboratory and in the field.

Most of the literature on bark-beetles is in German and also difficult of access. The purpose of the Bulletin is to give an account of those bark-beetles which occur in British woodlands and to show their relation to forestry practice.

The Bulletin has been prepared by the Commission's Entomologist, Dr. J. W. Munro. Acknowledgments are due to Professor G. H. F. Nuttall, F.R.S., who kindly gave him access during 1918 to the Zoological Library at Cambridge, where much of the literature was consulted; to Mr. R. N. Chrystal, B.Sc. (Edin.), who assisted in arranging and building up the collections on which the Bulletin is based; and to Dr. R. Stewart MacDougall and the Royal Scottish Arboricultural Society for permission to reproduce his figure of the galleries of *Pityogenes bidentatus*, and for the blocks of Mr. D. C. Fergusson's figures of those of *Scolytus ratzeburgi*.

R. L. ROBINSON,
*Commissioner.*

Forestry Commission,
22, Grosvenor Gardens,
London, S.W.1.
August, 1926.

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# BRITISH BARK-BEETLES.

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CONTENTS.

# BRITISH BARK-BEETLES

## CHAPTER I

### GENERAL BIOLOGY.

The bark-beetles (*Scolytidae*) are small insects ranging in the British species from $\frac{1}{16}$th to $\frac{5}{16}$th inches in length. They belong to the group *Rhynchophora*, or snouted beetles, and are closely allied to the weevils (Curculionidae), from which they differ in structure, chiefly in possessing a short, or even an indistinct, snout or rostrum. Biologically they differ from the weevils in that they enter their host-plants in order to lay their eggs, while the weevils with very few exceptions do not enter their host plants, but lay their eggs in the tissues by boring holes with the snout from outside. This is well seen if the mode of egg-laying of the pine weevil, *Pissodes pini*, is compared with that of the ash bark-beetle, *Hylesinus fraxini* (Plate VI, Figs. *a* and *b*).

Like all other beetles, the bark-beetles pass through four stages in completing their life-cycle—the egg, the larval, the pupal and the adult stages.

As is the case with most insects which lay their eggs in the tissues of plants or in other protected situations, bark-beetle eggs show no particular coloration or sculpture. They are mostly of small size, oval in shape and glistening white in colour. In *Cryphalus*, according to Swaine (1918),* the egg is almost as large as the beetle itself, but this is exceptional, at least in our species.

The larvae of the bark-beetles resemble those of the weevils but are less stout and as a rule less hairy (Fig. 1). They are curved, wrinkled, fleshy, legless grubs with brown head and strong jaws. In the majority of cases they live in their own

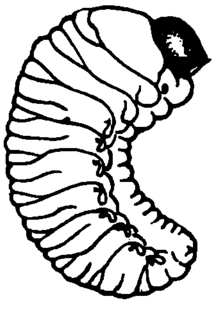

FIG. 1.

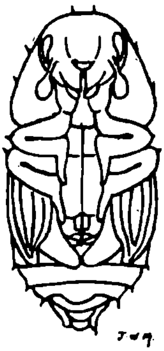

FIG. 2.

FIG. 1. Larva of *Scolytus destructor*.
FIG. 2. Pupa of *Scolytus destructor*.

tunnels or galleries, but in the case of some of the wood-boring species, the so-called "Ambrosia" beetles, the larvae live, for a time

* Dates given after authors' names indicate the papers listed in the Appendix.

at least, free and in communities in the main tunnel (e.g., *Platypus* and *Xyleborus*). These larvae are less curved than those of the bark-dwelling species, and in *Platypus* the body ends abruptly as if truncate and the first segment of the thorax is hump-backed and armed with locomotory spines.

Leisewitz (1906) has classified some of the bark-beetle larvae according to the varying nature of the hairs and spines they bear, and Hopkins (1909) has discussed the characters of the bark-beetle larvae generally and described those of the genus *Dendroctonus*. Swaine (1918) emphasises the need for a study of the larval characters in all genera and species.

The bark-beetle pupa is free and naked, white in colour, becoming yellowish in the later stages (Fig. 2). The body is covered with various hairs and spines, and in many species the abdomen bears a pair of prominent spines or processes on the last segment.

The adult beetles on emerging from the pupal state are pale in colour but darken on maturity. An important feature in the development of the adults of many species is that the reproductive organs are immature for some time after the beetles have assumed their adult form and colour.

*The two groups of bark-beetles.*—British bark-beetles may be divided into two biological groups, the bark-beetles proper and the wood-borers or Ambrosia beetles. The first group is the more important and the better represented in Britain and indeed in temperate regions generally. The second group includes only a few British species some of which are considered rare, probably because their more concealed mode of life renders them less easy of detection.

The bark-beetles proper deposit their eggs in tunnels made in the bark and cambium in which the larvae feed, entering the wood only for pupation and in some cases not even then. The wood-boring, or Ambrosia beetles, lay their eggs in tunnels cut within the wood and their larvae live in these tunnels, feeding on fungi growing on the walls. These fungi were first mentioned by Schmidberger in 1836, when he referred to them as "a kind of ambrosia," and the term Ambrosia beetles has been used by entomologists to designate the group.

## The Bark-beetles Proper.

In the true bark-beetles the eggs are laid in a tunnel excavated in the bark and cambium by the female and known as the egg- or mother-tunnel. In this tunnel the eggs may be laid in clusters (e.g., *Ips laricis* and *Dryocaetes autographus*), but more commonly they are laid in egg-niches cut in the walls of the tunnels. In addition to the egg- or mother-gallery other galleries and excavations are found: the entrance tunnel leading from the mother-gallery to the outside, variously shaped chambers excavated by the male and presumed to be pairing chambers, although this has not been proved in all cases, and short tunnels leading from the mother-gallery to the outside which are believed to serve as ventilating tunnels.

*The entrance tunnel.*—The entrance tunnel is usually very short and where the bark is thin, as in ash, may consist merely of a circular entrance hole. Such holes are usually inconspicuous, especially when they are situated in a bark crevice, but may be detected by the bore meal or dust which lies in their vicinity and which has been pushed through them.

In the case of bark-beetles which bore in living or very fresh stems and branches, the entrance hole may be surrounded by a resin or gum tube according as the tree is a conifer or a broad-leaved species ; gum tubes are, however, found only on fruit trees in this country.

The boring dust varies in appearance and composition and may sometimes indicate the species of bark-beetle concerned. In *Myelophilus piniperda*, for example, the dust is composed of white and brown fragments, as the beetle in boring cuts both bark and cambium ; in the *Hylastes* beetles it is, as a rule, entirely brown in colour. In *Dryocaetes villosus*, which bores in the thick bark of oak and chestnut, the dust is brown and very fine. The dust appears to be thrown out by the male, and in some species the male not infrequently blocks the entrance hole with his body—perhaps, as Swaine suggests, with a view to excluding predaceous and parasitic enemies and preventing undue evaporation from the egg-tunnel. How far the beetle is successful in attaining these objects is uncertain.

*The pairing chamber.*—The pairing chamber consists of a widening or extension of the egg-tunnel, and is usually found just within the entrance hole. In the polygamous species like *Ips* and *Pityogenes*, it is usually large and well defined and from it the various egg-tunnels radiate (Plate X, Figs. 1 and 2). In the monogamous species it is most evident in *Hylastes* and *Hylurgops*, where it forms with the entrance tunnel a crutch-shaped excavation at the base of the egg-tunnel (Plate VII, Fig. 5).

In those beetles which cut two-armed transverse egg-tunnels, e.g., *Hylesinus* and *Hylastinus*, the pairing chamber lies at the junction of the two arms. In the *Scolytus* species the pairing chamber is often absent owing, perhaps, to the beetles pairing outside the tunnels. In *Scolytus ratzeburgi* pairing takes place at the ventilating holes.

*Ventilating holes.*—Ventilating holes opening from the roof of the egg-tunnel to the outside occur in the tunnels of *Scolytus ratzeburgi* and *Ips sexdentatus*, both of which species cut long egg-tunnels. Such holes may also be present in abnormally long egg-tunnels of *Myelophilus piniperda*.

*Egg-niches.*—Egg-niches cut in the side walls of the egg-tunnels occur in nearly all the Hylesinid beetles. They are present in a few of the Ipid beetles, e.g., *Pityogenes*, *Pityophthorus* and *Ips*, but are absent in *Taphrorhychus*, *Dryocaetes autographus*, *Ips laricis*, *Xylocleptes bispinus* and the *Cryphalus* group.

*Egg-tunnels.*—The form and direction of the egg-tunnels vary considerably. Nearly every species forms a distinctive egg-tunnel which, together with the pairing chamber and entrance tunnel, forms a pattern on the bark or sapwood which is characteristic of the species and from which the identity of the species can often be determined without further information. The most striking contrast between the galleries of two closely allied species occurs in those of *Myelophilus piniperda* and *Myelophilus minor*. The two beetles closely resemble one another in shape, size and colouring, and to the novice appear identical. *M. piniperda*, however, makes a simple longitudinal egg-tunnel, while *M. minor* makes a two-armed transverse one (Plate IX, Figs. 1 and 5). A similar contrast is afforded in the *Scolytus* species. *S. intricatus* makes a short transverse tunnel, while all our other species make longitudinal egg-tunnels.

The breadth of the egg-tunnels naturally varies with the size of the beetle, but the length may vary in one and the same species. In *Pityogenes bidentatus* and *Ips acuminatus*, the first of which is normally smaller but which may approach the latter in size (*i.e.* large *Pityogenes* occurring with small *Ips*), the distance between the egg-niches serves to distinguish their tunnels. In *Pityogenes* the egg-niches are grouped near one another with occasional intervening gaps; in *Ips acuminatus* the egg-niches are far apart (about half an inch) and occur at regular intervals throughout the length of the tunnel (compare Figs. 1 and 2, Plate X). In the *Cryphalus* beetles the egg-tunnel consists of an irregular chamber usually surrounding the base of a twig. In *Ips laricis*, which is peculiar among our *Ips* beetles in being monogamous, the egg-tunnel consists of two loop-shaped chambers connected by a common passage with the pairing chamber and entrance hole. The majority of our bark-beetles cut their egg-tunnels in the stems and branches of trees and shrubs, but the *Hylastes* beetles are root breeders.

*Larval tunnels.*—As a rule the larval tunnels radiate outwards from the egg-tunnels, increasing in width as they extend according to the rate of growth of the larvae and ending in the pupal groove or chamber.

In *Scolytus destructor*, the large, elm bark-beetle, the larval galleries are very regular. In *Myelophilus* and *Hylurgops* they may be confused, crossing and recrossing one another. The larval mines vary considerably in length, being very long in *Scolytus intricatus* and *Hylesinus oleiperda*, and very short in *Hylesinus fraxini*, *Myelophilus minor* and *Ips sexdentatus*. In *Pityophthorus*, which occurs in pine twigs, the larval tunnels may enter the pith, and in *Xylocleptes*, which lives on clematis, the larvae occasionally enter the pith prior to pupation.

*The pupal chambers.*—The pupal chambers are situated at the end of the larval mines. They may occur as simple hollows gnawed in the bark or sapwood, *e.g.*, *Myelophilus piniperda* and *Hylurgops palliatus*, or may consist of short curved tunnels cut in the sapwood as in *Myelophilus minor* and *Hylesinus fraxini*. In some species, e.g., *Scolytus destructor*, all three types may be found, some cut in the bark, some mere hollows in the sapwood, others curved tunnels within the sapwood.

*The brood galleries.*—The brood galleries comprise the whole complex of pairing chamber, egg-tunnel, larval mines and pupal chambers, and the pattern produced by them is frequently of great value in determining the identity of the beetle. All the component parts of the brood galleries build up this pattern and even portions of the galleries may serve to indicate identity. Where, however. the galleries are numerous and crowded ; where the breeding material is too dry or too wet ; and where, as on Scots pine, several species occur together, care must be exercised in deciding which beetles have been at work. Too dry or too wet material affects the cutting of the egg-tunnel, which may then be irregular, and in *Pityogenes bidentatus* and *P. quadridens*, for example, the larval galleries are longer on thick branches than on thin, and on dry branches than on moist ones.

A frequent cause of difficulty in identifying bark-beetle galleries is the presence of irregular tunnels which do not appear to conform to any particular type. These are usually " feeding tunnels " cut by the female beetles either prior to egg-laying or after egg-laying has ceased. In the first case they are usually simple tunnels, but in the latter they may resemble true egg-tunnels and may show definite egg-niches. Such false egg-tunnels appear to be the work of beetles with exhausted ovaries.

The various types or patterns of brood galleries produced by our bark-beetles may be classed in four main groups ; longitudinal tunnels running parallel to the axis of the stem or branch and which are simple (except in *Phloeosinus*, in which they are two-armed) ; transverse tunnels, two-armed, except in *Scolytus intricatus* and occasionally in *Hylastinus obscurus* ; stellate or radiating tunnels occurring in the polygamous species and tunnels forming no regular pattern, as in *Cryphalus abietis* and *Ernoporus fagi*.

*Feeding tunnels.*—Feeding tunnels are cut by the " perfect " but still immature bark-beetles or by females proceeding to a second egg-laying. The feeding tunnels of *Myelophilus* in pine shoots and of *Hylastes* at the base of young plants are familiar to most foresters. The feeding habits of other species are, however, less known, and it is only within recent years that Wichmann, Spessivsteff, Fisher and others have called attention to the feeding habits of the *Scolytus* species. The feeding tunnels of the common ash bark-beetle, which produce rosette-like galls on the bark of ash saplings, have long been a familiar figure in the German text-books. In all these cases the feeding tunnels occur away from the brood galleries, but in many species the adult beetles emerge and feed in the immediate vicinity of their birthplace as in *Hylurgops*, or commence feeding without leaving the pupal cradle. In the latter case the feeding tunnels are continuous with the larval mines as in *Ips acuminatus*, *Phloeophthorus* and *Phloeosinus*.

The feeding tunnels are more or less peculiar for each species. In *Scolytus destructor* and *S. multistriatus* they consist of short tunnels cut in the axils of the small branches of elms. In *Hylesinus fraxini* and *H. oleiperda* they are very short tunnels cut in the bark below the small branches of ash. *Hylastinus obscurus*, which breeds in broom and gorse, or whin, cuts its feeding tunnels in clover, causing, according to Swaine, considerable injuries to the crop. The feeding habits of the bark-beetles are of considerable importance and it is interesting to notice that in this respect many beetles are directly and primarily injurious, feeding on healthy vigorous trees, e.g., *Myelophilus*, *Scolytus* and *Hylastes* species.

## The Ambrosia Beetles.

The galleries of the Ambrosia beetles have been described by Hubbard (1897). In our species two types of tunnels occur, those in which all stages of the beetles occur together throughout the life history, e.g., *Anisandrus* and *Xyleborus*, and those in which the larvae when partly grown gnaw pupal niches or "cradles" in the roof and floor of the main tunnel and pupate in them, e.g., *Trypodendron* and *Platypus*.

In *Xyleborus saxeseni*, the eggs, larvae, pupae and adults occur together in a common chamber and Hubbard states that part of this chamber may be partitioned off by boring dust to serve as a sepulchre for dead larvae, pupae and adults, the presence of which in the main chamber might affect the growth of the host fungus. In the Ambrosia beetles the walls of the tunnels are blackened by the fungus in the later stages.

Strohmeyer (1906) has contrasted the entrance holes of the various European Ambrosia beetles and pointed out differences in the pupal cradles of *Trypodendron* and *Platypus*, and has described the characters of the boring dust which in *Platypus* is peculiar, consisting of fibrous fragments markedly contrasting with the finer dust of *Trypodendron* and *Xyleborus*.

## Life-history.

*Bark-beetles proper.*—In the true bark-borers the general life-histories of the various species are somewhat similar. The female commences the egg-tunnels and is shortly joined by the male, which, in some species at least, excavates the pairing chamber and assists in removing the boring dust. In *Hylastes*, for example, which has been studied in detail by the writer, the female bores the egg-tunnel for a length of half an inch to an inch and then retreats to cut the egg-niches and deposit the eggs. This done, she resumes the cutting of the egg-tunnel for a space, retiring again for oviposition and continuing in this way until the tunnel is complete. Pairing may be repeated during the excavation of the egg-tunnel, and in the polygamous species frequent pairing appears to be normal. In *Scolytus destructor* pairing usually takes place outside the egg-tunnel.

The duration of the various stages in the life-cycle and of the life-cycle period itself is variable. Thus summer and winter broods are common. In the first case their development is rapid, in the second, slow. This question of the rate of evolution of the life-cycle and of the number of broods and of generations produced in a calendar year has for long occupied the attention of entomologists and foresters. Henning's (1907) researches have, however, thrown light on the subject. Working with *Ips typographus* he showed that the period of development in all stages was directly affected by temperature and humidity and that the optimum conditions for bark-beetle development were moderately high temperature (up to 24° C.) and high humidity (upwards of 50 per cent.). Where the humidity was constant, lower temperatures retarded development, and vice versa. Where the temperature was constant, lower humidity also retarded development. With high temperature and low humidity heat paralysis took place. Henning's conclusions are well borne out by experience in the field.

The biology of British species under our peculiar forest and climatic conditions is not sufficiently known in detail, and there is need for work in this direction. .It is evident that in the south the number of broods in a year in any given species is higher than in the northern and colder districts. Thus, in Surrey in 1922, *Hylastes ater* was found cutting its egg-tunnels and laying eggs in February, while in Forfarshire it did not appear till April when the first eggs were found.

The terms brood and generation are sometimes confused by writers on bark-beetle biology. Thus, two broods which bear the relation to one another of brothers and sisters are sometimes spoken of as generations—a term which, for the sake of clearness, ought to be applied only to broods which bear the relation of parents and children.

*Ambrosia beetles.*—The biology of the Ambrosia beetles has not been studied in this country. On the Continent, Strohmeyer (*loc. cit.*) has worked out the life-history of *Platypus cylindrus*, and Neger (1908*a*, 1908*b*) and Schneider Orelli (1913) have contributed to our knowledge of the biology of *Trypodendron*, *Anisandrus* and *Xyleborus*. The true nature of the Ambrosia fungi is apparently still obscure, but Schneider Orelli has shown that in *Anisandrus dispar* at least it is conveyed by the beetles themselves to new breeding ground and that infection of the new galleries takes place by the passing of the fungus through the mouth of the beetles and not, as had been considered, through the excrement. This observation suggests that the relation between the beetles and the fungus is a true symbiosis. The question is evidently a complicated one, and is made more difficult by the presence in the beetles' tunnels of other fungi than the true Ambrosia, such as wood-infesting fungi of the genus

*Ceratostomella,* which are familiar to foresters as the cause of " blueing " in pine and other timber.

## Host Plants.

The range of host plants inhabited by our bark-beetles is considerable, but with the exception of *Xyleborus saxeseni* none of our species appears to attack both conifers and hardwoods. Thus, *Trypodendron lineatum* confines itself to conifers, *T. domesticum* to hardwoods. The *Hylesinus* beetles attack ash. The *Hylastes* beetles breed in Scots pine, except *H. cunicularius,* which breeds in spruce. *Hylurgops* breeds in Scots pine and spruce indifferently. *Myelophilus piniperda* prefers Scots pine, but will breed in spruce and larch in the absence of pine. Several species are restricted in their host plants ; thus, *Xylocleptes* breeds solely in clematis and *Cissophagus* solely in ivy.

Some of our bark-beetles may breed in one species of tree and feed in others, or in other parts of the same tree. Thus, *Myelophilus* breeds on the stems of Scots pine and feeds in the young shoots, *Hylastes cunicularius* breeds in spruce stumps and roots but feeds on the roots of various young conifers (*e.g.*, Douglas fir, larch, Scots pine), and *Hylastinus obscurus* breeds in broom and whin or gorse, and feeds in clover.

The hosts of all our species are given in the descriptions which follow, but it should be remarked that the condition of the host trees bears a definite relation to the various species they support, and that certain beetles attack them only under certain conditions which are not yet fully understood. Thus the Scots pine in Britain probably supports more kinds of bark-beetles than any other tree, but not all of these beetles attack it at the same time. The writer (1916) has indicated the succession of attack by bark-beetles as they occur on Scots pine in the north-east of Scotland, and Trägårdh (1921*a* and 1925) has dealt with the question in Sweden.

A list of the bark-beetles classified according to their hosts is given in the Appendix.

## Distribution.

The detailed distribution of all our bark-beetles is by no means fully known. Such species as *Ernoporus fagi* and *Trypophloerus binodulus* which attack dying or dead branches and twigs and show little sign of their presence are easily overlooked and it is almost certain that their distribution is wider than existing records show.

Some ten years ago *Cryphalus abietis* was considered very rare in Scotland, but it is doubtful if there is a single county where Silver fir is common in which it does not occur and knowledge of its distribution has been greatly extended in recent years solely because its habits were made known and naturalists learned where to look for it. As with many of our insects, we owe our knowledge of the bark-beetle fauna almost entirely to the amateur entomologist, and his methods of collecting do not always give information regarding the breeding habits of his "captures." Once these habits are better known it is certain that knowledge of the distribution of our bark-beetles will rapidly be extended.

As regards the distribution of our Scolytids, Britain may be divided into two main regions, a southern and a northern. No sharp division can be drawn between these regions, but it lies approximately along a line running west from the Humber to the Mersey and corresponding roughly with latitude 54°. South of that line the members of the genus *Scolytus*, except *S. ratzeburgi*, are common, becoming rarer further north until, in Scotland, they are altogether absent. So too *Hylastes opacus* becomes rare north of this line and *Ips laricis* is replaced by *Ips acuminatus*. The southern region is richer in species than the northern, especially in species dwelling in hardwoods and in beetles of the Ambrosia group, which in Scotland is represented solely by the genus *Trypodendron*. On the other hand *Myelophilus minor, Scolytus ratzeburgi, Pityogenes quadridens* and *P. chalcographus** are so far as is known at present confined to Scotland.

The distribution of *Myelophilus minor* is especially interesting. Fowler (1891) records it as "very rare, Dee district, Braemar"; but states that it may be overlooked by collectors owing to its close resemblance to *M. piniperda*. It is now known to occur in several districts in Scotland (Munro, 1920) and its distribution indicates that it is found only in the neighbourhood of our older forests. It occurs at Dunkeld and Murthly in Perthshire, a district which harbours quite a number of interesting insects associated with extensive and old forest lands. Thus, at Dunkeld the Serricorn beetle *Hylecoetus dermestoides* is common and the bark-beetle *Pityogenes chalcographus* occurs there and nowhere else in Britain, at least as an established and breeding species. Another locality where *M. minor* is found is Montreathmont Muir in For farshire, and this district is also an old forest site. The Braemar locality given by Fowler is itself the site of Ballochbuie forest, believed to be a remnant of the great Caledonian forest, and it is interesting to note that *M. minor* extends down Deeside to Banchory and is especially abundant in the neighbourhood of Aboyne and Glentanar. It also occurs near Kildrummy, in Donside and in Ross-shire.

The distribution of *Pityogenes quadridens* appears to be similar to that of *M. minor* except that it also occurs in Rothiemurchus and other parts of Morayshire and in Peebles-shire.

Sharp (*Cambridge Natural History*, Vol. VI), remarking on the rarity of the Serricorn beetles *Hylecoetus* and *Lymexylon*, ascribes it to the destruction of our forests, and the occurrence and distribution of *M. minor* suggests that this species too is becoming

* *P. chalcographus* is occasionally found in England on imported timber.

extinct through the same cause, although it is highly probable that with extending afforestation it will again extend its range. *Scolytus ratzeburgi* until quite recently had been found only at Rannoch in Perthshire, but in 1923 was recorded from Stobs near Hawick (Fergusson, 1924), and in 1924, from Auchterawe, near Fort Augustus, Inverness.

Naturally the distribution of insects with such a limited range of food plants as our Scolytids have, is governed by the distribution of the food plant and this is well seen in *Xylocleptes bispinus* which lives on *Clematis vitalba.* Clematis is a chalk-loving plant and *Xylocleptes* is almost confined in its occurrence to chalky districts. It is especially abundant on the Surrey Downs in the neighbourhood of Boxhill and Reigate and, eastwards, to Dartford.

In Ireland the bark-beetle fauna is a very limited one as far as published records show. Johnson and Halbert (1902) give a list of the species, but it is incomplete and will probably be considerably extended. One feature of the fauna, however, is noteworthy, in that the genus *Ips* is entirely absent, and Johnson and Halbert ascribe this to the destruction of the pine forests and suggest that such pine weevils and pine-dwelling bark-beetles as do occur have been reintroduced into Ireland from Britain.

The occurrence and distribution of our bark-beetles is of interest to the forester as well as to the naturalist. In the past we seem to have been witnessing the gradual decline of our Scolytid fauna; in the future, with the advance of afforestation, we may see an increase in that fauna, and a knowledge of the present distribution and mode of increase of our forest insects cannot fail to be of practical value.

## Comparison of the British and Continental Bark-beetle Faunas

Compared with that of Central Europe the British bark-beetle fauna is a comparatively poor one. Several genera which are common on the Continent are not represented in Britain, e.g. *Dendroctonus, Phthorophloeus, Crypturgus, Pityokteines, Xylechinus* and *Polygraphus.* The last two genera are mentioned in the British literature, but the authenticity of the records of their occurrence has been questioned, and as these records refer only to solitary individuals in each case it is permissible to ignore them.*

In several of our genera, and particularly in the genus *Ips*, the number of species represented in Britain is small. Thus we are fortunate in the absence of *Ips typographus*, a spruce-dwelling species which is probably the most injurious bark-beetle in the Central European forests. On the other hand, our fauna is being increased by the introduction of various species in the bark of pit timber and even, it seems, on living plants. The recent discoveries of *Ips sexdentatus* and *Ips erosus*

* This opinion had the support of the late Canon Fowler.

in the west of England, at Cardiff and in the Forest of Dean, of *Hylastes attenuatus* at Bournemouth and, more recently, in the New Forest, and of *Phloeosinus thujae* at Kew, serve to show that our fauna is increasing. Many species are doubtless introduced which fail to establish themselves. Thus *Myelophilus minor* was frequently to be found in pit timber at Bo'ness, on the Firth of Forth, prior to the war, but never succeeded in establishing itself in that district, although it may be regarded as indigenous in Aberdeenshire, Perthshire and other counties of Scotland. The same is true of *Pityogenes chalcographus*.

While such instances of the failure of some species to maintain a hold is encouraging from the forestry standpoint, it is important to bear in mind that our forest areas are extending, and that their extension will more and more render it possible for introduced forest insects to obtain footing and ultimately to establish themselves. Such a locality as the Forest of Dean, where pit timber is brought from abroad to the mines situated in the heart of the forest, affords many opportunities for introduced forest insects, and already two of these have been referred to as bidding fair to become established.

The relative poverty of our bark-beetle fauna as compared with other European countries cannot readily be explained. Our insular position, the poverty of our indigenous tree flora and the scattered nature of our forests, are all contributing factors, but there may be others less apparent and as yet our knowledge of them is scanty. The very limited Irish bark-beetle fauna has already been mentioned.

In Britain we possess, so far as is known, no bark-beetle species peculiar to this country. A variety of *Pityophthorus lichtensteinii* described by Sharp as " variety *Scoticus* " has been cited by Russell Wallace (*Island Life*, 2nd Edn., p. 353) as an example of a bark-beetle peculiar to our fauna and presumably a variety produced by isolation. Fowler (1891), however, questions the propriety of Sharp's " variety *Scoticus*," which he considers is not sufficiently distinct to justify its separation from the type species.

It is probable that our knowledge of our bark-beetle fauna is still incomplete and that it may yet be considerably extended.* In the list of genera and species which is given in the latter part of this Bulletin, only those are regarded as British which have been found as " breeding " species and which may therefore be regarded as established. The species *Hypothenemus eruditus* Westw. is an exception; it is frequently introduced into this country and may occur as an established species in stores and warehouses, but it is scarcely to be regarded as a typical member of our fauna and is not dealt with in the keys and descriptions here given.

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* Since this was written Mr. St. J. K. Donisthorpe has discovered *Taphrorhychus villifrons* Duft. at Ruislip, Bucks (*Entomologist's Record*, 1924).

## Natural Enemies.

The chief natural enemies of the bark-beetles are predaceous and parasitic insects (belonging mainly to the Orders Coleoptera and Hymenoptera), birds, chiefly woodpeckers and tits, and entomophilous fungi.

Kleine (1908) has catalogued various beetles and parasitic Hymenoptera found in bark-beetle galleries, but it is uncertain whether all the beetles recorded are bark-beetle enemies in the strict sense. Many of them, like some of the *Epurea* beetles, are attracted by tree sap and are associated with other insects boring in trees, such as the Goat Moth and Willow Weevil (*Cryptorhynchus*), or may occur on felled trees quite independently of bark-beetles or other wood-borers.

The best-known coleopterous enemies of the bark-beetles belong to the families Cleridae and Nitidulidae. The Cleridae are represented in Britain by two species, the Ant beetle, *Clerus* (*Thanasimus*) *formicarius* L. and the rarer *Clerus rufipes* Brahms. The Ant beetle is an active, conspicuous insect more like an ant than a beetle in general appearance. It measures about half an inch in length. The head and legs are black. The thorax is reddish brown, with the anterior third black, broadest in front and constricted at the base, where it meets the wing-covers. It is this constriction combined with the colouring which gives the beetle its ant-like appearance. The basal part of the wing-covers is reddish brown, the remaining three-fourths being black, with two transverse white bands. The first of these bands is narrow, the second broad (Plate V, Fig. 3).

The larva of *C. formicarius* was first described and figured by Perris (1877), and has been figured in greater detail by Hopkins (1899). It varies considerably in colour from pale pink to rosy red. The head and first segment of the thorax are brownish black, and the last segment of the abdomen bears a chitinous plate ending in two short blunt processes which curve upwards. Both the adult and larva of *C. formicarius* are predaceous. They appear to be confined to coniferous woods. They attack longicorn beetles (e.g. *Rhagium*) as well as bark-beetles.

*Clerus rufipes*, the Red-legged Ant beetle, has been recognised as British only recently. It was discovered by Prof. Hudson Beare at Nethy Bridge in 1910. According to Saalas (1917), its habits are similar to those of *C. formicarius*. Its larva is paler in colour, and the processes on the oval plate are set more closely together.

The beetles of the family Nitidulidae which occur in the bark-beetle galleries are comprised in the four genera *Rhizophagus*, *Pityophagus*, *Glischrochilus* and *Epuraea*.

Four species of *Rhizophagus* are common, namely, *R. ferrugineus* Payk., *R. depressus* F., *R. dispar* Gyll., and *R. bipustulatus* F. They occur both in broad-leaved and coniferous woods. The four species resemble one another fairly closely, differing somewhat in colour, which varies from reddish brown to black, and in certain structural details. They range in size from one-eighth to one-quarter of an inch. The body is elongate and depressed, or flattened, and the wing-covers and thorax are shining (Plate V, Fig. 4). The larvae of *Rhizophagus depressus* and *R. dispar* have been described by Perris (*loc. cit.*), and those of *R. ferrugineus* and *R. grandis* by Saalas (*loc. cit.*). The *Rhizophagus* beetles are formidable enemies of various bark-beetles, destroying them in all their stages. The larvae of *Rhizophagus* are also predaceous. The writer records that in one of his experiments all the eggs in a *Hylastes* egg-tunnel were destroyed by the larvae of *R. dispar*.

The genus *Pityophagus* is represented by the single species *P. ferrugineus* F. In general appearance it resembles the *Rhizophagus* beetles, differing from them, however, in being larger and in certain structural characters of which the three-jointed antennal club is the most obvious. In *Rhizophagus* the antennal club is solid. *P. ferrugineus* (Plate V, Fig. 1) is less common than the *Rhizophagus* species and seems to prefer felled logs and roots to standing stems. It is frequently attracted to the galleries of the root-feeding *Hylastes* beetles. The larva of *P. ferrugineus* has been described by Perris, and more recently by Saalas.

The genus *Glischrochilus* contains two species which are not uncommon in bark-beetle galleries, namely, *G. quadripunctata* Herbst. which is the common English species, and *G. quadripustulata* L., which occurs most commonly in Scotland. The two species resemble one another in general appearance, being black in colour with four yellow spots on the wing-covers, but *G. quadripunctata* is oval in shape and *G. quadripustulata* (Plate V, Fig. 2) is elongate.

The genus *Epuraea* includes several species which occur under bark and in bark-beetle galleries. *E. angustula* Er. occurs in the tunnels of *Trypodendron lineatum* and *T. domesticum*, but it is doubtful whether any of the *Epuraea* species are insectivorous.

Besides the Clerid and Nitidulid beetles several other beetles belonging to various families occur in association with the bark-beetles living in their tunnel. These are listed in Kleine's paper already cited.

The Hymenopterous enemies of the bark-beetles belong chiefly to the families Ichneumonidae, Braconidae and Chalcididae. Kleine (*loc. cit.*) has enumerated those referred to in the Continental literature, but in Britain these parasites have been little studied, largely owing to the difficulty incurred in rearing them and to the difficulty their identification presents to the non-specialist. Hubault (1923) describes certain parasites observed during a bark-beetle outbreak in the Vosges, and gives notes on the biology of Chalcididae parasitic on various species of *Ips*, on *Myelophilus piniperda* and on *Hylurgops*. The most frequent parasites of these beetles were *Pteromalus spinulae* and *Roptrocerus xylophagorum*, species first described by Ratzeburg in his *Ichneumonen der Forstinsekten* (1844).

Escherich (*Die angewandte Entomologie in den Vereinigten Staaten*, p. 96) considers the natural enemies of the bark-beetles to be of little economic importance. Discussing Hopkins' attempt to control the bark-beetle *Dendroctonus frontalis* in Western Virginia by introducing *Thanasimus formicarius* from Europe, he states that bark-beetle outbreaks are due to quite other factors than lack of natural enemies and especially to the presence of abundant breeding material. Swaine (1918) also considers the insect enemies of the bark-beetles of minor importance as controlling factors.

Little is known concerning those birds which feed on the bark-beetles. Observations show that all our three native woodpeckers seek out the tunnels of the beetles, feeding on the larvæ and the adults. Tits (Paridae) are also frequently to be seen attacking the bark of branches containing bark-beetle grubs, but definite examination of the crop and stomach contents of these birds for bark-beetle remains has not been made in Britain. What other birds, such as the tree-creeper, wryneck and nuthatch, which haunt trees and woods in search of insects, live to any marked extent on bark-beetles is not known.*

The entomophilous fungi attacking bark-beetles have not been studied systematically. The fungus *Bouveria densa* Link and Picard., is sometimes an important check on the *Hylastes* beetles. Infected beetles show a white fluffy " ruff," or collar, around the junctions of the head and thorax, and thorax and abdomen.

# CHAPTER II

## IMPORTANCE IN FORESTRY

### General

The effects of bark-beetle outbreaks are well known, particularly to those who are acquainted with European and American forestry. In Canada and the United States the losses due to bark-beetle attacks have been enormous, and even in Europe serious losses have occurred. In Britain, while steady losses are incurred, we have had no extensive outbreaks, and our immunity from them is probably due to the limited extent of our forests. That considerable losses may occur was abundantly proved in recent years when, as a result of the extensive felling of timber for war purposes, considerable areas of pine in the New Forest and elsewhere were threatened by the Pine-shoot beetle, *Myelophilus piniperda*. (Forestry Commission, Bulletin No. 2.)

* Vietinghoff von Riesch (*Zeit. f. angew. Entomologie*, Bd. X, Heft 2, 1924), gives an analysis of the stomach contents of several birds which feed on bark-beetles. None of these birds are strictly bark-beetle feeders, but he shows that the common wren, the tree-creeper and the chaffinch may destroy considerable numbers of these insects.

It is interesting to note that the most important bark-beetles in temperate regions are those which attack conifers, and that almost all the losses incurred through bark-beetle outbreaks have occurred in coniferous forest. This is partly due to the predominance of coniferous forest over broad-leaved forest in temperate countries, but it is also due to the greater resistance which broad-leaved trees offer to bark-beetle attacks. Such trees as oak and elm retain their vitality long after they have been defoliated by caterpillars (*e.g.* Oak tortrix and Winter moths) or even felled; spruce and pine, on the other hand, die rapidly when defoliated, as by Nun and Pine Beauty moths, or when felled, and in the first case rarely recover sufficiently to resist bark-beetle attacks. The importance of this difference in resistance of the conifers and hardwoods is considerable. Broad-leaved trees attacked by bark-beetles serve longer as breeding ground than do conifers, and, accordingly, in broad-leaved forests the rate of spread of an outbreak is less than in coniferous forest, where the beetles are earlier compelled to seek new hosts. In broad-leaved forests the natural enemies of the bark-beetles, predaceous beetles and parasitic Hymenoptera, increase in numbers before fresh trees are attacked. In coniferous forests new breeding grounds are chosen and the outbreak is extended before these natural enemies can have much effect and the reduction of the outbreak is retarded.*

In Britain all our bark-beetles prefer suppressed, less vigorous, and felled trees to healthy trees as breeding ground. Some species rarely, if ever, attack healthy trees—e.g. *Ernoporus*, *Cryphalus*, and *Trypophloeus*; others, like *Myelophilus* and *Hylastes*, invariably attack living healthy trees for feeding purposes, and when they are numerous readily attack living standing trees for breeding purposes, though not always with success, as the deserted tunnels of *Myelophilus*, frequently to be seen on standing pines, testify.

The majority of our bark-beetles are secondary enemies of trees, their attacks being associated with other adverse influences, and the inter-relations between the bark-beetles and the various influences inimical to the vigorous growth of forest trees is the most important feature of the bark-beetle economy. A striking instance of the importance of vigorous growth in resisting bark-beetle attacks occurred in the New Forest in 1918 and 1919. In Knightwood Inclosure, Scots pine and Corsican pine of even age occur side by side. The Scots pine was severely attacked by *Myelophilus piniperda* which so pruned the leading shoots as to cause death of the upper crown, producing a lower bushy crown and causing almost complete cessation of height-growth. The adjoining Corsican pine remained almost untouched, and the contrast in the height-growth of the two groups of pines and in

* Trägårdh (1924) cites an instance of such an extension of an outbreak of *Ips typographus* which would otherwise have been checked by parasites.

the form of the crowns was visible from a long distance. Severely pruned Scots pine were freely utilised by *Myelophilus* as breeding ground, while the abandoned tunnels of the beetles on the Corsican pine showed how well that species was resisting attack. It is interesting to note that in Bulletin No. 3 of the Forestry Commission the rate of growth of the Corsican pine is stated to be faster than that of the indigenous species in the south of England, where at 50 years of age the Corsican pine shows a volume 50 per cent. greater than that of the Scots pine. In the north-east of Scotland (Aberdeenshire), however, Corsican pine grows no faster than Scots pine, and it is probable that there it will suffer equally badly from *Myelophilus* as does the indigenous tree. Felled Corsican pine is attacked by *Myelophilus* just as much as felled Scots pine.

Another illustration of the effect of reduced vigour in trees conducing to bark-beetle attack was seen at Kew in 1922, when as a result of the weakening of the elms through the very dry summer of 1921 the elm bark-beetles *Scolytus destructor* and *S. multistriatus* were unusually abundant. Similar attacks were observed in several districts in the south of England.

Schollmayer-Lichtenberg (1923) has pointed out the importance of the over-maturity of the forest crop in aiding outbreaks of the spruce bark-beetle, *Ips typographus*, and there is no doubt that this aspect of the bark-beetle problem is of great importance.

Delay in thinning, especially in stands in the pole stage, conduces to bark-beetle outbreaks, and, on the other hand, timely thinning may prevent the extension of a bark-beetle infestation and so prevent an outbreak. The relation of bark-beetles to thinning practice has been too little studied. It is a complex question requiring both entomological and silvicultural knowledge and entailing studies extending over a period of years in several districts.

The effect of fungus attacks in rendering trees liable to attack by bark-beetles and the inter-relations between bark-beetles and fungus attacks have received little attention from entomologists. R. Hartig appears to have been the first to call attention to this aspect of the bark-beetle problem: "In very many cases it is not sufficient where we are dealing with injuries due to animals, including insects, that we catch the creature at work and seek to observe it and its mode of life in nature as has hitherto been done; but, and particularly in the case of insect-injuries, we must determine whether the injured plants did not possess some predisposition to disease before they were attacked by the insects, &c. Especially does this hold good for the great family of the bark-beetles which often appear in the train of other prejudicial agencies and especially of injuries caused by parasitic fungi."*

Unfortunately Hartig does not give specific instances of bark-beetle outbreaks following fungus attacks and there are few

* R. Hartig. *The Diseases of Trees*, Somerville's translation, 1894, p. 17.

references to this subject in forestry literature. Dufrenoy (1920) makes the general statement that " the bark-beetles prefer sickly Maritime pines. They are to be seen secondarily infecting pines attacked by *Armillaria mellea*, and during an epidemic in 1915 we have seen the foresters seeking, as an index of the presence of the bark-beetles, the presence at the base of the trees of the white mycelium of *Armillaria*."

Several of our bark-beetles appear to confine themselves to trees or branches of trees already attacked by a fungus. *Ernoporus fagi* occurs only on dead beech branches which already show abundant fungus mycelium.* *Trypophloeus asperatus* was found at Kew only on poplars weakened by drought and attacked by the fungus *Cytospora*. *Dryocaetes autographus* is found most commonly on spruces and pines the bark of which is pervaded by fungus mycelium and which is often sodden with moisture.

Ratzeburg (quoted by Nüsslin) ascribed stag-headedness in oak to *Dryocaetes villosus*, but this bark-beetle seems rather to follow this condition and is frequently associated with attacks of the " Beef-steak " fungus, *Fistulina hepatica*, and other wound parasites. Osterwalden records the presence of *Scolytus rugulosus* on a fruit-tree the lower half of which was attacked by a *Fusarium*, and both *Scolytus rugulosus* and *S. pruni* have recently been associated with epidemics of " Silver leaf " (*Stereum purpureum*).

Outbreaks of defoliating insects such as the Nun Moth and Pine Beauty Moth are frequently followed by bark-beetle outbreaks, and sometimes the attacks of the defoliating insects have been overlooked and the sickly or dying condition of the crop so caused ascribed solely to bark-beetles. Packard (1890) has described how in Eastern America losses primarily due to the Spruce Budworm (*Tortrix fumiferana*) were at first ascribed entirely to bark-beetles.

Although the bark-beetles are frequently and, probably, normally secondary pests following such primarily injurious agencies as drought, fire and leaf-eating insects, they may, aided by such agencies and by sheer force of numbers, become primarily injurious, invading vigorously growing trees over large areas. Two factors are important in such outbreaks. The Pine Shoot Beetle, *Myelophilus piniperda*, when it occurs in large numbers may as a result of its feeding habits so prune the crowns of Scots pine as to render these pruned trees suitable for breeding purposes, and it is probable that with other bark-beetles this factor may also play a part in favouring outbreaks. More important, however, is the increase, through fellings, fire or similar agency, of the bark-beetles out of all proportion to the slash or sickly trees available for breeding ground. In these circumstances the beetles are compelled to attack vigorously growing trees, and while hundreds of beetles may die in the attempt, being

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* This species was found in the summer of 1924, at Mickleham, Surrey, cutting feeding tunnels in the bracket-fungus *Polystictus versicolor* on beech, in association with the beetle *Cis bilamellatus*.

drowned out by resin-flow, nevertheless the numerous wounds which their abandoned entrance tunnels cause may so reduce the sap-flow and resistance of the trees as to enable later maturing beetles to breed freely in them.

Escherich (*Forstinsekten*, 1914, Chap. VII, p. 309) classifies the bark-beetles as secondary pests, becoming seriously injurious only when conditions arise, through one or several causes, which enable them to increase in numbers. He calls attention to the importance of weather conditions in favouring bark-beetle development by reducing the vigour of forest trees (*e.g.* great heat and drought) and suggests that for the bark-beetles such factors are probably of more importance than for other groups of forest insects which, however, are as yet not so well understood from the ecological standpoint.

## Losses caused by Bark-beetles

The losses caused by extensive bark-beetle outbreaks are twofold. There is a direct loss arising from the cutting short of the rotation by the bark-beetles destroying the living trees, and there is an indirect loss due to the flooding of the market with a specific class of timber which results in a fall in price. In addition to trees actually killed, others become weakened and, as in *Myelophilus* attacks, misshapen. In the latter case loss of increment is the chief loss, but the value of such misshapen trees as timber is also reduced.

By the Ambrosia beetles which enter the wood, direct injuries are caused, reducing the value of the wood for technical purposes, and Strohmeyer considers that in the case of oak the losses caused by *Platypus cylindrus* in Germany are considerable.

In Britain, apart from the *Hylastes* beetles, which are injurious only in young plantations, our most injurious bark-beetle is the Pine Shoot Beetle, *Myelophilus piniperda*. This beetle is the cause of considerable loss, but as the damage which it causes is not always prominent and is, moreover, difficult to assess, it is not sufficiently realised.

## Prevention and Control of Bark-beetle Outbreaks.

The preference of the bark-beetles for felled trees and trees reduced in vitality, from whatever cause, is, from the forester's point of view, the most important feature of their economy. The knowledge that certain weather conditions affect the rate of increase of the bark-beetles by acting directly and favourably on the beetles and indirectly and unfavourably on the trees is of especial value in the work of preventing and controlling outbreaks.

In modern forestry practice the most important factors contributing to the increase of the bark-beetles are the systems of pure, that is, unmixed, forest planting and of clear-felling. In forests composed of several coniferous species or, better, of coniferous and broad-leaved species in even mixture, bark-beetle outbreaks rarely make headway. Under the shelter-wood systems the danger of serious increase of these beetles is small; but in clear-felling of pure woods, especially if it is practised over large areas, bark-beetle outbreaks are almost inevitable unless proper precautions are taken.

An important factor in clear-felling is the disposal of the slash or brushwood. This forms a favourable breeding ground for bark-beetles, and its removal or burning is frequently urged by forest entomologists. The question of slash disposal is by no means simple and while, entomologically, burning of slash is always a safe recommendation there are objections to this practice on silvicultural and economic grounds.

In the United States and in Canada, where the slash not infrequently consists of broken or shattered stems of considerable size and where the felled area is littered with large branches and tops, it is probable that burning is the only practicable measure.

In Europe, in those countries where the timber is fully utilised and both tops and branchwood are removed, slash burning is unnecessary.

In Britain, where forest utilisation is not highly developed, the disposal of slash requires consideration. The beetles which breed in slash vary according to the size and nature of the tops and branches left, and the period during which slash serves as breeding ground varies with locality and climate. As the most important bark-beetles are those living on conifers, and as at present the most important conifers are spruce, Scots pine and larch, these types of slash may be considered first. In this country at present spruce and larch harbour few bark-beetles of importance (Bulletin No. 2, Forestry Commission). *Myelophilus piniperda, Hylurgops palliatus* and *Pityogenes bidentatus* breed in both these conifers, but they are properly Scots pine breeders and rarely increase greatly as a result of felling of spruce and larch woods. The chief danger is the Scots pine felling, especially in districts where woods of this species predominate.

The extent to which the slash is important varies with several factors, climatic and forest. The climatic factor affects chiefly those bark-beetles which breed in thin-barked tops and branches, the most important species being *Pityogenes bidentatus*. In warm, dry districts branches serve as breeding ground only for one season. In colder or wetter districts the rate of increase of *Pityogenes* is slow, and accordingly thin-barked branches of from half an inch to two inches in diameter afford but little opportunity for bark-beetle increase. Only in rare circumstances is slash important as breeding ground for *Pityogenes*. One instance where extensive loss arose from this source may be cited. It occurred in 1919, when *Pityogenes* beetles, bred from slash, attacked some rather large-sized and recently planted Corsican pine, which were already weakened by a spell of drought following the planting.

Much more important than small branches and twigs are the twisted tops and gnarled branches left after the felling of pine trees which are misshapen by squirrel or pine-shoot moth injuries or by wind and snow-break. Such tops and branches have no value for the timber merchant. Some of them may be disposed of locally for firewood and the bottoming of hay stacks, but frequently such means of disposal are inadequate. This is the slash which must be burned or barked. It affords breeding ground for *Myelophilus* and *Hylastes*, and is of real importance as a breeding centre for these beetles.

It should therefore be barked or burned before the end of May in England and the end of June in Scotland, where felling is done in winter, and before August where felling is done in summer.

Slash from broad-leaved trees is of minor importance as a breeding ground for bark-beetles. Elm logs and limbs serve as centres of breeding and dispersal of the elm bark-beetles, *Scolytus destructor* and *S. multistriatus*, and in parks, avenues and pleasure-grounds such logs should be barked. In forestry, however, hard-wood areas rarely suffer from bark-beetle outbreaks.

Outbreaks arise from small and almost negligible beginnings. A recent severe outbreak of *Ips typographus* in the spruce forests of the Austrian Mittelgebirge was traced to a wind-storm in 1916 when lack of labour caused by the war prevented the necessary "cleaning up" and the bark-beetles rapidly spread unchecked in the over-mature spruce stands. Clean forestry—the rapid removal or barking of wind- or snow-broken, or falling stems, and the early removal or barking of timber in clear-cuttings and in thinnings—is the best safeguard against bark-beetle outbreaks. In extensive pure forests regular inspection of the stands for bark-beetle infested stems, which are usually to be recognised by the exudation of resin or the little heaps of boring-dust thrown out by the beetles, is valuable as a means of detecting the beginnings of outbreaks and enabling early measures to be taken against them.

The view, once prevalent, that bark-beetle outbreaks arise suddenly by invasion from other woods more or less distant is now but little credited by entomologists, and in any case invasion of a stand by bark-beetles can be successful only if the conditions in the stand are favourable to it because of the presence of suppressed, fallen, or broken stems; or of the occurrence of weather conditions acting adversely on the stand and favourably on the beetles; or if the invading beetles are extraordinarily numerous. Such invasions occur but seldom, and experience both in this country and in Central Europe shows that the bark-beetles always form a part, however small, of the insect population of standing woods and that outbreaks, caused by the gradual increase of the ever-present few, arise slowly and often unobserved until they attain alarming dimensions.

Where bark-beetle outbreaks have arisen the chief measures used to check them are the removal, or barking, as far as silvicultural conditions and the supply of labour available permit, of all stems likely to form breeding ground and of all fallen stems and slash serving as breeding ground. Then follows control by trap-trees—stems specially felled and laid to attract as many of the mature and breeding beetles as possible and to restrict their spread. Such traps are most efficient after all sickly or suppressed stems in the neighbourhood of the outbreak have been removed, as these outlying stems or trees if not removed may cause the centre of infestation to change and result in small sporadic outbreaks over a wide area.

The use of trap-stems is one of the oldest but most efficient control measures. The types of trap-stems in use have been increased and more varied in recent years, but they all depend for their success on the fundamental principle that the bark-beetles are particular in their choice of breeding ground and select for breeding purposes such stems as are lacking in vigour or show some condition akin to sap stagnation or resulting either from sap stagnation or from reduction of the sap flow.

Sedlaczek (1921) has carried out a series of experiments to test various types of trap-stems and has indicated what types the more common or important bark-beetles prefer. His explanation of the different conditions produced by incising stems and by ring barking is not clear, but his entomological results may be relied on. He distinguishes between standing trap-stems and fallen stems.

Standing trap-stems are of four types : " incised," or ringed by incisions a hand's breadth apart at breast height ; " ring barked," by the removal of a ring of bark a hand's breadth in width at breast height ; " topped," by the removal of the crown and " pruned " by the removal of the branches. Sedlaczek considers that " incised " (" Doppelring Schnitt ") stems are moist with sap and attract the moisture-loving bark-beetles, that " ring-barked " stems (" Ringelung ") are dry and attract beetles which like dry conditions. Topped stems (" Entgipfelung ") and pruned stems (" Schwentung ") attract dry-loving bark-beetles in the upper part of the stem, moisture-loving beetles in the lower part. Standing trap-stems are more useful for experimental study of bark-beetle habits than for actual control work.

Felled trap-stems may be unpruned and unbarked or may be pruned and barked in strips. These methods of treatment again produce different types of trap, wet and dry, and the adoption of either method will vary under different forest and weather conditions. " One would assume that felled trees on which the branches and foliage were left would dry out more rapidly than pruned trees. This is only provisionally correct. In sheltered localities, such as the interior of the stands, and during wet weather, the leaves on felled trees transpire for some time, drawing up the water from the sapwood layers, so that such trees dry out better. The result is that the dry-loving bark-beetles are attracted, while the moisture-loving species, and above all *lineatus* ('*Trypodendron lineatum*') use such stems less frequently than pruned stems in the same locality. In localities exposed to sun and wind the leaves (needles) soon become incapable of transpiration, so that the stem in spite of its foliage loses moisture no more rapidly than pruned stems in the same locality; moreover, the branches serve to shade the unpruned stems in part. In such exposed localities unpruned stems accordingly remain longer attractive than pruned stems."

Sedlaczek finds that scarifying or barking in strips renders trap-stems more attractive, and that such stems are earlier occupied than stems not scarified. In scarified stems the broods usually fail to complete development owing to drying out and, moreover, the strips of bark left afford harbour for predaceous and parasitic enemies in great numbers. "Scarifying thus aids the biological control of the bark-beetles."

The number of trap-stems necessary for the control of an outbreak depends on a number of factors which vary with the locality. The times of preparing the stems, the times of barking them to destroy the contained broods, the type of trap-stem to be employed, all depend on the species of bark-beetles to be controlled and on the extent and locality of the outbreak. Where the biology and, in particular, the flight times and the number of broods raised in a season are known for the species in any district, the timely preparation of traps is a comparatively simple matter. In circumstances, however, where these factors are uncertain, the use of trial or test traps is a useful aid to successful control. Such traps should be prepared first in winter, and as soon as it is seen that they are being extensively utilised by the bark-beetles a second series should immediately be prepared, and at intervals throughout the summer further trees should be felled to catch the second or summer broods. Only by such means can effective control be attained. As a rule, it will be found that in winter felling, trap-trees or stems should be barked by the end of May in the south of England, and by the middle or end of June in the north of England, or in Scotland. Where summer felling is necessary, as a result of wind-blow or other cause, the felling itself will trap most of the beetles, and all felled stems should be barked or removed before August.

The use of parasitic and predaceous insects as a control measure against bark-beetles has never been favoured by forest entomologists. Mention has been made of the unsuccessful attempt made by Hopkins in 1892 and 1893 to control a *Dendroctonus* outbreak by the introduction into the United States of the Clerid beetle, *Thanasimus formicarius*, from Europe (Hopkins, 1899), and since then no serious efforts have been made again in that direction. Predaceous beetles and parasitic Hymenoptera do undoubtedly play an important part in terminating outbreaks, but their use artificially entails long study and experiment and, even under the best conditions, biological control must always be slower, less effective and very much more expensive than control by trapstems.

The general reduction of the bark-beetle population in a forest area and the prevention and reduction of bark-beetle outbreaks are best brought about by systematic forest management. Escherich (1923) has summed up the relation of the bark-beetles to the forest and the importance of forest management as a controlling factor as follows :—

"The bark-beetle menace in general stands in inverse ratio to the intensity of the forest management. The higher and more intense the management, the less the menace. The bark-beetles are suppressed by the practice of silviculture, in contrast to the weevils, which are favoured by it. So it is that in countries with a low degree of forest management, as, for example, North America, enormous bark-beetle damage occurs involving millions of dollars yearly. So, too, we read in the older writings of the 18th and the beginning of the 19th centuries of serious destruction by bark-beetles even in our German forests, while, on the other hand, to-day we hear of extensive bark-beetle outbreaks much more rarely, and then only as the result of catastrophes of quite another kind (wind-storms, snow-break and caterpillar devastation) or as a result of the periodic neglect of the prescribed forest management."

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# CHAPTER III

## STRUCTURE AND CLASSIFICATION

### Structural and Morphological Characters

The Scolytidae present in their external structure valuable characters for their identification and classification. The older writers up to Eichoff relied wholly on these characters for the description and classification of the bark-beetle species, but, in 1875, with the publication of Lindeman's anatomical researches on the male genitalia of the bark-beetles, attention was turned to the characters afforded by internal structures—in particular, the reproductive organs and genitalia, and the proventriculus. Nüsslin (1911–1912) has, in fact, made use of almost every important structure which affords constant characters, from the venation of the hind wings to the form of the spermatheca. While from the point of view of the student of classification and phylogeny all such characters must be considered, they cannot always be studied by the field worker. Their proper study involves a considerable knowledge of microscope technique and the devotion of considerable time to the preparation of specimens, and it is unlikely that these difficult, if valuable, characters will ever come into ordinary use. Nüsslin's system, elaborate as it is, is still incomplete, and, as Swaine points out, an examination and careful study of many types are required before any definite conclusions as to the relationship and phylogeny of the Scolytidae can be formed. Hopkins (1915) has published his views on the classification of the bark-beetles, which he places in the super-family Scolytoidea, but they too are not wholly accepted by all authorities, and meanwhile the forest entomologist must content himself with the examination of such characters as seem trustworthy, and easy of examination, for the safe identification or determination of the species with which he may be concerned. Reitter (1913), while recognising the value of internal characters for phylogenetic studies, relies in his recent *Bestimmungstabellen* solely on external characters. In the keys to the British bark-beetles which follow, every effort has been made to render them as simple as possible and to use only such characters as can be examined with a good pocket lens of moderate power, without dissection of the specimens concerned.

The student seeking further characters and more comprehensive descriptions is referred to the works of Nüsslin, Hagedorn, Hopkins, Swaine and others already cited. (See Appendix.)

*External Characters*

The more important external characters of the bark-beetles are indicated in Figs. 3, 4 and 5 of *Hylastes ater*. Viewed

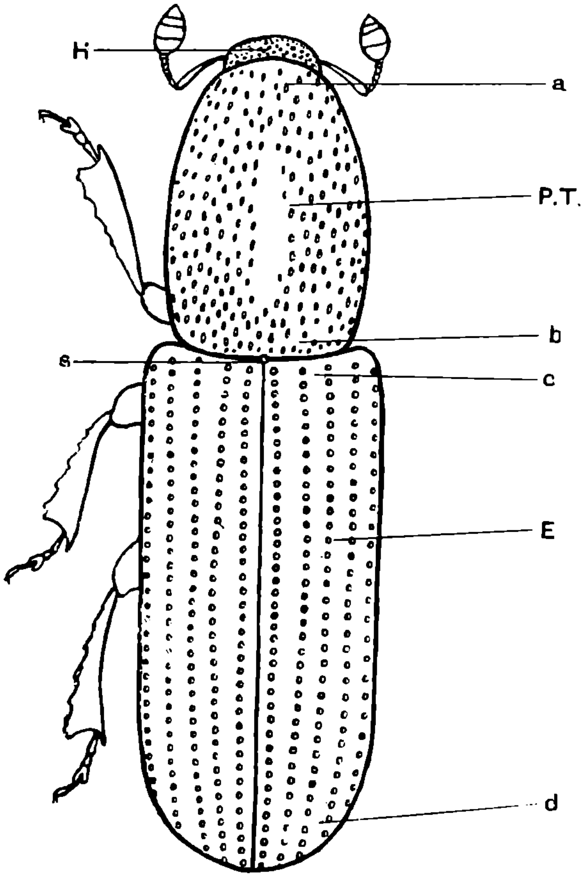



FIG. 3. *Hylastes ater*, dorsal aspect.
H, head. P.T., pro-thorax. S, scutellum. E, wing cover or elytron. *a*, anterior part of thorax. *b*, base of thorax. *c*, base of wing cover. *d*, apex of wing cover.

dorsally the three main regions of the body are seen : the head, only the vertex of which is visible ; the pro-thorax (pro-notum), the small, almost circular scutellum, usually the only dorsal part of the meso-thorax which is visible without dissection ; the wing-covers, which conceal the meta-thorax, the folded wings, and the tergites of the abdomen.

Ventrally are seen : the head, in which the epistome, the mouth-parts and the gular region are visible (the right antenna

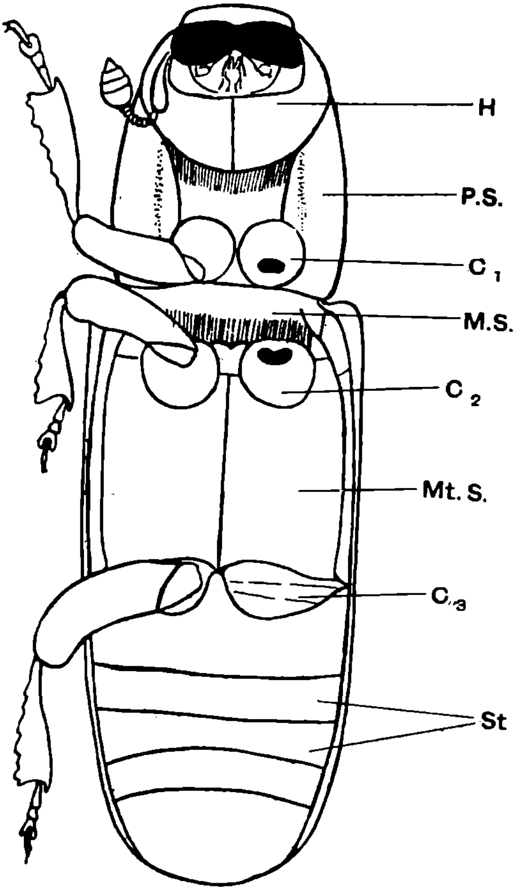



FIG. 4. *Hylastes ater*, ventral aspect.

H, head. P.S., pro-sternum. $C_1$, anterior coxa. M.S., meso-sternum. $C_2$, middle coxa. Mt. S., meta-sternum. $C_3$, posterior coxa. St, abdominal sternites.

is not shown) ; the pro-thorax or pro-sternum, with the anterior coxae or first joints of the anterior legs ; the meso-thorax (meso-sternum), with the middle coxae, the meta-thorax terminated by the posterior coxae, and the sternites of the abdomen. The margins of the wing-covers are also seen bordering the meso- and meta-sterna and abdominal sternites.

Viewed laterally, the head shows the eye, the antenna and the mandible. The pro-thorax conceals the occipital region of the head. The wing-covers, with their rows of punctures or punctured striae, and the interstriae, or interstices lying between

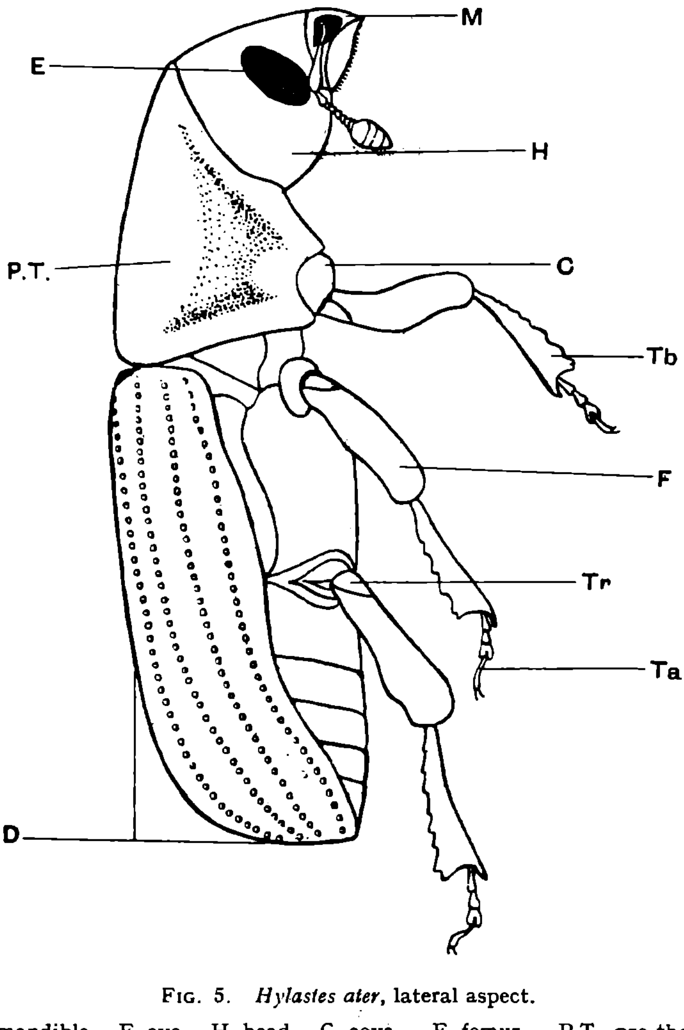



FIG. 5. *Hylastes ater*, lateral aspect.

M, mandible. E, eye. H, head. C, coxa. F, femur. P.T., pro-thorax. Tr, trochanter. Tb, tibia, Ta, tarsus. D, apical declivity of wing cover.

the rows, extend over the meso- and meta-thorax and abdomen. The apical curve or declivity of the wing-covers is seen, a region of special value in the identification and classification of the Ipinae group of the bark-beetles.

These are the main regions of the body affording the characters which, with those presented by the appendages (legs and antennae), are used in the keys for the identification of the British bark-beetles given below.

The legs of the bark-beetles afford useful characters for their division into the main groups here recognised. The leg consists of five joints or segments, the last of which, the tarsus, consists of five small joints grouped together (Fig. 5). Adjoining the body is the coxa, a large, somewhat globular joint in the first pairs of legs, but extended and flattened outwardly in the posterior pair. Next it lies a small joint, the trochanter, which may extend along the next joint or tibia for a short distance. The tibia affords important characters given below. It is followed by the tarsus, of five joints, of which the fourth joint is very minute and in some species is concealed by the bi-lobed third joint. In *Platypus* the first tarsal joint is longer than the remaining joints taken together, but in all our other bark-beetles never attains such length, and is usually commensurate with the second and third joints. The last tarsal joint ends in two small claws.

The antennae were much used in classification by the older writers on the bark-beetles, and Eichhoff and Nitsche, in particular, lay stress on the antennal characters. The antenna is composed of three parts: the scape, or shaft, the funiculus, or whip, and the club (Fig. 6). The scape is the first or basal joint of the antenna articulating with the head. In our genera, except *Scolytus*, it is markedly elongate, and causes the antennae to appear elbowed or geniculate. The older writers made much use of the number of joints in the

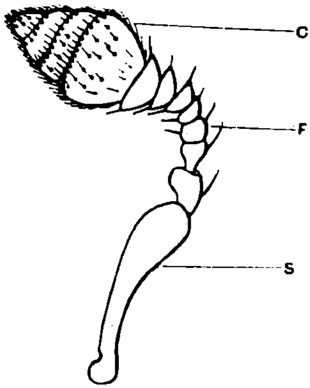



FIG. 6. Antenna of *Hylastes*.

C, club. F, funiculus or whip. S, scape or shaft.

funiculus in classification, and this character is still used, but as the number of joints may differ in the males and females of the same species and even in the right and left antennae of the same individual, it must be used with caution. The club is composed of the enlarged terminal joints of the antennae, which may be more or less distinct. It may be solid, definite traces of the joints being absent ; sutured, the sutures representing the divisions of the joints ; or septate, the septa probably representing former sutures and resulting, perhaps, from a fusion of the joint margins and of the intersegmental membranes. The strength or distinctness of the sutures and their conformation afford useful characters for classification, but must be used with care. In *Phloeosinus thujae*, for example, the antennal club appears sutured when viewed *in situ*, but in a microscope preparation appears septate. The shape of the club, whether round or flattened (depressed), truncate, pointed (acuminate), or rounded at the apex, affords in some genera a ready means of separating them, as in *Cryphalus Ernoporus* and *Trypophloeus* in our British fauna.

The eyes in the bark-beetles present useful taxonomic characters. In *Trypodendron* they are divided, thus separating the beetles in this genus from all other British bark-beetles.

In the following keys for the identification of our bark-beetles the characters of the pro-thorax (pro-notum) are much used, as they are easily examined, and although their use somewhat awkwardly separates the males and females in *Xyleborus* and *Xylocleptes* it is hoped that such easily examined characters will prove useful to the field worker to whom minute antennal characters are often difficult. There does not, in fact, appear to be any one character or group of characters which will allow of an easy determination on the one hand, and of a natural classification on the other.

## *Internal Characters*

Those parts of the internal anatomy of the bark-beetles which have received most attention from students of the group are the alimentary canal and the reproductive organs and genitalia.

The alimentary canal consists of three main divisions—the fore-gut, the mid-gut and the hind-gut. The fore and hind guts are lined with chitin, the mid-gut is not so lined. The fore-gut comprises the gullet or oesophagus, into which the salivary glands open ; the crop, and the gizzard or proventriculus. The bark-beetle gizzard in cross section is octagonal in shape, composed of eight plates, the "proventricular plates" of Hopkins. These plates are armed on the inner side with a series of teeth and spines the nature and arrangement of which, as Lindeman first showed, afford valuable distinguishing characters. The gizzard terminates the fore-gut and is followed by the enlarged stomach or ventriculus, after which the mid-gut narrows suddenly, gradually dilating again where the caecal tubes arise, until it terminates with the origin of the malpighian tubules (see Fig. 7). Nüsslin has made use of the number and arrangement of the caecal tubes of the mid-gut in his recent classification. The hind-gut, which forms the continuation of the mid-gut below the malpighian tubes, is a simple tube terminating in the rectum.

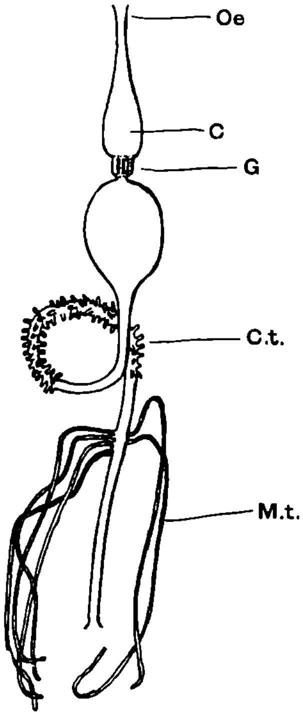



FIG. 7. Alimentary canal of *Hylastes ater*.

Oe, oesophagus. C, crop. G, gizzard. C.t., caecal tubes. M.t., malpighian tubes.

*The Reproductive Organs.*—The male reproductive organs in the bark-beetles comprise the testes in which the sperms or spermatozoa are formed, the paired ducts, or " vasa deferentia," arising from these, and into which the paired diverticula or seminal tubes open, and the unpaired duct or vas deferens formed by the union of the paired vasa leading into the ejaculatory duct in the penis (Fig. 8).

The penis (more properly called the adeagus) is a complex structure comprising in addition to the muscular tissues a number of chitinous plates derived apparently from the abdominal tergites. These plates vary in shape and position in various species.

The female reproductive organs comprise the egg-tubes or ovaries, the paired and unpaired oviducts, the bursa copulatrix, the spermatheca and the slime glands (Figs. 9 and 10).

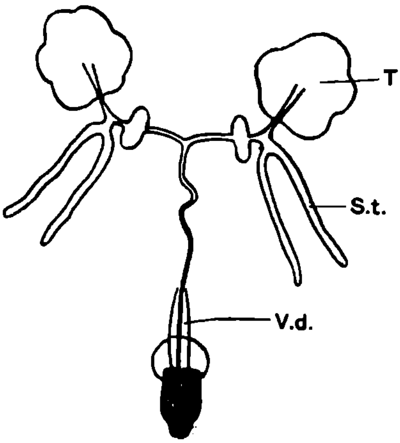



FIG. 8. Male reproductive organs of *Hylastes*.
T, testis. S.t., seminal tubes. V.d., vas deferens.

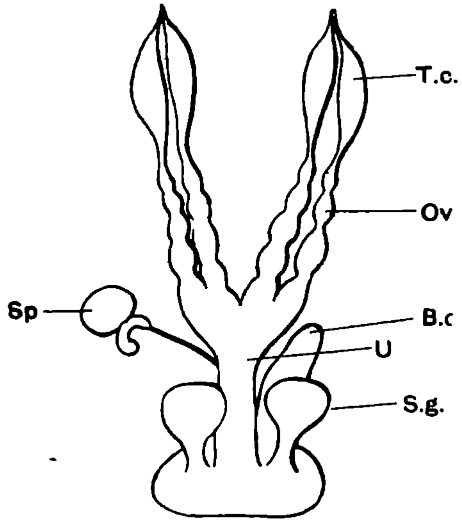



FIG. 9. Female reproductive organs of *Hylastes* (mature).
T.c., terminal chamber. Ov, ovary or egg tube. Sp, spermatheca.
B.c., bursa copulatrix. U, unpaired oviduct S.g., slime glands.

FIG. 10. Female reproductive organs of *Hylastes* (immature).

The development of the ovaries in the bark-beetles, as in the weevils, is frequently delayed for some time after the emergence of the " adult " from its pupal bed, and a comparative study of the condition of the ovaries affords a guide to the age and maturity of the beetles.

Nüsslin (*Leitfaden*, 2nd Edn., p. 19) lays stress on the development and shape of the egg-tubes, the distension of the bursa copulatrix and the spermatheca, and the presence at the base of the egg-tubes of the yellow bodies, consisting of discarded and degenerate egg-follicle, known as corpora lutea, as criteria of stages in maturity or immaturity. He gives the following description of stages in development :—

1. Shrivelled egg-tubes not definitely showing egg-formation within them are a sure criterion of sexual immaturity.
2. Pearl-necklet-like egg-tubes indicate a more or less advanced maturity.
3. The presence of corpora lutea is a criterion of egg-laying.
4. Distended bursa copulatrix and receptaculum indicate successful pairing.
5. Empty bursa and receptaculum indicate a virgin condition.
6. The presence of corpora lutea, with exhausted ovaries, is evidence of a previous egg-laying (as in overwintering females).

The various criteria of development may prove of importance in biological studies of the bark-beetles, and examination of the female reproductive organs is often the only means of distinguishing between members of different broods. Such an examination is not difficult to make in our larger bark-beetles, but in small species like *Cryphalus* and *Phloeophthorus* it requires considerable facility in the use of the dissecting needle and some knowledge of microscope technique. For information on the condition of the female reproductive organs, in particular, where certain knowledge that pairing has successfully taken place is desired, it is necessary to examine the receptaculum and bursa for spermatozoa, and this requires careful dissection and preparation of dissections for examination under the higher powers of the compound microscope. Such information is usually sought only by the entomologist engaged in a definite line of research and is rarely, if ever, required in general forestry practice.

## Classification and Identification.

Within recent years a number of important papers dealing with the classification of the bark-beetles have been published, the most notable being those of Hagedorn (1910), Nüsslin (1911 and 1913), Hopkins (1915), Reitter (1913 and 1916) and Swaine (1918). Spessivtseff (1922) has published an excellent and wellillustrated key for the identification of the Swedish bark-beetles, and more recently Escherich (*Forstinsekten,* Bd. II) has published a modification of Nüsslin's and of Reitter's keys for the identification of the Central European genera and species of those bark-beetles which are of economic importance or are commonly met with by the forester and forest officer. All these authors have been consulted, but the classification and keys for identification which are here given are also based on first-hand examination of beetles collected in this country and every effort has been made to render the keys as simple and straightforward as possible.

In many instances the identification of bark-beetle species can be made from the host plant on which they occur or on the combined characters of the host plant and brood tunnels. As Hopkins has pointed out, the use of such characters, "physiological characters" as he terms them, is sound even although they can rarely, if ever, be used by the systematist working with a museum collection. Some of our bark-beetles are restricted to a single species of host plant (e.g., *Cissophagus* on ivy (*Hedera*)); in others the characters of the tunnels, although cut in the same host plant, are so different that species which may be, at first, difficult to determine morphologically can immediately be distinguished by their brood tunnels, e.g. *Myelophilus minor* and *M. piniperda.* In some instances it is even possible to determine the identity of the host plant by reference to the bark-beetles inhabiting it, and in the writer's experience such an instance occurred where a branch of lilac (*Syringa*) bare of buds, foliage and bark was identified by the presence on it of the tunnels of *Hylesinus fraxini.* Accordingly the characters of the host plant and of the brood tunnels should be used freely by the forest officer and forest entomologist, not as the final criterion of identification, but certainly as a means of saving time otherwise spent in "going through" a series of keys to determine genera and species. In the keys to the families, sub-families and genera given below only morphological characters are used, but in the descriptions of genera and species the physiological characters (host plant and brood tunnels) are described, and in the Appendix a list of our bark-beetles classified according to their host plants is given which should be used along with the keys to the genera.

In any work dealing with the classification and identification of a group of insects it is impossible to avoid reference to the vexed question of "names" and synonymy. Most of us have witnessed a change in the names of some of our most familiar bark-beetles, and how far it is wise to retain "old" names or to adopt "new" ones is a very difficult question to decide. This question arises more urgently in the study of the bark-beetles than in that of almost any other insect group. The names of some of our bark-beetles are almost household words among foresters and they are not lightly to be altered. In the keys and descriptions which follow, "new" or unfamiliar names are used as little as possible, but it seems that such familiar names as *Tomicus* and *Hylurgus* (for *Myelophilus piniperda*) must be dropped if we are to keep abreast of recent work in Europe and America. In order to avoid confusion and to simplify recognition of important bark-beetle genera and species cited in European or American literature both "old" and "new" names are given in the description of genera.

The keys to sub-families and genera are arranged in the usual dichotomic form. Thus if a beetle does not conform to the characters given in section I the student refers to section IA, &c., until he finds himself in agreement with the characters in that section. Where any difficulty is experienced in deciding between two sections or subsections the text figures and plates should prove helpful and the list of host plants in the Appendix should further simplify matters. It is supposed that in making use of these keys the student is familiar with the use of a good pocket lens with a magnification of ten to twenty diameters.

Hopkins (1915) gives the position of the bark-beetles in the Order *Coleoptera* as follows :—

ORDER COLEOPTERA.

Maxilla undivided, the palpi rigid and with not more than three joints ; larvae legless. Sub-order **RHYNCHOPHORA.**

Maxilla divided, more or less flexible and with a flexible palpus, usually 4-jointed, larvae rarely without legs.
All other **COLEOPTERA.**

SUB-ORDER RHYNCHOPHORA.

Head without prominent rostrum or beak and the submentum never produced into a gular peduncle.
Super-family **SCOLYTOIDEA.***

Head usually with prominent rostrum or beak and the submentum always more or less produced into a gular peduncle.
All other **RHYNCHOPHORA.**

In our British bark-beetles it is convenient to recognise two families, distinguished as follows :—

Tarsi with the 1st segment as long or longer than the remaining segments together (Fig. 11). Family **PLATYPODIDAE.**

FIG. 11. Tibia and tarsus of *Platypus*.

* Here regarded as comprising the two families *Scolytidae* and *Platypodidae*.

Tarsi with the 1st segment much shorter than the remaining segments together (Figs. 12 and 13). Family **SCOLYTIDAE.**

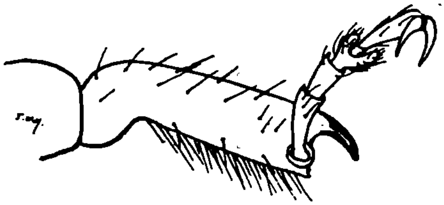


FIG. 12. Tibia and tarsus of *Scolytus*.

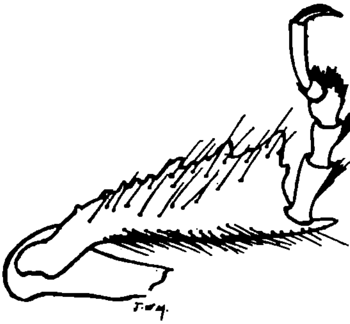


FIG. 13. Tibia and tarsus of *Hylastes*.

## FAMILY PLATYPODIDAE.

This family is represented in Britain by the genus *Platypus* Herbst. containing the single species *P. cylindrus* F. (Plate I, Fig. 1).

## FAMILY SCOLYTIDAE.

This family, termed by recent American and European authors Ipidae, is regarded as divisible into three sub-families distinguished as follows :—

1. Anterior tibiae produced at the outer apical angle to form a prominent claw. Outer borders of anterior tibiae smooth (Fig. 12).

Sub-family **SCOLYTINAE** (Plate I, Figs. 2 and 3).

1A. Anterior tibiae not produced at the outer apical angle. Outer borders of anterior tibiae denticulate (Fig. 13).

2. Pro-thorax (pro-notum) elongate, or narrowed in front, not concealing the head from above, not asperate in front, not markedly differing in sculpture from front to back. Third tarsal joint bi-lobed, flattened. (Fig. 14*a*.)

Sub-family **HYLESININAE** (Plate 1, Fig. 4, and Plate II, Figs. 1-5.)

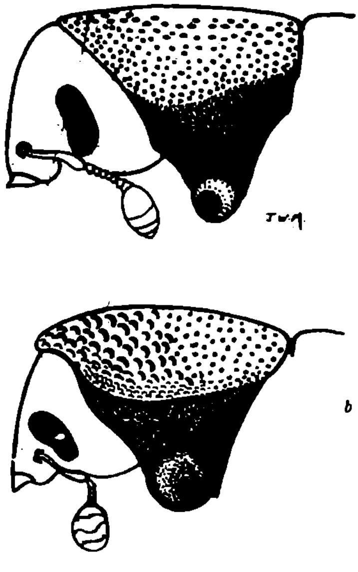


FIG. 14. Head and pro-thorax (a) *Hylastes*, (b) *Ips*.

2A. Pro-thorax sub-globular, concealing the head from above, asperate or rugose in front, rugose or punctured behind, the contrast in sculpture from front to back usually very marked. Third tarsal joint simple, cylindrical. (Fig. 14*b*).

Sub-family **IPINAE.** (Plates III and IV).

### SUB-FAMILY SCOLYTINAE.

This sub-family is represented in Britain by the single genus *Scolytus* Geoff. containing six species. (Page 44.)

### SUB-FAMILY HYLESININAE.

This sub-family is represented in Britain by nine genera which may be distinguished as follows :—

1. Bases of elytra arched, distinctly raised and serrulate (Plate II, Figs. 1, 2 and 3).

2. Elytral declivity, gradual oblique, abdominal sternites ascending posteriorly. (Fig. 15*a*).

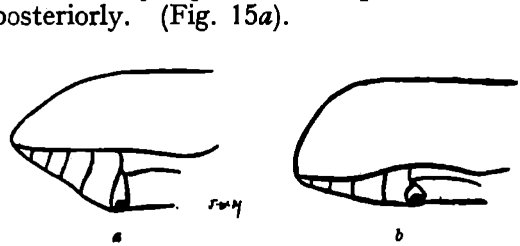
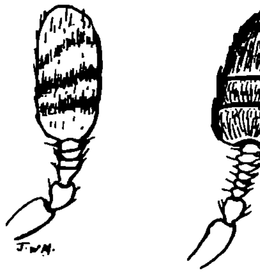


FIG. 15. Elytral declivity of (a) *Hylesinus*, (b) *Pteleobius*.

3. Antennal club long oval, flattened, rounded at apex (Fig. 16*a*). Eyes emarginate on inner border. **Phloeosinus** Chap.



*a* *b*

FIG. 16. Antenna of (a) *Phloeosinus*, (b) *Hylesinus*.

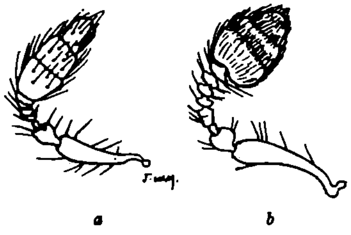
3A. Antennal club conical, pointed at apex. (Fig. 16*b*). Eyes entire. **Hylesinus** F.

2A. Elytral declivity abruptly arched. Abdominal sternites horizontal. (Fig. 15*b*).

4. Body clothed with scales forming a variegated pattern. **Pteleobius** Bed.

4A. Body clothed with hairs.

5. Beetles very small (2 mm.). Antennal club elongate (Fig. 17*a*). **Phloeophthorus** Woll.



*a* *b*

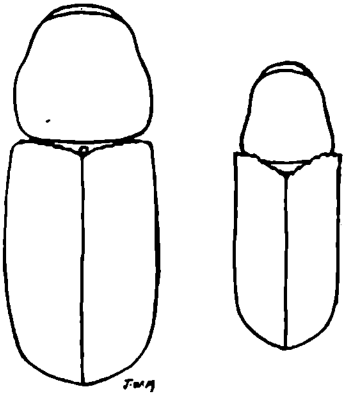
FIG. 17. Antenna of (a) *Phloeophthorus*, (b) *Hylastinus*.

5A. Beetles larger. Antennal club not elongate (Fig. 17*b*).

6. Pro-thorax finely punctured, shining, sparsely clothed with fine hairs. **Myelophilus** Eich. (Plate II, Fig. 2).

6A. Pro-thorax rugosely punctured, body clothed with short yellow hairs.

7. Bases of elytra strongly arched and raised. Elytra densely clothed with short yellow hairs. Beetles elongate (Fig. 18*b*). **Cissophagus** Chap.



a b

FIG. 18. (a) *Hylastinus*, (b) *Cissophagus*.

7A. Bases of elytra only moderately arched and raised. Elytra sparsely clothed with short erect hairs. Beetles stouter.
**Hylastinus** Bed. (Fig. 18*a*)

1A. Bases of elytra not arched, not markedly raised or serrulate.

2. Pro-thorax broader than long, constricted before the middle, blunt pear-shaped (Fig. 19 and Plate I, Fig. 4).
**Hylurgops** Sec.

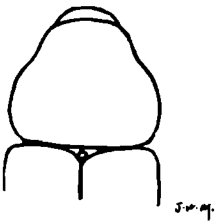


FIG. 19. Pro-thorax of *Hylurgops*.

2A. Pro-thorax as long, or longer, than broad, not constricted in front. **Hylastes** Er. (Plate II, Figs. 4 and 5).

SUB-FAMILY IPINAE.

This sub-family contains thirteen British genera which may be recognised as follows :—

1. Sides of elytra distinctly rounded.
**Anisandrus** Ferr. ♂ (Plate III, Fig. 1).

1A. Sides of elytra straight, sub-parallel. Beetles cylindrical (Plate III, Figs. 2, 4 and 5).

2. Pro-thorax broader than long.

3. Body sparsely clothed with hairs. Thorax black, elytra yellow-testaceous. Eyes divided.

**Trypodendron** Steph. (Plate III, Fig. 4) = **Xyloterus** Er.

3A. Body clothed with scales and hairs. Thorax and elytra unicolorous black. Eyes entire.

4. Antennal club rounded at apex.

5. Asperities on anterior border of thorax not projecting beyond the margin (Fig. 20). Beetles oval.

**Cryphalus** Er. (Plate III, Fig. 3).

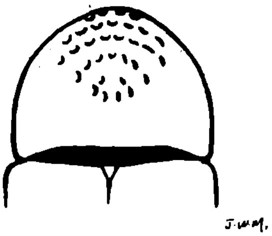


FIG. 20. Pro-thorax of *Cryphalus*.

5A. Asperities on anterior border of thorax projecting beyond the margin (Figs. 21, *a* and *b*). Beetles elongate.

**Ernoporus** Thoms.

FIG. 21. Pro-thorax of *Ernoporus*: (a) *fagi*, (b) *tiliae*.

4A. Antennal club pointed at apex. **Trypophloeus** Fairm.

2A. Pro-thorax as long or longer than broad.

6. Pro-thorax strongly convex or domed in front.

7. Pro-thorax distinctly longer than broad. Beetles elongate.

**Xyleborus** Eich. ♀ (Plate III, Fig. 5).

7A. Pro-thorax as broad as long. Beetles stout.

**Anisandrus** Ferr. ♀ (Plate III, Fig. 2).

6A. Pro-thorax not strongly convex or domed.

8. Pro-thorax broadest at base, asperate in front, smooth and sparsely punctured behind. (Plate IV, Figs. 1, 2, 3 and 4).

9. Pro-thorax somewhat prolonged and narrowed in front with the asperities on the anterior half very prominent, ceasing abruptly and contrasting strongly with the posterior half. Beetles small, 2–3½ mm.

10. Pro-thorax finely margined at the base, beetles very small (2 mm.) and narrow.

**Pityophthorus** Eich. (Plate IV, Fig. 3).

10A. Pro-thorax not margined at base, larger beetles 2–3½ mm.

11. Elytral declivity oblique or rounded, armed with teeth, at least in the males. **Pityogenes** Bed. (Plate IV, Fig. 2).

11A. Elytral declivity abrupt and truncate, not armed with teeth. **Taphrorhychus** Eich.

9A. Pro-thorax broadly rounded in front, asperities on the anterior half less prominent, becoming less distinct posteriorly, gradually merging into the punctured and shining posterior third. Beetles larger, 3–4 mm.

12. Elytra excavated at apex and armed with prominent teeth.

13. Excavation of elytra with a single tooth on each side. **Xylocleptes** Fer. ♂ (Plate IV, Fig. 4).

13A. Excavation of elytra with three or more teeth on each side. **Ips** De Geer (Plate IV, Fig. 1 and text figs. 29-32, pp.67–68).

12A. Elytra not excavated, not armed with teeth.

14. Beetles depressed or flat. **Xyleborus** ♂.

14A. Beetles cylindrical. **Lymantor** Löw.

8A. Pro-thorax oval, asperate in front, rugose behind.

15. Scutellum distinct ; rows of punctures on elytra deep and distinct. **Dryocaetes** Eich. (Plate IV, Fig. 5).

15A. Scutellum indistinct ; rows of punctures on elytra shallower. **Xylocleptes** ♀

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## CHAPTER IV

## BRIEF ACCOUNTS OF GENERA AND SPECIES.

### FAMILY PLATYPODIDAE

### SUB-FAMILY PLATYPODINAE

#### Genus **Platypus** Herbst.

First tarsal joint elongate, sides of thorax emarginate, body elongate, cylindrical. Antennae short with a large flattened club.

This genus is represented in British by one species, *P. cylindrus* F. (Plate I, Fig. 1), which is readily distinguished from all our other bark-beetles by its elongate form, the unusual length of the first tarsal joint and the large prominent head. Colour brown to pitchy. Length, 6–7 mm.

Its host plants are oak, beech and sweet chestnut and, according to Reitter, ash. The brood galleries (Plate VII, Fig. 1) are easily recognised and the boring dust is also peculiar, consisting not of fine dust but of fibrous shavings.

The life-history in Britain has been studied by Chapman (1872), and Strohmeyer (1906), who has monographed the family, has described the life-history and bionomics of a variety of the species (var. *cylindriformis*) as it occurs in Europe.

The distribution of *Platypus* in Britain is limited, so far as present records show, to the south of England from Kent westwards to the New Forest in Hampshire and the Forest of Dean in Gloucester and Monmouth. It is of minor forest importance in this country, although Strohmeyer considers it frequently injurious to felled oak in Germany.

## FAMILY SCOLYTIDAE.

### SUB-FAMILY SCOLYTINAE.

### Genus **Scolytus** Geoff.

This genus is known to Continental and American authors as *Eccoptogaster* Herbst.

Anterior tibiae armed with a hook-shaped claw on the outer apical angle, margin not denticulate. Abdominal sternites receding from the base upwards towards the apices of the wing-covers, which are not arched. Antennal scape short, antennae not elbowed or geniculate.

The genus contains six British species, distinguished as follows:

1. Second abdominal sternite with prominent horizontal projection. (Plate I, Fig. 3). On elm. *multistriatus* Ratz.

1A. Second abdominal sternite without prominent horizontal projection.

2. Elytra with distinct rows of deeper and shallower punctures. Large species, 5–7 mm.

3. Frons with distinct raised keel. On birch. *ratzeburgi* Jans.

3A. Frons without raised keel. On elm. *destructor* Ol. (= *scolytus* F.)

2A. Elytra with rows of punctures similar, not always distinct. Smaller species, under 5 mm.

4. Elytra shining, interstices smooth. On *Pyrus*, *Prunus*, *Laurus*, &c. *pruni* Ratz.

4A. Elytra dull, interstices wrinkled.

5. Thorax broader than long, shining. On oak. *intricatus* Ratz.

5A. Thorax longer than broad, dull. On *Pyrus*, *Prunus*, &c. *rugulosus* Ratz.

**Scolytus ratzeburgi** Jans. Birch Bark-beetle.

Black, with the elytra dark brown to black; the largest of our species. 5–6½ mm.

The host plant of *S. ratzeburgi* is birch. The egg-tunnels are longitudinal (Plate VIII, Figs. 1 and 2) and show numerous air-holes or ventilating tunnels at which pairing takes place. Short tunnels at right angles to the brood tunnels are believed to be feeding tunnels.

The life-history of this species has not been studied in Britain. Fergusson (1924) has given a short account of the beetle and its habits in Scotland, and Pauly (1892) and Trédl (1915) have described its life-history in Europe.

The distribution of *S. ratzeburgi* in Britain is by no means fully known; it is apparently restricted to Scotland, where it was first found at Rannoch, Perthshire, and described as a new species by Janson in 1856. Until 1923 it had not again been seen, when Fergusson discovered it at Stobs, near Hawick, Peebles-shire. In 1924 the writer found the species at Auchterawe, near Fort Augustus, and it is probable that *ratzeburgi* is fairly widely distributed in Scotland, but local in its occurrence.

**Scolytus destructor** Ol. Large Elm Bark-beetle.

Black, with the elytra pitchy red to brown, 5–6 mm. (Plate I, Fig. 2). This species, together with *S. multistriatus*, is at times very destructive to park and avenue elms. The egg-tunnels are longitudinal and the larval tunnels are most regular, the whole forming an oval figure on the bark and on the sapwood, chiefly of the main stem and larger branches.

The life-history has been studied in Britain by Chapman (1870), and in greater detail by Fisher (1926). There are two generations in the year. The first eggs are laid in April and May, producing adults in late July and August; these produce the second generation, the larvae of which overwinter, pupating in March and emerging in April. The sexually immature beetles cut feeding tunnels in the axils of small branches and twigs of elm, and may in this respect be considered primarily injurious (Fisher, *loc. cit.*).

Control measures consist in the removal of dead limbs from avenue trees, the removal of felled trees and branches, and the use of trap logs in April and July to trap the swarming beetles. Experiments carried out for the London County Council by the Forestry Commission in Ravenscourt Park in 1924 showed that late planting and severe root pruning of young trees predispose them to attack by *Scolytus destructor* and *Scolytus multistriatus*. *Scolytus destructor* is common in the south of England, but becomes scarcer in the Midlands and north and does not occur in Scotland.

**Scolytus multistriatus** Ratz. Small Elm Bark-beetle.

Black, with elytra pitchy red to dark brown, 2½–3½ mm. (Plate I, Fig. 3). This species occurs on the smaller limbs and branches of elm and less commonly on the main stem. The egg-tunnels are longitudinal and much narrower than those of *S. destructor*, corresponding with the smaller size of the beetle.

The life-history in Britain has been studied by Chapman (1870) and by Stewart MacDougall (1900). It is similar to that of *S. destructor*.

The control measures against *S. destructor* apply also to this species, except that branches are preferable to thick-barked stems as traps.

In distribution *S. multistriatus* resembles *S. destructor*. It is frequently associated with the elm bark-weevil *Magdalis armigera*.

**Scolytus pruni** Ratz. (= *mali* Bechst.). Large Fruit-tree Bark-beetle.

Black, with elytra pitchy brown, shining, 3½–4½ mm. This species is occasionally injurious to fruit-trees. It also attacks white-beam (*Pyrus aria*) and laurel (*Laurus*). Trees in full vigour or which have received a dressing of stable manure may recover from attack, and in the Commissioners' collection there is a branch of cherry showing almost complete healing of wounds made by the brood gallery.

The egg-tunnel is longitudinal, with a more or less distinct pairing chamber at the foot of the tunnel.

The life-history has been described by Chapman, but there is need for a fuller account.

Control measures lie in proper and careful cultivation of fruit-trees and, in particular, in removal and burning of dead and dying trees and branches.

In its occurrence *S. pruni* is somewhat local. It is like all its congeners, except *S. ratzeburgi*, a southern species, and is doubtless distributed with fruit-trees and so widespread in the south and Midlands.

**Scolytus rugulosus** Ratz. Small Fruit-tree Bark-beetle.

Black, with pitchy elytra. Thorax dull, 2–2½ mm. The smallest of our species, this beetle is frequently destructive to fruit-trees in orchards and gardens. It also attacks hawthorn. The egg-tunnel is longitudinal and very narrow and is cut both in the main stem and on small branches and twigs.

The life-history has been described by many authors—Chapman, Ormerod, Theobald and others. Theobald (1909) suggests that there are three broods in the year. These are probably of only two generations, namely, a summer brood and two spring broods.

Control measures against *Scolytus rugulosus* consist in early removal of all infested branches, careful pruning of both branches and roots and clean cultivation generally. Trapping to be successful must be intensive.

*S. rugulosus* is widely distributed in England and Wales.

**Scolytus intricatus** Ratz. Oak Bark-beetle.

Black, with elytra pitchy brown. Thorax shining, 3–4 mm. This species attacks oak and is the only *Scolytus* species in Britain which cuts horizontal or transverse egg-tunnels. These are short and not evidently two-armed. The larval tunnels are long and always at right angles to the egg-tunnels (Plate VII, Fig. 2).

Some account of the life-history of *S. intricatus* has been given by Chapman, but further information on it is needed. According to Escherich (*Forstinsekten*, Bd. II) Fuchs has observed a double generation in Europe, while Judeich, in rearing experiments, obtained only one generation in the year. At Kew and Richmond and in the New Forest there appears to be only one brood in the year and *S. intricatus* appears later in the spring than our other *Scolytus* species.

*S. intricatus* feeds at the base of young shoots of the oak. Its feeding habits were observed by Eckstein, who first called attention to the feeding habits of the *Scolytus* species (Escherich, *loc. cit.*).

Control measures are seldom necessary against *S. intricatus*, which, though abundant in many districts, appears to be entirely secondary in its attacks. Even in woods devastated by the Oak Tortrix moth this beetle is much less important than fungi in causing the final death of sickly trees. Against this must be put an account by Audouins, quoted by Escherich, which describes the destruction of 30,000 oaks 25–30 years old by these beetles in the Bois de Vincennes!

*S. intricatus* is southern in its distribution but occurs rarely in Northumberland and Durham (Fowler).

## SUB-FAMILY HYLESININAE.

### Genus **Phloeosinus** Chap.

Antennal club elongate oval, flattened. Eyes emarginate on the inner side. Length 1½–2 mm.

The only representative of this genus in Britain is *Phloeosinus thujae* Perris. It is black, with raised yellow hairs, the rows of punctures on the elytra being depressed and distinct. The third interstice at the apices of the elytra is raised and armed with a row of tubercles which in the male form a comb-like ridge (Plate II, Fig. 3).

The life-history of *P. thujae* in Britain is not known. On the Continent, Torka (1906) has described the habits and egg-laying of the species. Henschel (*Forstzoologie*) considers that there are two generations in the year. The egg-tunnels of *Phloeosinus thujae* are two-armed but longitudinal. (Plate IX, Fig. 2). They are cut in *Thuja, Cupressus, Sequoia* and *Juniperus*.

The only record of *P. thujae* in Britain is that by Dallimore, who found the species on *Thuja orientalis* in July 1922 in the Royal Botanic Gardens, Kew. Later it was found on *Cupressus pisifera*. The beetles had been breeding in the pinetum at Kew for some years and are therefore quite capable of becoming established in this country. (Dallimore and Munro, 1922.)

## Genus **Hylesinus** F.

Antennal club conical, eyes entire (not emarginate). Body clothed with scales or with hairs. All the species occur on ash and allied trees and shrubs. The genus contains three British species, distinguished as follows :

1. Body densely clothed with scales forming a pattern. *fraxini* Panz.

1A. Body sparsely clothed with scales and hairs.

2. Elytra with very sparse, short, erect hairs. Asperities on pro-thorax forming low ridges. Size large, 6–7 mm. *crenatus* F.

2A. Elytra with long, yellow hairs, the line of the suture being densely clothed. Asperities on thorax small, denticulate. Size small, 3·5–4·5 mm. *oleiperda* F.

**Hylesinus fraxini** Panz. Common Ash Bark-beetle.

This species has been placed by Reitter in his sub-genus *Leperisinus* ; it is readily recognised by the covering of scales and is the commonest of our ash bark-beetles. The colour is black with ashy grey and black scales. Length 3 mm. (Plate II, Fig. 1). The egg-tunnels of *fraxini* are two-armed and horizontal, the larval tunnels are short and pupation takes place in the sapwood (Plate VI, Fig. *b*). In small branches the tunnels are often irregular and the egg-tunnels frequently askew.

The life-history has been discussed by Chapman (1868), Forbes (1899) and others. In the south of England there are two broods in the year, a summer brood and a winter brood. The beetles emerge from their winter quarters in tunnels cut below the axils of small branches, or from their pupal beds, in April and May, when egg-laying commences. The young beetles appear in August and apparently overwinter. Meanwhile the older beetles proceed to a second egg-laying which produces beetles in the following spring. In the north of Scotland (Perthshire) there appears to be but one brood in the year.

While in forestry proper *fraxini* is of minor importance, this beetle may cause considerable injury and loss where ash is grown for hop-poles and walking-sticks. The feeding tunnels of the beetles cause canker-like growths (the " rinden-rosen " of the German literature) which, in themselves harmless, appear to afford entrance for the true canker fungus, *Nectria galligena*. Both the beetles and the *Nectria* cause similar malformation of the stem, but the galling caused by the beetles is usually easily to be recognised by the presence in the gall crevices of the beetles themselves.

In cutting their brood galleries the *fraxini* beetles cause definite loss to walking-stick manufacturers. The egg and larval tunnels deface the stick, and the pupal tunnels, which may penetrate even to a depth of $\frac{3}{8}$ of an inch, weaken it. Treatment of ash cut for sticks is not easy ; tar oils such as creosote and " carbolineum " discolour the bark and wood. One method of protection is to bury the better class of sticks in sand until they are somewhat seasoned and ready for " making." *H. fraxini* is capable of feeding on relatively dry wood and beetles have emerged from ash made into church furniture ! In the walking-stick trade *fraxini* is known as " the fly," probably because it is most conspicuous during the swarming season, when the beetles readily take wing.

*H. fraxini* is common throughout England and Wales, and occurs in Scotland as far north as Pitlochry. Its common host is ash, but it occurs also on lilac (*Syringa*), and on the Continent, according to Reitter, on walnut.

**Hylesinus crenatus** F. Large Ash Bark-beetle.

Black, with sparse yellow hairs. The largest of our Hylesinid beetles, length 4–5 mm. It occurs chiefly on dying ash, where it cuts its galleries only on the main stem and branches. The gallery is transverse and two-armed, one arm usually being shorter than the other. The egg-tunnels are wide and conspicuously niched ; the larval tunnels are very long and irregular (Plate VII, Fig. 4).

*H. crenatus* normally produces but one brood in the year (Forbes), but in the south of England and under favourable weather conditions three broods may emerge in two years.

This beetle is widely distributed in England and Wales, and occurs as far north as Forfarshire in Scotland. It is most common in Scotland in the Tweed (Peebles-shire) and Forth districts.

*H. crenatus* is of no economic importance.

**Hylesinus oleiperda** F. Lesser Ash Bark-beetle.

Black, with sparse yellow hairs, except along the line of suture of the wing-covers, which is densely clothed. Length 2½–3 mm.

*H. oleiperda* inhabits the branches and twigs of ash, in which it cuts a short, rarely distinctly two-armed, transverse egg-tunnel. The larval galleries are very long and irregular. *Oleiperda*, like *H. fraxini*, cuts short feeding and hibernating tunnels in, and below, the axils of small branches and twigs, but it seems to be a less gregarious beetle than *fraxini*, and rarely produces marked galling. The two species may occur together, but such occurrences are rare, and it is interesting that *H. oleiperda* occurs most frequently on ash growing on poor soils, or which has suffered bad handling, either in careless coppicing or, as in hedgerow ash, by heavy slashing.

*H. oleiperda* is southern in its distribution. It is common in England and Wales, but has not been recorded north of the Tweed and the Solway. It is of no economic importance in Britain, but on the Continent proves injurious to the olive ; hence its name.

## Genus **Pteleobius** Bedel.

The genus is represented in Britain by one species—*P. vittatus* F. This beetle was formerly known as *Hylesinus vittatus*, but was placed in the new genus *Pteleobius* by Bedel. It resembles a small *H. fraxini*, but is more elongate in shape and differs from *Hylesinus* proper in having the elytral declivity abrupt and the abdominal sternites horizontal.

The ground colour is black, concealed by ashy grey and brown scales, forming a variable pattern. Length 1½–2 mm.

The life-history of *P. vittatus* has not been closely studied in Britain, but Chapman has given some account of it. Its chief host is the elm, but it may attack ash. On the Continent it is, according to Escherich, associated with the *Scolytus* beetles, but this is rarely so in Britain, where its place in this respect is taken by the elm weevil, *Magdalis armigera*. In this country *P. vittatus* is an inhabitant of the hedgerows rather than of the woods and parks. It is especially associated with the type of hedging known as "plashing," in which erect stems of elm are half cut through, bent down and interlaced to strengthen the hedge. The egg-tunnels of *P. vittatus* are two-armed and horizontal, and very similar, except in size, to those of *H. fraxini*. According to Strohmeyer, *P. vittatus* produces a galling at the nodes of elm branches similar to that produced by *H. fraxini* on ash.

*Pteleobius* is southern and somewhat local in its distribution. It has been recorded as far north as the Solway district, but is not known to occur elsewhere in Scotland.

## Genus **Phloeophthorus** Woll.

This genus is represented in our fauna by the single species *Phloeophthorus rhododactylus* Marsh., the smallest of our Hylesinid beetles (1⅓–1⅝ mm.). *P. rhododactylus* is black in colour, with short recumbent yellow hairs. The elongate antennal club and its small size readily distinguish it from all our other Hylesinid beetles. Its host plants are broom and whin, or gorse.

The life-history has been studied in some detail by Chapman (1869). He considered that there was one brood in the year, but his observation that larvae are found over winter points to two broods, and in England two broods occur. The egg-tunnels of *P. rhododactylus* are Y-shaped, and the combination of egg and larval tunnels produces one of the prettiest brood tunnel patterns found in our native bark-beetles.

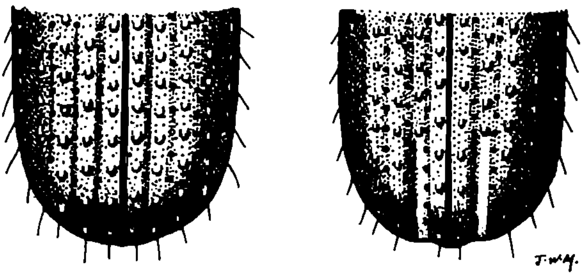
This species is widely distributed, extending as far north as Inverness-shire. It is of no economic importance.

## Genus **Myelophilus** Eich. Pine-shoot Beetles.

This genus contains two European species, both of which are represented in Britain (Plate II, Fig. 2). They are distinguished as follows :—

1. Rows of tubercles on the second interstices of the wing-covers continuing to the apex (Fig. 22*a*). *minor* Hart.

1A. Rows of tubercles on the second interstices of the wing-covers, ceasing at the declivity (Fig. 22*b*). *piniperda* L.




*a* *b*

FIG. 22. Elytra of *Myelophilus* : (a) *minor*, (b) *piniperda*.

The genus *Myelophilus* has long been known to foresters under the names *Hylurgus* and *Hylesinus*, and European writers have recently restored the name *Blastophagus* for it. Hopkins on the other hand would retain Latreille's name of *Tomicus* and here the name *Myelophilus*, which is most familiar to the present generation of foresters, is retained.

## **Myelophilus minor** Hart. Lesser Pine-shoot Beetle.

Black, with the wing-covers pitchy red to brown, shining. Length $3\frac{1}{2}$–$3\frac{3}{4}$ mm. (Plate II, Fig. 2). The species is readily recognised by the continuance of the rows of tubercles on the second interstices to the apices of the wing-covers, and in the field by the two-armed transverse egg-tunnels cut in thin barks, pine stems and branches (Plate IX, Fig. 5).

The life-history of *M. minor* has been studied by Ritchie (1917). He considers that one generation and two broods occur in the year in the Aboyne district (Aberdeen and Kincardine) of Scotland.

The distribution of *M. minor* has recently been studied by the writer. The species occurs in Perthshire, Forfarshire, Kincardine and Aberdeenshire, and its galleries have been observed by Dr. Steven west of Loch Garry, Inverness-shire.

Compared with *Myelophilus piniperda*, *M. minor* is of small importance owing to its more restricted range and its numerical inferiority in the localities where it does occur. It is probable that the preference which *M. minor* shows for the upper third of the pine stem and for thin-barked branches is an important factor in its distribution. Such thin-barked stem and branches " dry out " more readily than thicker-barked stems, and in wet districts the bark rots and falls off more easily. In the Aboyne district extensive squirrel damage probably favours *M. minor.*

Like its larger congener, *M. minor* cuts feeding tunnels in Scots pine shoots and causes deformation of the tree crown.

Control measures against *M. minor* resemble those given below for *M. piniperda*, except that *minor* prefers standing stems and is not readily attracted to fallen timber.

**Myelophilus piniperda** L. Pine-shoot Beetle.

Black, with elytra pitchy red to black, shining. Rows of tubercles on second interstices of wing-covers not extending to the apices. Length 3½–4 mm.

This is the commonest and most important of our pine bark-beetles. While Scots pine is its favourite host it attacks most *Pinus* species and also spruce and larch if pine fails.

The egg-tunnel, in contrast to that of *M. minor*, is simple and longitudinal and there is an irregular pairing chamber at its base just within the entrance tunnel (Plate IX, Fig. 1). Thick-barked stems are preferred by this species but it will breed in thin-barked stems and branches, in such conditions cutting the egg-tunnels more deeply into the sapwood.

The life-history of *M. piniperda* has been described by many writers. Good accounts in English are those of MacDougall (1902) and Somerville (1891), but the most comprehensive description of its life-history and habits is that of Trägårdh (1921 b.) in Swedish. Generally there are two broods in the year, a spring or summer brood emerging in July and August and a winter brood emerging in April. In the north the summer brood is of little importance, but in the south of England, as in the New Forest, this brood may in years favourable to the bark-beetles be numerous.

*M. piniperda* winters partly in the bark at the base of standing pines and partly in pine shoots in which it feeds. Trägårdh considers the short tunnels cut by the beetles in winter at the base of the trees as winter feeding, the tunnels in the shoots as food tunnels cut by beetles developing their undeveloped or exhausted reproductive organs in spring and summer. In this country, however, beetles are to be found in tunnelled shoots all through the winter from October onwards to March, and there is some evidence that in Scotland (in Aberdeen and Banff for example) hibernation at the base of the trees is less common than hibernation in the shoots, while in England (Surrey and Hampshire) the reverse is the case. Rarely *M. piniperda* has been found boring in spruce (*Picea morinda*) and in larch and Douglas fir shoots. The injury caused by *Myelophilus* is two-fold ; it tunnels in the shoots of healthy standing pines and may seriously reduce their vigour and it cuts its brood tunnels in trees which are but little reduced in vigour. When the beetles occur in large numbers they successfully invade and kill healthy trees much more frequently than any other of our bark-beetles. Reference has been made (p. 19) to the importance of the factors soil, light and heat as affecting *Myelophilus* attack in the New Forest, and it is a feature of *Myelophilus* attack that factors only slightly unfavourable to the growth of pine predisposes them to attack. For these reasons *M. piniperda* is the most injurious of our bark-beetles.

The main control measures against *Myelophilus* are clean forestry, early removal of felled timber, the barking of it, if removal is impracticable, and the early use of trap-stems whenever an outbreak is detected or is likely to arise. (See pp. 22–27.)

### Genus **Cissophagus** Chapuis.

This genus contains the single British species, *Cissophagus hederae* Schmidt, which occurs on ivy. It is readily recognised by the strongly arched bases of the wing-covers and the short stiff hairs which give the beetle a golden or auburn tinge. Length 2–2½ mm.

The life-history of *C. hederae* is not fully known. The egg-tunnels are transverse and two-armed (Plate IX, Fig. 3), but such perfect tunnels are rarely found owing, probably, to the somewhat soft wood of the ivy in which they are cut and partly to the frequent presence, in association with the bark-beetle, of the Longicorn beetle, *Pogonochaerus dentatus*, and the Anobiid beetle, *Ochina hederae*, whose grubs deface the tunnels of *Cissophagus* in their mining.

The distribution of *C. hederae* is by no means fully known. The beetle is fastidious in its selection of breeding ground, preferring ivy which is just drying after severance from its roots but not quite dead and sapless. Such conditions are not always to be found, and accordingly *C. hederae* is reputed to be rare and local. It is probably more widely distributed then the records show, but it would seem to be a southern species. Fowler (*British Coleoptera*) gives the following localities for the beetle—Kent, Sussex, Monmouth, and near Manchester and Scarborough. Specimens in the Forestry Commission collection were taken in the New Forest, Hampshire.

### Genus **Hylastinus** Bedel.

This genus comprises two European species, only one of which, *Hylastinus obscurus* Marsh., occurs in Britain. *H. obscurus* is dull brown to black, the pro-thorax is constricted in front and the bases of the wing-covers only slightly arched. Length 2½–3 mm.

The life-history has been partly studied by various authors but is not fully known. The host plants are broom (*Cytisus*) and whin (*Ulex*), and according to Reitter the Spanish broom, *Spartium junceum*, and *Ononis natans*.

The egg-tunnels are cut at the base of the stem in gorse, or, in broom, well up the stem. They are two-armed and more or less horizontal, but one arm is usually markedly longer than the other and the entrance tunnel is indistinct. The larval tunnels are moderately long and regular. *H. obscurus* is reputed by various authors to cut its feeding tunnels in the roots of clover and Swaine (1918) states that it may be very injurious to clover crops.

*H. obscurus* is widely distributed throughout Britain, but is local in its occurrence.

## Genus **Hylurgops** Lec.

This genus, formerly included in *Hylastes*, is represented in Britain by one species, *Hylurgops palliatus* Gyll. It differs from the *Hylastes* beetles in having the pro-thorax constricted in front, and evidently broader than long (Plate I, Fig. 4). Colour brown to dark brown. Length 3½–4 mm.

The life-history of *H. palliatus* has been studied by MacDougall (1899) and the writer (1917). The host trees are pine, spruce and, less commonly, larch. The egg-tunnels are longitudinal with a well-defined crutch-shaped entrance tunnel at the base (Plate VII, Fig. 5). The larval galleries are usually fairly distinct and form one or other of two patterns. They may radiate, as it were, from the mother-gallery as distinct individual tunnels, or may merge for a time to diverge later, producing a more or less branched pattern. The feeding tunnels may be collective or individual. In thicker bark the feeding tunnels are usually collective, several beetles feeding side by side. Such collective tunnels occur commonly just after the beetles emerge from pupation. Individual tunnels, usually branched, are most common on thinner bark and are presumably cut by beetles preparatory to a second egg-laying.

*H. palliatus* is of secondary importance as a forest pest, and is usually associated with *Myelophilus* attack or with other injuries. It prefers bark in a moister condition than freshly-cut stems usually present, and is best described as a follower of primary injuries. *H. palliatus* is widely distributed in Britain.

## Genus **Hylastes** Er.

This genus is represented in Britain by five species, which may be distinguished as follows :—

1. Size larger, 4–5 mm. Rostrum with a fine keel or ridge (Fig. 23).

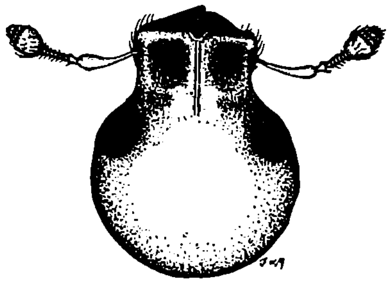


FIG. 23. Head of *Hylastes ater.*

2. Thorax shining, distinctly longer than broad, sides subparallel. Impunctate median line broader at middle, not raised. *ater* Payk.

2A. Thorax dull, not longer than broad, sides distinctly rounded. Impunctate line fine, often slightly raised. *cunicularius* Er.

1A. Size smaller, under 4 mm. Rostrum without keel or ridge (Figs. 24*a* and *b*).

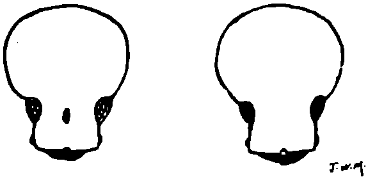



FIG. 24. Head of *Hylastes*: (a) *angustatus*, (b) *opacus*.

3. Beetles narrow and elongate, rostrum with fine longitudinal channel (Fig. 24*a*).

4. Lines of punctures on elytra confused at the base, but becoming distinct towards the apex. Size larger, 3·5 mm. *angustatus* Herbst.

4A. Lines of punctures on elytra distinct throughout. Size smaller, 2·5 mm. *attenuatus* Er.

3A. Beetles less elongate, stouter. Rostrum without fine longitudinal channel. 3·5 mm. (Fig. 24*b*). *opacus* Er.

All the *Hylastes* species are root feeders, breeding in the stumps and roots of pine and spruce (*cunicularius*) and feeding at the base of the stem and roots of young conifers.

**Hylastes ater** Payk.

Black, shining, pro-thorax elongate oval (Plate II, Fig. 4).

This is the commonest and most abundant of our *Hylastes* species. Its life-history has been studied by the writer (1917), as it takes place in Scotland. There are two broods in the year, the eggs of which are laid in May and September. Observations made in Surrey and Hampshire show that in these southern counties three broods may occur under favourable conditions. Egg-laying may there commence as early as February.

The egg-tunnels of *H. ater* are cut in the stumps, or, more frequently, in the roots of pine, spruce and, rarely, of larch. They resemble those of *Hylurgops palliatus*, except that the crutch-like entrance tunnel is less regular and that one or more turning niches, used by the males in clearing out boring dust, occur above the crutch.

In its feeding habits *H. ater* is of considerable importance where felled pine woods are being replanted. The beetles feed in the root-collar region of young conifers ; pines, spruces, larches, Douglas fir and *Thuja*. As a rule, weakly or badly planted plants are most readily attacked, but vigorous plants are frequently killed when the beetles are numerous. The beetles in feeding girdle the stem and roots, and even where girdling is incomplete the fungus *Fomes annosus* may enter, ultimately killing the plant.

In all localities where planting conditions are adverse, *Hylastes ater* and its congeners must be guarded against. The best control measure is the billet-trap, such as is used against the pine weevil, *Hylobius*. It consists of a short billet of pine 2 to 3 feet long and about 2 inches in diameter. In using such billets it is imperative that they should come in contact with the soil, and where herbage or other vegetation makes this difficult a shallow trough should be cleared with a mattock or planting spade in which the billet can lie. Slash or branch wood where it touches the soil is a frequent breeding ground of *Hylastes*, and should be removed or burned. All billet-traps should be barked or burned after use.

**Hylastes cunicularius** Er.

Black, dull, pro-thorax roundly oval (Plate II, Fig. 5).

*H. cunicularius* breeds solely in spruce stumps and roots. Its life-history has not been fully studied in Britain, but the writer (1917) has given some account of its habits. The egg-tunnels resemble those of *H. ater* except that the arms of the crutch are equal. In *Hylurgops palliatus* and *Hylastes ater* one arm of the crutch is longer.

In habits and life-history, so far as is known, *H. cunicularius* resembles *H. ater* except that spruce is its breeding host. The species is therefore important in the replanting of spruce areas or where spruce forms any considerable proportion of the crop felled.

The control measures given against *H. ater* apply to *H. cunicularius*, except that spruce billets must be used instead of pine in trapping.

*H. cunicularius* is widely distributed in Britain.

**Hylastes angustatus** Herbst.

Black, cylindrical. Length 3·5 mm.

This species occurs on pine in the south of England, but little is known concerning it. Nüsslin considers that it is not definitely distinct from *H. attenuatus* Er., and some support to his view is given by the fact that in traps set for *Hylastes* in the New Forest, of 43 beetles taken 41 were undoubtedly *H. attenuatus* and only two were *H. angustatus*. The question can be settled only by breeding experiments and comparison of long series of the beetles with authentic Continental specimens.

**Hylastes attenuatus** Er.

Elongate, cylindrical. Thorax black, wing-covers brown to dark brown. Length 2·5 mm.

This species, so far as is known, is strictly local in its occurrence, and may prove to be a recent addition to our bark-beetle fauna. Its life-history and habits are little known. It has been recorded only on Scots pine in Britain, and, like *H. ater*, it is a root breeder and also attacks young conifers. Control measures as for *H. ater* are applicable to this species.

**Hylastes opacus** Er.

Black, dull, stout cylindrical. Length 3·5 mm.

The life-history of this species is similar to that of *H. ater*. The egg-tunnels are smaller, corresponding with the smaller size of the beetle.

*H. opacus* is widely distributed in England and Wales, but does not occur in Scotland. It is frequently injurious in you g plantations formed on recently cleared pine ground, but is readily controlled by billet-traps.

## SUB-FAMILY IPINAE.

### Genus **Anisandrus** Ferr. Shot-hole Borer.

This genus contains one British species, *Anisandrus dispar* F., which was formerly included in the genus *Xyleborus* Eich. The females differ from *Xyleborus* in having the body very stout, the pro-thorax serrate on the front margin, and the scutellum always distinct and never depressed. (Compare Plate III, Figs. 2 and 4.)

*A. dispar* shows, as its name implies, marked disparity in the two sexes (Plate III, Figs. 1 and 2). The male is smaller than the female, depressed and wingless. The female is stout and cylindrical. Both are black or dark brown in colour. Length, male, 2½ mm.; female, 3–3½ mm.

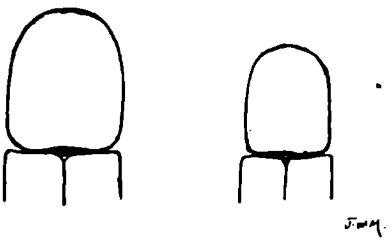
The life-history of *A. dispar* has been studied by various authors, in particular by Schneider-Orelli (1913), but is still incompletely known. The beetle belongs to the Ambrosia group and cuts its tunnels directly into the heart wood. Its best-known hosts are fruit-trees, especially plum and apple, but in our woodlands oak and holly are its usual hosts. The males are always scarcer than the females. Control measures against *A. dispar* consist in careful tree-pruning and cleaning of orchards and removal of dying or sickly trees. In forestry *Anisandrus* is of no importance. It is a southern species widely but locally distributed.

### Genus **Xyleborus** Eich.

This genus includes two species found in Britain, which may be distinguished as follows :—

(1) Scutellum distinctly visible (Fig. 25*a*).
*dryographus* Ratz.

(1*a*) Scutellum indistinct and markedly depressed (Fig. 25*b*).
*saxeseni* Ratz.



a b

FIG. 25. Pro-thorax and scutellum of *Xyleborus* : (a) *dryographus*, (b) *saxeseni*.

As in *Anisandrus*, which was formerly included in this genus, there is a marked difference in the sexes in *Xyleborus*.

The males are depressed or flat and smaller in size than the females.

### **Xyleborus dryographus** Ratz.

Female with the pro-thorax roundly domed in front, sparsely punctured behind with large punctures. Apical declivity of the wing-covers moderately steep. Male with the pro-thorax notched in front, with a small tubercle in the middle. Length 2–3½ mm.

This is the rarer of our two species. It is local in its occurrence but is probably more widely distributed than the records indicate. It occurs on oak and beech, where it cuts galleries somewhat resembling those of *Trypodendron* in pattern. (Strohmeyer, 1910.) *X. dryographus* occurs in Kent, Surrey, Sussex, Oxford and Monmouth.

### **Xyleborus saxeseni** Ratz.

This species is smaller than the last and may be distinguished by the indistinct scutellum and extremely finely punctured prothorax behind. Length 2–3 mm. In the male the anterior border of the pro-thorax is not notched (Fig. 25 and Plate III, Fig. 5).

*X. saxeseni* attacks oak, beech, sweet chestnut and other hardwoods, but it has also been found on pine in the Dean Forest by Mr. D. C. Fergusson and on the Continent it is well known as a conifer-dwelling beetle. Its egg-tunnels, or more properly its brood-tunnels, are peculiar, consisting of a narrow tunnel in the sapwood ending in a large excavation in which larvae, pupae and adults occur indiscriminately.

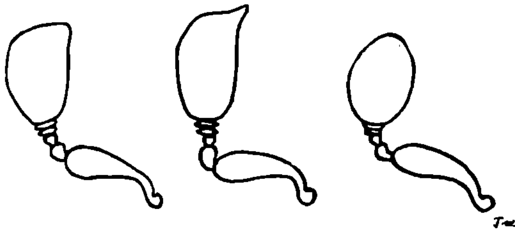
*X. saxeseni* is widely distributed in the south of England. It does not occur in Scotland.

In America the *Xyleborus* beetles are known as pin-hole borers and are often very destructive, but in Britain and in Europe generally they are of minor forest importance.

Genus **Trypodendron** Steph.

This genus, called by some authors *Xyloterus** Er., includes three British species, distinguished as follows :—

1. Antennal club straight on one side rounded on the other, and ending in a point (Fig. 26*b*).



*b* *c*

FIG. 26. Antennae of *Trypodendron*: (a) *quercus* (b) *domesticum*, (c) *lineatum*.

Pro-thorax thickly clothed with long hairs. Declivity of the elytra with a distinct furrow on each side of the suture.

*domesticum* L.

2. Antennal club straight on one side rounded on the other, but not produced into a point (Fig. 26*a* and Plate III, Fig. 4).

Pro-thorax sparsely clothed with hairs which are shorter. Furrows on the elytral declivity indistinct or absent.

*quercus* Eich. (= *signatum* F.)

3. Antennal club rounded at apex (Fig. 26*c*). No furrows on the elytral declivity. *lineatum* Ol.

**Trypodendron domesticum** L.

Thorax black, hairy; elytra yellow, with the sutures and lateral margins black. Length $2\frac{1}{2}$–$3\frac{1}{2}$ mm.

The life-history of the species has not been studied in Britain. On the Continent Trédl has studied both this species and *T.*

* The name *Trypodendron* is considered preferable to *Xyloterus*, which is apt to be confused with *Xyleborus*.

*quercus*. In *T. domesticum* there is apparently only one generation in the year.

The egg-tunnels of *T. domesticum* are cut in the sapwood and are, as in all the Ambrosia beetles, lined with fungus. The larvae live in cradles cut in the wood above and below the main tunnel.

This species is widely distributed in Britain. Its host plants are oak, beech, ash, alder, birch, hawthorn and other broad-leaved trees and shrubs. It is rarely sufficiently abundant to prove harmful.

**Trypodendron quercus** Eich.

Thorax black, not markedly hairy, often reddish at the base and on the margins ; elytra yellow or reddish yellow, with the suture and lateral margins narrowly black. Length 3–3½ mm. This species is found along with *T. domesticum* and, although considered rare, it is probably not uncommon, being confused with *domesticum* and so overlooked. Its distribution is not well known, but seems to be southern. According to Trédl (quoted by Escherich, *Forstinsekten*, Bd. II) there are two generations in the year. The host plants of this species are beech and oak and probably other broad-leaved trees and shrubs.

**Trypodendron lineatum** Ol.

Thorax black, not markedly hairy ; elytra reddish yellow, with the suture and margins, and a broad stripe between these, black. Length 2½–3 mm.

The life-history of this species is not fully known, although various authors have worked on it, chiefly from the point of view of its relations to the Ambrosia fungi. (Neger, Schneider-Orelli and others.) The species occurs only on conifers, pine, larch and spruce. It is rarely injurious. The egg and brood-tunnels resemble those of *T. domesticum* and *T. quercus*. *T. lineatum* is widely distributed in Britain.

Genus **Cryphalus** Er.

This genus contains two British species which may be distinguished as follows :

1. Wing-covers with long projecting hairs, rows of punctures indistinct. *piceae* Ratz.

1A. Wing-covers with short erect hairs, rows of punctures distinct, at least anteriorly. *abietis* Ratz.

These two species are extremely difficult to distinguish except in fresh or newly emerged specimens, and it is probable that they are confused in collections.

**Cryphalus abietis** Ratz.

Dark brown to black with distinct yellow scale-like hairs or scales. Length 1–2½ mm. (Plate III, Fig. 3.)

This would appear to be our commoner species. The life-history has been studied by Ritchie (1919) but his results are inconclusive. The host plants of *C. abietis* are silver fir, spruce, Douglas fir, and occasionally Scots pine. The egg-tunnel is an irregular cavity cut in the bark, frequently at the branch nodes. The larval tunnels are irregular.

*C. abietis* is of no economic importance in Britain. It is widely distributed in England and Scotland.

**Cryphalus piceae** Ratz.

Dark brown with the wing-covers often lighter in colour. Length $1\frac{1}{2}$–2 mm.

Little is known of this species in Britain and the records of its occurrence are few. It is probably more common than these records indicate.

On the Continent Nüsslin (1910) and Scheidter (quoted by Escherich in his *Forstinsekten*, Bd. II) have studied the biology of *C. piceae*. In Central Europe this species would seem to be injurious in silver fir forests, and is associated with the weevil *Pissodes piceae* and the bark-beetle *Pityokteines curvidens* in causing the death of middle-aged trees. It is probable that some other factor is at work in these cases, and the dying of the silver fir which has recently been extensive in the Frankenwald requires closer investigation (Scheidter, 1919).

The brood tunnels of *C. piceae* resemble those of *C. abietis*, but the former, in spite of its name, is almost exclusively a silver fir dweller.

Genus **Ernoporus** Thoms.

This genus contains two British species, distinguishable as follows :—

1. Asperities on the pro-thorax confined to the middle anterior region, forming well-defined concentric ridges (Fig. 21*b*, p. 42). Wing-covers $1\frac{1}{2}$ times longer than broad. Sutures of antennal club transverse. On lime. *tiliae* Panz.

1A. Asperities on the pro-thorax extending to the sides, ridges less definite (Fig. 21*a*, p. 42). Wing-covers $2\frac{1}{2}$ times longer than broad. Sutures of antennal club strongly curved. On beech. *fagi* F.

**Ernoporus tiliae** Panz.

Black. Length 1–$1\frac{1}{2}$ mm.

Little is known of this species in Britain. It cuts short, transverse egg-tunnels in the bast of lime branches, but appears fastidious in its choice of breeding ground. It is apparently very local in its occurrence, and is most frequent in the south-west of England, but has been recorded from Lincoln and Northumberland.

*E. tiliae* is of no forest importance.

**Ernoporus fagi** F.

Black. Length $1\frac{1}{2}$–$1\frac{3}{4}$ mm.

The narrow elongate form of this beetle readily distinguishes it from *E. tiliae*.

*E. fagi* has been studied on the Continent by Fuchs (1905). There are two generations in the year. The species occur only on beech branches and twigs already attacked by fungi. The brood galleries are seldom regular, and on small twigs are rarely to be obtained complete. The egg-tunnel is longitudinal and the larval tunnels are indistinct. The pupal chambers are cut in close proximity to the egg tunnel, and it is usually these two characters which compose the typical brood-gallery pattern.

*E. fagi* is local in its occurrence, but is more widely distributed than published records show. It is common in the southern counties of England in Essex, Herts, Berks, Bucks, Surrey, Sussex and Hampshire.

*E. fagi* is of no forest importance.

## Genus **Trypophloeus** Fairmaire.

Two species in this genus have been recorded in Britain, but only one appears to be definitely indigenous and established.

1. Wing-covers with rows of punctures more or less distinct. *granulatus* Ratz.

1A. Wing-covers with rows of punctures indistinct or obsolete. *binodulus* Ratz (= *asperatus* Gyll.)

**Trypophloeus granulatus** Ratz.

This species was recorded in 1867 from Surbiton, in Surrey, when a single specimen was found. Nothing further is known of it in Britain.

**Trypophloeus binodulus** Ratz.

Black, shining. Length 1·5–1·75 mm.

This species occurs on poplars. It attacks only dead branches which, owing to the rapid disintegration of the bast and bark, rarely show the pattern of the egg-tunnel. Little is known of this beetle in Britain. It is described by Fowler (*British Coleoptera*) as extremely rare, but it is probably more common than the records show. Its habitat in the tops of dying poplars renders it difficult to observe, and even when infested branches are found the flight or exit holes of the beetles are difficult to detect, or have gone with the outer bark.

*T. binodulus* is of no forest importance. It occurs chiefly in the south of England and Wales from Herts, west to Gloucester and Monmouth, but has been recorded doubtfully from the Manchester and Scarborough districts.

## Genus **Pityophthorus** Eich.

This genus contains two species which are recorded as British and distinguished as follows :—

1. Depressions or furrows on elytral declivity wide and deep, shining. *lichtensteinii* Ratz.

1A. Depressions or furrows on elytral declivity narrower and dull. *pubescens* Marsh (= *ramulorum* Perris.)

These beetles may be recognised by their small size and the narrow border at the base of the pro-thorax, which is strongly tuberculate and somewhat prolonged in front.

### **Pityophthorus lichtensteinii** Ratz.

This species, recorded as British by Sharp, is known only from the Dee and Moray districts of Scotland. Although careful search for it was made during a survey of forest insect conditions in Britain made in 1919 (Munro, 1920) all the *Pityophthorus* species collected proved to be *P. pubescens*, and it is evident that some specimens standing in collections as *P. lichtensteinii* are really *P. pubescens*, while others are females of *Pityogenes bidentatus*.

On the Continent *P. lichtensteinii* is a pine-dwelling species. Its brood galleries are of the stellate form usual among the polygamous species.

### **Pityophthorus pubescens** Marsh.

Pro-thorax brown to black, villose, wing-covers yellowish to reddish brown. Length 1½ mm. (Plate IV, Fig. 3.)

This species is common throughout Britain on the twigs of Scots pine. It is frequently associated with " wind scorching " in exposed situations, or with suppressed branches or, as at Dunkeld, Perthshire, with the fungi *Peridermium pini acicola* and *Hysterium pinastri*.

The brood tunnels consist as a rule of two longitudinal egg-tunnels leading in opposite directions into a central pairing chamber. Such tunnels are cut deeply into the wood of small twigs. The larval tunnels are cut in the bark and pupation takes place as a rule in the pith. The life-history is not known in detail.

*P. pubescens* was formerly considered rare in Scotland, but is in reality the common, if not the only, breeding species. Fowler (*British Coleoptera*) states that " the Scotch records (of *P. pubescens*) appear to apply to the preceding species " (*P. lichtensteinii*), but this is evidently a mistaken view, and indeed the reverse is correct.

*P. pubescens* may be injurious in young plantations when drought reduces the vigour of recently planted pines or where pines have suffered a check through injuries caused by the pine weevil, *Hylobius*, or the bark-beetle, *Hylastes*.

## Genus **Pityogenes** Bedel.

This genus is to be distinguished from *Pityophthorus* by the larger size of the beetles, the absence of a raised border at the base of the pro-thorax and the occurrence of teeth or projections on the apical declivity of the wing-covers in the male beetles. Four species of *Pityogenes* have been recorded in Britain in which the males can be distinguished as follows :—

1. Apical declivity with a depression or furrow on each side of the suture, on the outer rim of which are three teeth.

2. Rows of punctures on the wing-covers distinct. *trepanatus* Nördl.

2A. Rows of punctures on the wing-covers indistinct or obsolete. *chalcographus* L.

1A. Apical declivity slightly excavated and armed at each side with a strong hooked tooth.

3. Apical declivity with an additional small tooth below the hook (Fig. 27). *quadridens* Hart.

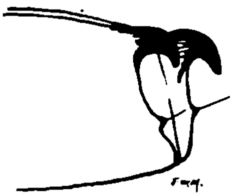


FIG. 27. Elytral declivity of *Pityogenes quadridens*.

3A. Apical declivity with no additional tooth below the hook (Fig. 28). *bidentatus* Herbst.

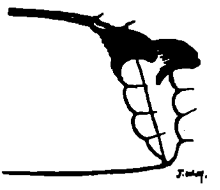


FIG. 28. Elytral declivity of *Pityogenes bidentatus*.

**Pityogenes trepanatus** Nördl.

A single specimen of this species was taken by Dr. Joy in 1909 at Blair Atholl, Perthshire. Nothing further is known of the species in Britain.

**Pityogenes chalcographus** L.

Thorax brown to black, wing-covers reddish. Length 1½–2 mm. (Plate IV, Fig. 2.)

The life-history of this species is not known in detail for British conditions. In Central Europe under favourable weather conditions there are, according to Hennings, two generations in the year. The brood gallery of *P. chalcographus* is peculiar. It is three- to five-armed, but as the pairing chamber is cut in the bast it does not show either on the wood or on the bark (Plate X, Fig. 3.) Spruce is the main host tree of *chalcographus*, but pine is also attacked.

*P. chalcographus* is known as a breeding species only near Dunkeld in Perthshire, where it was first found in 1919 (Munro, 1920). It is frequently introduced into Britain on imported spruce poles and pit props.

Nothing is known so far of its importance in forestry, but it may prove injurious in the Perthshire district in years when spruce is defoliated by the Spruce Aphis (*Aphis abietina* Walker). Doubtless with the extensive planting of spruce *P. chalcographus* will extend its range.

**Pityogenes bidentatus** Herbst. Two-toothed Pine Beetle.

Pro-thorax brown to black, wing-covers reddish brown to black. Declivity of female arched, not armed with teeth. Length 1½–3 mm.

The life-history of this species has not been studied in detail in Britain. In the south of England there may be three broods in the year under favourable weather conditions, but in the northern counties and in Scotland two would appear to be the normal. The host trees are Scots pine, spruce, larch, silver fir, Thuja, Douglas fir and Cupressus, but Scots pine and spruce are the main breeding hosts. The brood tunnels are stellate, three- to five-armed, and the pairing chamber is usually clear-cut and distinct (Plate X, Fig. 2). The larval tunnels vary in length with the condition and size of the stem or branch in which they are cut.

At times *P. bidentatus* is harmful in young plantations. The beetles attack the less vigorous plants or young trees in the region of the branch whorls and are able to work in comparatively green and resinous material.

The main breeding ground of *P. bidentatus* is the slash left after felling, on which the beetles breed freely. Fortunately, the thin-barked branches which this species selects soon dry and this, together with a large number of natural enemies, both Coleopterous and Hymenopterous, prevents *P. bidentatus* from being seriously harmful. Of the predaceous beetles, *Rhizophagus dispar* and *R. ferrugineus* and, in the southern counties of England, *Hypophloeus linearis* F. (Plate V, Fig. 5) are the most important. Among the Hymenoptera several species of Braconid and Proctotrypid wasps are the most frequent enemies of *Pityogenes*. The larvae of these tiny wasps are to be found in the pupal beds of the *Pityogenes* larvae in most brood galleries, and may be recognised by their shining white bodies, which contrast with the yellowish white bodies of the bark-beetle grubs. These parasitic larvae are moreover to be recognised by the very small, almost indiscernible head which is never strongly chitinised.

Control measures against *Pityogenes bidentatus* consist in early removal or burning of slash, regular cleaning of dead or dying trees in young stands, and trapping of the beetles with pine branches.

*P. bidentatus* is widely distributed in Britain. A variety of the type species is not uncommon. It differs from the type in having a small tooth at the top of the apical declivity. This variety is known to Continental authors as *P. bidentatus* var. *β*.

A useful description of *P. bidentatus* and *P. quadridens* and their varieties has been given by Fraser (1920).

**Pityogenes quadridens** Hart.

Smaller and more elongate than *P. bidentatus* and differing in the possession of a small tooth below the hook. Length 1½–2 mm.

In habits and general life-history this species resembles *P. bidentatus*. Its distribution is much more limited, as described on p. 13.

A variety of this species corresponding to the variety *β*. of *P. bidentatus* is not uncommon. It differs from the type in possessing a small tooth behind the hooked tooth on each wing-cover. This variety is given specific rank by some authors and is known as *P. bistridentatus* Eich.

Genus **Taphrorhychus** Eich.

Two species of *Taphrorhychus* have been recorded in Britain, but of the second species only one specimen has been found. They may be distinguished as follows :—

1. Declivity of elytra without rows of small tubercles. *bicolor* Herbst.

1A. Declivity of elytra with three distinct rows of tubercles. *villifrons* Dufour.

**Taphrorhychus bicolor** Herbst.

Dark brown to black, with long yellow hairs in rows on the wing-covers. Female with a circular tuft of hairs on the forehead or frons. Length 2–2½ mm.

*T. bicolor* is an oak and beech dweller. It cuts a double longitudinal egg-tunnel which, when regular, is shaped like a tuning-fork. Little is known in Britain of the species, which is southern and local in its distribution. Its main breeding ground is Epping Forest, in Essex, but the species also occurs in Kent. It is of no forest importance.

The name *bicolor* is confusing, as this species is uniformly dark brown or black in colour.

**Taphrorhychus villosus** Dufour.

A single specimen of this species has been recorded by Donisthorpe (*Entomologist's Record*, Vol. XXXV, No. 9, 1924) from Ruislip, Bucks, on oak. Nothing further is known of it.

## Genus **Xylocleptes** Ferr.

This genus contains the single European species, *Xylocleptes bispinus* Duft.

This species in the male sex seems allied to *Taphrorhychus* and *Pityogenes*; in the female sex to *Dryocaetes*. It is brown to dark brown in colour—the male with the pro-thorax broadly rounded in front and asperate anteriorly; the elytra excavate at the apex and armed with a short tooth; the female has the thorax rugose anteriorly and the apical declivity of the wing-covers abrupt but not excavated. Length 2–3½ mm.

*Xylocleptes* lives solely on *Clematis vitalba*, and its distribution corresponds probably with that of its host. It is a southern species.

## Genus **Ips** De Geer.

This genus, formerly known as *Tomicus* Latreille, contains six species recorded as British. Of these at least two are doubtfully indigenous. The species are as follows :—

1. Apical declivity of elytra gradual, oblique, occupying the apical third of the wing-covers, the teeth confined to the margins of the declivity, not occurring between these and the suture (Figs. 29–31).

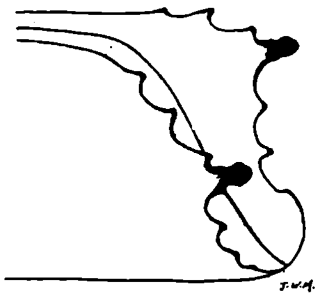


FIG. 29. Elytral declivity of *Ips sexdentatus*.

2. Elytral declivity with six teeth on each margin, the fourth being the largest (Fig. 29). Large beetles, 6–7 mm.

*sexdentatus* Boern.

2A. Elytral declivity with four teeth on each margin, the third being the largest (Fig. 30). Medium-sized beetles, $4\frac{1}{2}$–5 mm. *typographus* L.

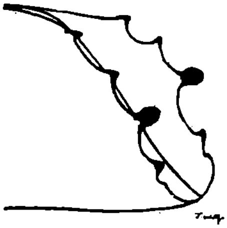


FIG. 30. Elytral declivity of *Ips typographus*.

2B. Elytral declivity with three teeth on each margin, the lowest being the largest (Fig. 31). Small beetles, $2\frac{1}{2}$–$3\frac{1}{2}$ mm. *acuminatus* Gyll.

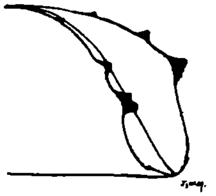


FIG. 31. Elytral declivity of *Ips acuminatus*.

1A. Apical declivity abrupt and steep. Excavation oval. Teeth on declivity not confined to the margins of the excavation, but also occurring between these and the suture (sutural teeth) (Fig. 32). Sub-genus *Orthotomicus* Ferr.

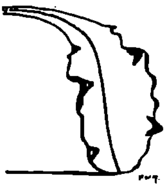


FIG. 32. Elytral declivity of *Ips laricis*.

3. Excavation of declivity elongate oval. *suturalis* Gyll. ( = *nigritus* Gyll.)

3A. Excavation of declivity roundly oval.

4. Second tooth from above rectangular. *erosus* Woll. ( = *rectangulus* Eich.)

4A. Second tooth from above pointed conical. *laricis* F.

Of these six species the last three (*Orthotomicus* or *laricis* group) are most difficult to distinguish, and unless the student is familiar with all three species he will do well to consult a good, authentic collection. The only common species in the group is *laricis*, and unless the student is working in the Forest of Dean or on imported timber he is unlikely to meet with the other two species. *Ips suturalis* has been taken only on two occasions by the late Dr. Sharp in Scotland, and has not been seen since. *Ips erosus* is a Mediterranean species, imported in pit props into the Forest of Dean, and is not known to occur elsewhere in Britain.

Of the other three species *Ips acuminatus* alone is widely distributed.

**Ips sexdentatus** Boern.

The largest of our Ipinae. Brown to black, readily recognised by its large size and numerous apical teeth.

This species is frequently found in imported pine timber and occurs as a breeding species in the Forest of Dean. Its egg-tunnels are stellate and very long; the larval tunnels, on the other hand, are very short. Nisbet (*The Forester*) states that the species occurs in Scotland where the generation " is simple and annual " ! There is nothing further known concerning it in Britain. On the Continent *Ips sexdentatus* is a common pine species in South Europe, but it is always secondary in its attacks.

**Ips typographus** L.

Readily distinguished from *sexdentatus* by its smaller size and the four teeth on each wing-cover.

This species is not established in Britain but occasionally occurs on imported spruce timber. It is the most injurious of the European bark-beetles and, next to the Nun moth, is the chief insect enemy of the spruce forests. The brood tunnels are stellate, two- to five-armed, the arms running in a longitudinal, never in a transverse, direction. Two-armed tunnels are the more common. There are, under favourable conditions, two generations in the year. The usual host is spruce, but pine and larch are also attacked.

The most important feature of *Ips typographus* is its ability to attack trees but slightly reduced in vigour, that it is almost primarily injurious. It has been included here because with the extension of our spruce forests the species, frequently introduced in imported timber, may become established in Britain and prove of considerable importance.

**Ips acuminatus** Gyll.

Light brown to dark brown, readily recognised by the three teeth on each wing-cover, the lowest of which is largest (Plate IV, Fig. 1).

The biology of *Ips acuminatus* has not been studied in detail in this country. The beetles cut stellate tunnels in the thinner-barked portions of pine stems and branches (Plate X, Fig. 1).

*Ips acuminatus* occurs commonly in Scotland and in Northumberland and Durham ; south of this it is replaced by *Ips laricis.* The species is of merely secondary importance.

**Ips suturalis** Gyll.

Except that the late Dr. Sharp has recorded this species from Moray and Inverness under the name of *nigritus* Gyll., nothing is known of it in Britain.

**Ips erosus** Woll.

This species, whose normal range is the Mediterranean region, has been imported in pit props into the Dean Forest, where for a time at least it succeeded in breeding on slash from pine fellings. It was first recorded as British by Atkinson in the *Entomologist's Monthly Magazine* of November, 1921. Nothing further is known of the species in Britain.

**Ips laricis** F.

Brown to black, 3½–4½ mm. long, readily distinguished from *I. acuminatus*, our only other common species, by its cylindrical form, steep declivity and well marked rows of punctures on the wing-covers.

The biology of *Ips laricis* has been studied in detail by Atkinson (unpublished MSS.). The egg-tunnels are unique among the *Ips* species, consisting of short tunnels opening into a wide cavity in which the eggs are laid in clusters. There are two broods in the year. Despite its name, *Ips laricis* breeds most commonly on pine and only rarely on larch. It is the common *Ips* south of Northumberland and Durham. It is of little economic importance.

### Genus **Lymantor** Löw.

This genus was formerly included in *Dryocaetes* Eich, from which it is distinguished, however, by the broadly rounded thorax, which is asperate in front and finely, not rugosely, punctured behind. It contains the single British species *Lymantor coryli* Perris.

**Lymantor coryli** Perris.

Elongate, reddish brown to black, 1½–2 mm. long.

This species occurs on hazel and hornbeam, but is very rare. It was formerly found at Darenth in Kent. It has also been found at Ashtead and at Coombe Wood, Wimbledon, in Surrey and at Kidderminster in Worcestershire. Little is known of the species in Britain.

### Genus **Dryocaetes** Eich.

This genus contains three British species, distinguished as follows :—

1. Declivity of elytra with sutural striae depressed, forming a furrow on each side of the suture, which is raised. Beetles smaller, 2–3 mm.

2. Body clothed with long, erect yellow hairs. On oak and chestnut. *villosus* F.

2A. Body clothed with short hairs. On alder. *alni* Georg.

1A. Sutural striae not depressed, suture not raised. Beetles larger, 4–5 mm. On spruce and pine. *autographus* Ratz.

**Dryocaetes villosus** F.

Brown to black, with long yellow hairs. Length 2½–3½ mm.

The life-history of *D. villosus* has not been studied in Britain nor by Continental workers. It cuts its egg-tunnels in the thick bark of oak and sweet chestnut. These are stellate, the arms connected not by a wide pairing chamber but by a narrow tunnel, and running transversely. The dust thrown out by the beetles in boring is extremely fine and always brown in colour. *D. villosus* is especially common on dying park oaks, but is of no economic importance.

It is widely distributed in England and Wales but does not occur in Scotland.

**Dryocaetes alni.**

Brown to black, clothed with short yellow hairs. Length 2½–3¾ mm.

The life-history of this species has not been studied, and little is known concerning it. The species is considered rare, but it is probable that it is more widely distributed than the existing records show. In England it has been recorded from the vicinity of Birmingham and Manchester and in Surrey. Chrystal (1922) found the species breeding in dead alder trees at Cockburnspath in Berwickshire.

**Dryocaetes autographus** Ratz.

Our largest species. Brown to dark brown in colour, clothed with moderately long pale yellow hairs. Length 3½–4 mm. (Plate IV, Fig. 5).

*D. autographus* breeds chiefly in dead spruce stems of which the bark is sodden and invaded by fungus mycelium. It occurs rarely on pine (Dupplin, Perthshire). The egg-tunnels are irregular, sometimes hook-shaped, sometimes more or less straight and simple, but always wide across. The eggs are laid in groups separated at some distance from one another. The species is sometimes associated with *Hylurgops palliatus* and rarely with *Hylastes cunicularius* (Ballogie, Kincardineshire), but as a rule it breeds in material which other bark-beetles have abandoned. It appears to be a northern species, the only English records being from Northumberland and Yorkshire. In Scotland it is local in its occurrence, but widely distributed.

## APPENDIX I.

### List of British Bark-beetles arranged according to Host Plants.

Full accounts of the host plants of the European bark-beetles have been given by Eichhoff (1881), Trédl (1907) and Kleine (1909). In the following list only the common broad-leaved and coniferous trees are given, but generally, species attached to Scots pine also inhabit other pines, e.g., *Pinus Laricio* and *Pinus Strobus*. So too with the spruces, species inhabiting Norway spruce also occur on other spruces, e.g., *Picea sitchensis* and *Picea alba*. Of the other conifers, such as Douglas fir, Lawson's cypress and *Tsuga* and *Thuja* species, little is yet known concerning the bark-beetle fauna they may support, because so far these exotic species are too restricted in extent of planting to afford such breeding grounds as our Scots pine and spruce woods offer.

It may be noted that among our broad-leaved trees sycamore, maple, willows and horse-chestnut have not so far been found to afford breeding ground for bark-beetles, although in Europe the willows sometimes support a bark-beetle fauna similar to that of the poplars and sycamore is attacked by at least two species. It is probable that the hornbeam under conditions favourable to the beetles will show the same species attacking it as occur on beech, and in Europe it also supports a species of *Scolytus* (*S. carpini*) peculiar to it.

In the list given below the host plants serve as breeding hosts. Such species as *Hylastes ater* and *Hylastes opacus* feed on many coniferous trees.

*Broad-leaved Trees.*

| | |
|---|---|
| Alder (*Alnus* spp.) .. .. .. | *Dryocaetes alni.* |
| Ash (*Fraxinus excelsior*) .. .. | *Hylesinus fraxini.* |
| | *Hylesinus crenatus.* |
| | *Hylesinus oleiperda.* |
| | *Platypus cylindrus.* |
| | *Trypodendron domesticum.* |
| | *Xyleborus saxeseni.* |
| Beech (*Fagus sylvatica*) .. | *Dryocaetes alni.* |
| | *Taphrorhychus bicolor.* |
| | *Trypodendron domesticum.* |
| | *Xyleborus saxeseni.* |
| | *Platypus cylindrus.* |
| | *Ernoporus fagi.* |
| Birch (*Betula* spp.) .. | *Scolytus ratzeburgi.* |
| | *Trypodendron domesticum.* |
| Elm (*Ulmus* spp.) .. | *Scolytus destructor.* |
| | *Scolytus multistriatus.* |
| | *Pteleobius vittatus.* |
| Lime (*Tilia* spp.) .. | *Ernoporus tiliae.* |
| Oak (*Quercus* spp.) .. | *Scolytus intricatus.* |
| | *Dryocaetes villosus.* |
| | ? *Taphrorhychus villosus.* |
| | *Trypodendron domesticum.* |
| | *Trypodendron quercus.* |
| | *Anisandrus dispar.* |
| | *Xyleborus saxeseni.* |
| | *Xyleborus dryographus.* |
| | *Platypus cylindrus.* |
| Poplar (*Populus* spp.) .. .. | *Trypophloeus binodulus.* |
| | *Trypophloeus granulatus.* |
| | *Trypodendron domesticum.* |
| Spanish Chestnut (*Castanea vesca*) .. | *Dryocaetes villosus.* |
| | *Xyleborus saxeseni.* |
| | *Trypodendron domesticum.* |
| | *Platypus cylindrus.* |

*Fruit-trees and Shrubs.*

| | |
|---|---|
| Apple, Pear, Plum, Cherry (*Pyrus* and *Prunus* spp.) .. .. .. | *Scolytus rugulosus.*<br>*Scolytus pruni.*<br>*Xyleborus saxeseni.*<br>*Anisandrus dispar.* |
| Hazel (*Corylus avellanae*) .. .. | *Lymantor coryli.* |
| Lilac (*Syringa vulgaris*). .. .. | *Hylesinus fraxini.* |
| Hawthorn (*Crataegus* spp.) .. .. | *Trypodendron domesticum.* |
| Holly (*Ilex* spp.) .. .. .. .. | *Anisandrus dispar.* |
| Broom (*Cytisus scoparius*) .. .. | *Phloeophthorus rhododactylus.*<br>*Hylastinus obscurus.* |
| Whin or Gorse (*Ulex* spp.) .. .. | *Phloeophthorus rhododactylus.*<br>*Hylastinus obscurus.* |

*Climbing Plants.*

| | |
|---|---|
| Clematis (*Clematis vitalba*) .. .. | *Xylocleptes bispinus.* |
| Ivy (*Hedera helix*) .. .. .. | *Cissophagus hederae.* |

*Conifers.*

| | |
|---|---|
| Scots pine (*Pinus sylvestris*) .. .. | *Myelophilus piniperda.*<br>*Myelophilus minor.*<br>*Hylastes ater.*<br>*Hylastes opacus.*<br>*Hylastes angustatus.*<br>*Hylastes attenuatus.*<br>*Hylurgops palliatus.*<br>*Pityophthorus pubescens.*<br>? *Pityophthorus lichtensteinii.*<br>*Pityogenes bidentatus.*<br>*Pityogenes quadridens.*<br>*Ips acuminatus.*<br>*Ips sexdentatus.**<br>*Ips laricis.*<br>? *Ips suturalis.*<br>*Ips erosus.**<br>*Trypodendron lineatum.*<br>*Xyleborus saxeseni.* |
| Spruce (*Picea excelsa*) .. .. .. | *Hylastes cunicularius.*<br>*Hylurgops palliatus.*<br>*Pityogenes chalcographus.*<br>*Pityogenes bidentatus.*<br>*Dryocaetes autographus.*<br>*Trypodendron lineatum.*<br>*Cryphalus abietis.* |
| Larch (*Larix* spp.) .. | *Myelophilus piniperda.*<br>*Ips laricis.*<br>*Ips acuminatus.*<br>*Pityogenes bidentatus.*<br>*Cryphalus abietis.* |
| Silver fir (*Abies pectinata*) .. | *Cryphalus abietis.*<br>*Cryphalus piceae.*<br>*Pityogenes bidentatus.* |
| Douglas fir (*Pseudotsuga* spp.) .. .. | *Pityogenes bidentatus.*<br>*Ips acuminatus.*<br>*Cryphalus abietis.* |
| *Chamaecyparis Lawsoniana* .. .. | *Pityogenes bidentatus.* |
| *Thuja orientalis* .. .. .. | *Phloeosinus thujae.* |

* Known as breeding species only in the Forest of Dean.

? Not known as breeding species.

## APPENDIX II.

### Bibliography.

The literature on the bark-beetles is very extensive, but full references to it have been published by Trédl and Kleine (1911), with additional lists by Kleine (1915 and 1923). The following list refers only to those papers consulted in preparing this Bulletin. For further references the reader should consult Trédl and Kleine's lists and the works of Hopkins (1909 and 1915) and Escherich (1923). Much of the literature relating to the bark-beetles is scattered in many journals dealing with forestry, entomology, pure and applied, and zoology. For current literature the *Entomologist's Monthly Magazine*, the *Entomologist's Record*, the *Review of Applied Entomology*, published monthly in London by the Imperial Bureau of Entomology, and the Insect Section of the *Zoological Record*, which is published annually by that Bureau, should be consulted.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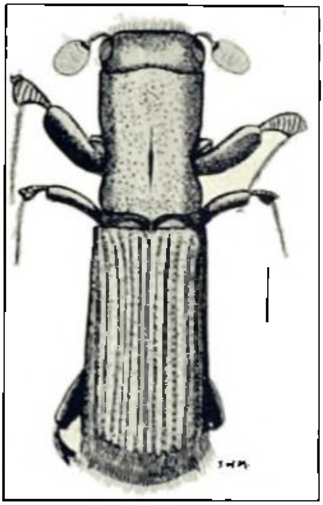


FIG. 1. *Platypus cylindrus.*

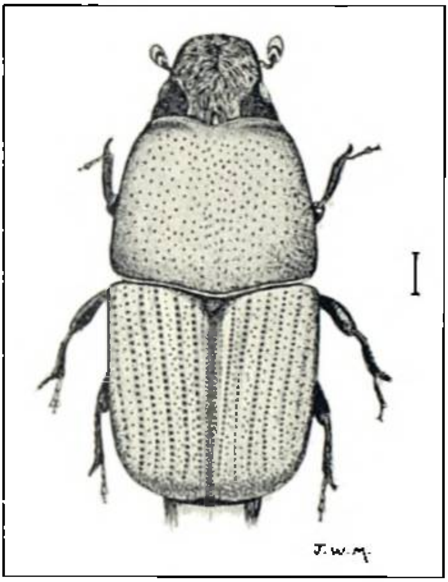



FIG. 2. *Scolytus destructor.*

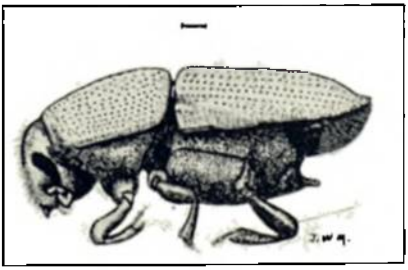



FIG. 3. *Scolytus multistriatus.*

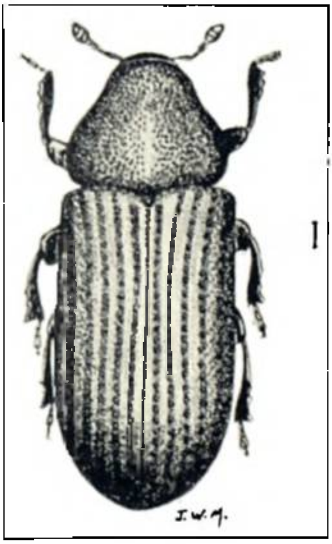



FIG. 4. *Hylurgops palliatus.*

PLATE II.

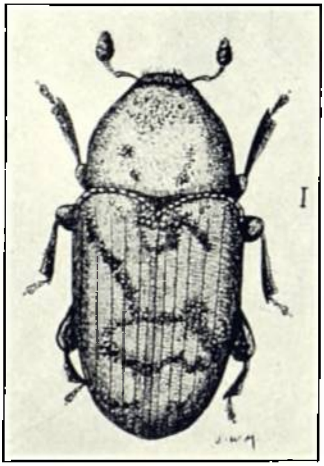


FIG. 1. *Hylesinus fraxini.*

FIG. 2. *Myelophilus minor.*

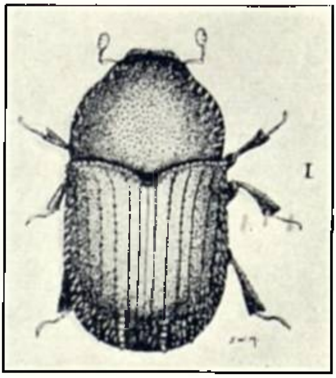


FIG. 3. *Phloeosinus thujae.*

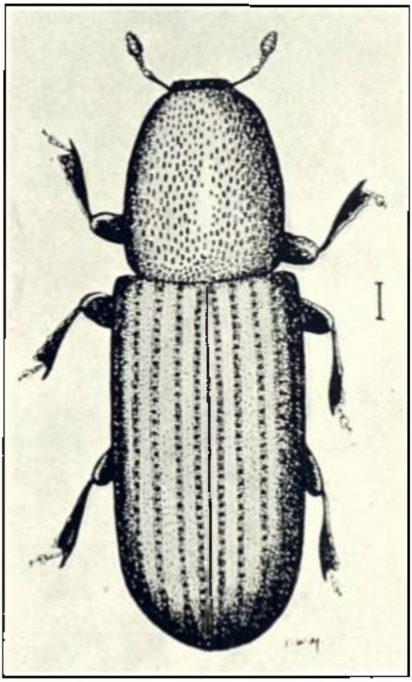


FIG. 4. *Hylastes ater.*

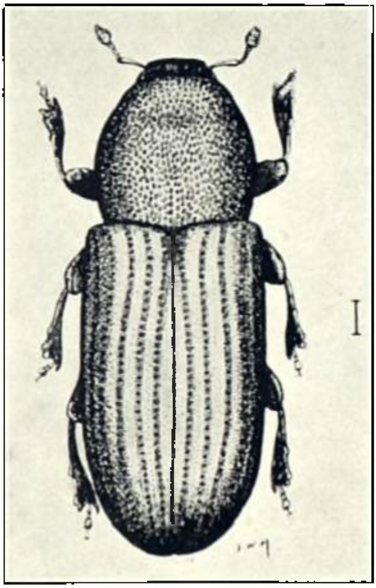


FIG. 5. *Hylastes cunicularius.*

PLATE III.

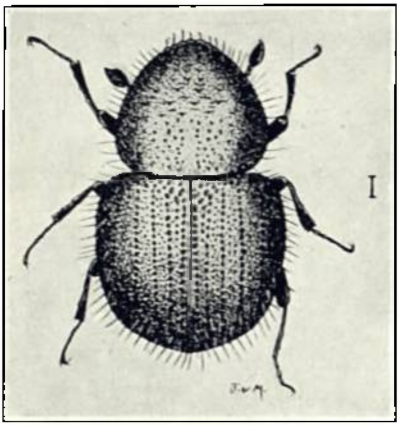


FIG. 1. *Anisandrus dispar* (male).

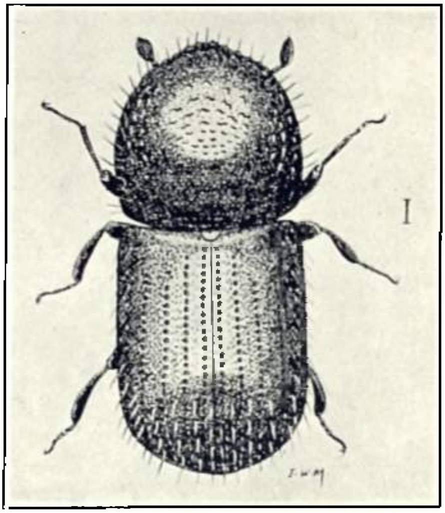


FIG. 2. *Anisandrus dispar* (female).

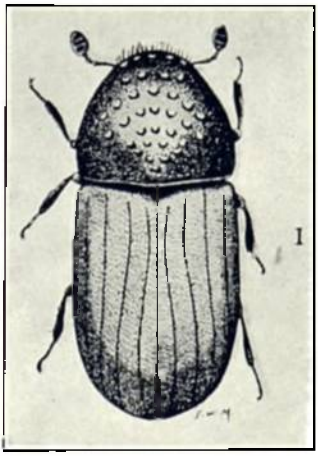


FIG. 3. *Cryphalus abietis*.

PLATE III—*continued.*

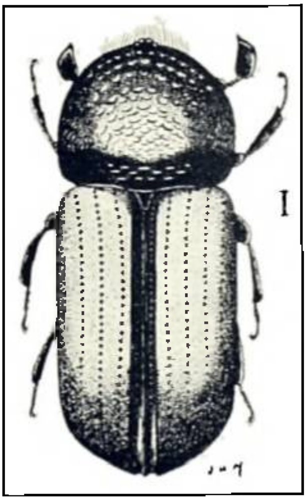


FIG. 4. *Trypodendron domesticum.*

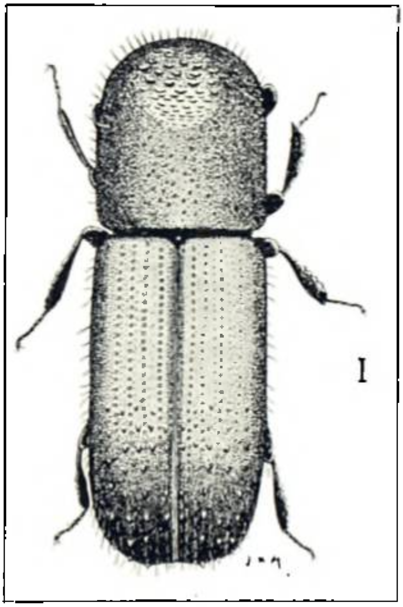


FIG. 5. *Xyleborus saxeseni.*

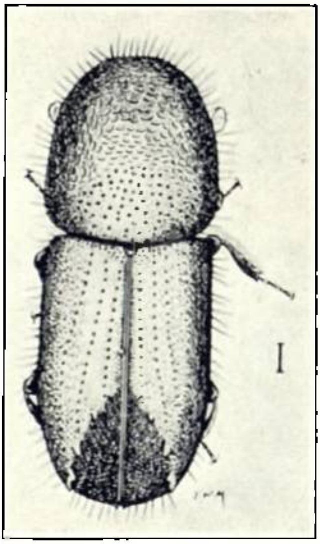


FIG. 1. *Ips acuminatus.*

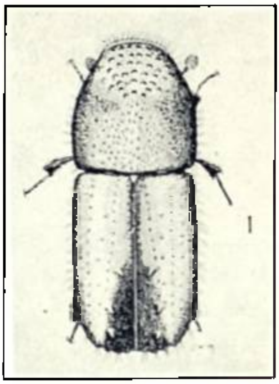


FIG. 2. *Pityogenes chalcographus.*

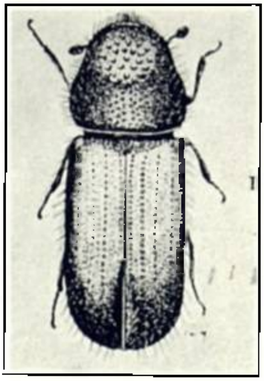


FIG. 3. *Pityophthorus pubescens.*

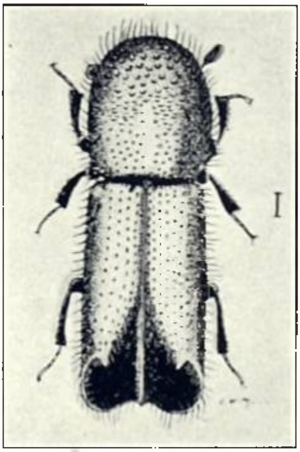


Fig. 4. *Xylocleptes bispinus*.

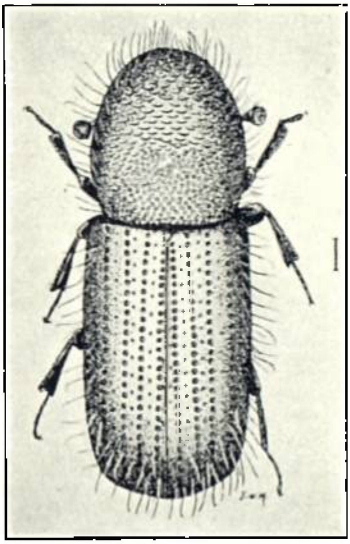


Fig. 5. *Dryocaetes villosus*.

PLATE V.

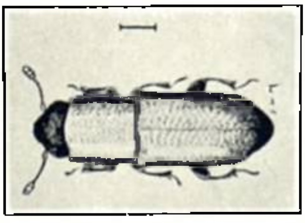


FIG. 1. *Pityophagus ferrugineus.*

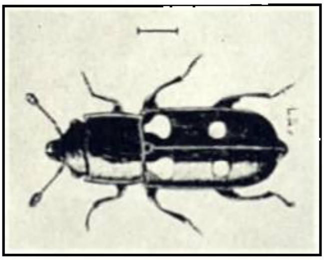


FIG. 2. *Glischrochilus quadripustulatus.*

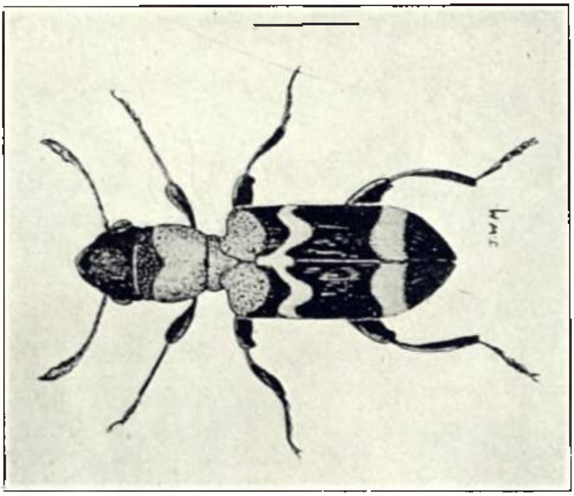


FIG. 3. *Clerus (Thanasimus) formicarius.*

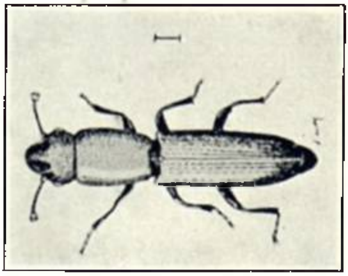


FIG. 4. *Rhizophagus dispar.*

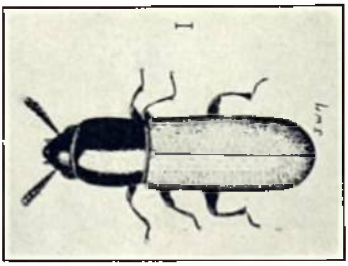
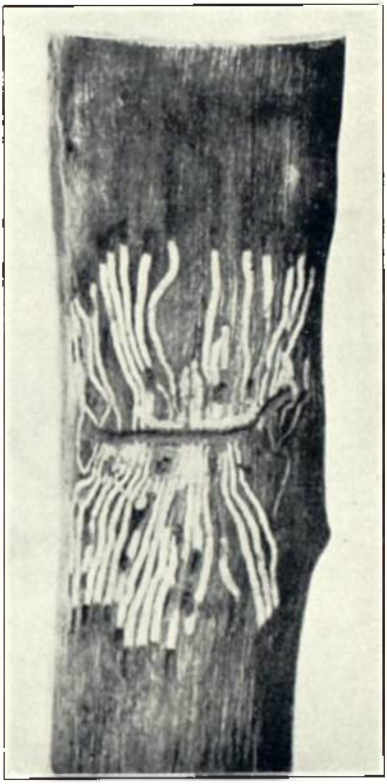


FIG. 5. *Hypophlœus linearis.*

PLATE VI.

*a*



*b*

Galleries of (*a*) *Pissodes pini* and (*b*) *Hylesinus fraxini*.

PLATE VII.

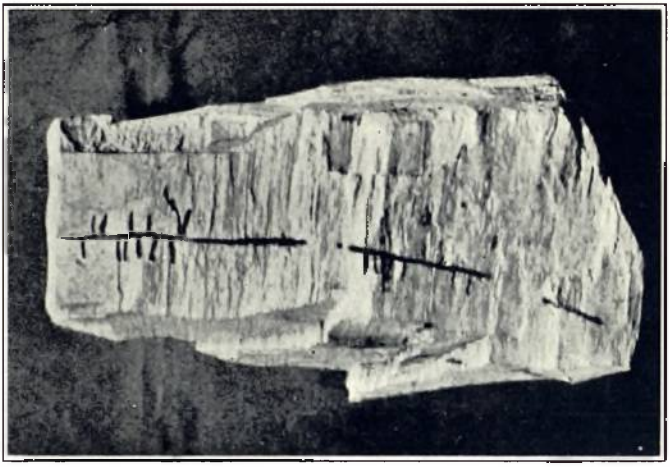


Fig. 1. Galleries of *Platypus cylindrus*.

Fig. 2. Galleries of *Scolytus intricatus*.

PLATE VII—*continued.*

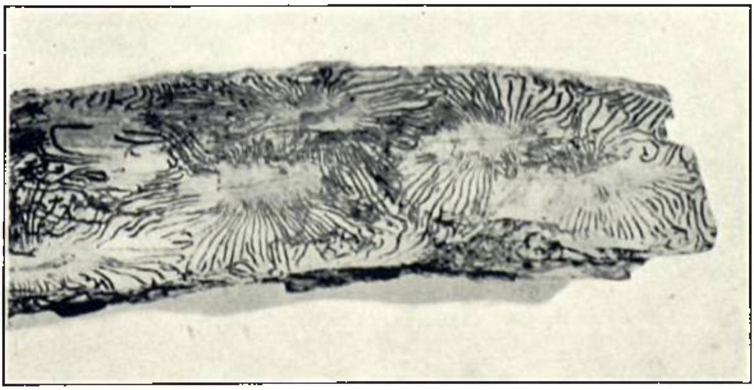


FIG. 3. Galleries of *Scolytus multistriatus.*

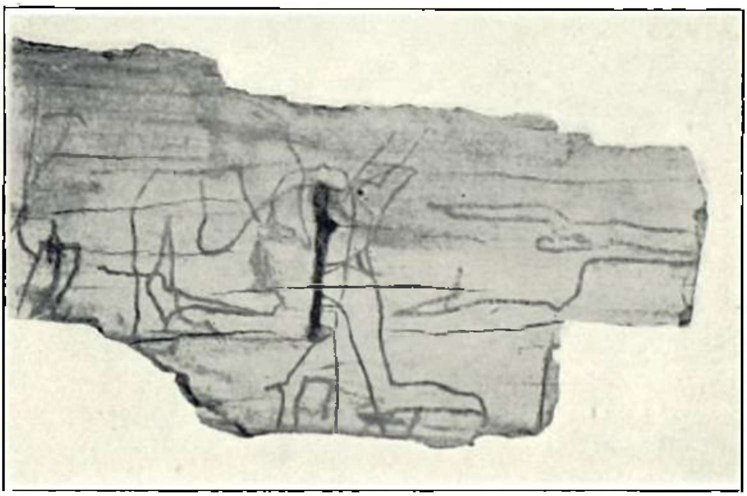


FIG. 4. Galleries of *Hylesinus crenatus.*

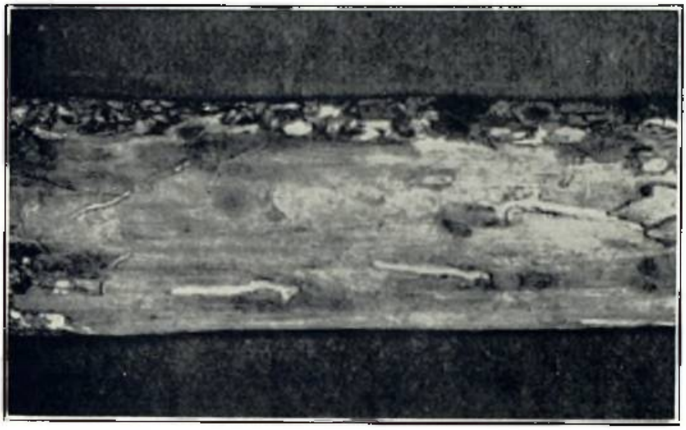


FIG. 5. Mother galleries of *Hylurgops palliatus.*

FIG. 1. Exit and ventilation holes of *Scolytus ratzeburgi*.

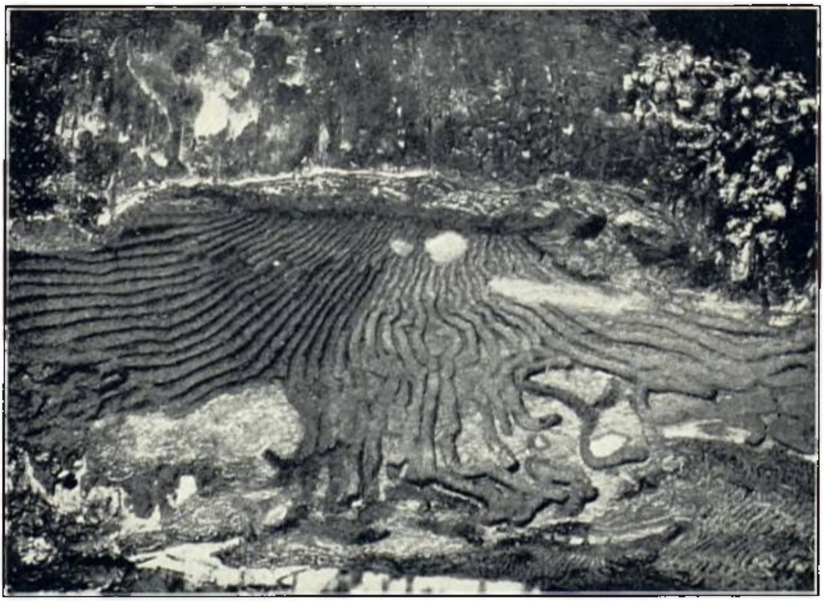


FIG. 2. Galleries of *Scolytus ratzeburgi*.

PLATE IX.

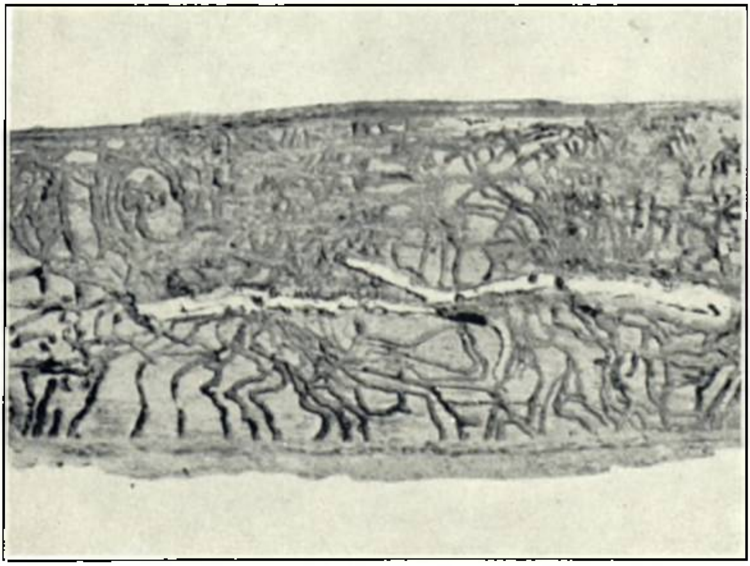


FIG. 1. Galleries of *Myelophilus piniperda.*

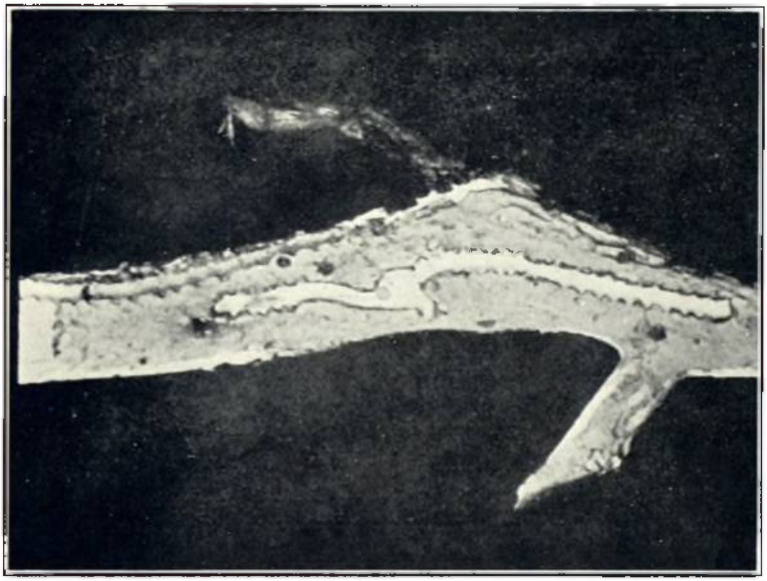


FIG. 2. Galleries of *Phloeosinus thujae.*

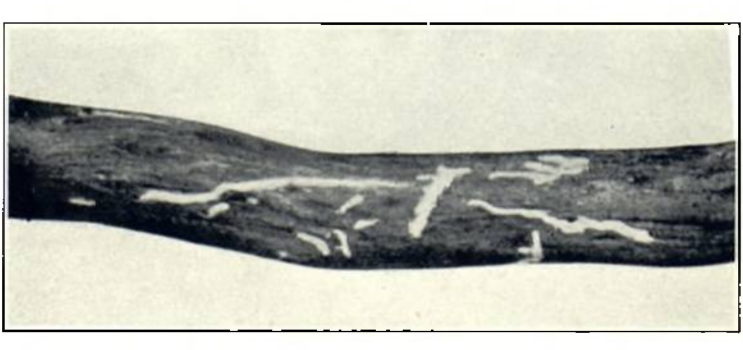


FIG. 3. Galleries of *Cissophagus hederae.*

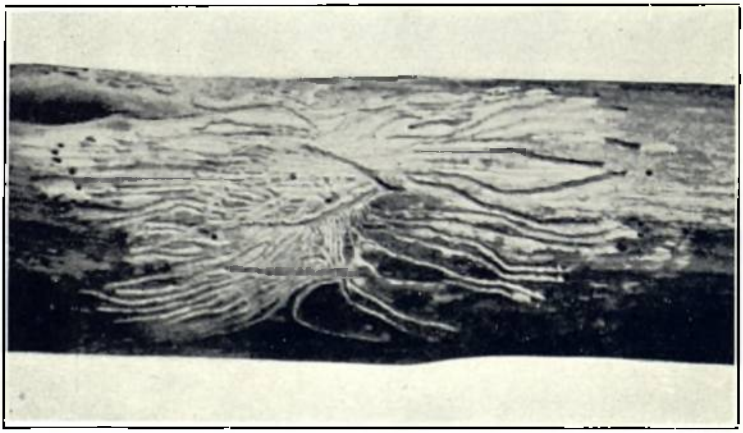


FIG. 4. Galleries of *Phloeophthorus rhododactylus.*

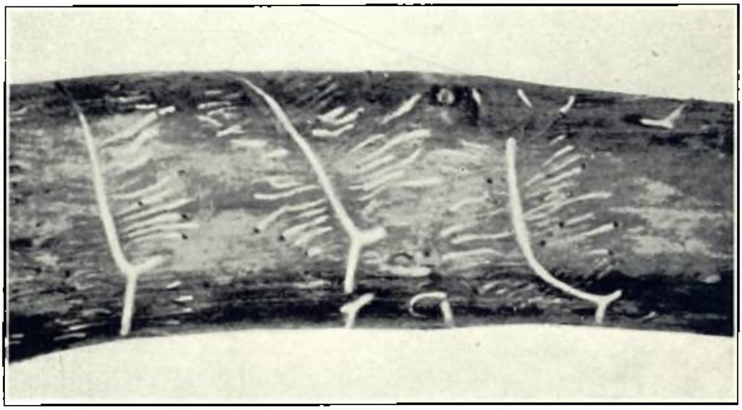


FIG. 5. Galleries of *Myelophilus minor.*

PLATE X.

Fig. 1. Galleries of *Ips acuminatus*.

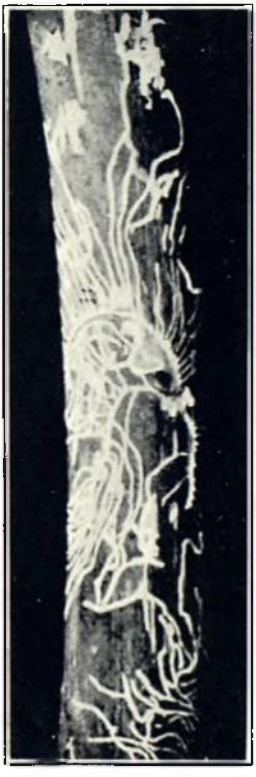


Fig. 2. Galleries of *Pityogenes bidentatus*

FIG. 3. Galleries of *Pityogenes chalcographus.*

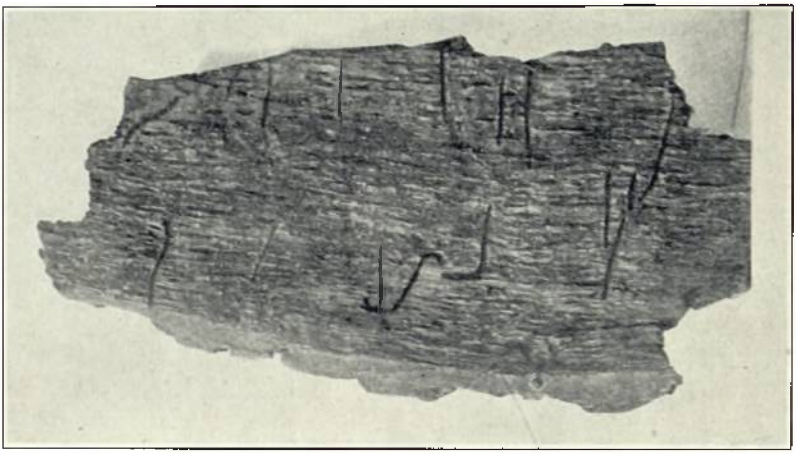


FIG. 4. Galleries of *Dryocaetes villosus.*

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