



FORESTRY COMMISSION

BULLETIN No. 9

**BETTER INJURIOUS
TO TIMBER**

BY

J. W. MUNRO,
Hon. M.A. (Oxon), D.Sc. (Edin.).

LONDON:

PUBLISHED BY HIS MAJESTY'S STATIONERY OFFICE

To be purchased directly from H.M. STATIONERY OFFICE at the following addresses:
Adastral House, Kingsway, London, W.C. 2; 120, George Street, Edinburgh;
York Street, Manchester; 1, St. Andrew's Crescent, Cardiff;
15, Donegall Square West, Belfast;
or through any Bookseller.

1928.

Price 1s. 3d. Net.

70—31—9

Forestry Commission
ARCHIVE



FORESTRY COMMISSION
BULLETIN No. 9

BETTER INJURIOUS
TO TIMBER

BY

J. W. MUNRO,
Hon. M.A. (Oxon), D.Sc. (Edin.).

LONDON:

PUBLISHED BY HIS MAJESTY'S STATIONERY OFFICE

To be purchased directly from H.M. STATIONERY OFFICE at the following addresses:
Astral House, Kingsway, London, W.C. 2; 120, George Street, Edinburgh;
York Street, Manchester; 1, St. Andrew's Crescent, Cardiff;
15, Donegall Square West, Belfast;
or through any Bookseller.

1928

Price 1s. 3d. Net.

This Bulletin has been prepared by Dr. J. W. Munro of the Imperial College of Science and Technology, London, lately Entomologist to the Commission, and is one of a series of publications dealing with the destruction and decay of timber. The other Bulletins are to be issued by the Forest Products Research Laboratory (under the Department of Scientific and Industrial Research) and it is understood that one on Dry Rot will be published at an early date.

R. L. ROBINSON,
Commissioner.

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

January, 1928.

BULLETIN No. 9.

BETLES INJURIOUS TO TIMBER.

CONTENTS.

	PAGE
INTRODUCTION	5
LONGICORN BEETLES (<i>Cerambycidae</i>) ..	5
Timbers Attacked and Damage Done	8
Preventive and Remedial Measures ..	10
PIN-HOLE BORERS (<i>Scolytidae</i> and <i>Platypodidae</i>)	11
Timbers Attacked and Damage Done ..	13
Preventive and Remedial Measures ..	13
POWDER-POST BEETLES (<i>Bostrychidae</i> and <i>Lyctidae</i>) ..	14
The Bostrychid Beetles	14
Timbers Attacked and Damage Done	15
The Lyctid Beetles	16
Life-history of <i>Lyctus</i>	17
Timbers Attacked and Damage Done	17
Preventive and Remedial Measures ..	19
THE FURNITURE BEETLES (<i>Anobiidae</i>)	21
The Common Furniture Beetle (<i>Anobium punctatum</i>) ..	23
The Death-Watch Beetle (<i>Xestobium rufo-villosum</i>) ..	24
<i>Ernobius mollis</i>	25
<i>Ptilinus pectinicornis</i>	26
Damage Done by Anobiid Beetles ..	27
Preventive and Remedial Measures ..	28

BEETLES INJURIOUS TO TIMBER.

Apart from the termites or white ants which are so destructive in tropical and sub-tropical countries, the most important enemies of timber belong to various families of the order Coleoptera of which four groups may be recognised, namely, longicorn beetles (Cerambycidae), pin-hole borers (Scolytidae and Platypodidae), powder-post beetles (Bostrychidae and Lyctidae) and furniture beetles (Anobiidae)

The longicorn beetles and pin-hole borers are essentially forest insects for they attack timber just after it has been felled and abandon it when it has become dried or seasoned. The powder-post and furniture beetles on the other hand are enemies of seasoned timber, the former abounding in timber yards and the latter infesting antique furniture and the roofs of old buildings.

The destruction caused by these insects is very great and is to some extent avoidable. The object of this bulletin is therefore to describe the insects and the damage done and to make suggestions regarding preventive and remedial measures.

LONGICORN BEETLES (CERAMBYCIDAE).

Longicorn beetles are large and conspicuous insects from a quarter of an inch to three inches in length, readily recognised by the length of their horns or antennae, which in some species are much longer than the insect itself (e.g., *Acanthocinus*, fig. 1). Many

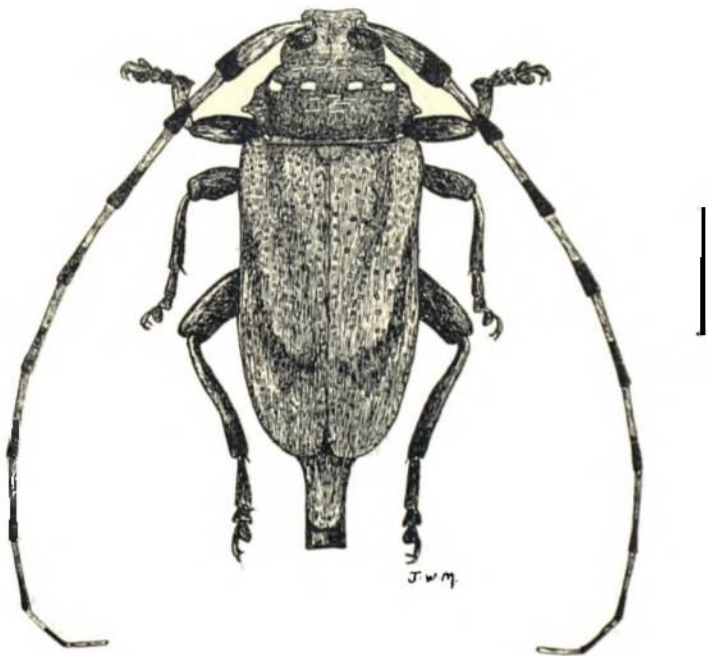


FIG. 1. *Acanthocinus aedilis* (Female).

of them are brightly coloured and when flying or resting on logs or trees in the forest are conspicuous objects.

The longicorns, like other beetles, pass through four stages in their life cycle—egg, larva, pupa and adult. The eggs are long oval, or spindle-shaped, white in colour, shiny, and show on the surface various tiny pits or markings. They are laid in crevices in the bark of trees or in tiny slits cut in the bark by the female beetles. The eggs may hatch in a few days or may require several weeks for their development, according to climatic conditions and the season of egg-laying.

The larvae of all the longicorns are fairly similar in general shape and appearance, being long, narrow grubs of whitish yellow colour, with the body showing a number of rings or segments tapering from front to back or narrow in the middle segments (fig. 2). The head, which is inconspicuous, except for the strong,

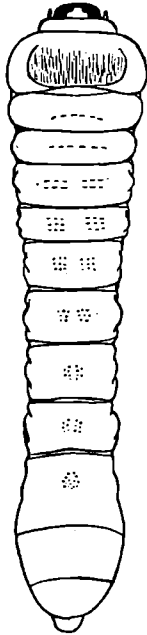


FIG. 2. Larva of *Phymatodes testaceus* (Magnified).

brown or dark brown jaws, is often partly withdrawn into the first segment of the body. Many of the larvae are legless, but some bear a pair of very short and apparently useless legs on the lower surface of each of the first three segments behind the head. In many species the upper (dorsal) and lower (ventral) surfaces of the body segments bear various warts or tubercles which enable the grubs to gain a purchase on the walls of their tunnel while gnawing, or to crawl along by alternately contracting and relaxing, first the front part and then the hind part of the body. Outside their tunnels the grubs progress feebly and slowly.

The size of the grub varies with its age, but full-grown grubs range in length from half an inch to 3 or even 4 inches, according to the species.

The period spent by the larva in attaining its full growth may last from a few weeks or months to one or two years under normal conditions, but in some circumstances it may be prolonged to an extraordinary degree and extend to thirty or forty years. In such cases it would appear that the dry nature of the timber is the chief factor in causing this slow development and in the writer's experience the larva of one of the largest British longicorns (*Prionus coriarius*) decreased in size when imprisoned in a very dry elm branch, but increased and finally pupated in a relatively fresh oak log.

When fully grown the grub gnaws a special chamber or cradle in the wood in which it changes into its pupal state. This chamber usually lies near the surface of the wood and communicates with the open air by means of a short tunnel which may be closed either by the bark or with wood shavings or fibre carefully packed. When fully grown the grub rests for some time, often all the winter, before shedding its skin and becoming a pupa. The pupa resembles a ghostly or mummified pale yellow beetle, with its limbs tucked to its sides as if swathed in a swaddling skin (fig. 3). The eyes generally turn pale brown and then dark brown or black, then the limbs and body acquire colour and the pupa becomes restless, sheds its skin and is revealed as the adult beetle, which makes its way from its pupal bed to the outside.

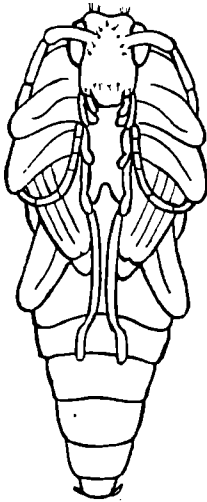


FIG. 3. Pupa of *Strangalia armata* M (magnified).

The whole of the injury caused to timber by the longicorns is brought about by the larva or grub, but the amount of injury varies with the species and with certain other factors (Plate I).

In natural forests the majority of the longicorns are scavengers, hastening the decay of dead, dying and fallen trees; only a few

among the many species are injurious to timber when felled and a still smaller number cause damage to living and standing trees.

Where forestry is organised and woods are regularly managed, longicorn beetles are to be found chiefly in felling areas where lumbering is in progress; they are rarely found in standing timber, and then as a rule only in trees weakened by drought or fungi. The rapidity with which these beetles recognise unhealthy trees and felled logs is remarkable, and this preference for dying or felled trees has an important bearing on prevention of their attacks.

Timbers Attacked and Damage Done.

Nearly all kinds of trees support one or more species of longicorn beetle, and in our dock-yards and timber yards grubs and their borings may be found in consignments of most of the timbers of commerce from the common spruce and pine of the Baltic to the mahoganies and the box-woods of the Philippines and Africa.

As a rule the loss caused by longicorn beetles found in imported timber is confined to the sapwood. In such timbers as hickory and American ash, however, the loss may be considerable, as in these ring-porous woods the longicorns bore extensively in the sapwood and even in the inner layers of the heartwood. The species chiefly concerned are *Neoclytus* and *Cyllene* spp. Polish oak is another timber which harbours many longicorn grubs and its sapwood is frequently extensively tunnelled by them, more especially by *Phymatodes testaceus* (fig. 4). Other longicorn

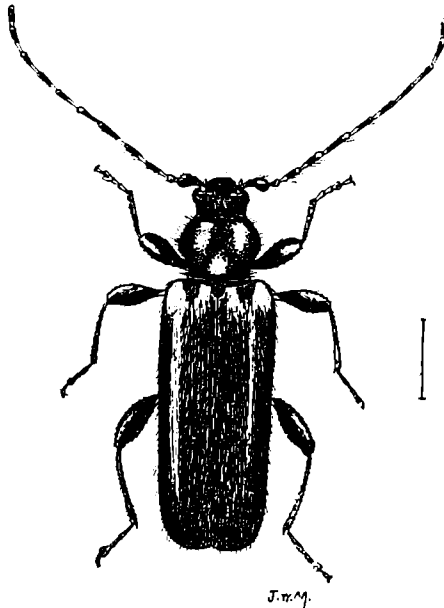


FIG. 4. *Phymatodes testaceus*.

beetles found in hardwoods are *Clytus arcuatus* (fig. 5) and *Cerambyx cerdo*, from Poland and Austria.

As regards imported softwoods, longicorn beetles are chiefly found in timber from Scandinavia and Russia, the species most frequently occurring being *Callidium violaceum* in larch

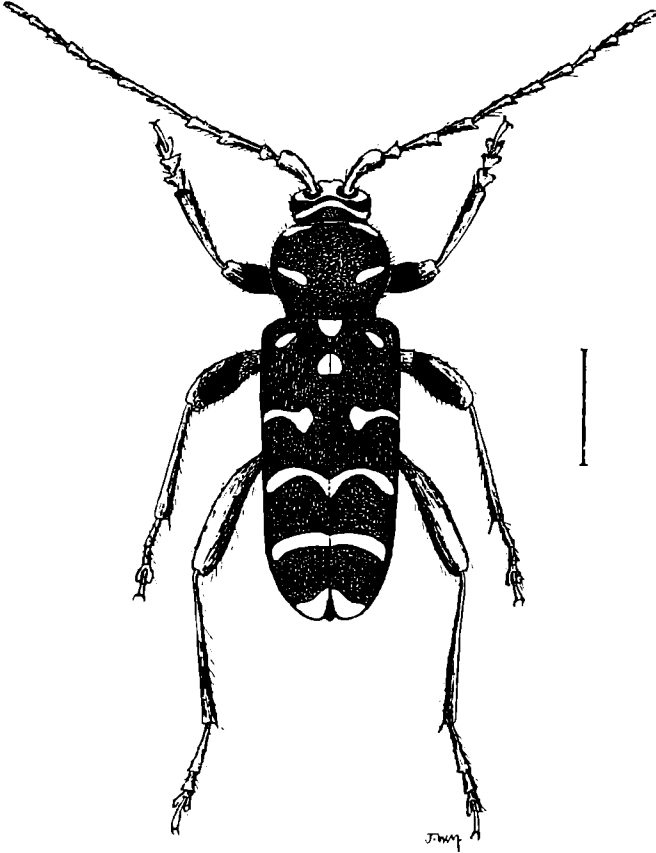


FIG. 5. *Clytus arcuatus*.

and pines, *Hylotrupes bajulus* and *Tetropium luridum* in spruce, *Tetropium gabrieli* in larch and *Acanthocinus aedilis*, *Asemum striatum* and *Monohammus* sp. in pine and spruce. American softwoods, such as white and pitch pines, occasionally harbour longicorn grubs. Douglas fir or Oregon pine and Sitka spruce less commonly show borings or contain larvae.

It is important to observe that with the possible exception of *Hylotrupes* all the longicorn beetles commonly imported prefer unseasoned timber as a breeding ground, and for that reason they rarely increase in numbers in timber yards, and the injuries they cause do not extend to other timber in the vicinity. Where timber yards and saw mills are situated in a forest district longicorn beetles introduced in imported timber may become established in the district. Thus, such beetles as *Tetropium gabrieli*, *Acanthocinus*

aedilis, *Monohammus* sp. and *Callidium violaceum* found in British woodlands are considered to be the descendants of beetles introduced at our ports in larch, pine and spruce logs. Timber "in the round" more frequently harbours longicorn grubs than sawn or converted timber.

In home timber the chief longicorns found in hardwoods are *Phymatodes testaceus*, *Rhagium indagator* (fig. 6), *Strangalia armata* and *Liopus nebulosus*. The last three live in sapwood which is partly decayed. In home-grown softwoods the longicorns found are *Acanthocinus aedilis*, *Crioccephalus rusticus* and *Asemum striatum* in pine, and *Tetropium gabrieli* in larch.

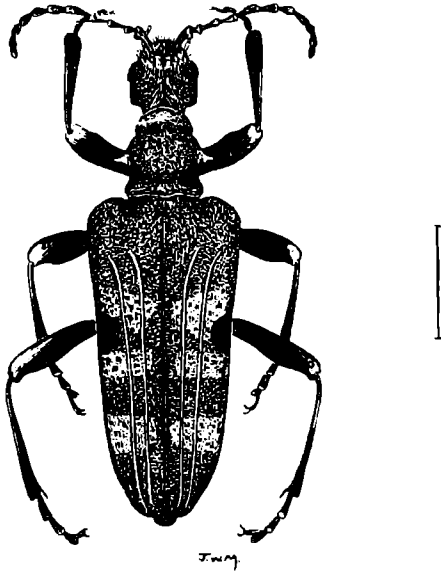


FIG. 6. *Rhagium indagator*.

Preventive and Remedial Measures.

The prevention of injury to timber by longicorn beetles is really a forestry question. The beetles are to be found in all forests and, when fellings occur, they rapidly take advantage of the breeding ground afforded and deposit their eggs in the felled timber. Before extensive fellings are made, individual trees should be felled here and there, to serve as traps; the bark should be stripped off soon after the longicorn grubs have emerged from the egg.

Where these early preventive measures are impracticable, or where it is necessary to check longicorn beetle attacks during felling operations, other measures may be adopted. The most obvious means of checking attacks is to remove felled timber from the forest as rapidly as possible. Another measure is the barking of logs immediately on felling, which prevents egg laying by the beetles. The cost of bark removal varies with the species of tree and the season of felling. It is a very effective check

against wood-boring insects, but it is apt in some timbers, and in hot climates, to cause too rapid drying of logs, which become cracked or "shaken" in consequence.

Experiments have been carried out in the United States and Europe with spray solutions applied to logs, in order to reduce the numbers of longicorn and other borers, but although many different sprays have been tried, none has proved useful in practice. Their successful application is dependent on a detailed knowledge of the habits of the insects, and the majority of the sprays are effective only for a limited period.

In general, the surest method of preventing loss is the early removal of the timber from the forest, or rapid conversion of it, wherever rapid handling and conversion of timber is insisted upon, and where fellings are undertaken before the beetles fly, losses can be reduced to a minimum or even wholly avoided.

PIN-HOLE BORERS (SCOLYTIDAE AND PLATYPODIDAE).

The pin-hole borers are small beetles $\frac{1}{8}$ th to $\frac{1}{4}$ of an inch in length, belonging to the families Scolytidae and Platypodidae. They are frequently called "ambrosia" beetles by entomologists, because, although they bore deeply into the wood of trees, they do not feed on this, but on a mould or fungus which grows within the tunnels. This mould was first termed "ambrosia" by the naturalist Schmidberger, in 1836, and as very little is known about it the term "ambrosia fungus" is still retained. The fungus stains the tunnels black or dark brown, and this, together with the cutting of the tunnel across the grain of the wood, and the absence of dust, is characteristic (Plate II, figs. 1 and 2).

The term "pin-hole borers" is an American one, but is now widely used in the British timber trade, and is quite appropriate.

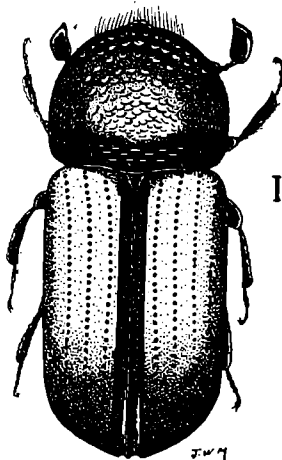


FIG. 7. *Trypodendron domesticum*.

for the smaller species, which scarcely exceed in width the thickness of a pin.

Of the two families of pin-hole borers, the Scolytidae are the more numerous in species and the more frequent in timber, but some of the Platypodidae are quite important. The pin-hole

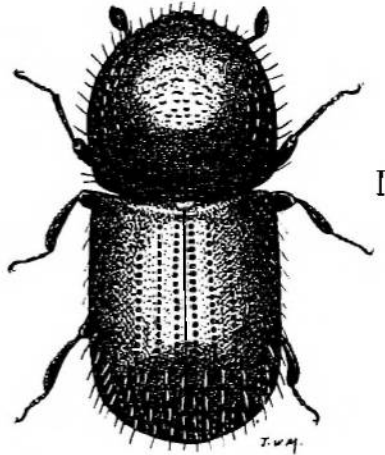


FIG. 8. *Anisandrus dispar* (Female).

borers, poorly represented in Europe, are more numerous in the Southern States of North America, and are especially abundant in the tropics. It is probable that only a small number of the existing species have been described by entomologists.

In the Scolytidae, the chief pin-hole beetles injurious to timber belong to the genera *Trypodendron*, *Anisandrus* and *Xyleborus*, the last of which is much the most important and most numerous

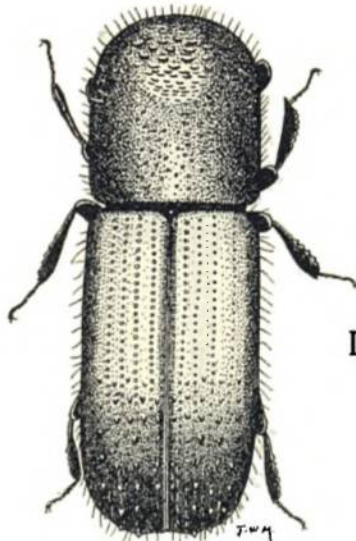


FIG. 9. *Xyleborus saxeseni*.

in species, and in the Platypodidae, the commonest belong to the genera *Platypus*, *Crossotarsus* and *Diapus* (figs. 7—10).

So far as they have been studied, the pin-hole borers are somewhat similar in their life-histories. The female beetles cut cylindrical tunnels through the bark into the sapwood, always in a transverse direction, and in these tunnels deposit their eggs. In some species, eggs, larvae, pupae and adults may live together in the tunnel, or in a roomy enlargement of it; or the larvae may gnaw niches above and below the main tunnel, and in these they pupate. The larvae feed on the mould growing on the walls of the tunnel, this mould being introduced into the tunnels by the female beetles. The patterns of the tunnels in the various species of pin-hole borers vary considerably, and closely related species, separable with difficulty as beetles, may readily be recognised by these patterns.

Timbers Attacked and Damage Done.

Pin-hole borers attack timber immediately after it is felled, or within a few weeks of felling. Seasoned timber is immune, because the drying process prevents the growth of the fungus on which the borers live. They are more often found in hardwoods than in softwoods, and the wide range of timbers attacked is indicated by the following list:—oak (American, English and Polish), ash (American and English), hickory, various box-woods and lignum-vitae, eucalypts, mahogany and its substitutes, maples, poplars and gums (*Liquidambar* and *Nyssa* spp.).

Except in heavily attacked logs, the actual mechanical injury done is slight but the value of the timber is considerably reduced. Philippine mahogany, for example, is rendered much less valuable by minute pin-holes which spoil its appearance but probably do not affect its strength to any appreciable extent.

Apart from the tunnels cut by the beetles, secondary damage is found in pin-holed timber. This consists in a staining of the wood in a longitudinal direction on each side of the pin-hole, representing incipient decay caused by the growth of a fungus. Whether this fungus is the ambrosia fungus itself extending into the wood, or another fungus which has gained admission through the pin-hole, has not yet been definitely ascertained. This type of injury is most apparent in white woods such as poplar, lime, maple and gum, but it occurs in all, and is often more important than the pin-holes themselves (Plate II, fig. 3).

Preventive and Remedial Measures.

As in the case of longicorn beetles, preventive and remedial measures against pin-hole borers consist in the early removal of timber and the barking and submersion of logs. Equally important, however, is the time of the felling, for if this is undertaken in winter, or during the seasons when pin-hole borers are inactive, much loss is prevented. In Europe, oak felled in winter is not, or only rarely, attacked by pin-hole borers, but when felled

in summer may suffer severely both from *Xyleborus* and *Platypus* beetles. In the United States timber felled and removed from the forest before the month of April is not attacked, but if felled or left lying in the forest from April to October may be badly attacked. In the tropics the beetles are active all the year round and the only effective control measures are the barking or removal of the trees immediately after felling, or the stripping of both bark and sapwood from the logs a week or two later.

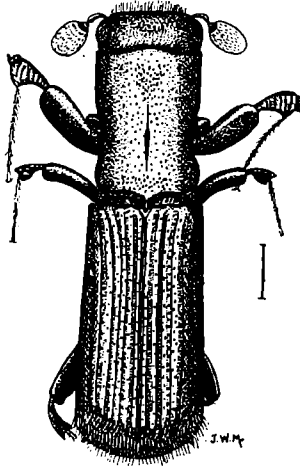


FIG. 10. *Platypus cylindrus*.

POWDER-POST BEETLES (BOSTRYCHIDAE AND LYCTIDAE).

The powder-post beetles are wood-borers living in seasoned timber. They get their name from the way in which they reduce wood to a very fine dust or powder, which is especially well seen in the borings of the Lyctidae. This family has been classed as a sub-family of the Bostrychidae, but as the Lyctid beetles most injurious to timber differ markedly in general appearance and in their habits from the Bostrychid beetles proper, it is convenient to consider the two families separately.

THE BOSTRYCHID BEETLES.

The Bostrychid beetles are of small or moderate size ranging from $\frac{1}{8}$ th. of an inch to one inch in length. Most of them are dark brown to black in colour but in one of our British species (*Aphate capucina*) the wing covers are brick red. The chief characters of the beetles are their cylindrical build and the hood-shaped, roughened thorax which covers the head (fig. 11). The feelers or antennae end in a three-jointed club.

Both the beetles and their grubs are borers. The females enter the wood in order to lay their eggs and the males assist them in cutting the egg tunnel, which is bored at right angles to the axis of the tree or branch and usually follows one of the annual

rings in direction. The tunnel is Y-shaped with the arms of the Y curved. From this tunnel other tunnels arise which are used by the beetles for turning round and in feeding. The galleries or

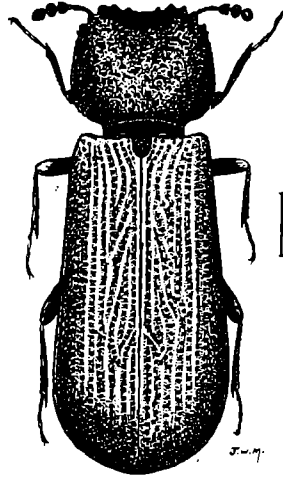


FIG. 11. *Apate capucina*.

tunnels cut by the grubs run parallel with the axis of the tree or branch, *i.e.* with the grain of the wood, and are filled with very fine dust. The Bostrychid larvae are curved, wrinkled, whitish yellow grubs with brown jaws, and have three pairs of short four-jointed legs.

Timbers Attacked and Damage Done.

The Bostrychid beetles most injurious to timber are those which attack mimosas and bamboos, and belong to the genera *Heterobostrychus* and *Dinoderus*. Probably because of their

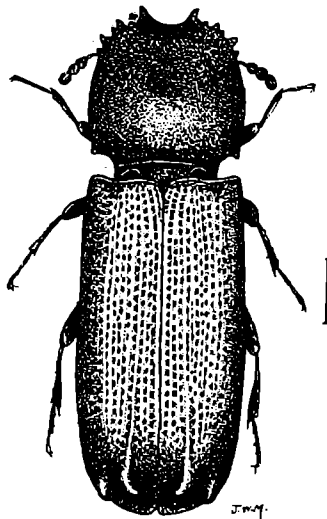


FIG. 12. *Heterobostrychus australis*.

larger size and the nature of their ravages, necessitating the rejection of infested wood before shipment, the Bostrychid beetles are not common in timbers imported into Great Britain, but species like *Heterobostrychus australis* (fig. 12), *Dinoderus minutus*, *Apate capucina* and *Amphicerus bi-caudatus* occasionally occur. Only hardwoods are attacked and of these the majority are ring-porous timbers in which the sapwood only is destroyed.

As most of the Bostrychidae are tropical or sub-tropical insects they rarely persist in timber yards or houses in Great Britain. Exceptions are *Dinoderus minutus*, the bamboo borer, which is occasionally found in bamboo work and basket work in houses and *Apate capucina* which occurs rarely in oak boards. Damage by Bostrychid beetles may be checked by the methods described for the Lyctid beetles given below.

THE LYCTID BEETLES.

The beetles of the family Lyctidae differ from those of the Bostrychidae in that the thorax does not form a hood over the head and the club of the antenna is two-jointed. In their life-histories the members of the two families also differ. The Lyctid beetles do not bore deeply into the wood in order to lay their eggs but deposit them in the pores. The larvae have three-jointed legs.

The family Lyctidae includes two genera of interest as wood-borers, the genus *Lyctus* and the genus *Minihea*, and of these the first is much the more important. It contains several species, two of which are commonly found in timber yards, *Lyctus brunneus*, Steph. (fig. 13), and *Lyctus linearis*, Goeze; and one, which has apparently been introduced into Great Britain within the last six or seven years, *Lyctus planicollis*, I.e Conte (fig. 14).

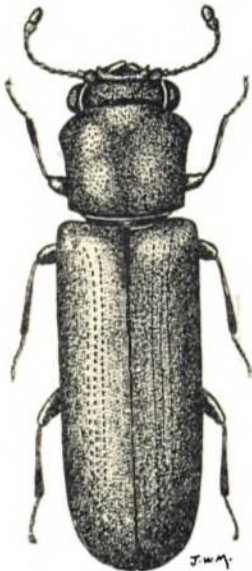


FIG. 13. *Lyctus brunneus*.

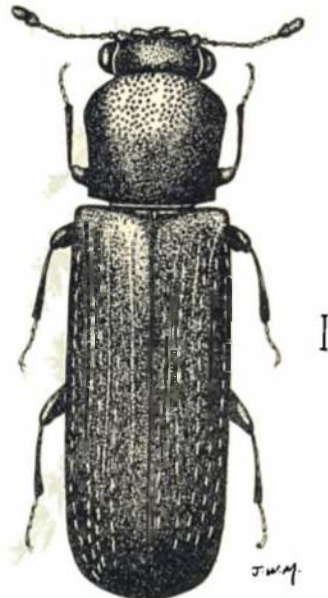


FIG. 14. *Lyctus planicollis*.

Life-history of *Lyctus*.

The period occupied by the life-cycle, *i.e.*, from egg-laying to egg-laying, is usually a year, but in artificially-heated workshops and stores this may be shortened to nine or even seven months. The beetles are active normally from May to August, but indoors they may appear as early as March. The period when most beetles emerge is June and July, and it is during these months that their presence in timber and furniture is most frequently detected.

The beetles pair almost as soon as they emerge from the wood, and the females then begin egg-laying. In this they show considerable acumen in selecting suitable pores or vessels in the sapwood in which to lay their eggs. They are armed with a long, slender ovipositor, or egg-laying probe, with which they sound the wood vessels before egg-laying. Two or more eggs are usually laid near one another. The egg is long, oval or cylindrical, and bears at one end a thread-like attachment. It hatches in from seven to ten days, and the young larva feeds for a few days on the yolk of the egg. At this stage it is straight-bodied. As it feeds it grows in girth and thus fills the pore in which it lies, and so obtains a purchase on the walls which enables it to begin gnawing the wood. Moulting takes place, and the grub assumes a curved form (fig. 15), which enables it to

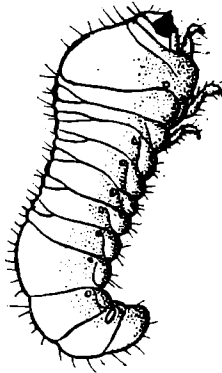


FIG. 15. Larva of *Lyctus brunneus* (Magnified).

progress. It travels along in the direction of the pores, and normally feeds in the region of the spring zone of the wood. When fully grown the grub bores its way to the outside of the wood and makes a curved pupal chamber for itself in which it turns into the adult beetle. The pupal chamber is closed from the outside by a mere film of wood, which is broken down by the beetle in making its way out. All these habits of the *Lyctus* are important in considering preventive measures against it.

Timbers Attacked and Damage Done.

Lyctus is only found in hardwoods and its attacks appear to be limited to recently-seasoned timber, whether manufactured

or not. It may be noted that old furniture is not attacked, nor is newly felled timber. The pest principally occurs in the stores and workshops of manufacturers of furniture, tennis racquets, tool handles, etc., where it causes considerable damage.

Not all hardwoods are attacked by *Lyctus*, and it would seem that only those species in which the pores attain moderate size are suitable for its breeding, although experimental proof of this is lacking. Observations show, however, that even in timber-yards and workshops where *Lyctus* beetles abound, close-grained narrow-pored woods such as true mahogany (*Swietenia*), birch, beech and maple are immune from attack, and the immunity of softwoods is almost certainly to be ascribed to the total absence of vessels. Of the common woods of commerce attacked by *Lyctus*, oak, ash, hickory, sweet chestnut and walnut are the most important.

The damage caused by *Lyctus* results ultimately in the complete destruction of the sapwood which is reduced to a powdery dust. The process of destruction is frequently rapid, for example, chair legs may be totally destroyed in the course of two seasons. Except for the presence of the exit-holes and of the dust from them, *Lyctus* shows no signs of its presence, as a thin layer of wood is always left so that a piece of furniture may appear sound, although it is really a mere shell (Plates III and IV).

It is not easy to gauge the extent of the damage caused by *Lyctus* beetles, but it is known that there has been a marked increase in recent years. Formerly the genus was represented in Britain by the single species *L. linearis*, which occurred in oak palings and under oak bark in the neighbourhood of London, in hop-poles in Kent, and in Birmingham in ash used for spade and tool handles, gun-stocks, etc. Later, a second species, *L. brunneus*, appeared, and now a third species, *L. planicollis*, is not uncommon. In 1914 *L. brunneus* was the cause of considerable anxiety to walking-stick makers. It was introduced from Austria in specially-grown sweet chestnut, known in the trade as Congo cane, but it also attacked ash and ordinary sweet chestnut sticks. In the timber industry, *L. brunneus* and *L. planicollis* became very injurious after the war, and frequently whole consignments of American oak and ash arrived in this country badly infested with these two beetles. The more frequent occurrence of *Lyctus* in American timber at this time was caused by the holding up of stocks in the American timber-yards as a result of lack of shipping during the war. The yards became overstocked, the timber could not be properly handled and examined, and so the beetles multiplied enormously. This is the more easily understood because one of the chief preventive measures recommended by the United States Department of Entomology is the removal from the yards of all timber as it becomes seasoned.

Consignments of oak and ash from America still contain a certain amount of *Lyctus*-infested material which is distributed

throughout the country. The reason for this apparently negligent dispersal of the beetle is that during the colder months from October to March the grubs are relatively inactive, very little dust is thrown out of their burrows, and consequently infested timber cannot easily be recognised.

Even when dust is apparent it is not always considered important ; or, if it is abundant, the infested timber is reduced in grade and sold as "wormy" oak or ash at a low price. Such timber evidently commands a market, but it is to be regretted that too often the dangerous nature of wormy timber is not realised by its purchasers, who assist still further in the distribution of the pest.

While the *Lyctus* beetles were originally introduced in American oak and ash, they now occur chiefly in English and Polish oak, probably because American timber is less used now than formerly and much of it is kiln-dried and freed from the pest before it is shipped from the United States. The beetle has now established itself in many timber-yards and workshops where previously it was unknown, and unless measures are taken against it losses will increase.

Preventive and Remedial Measures.

The prevention or reduction of losses caused by *Lyctus* beetles may be attained in three main ways : (1) by the removal of sapwood before the timber is manufactured into the final product ; (2) by sterilisation ; and (3) by treatment with insecticides. Where practicable, the last two methods may be combined.

(1) Removal of Sapwood.

The removal of sapwood from oak and ash timber before it is made into furniture is adopted by some firms in this country. It entails a certain amount of waste and is economically possible only in the manufacture of high-grade furniture. In cabinet making the loss of timber involved in avoiding sapwood is more serious than, say, in chair-making, because the size of the boards required is usually greater and these are not always to be obtained wholly free of sapwood. Thus, a bookcase or cabinet-top may, on being cut and dressed, retain a fillet of sapwood on one edge which may harbour *Lyctus* and render the whole article suspect in the eyes of the buyer.

In making tennis racquets, sapwood cannot be eliminated because its elasticity and lighter weight and its aptitude for steam-bending make it preferable to heartwood.

(2) Sterilisation of Timber by Heat.

The destruction of insects and fungi in timber by sterilisation in a heated kiln is now extensively practised in the United States. In the development of this process, dry heat was first tried and it was found that a temperature of 180° F. was necessary. So

high a temperature is stated to weaken the wood fibres and to cause discoloration and "case hardening." There is the further disadvantage that it cannot easily be attained in kilns constructed for ordinary timber seasoning.

Experiments showed that moist heat was more successful than dry heat, and the results of recent experiments conducted by Snyder in the United States proved that Lyctus beetles could be killed by using a kiln of the water-spray type with temperatures of 130° F. and upwards maintained for 1½ hours or longer, if all parts of the timber had first been brought to the minimum temperature of 130° F. He found, further, that the standard kiln-drying schedule for ash and oak for aircraft stock in a kiln operated by live steam sufficed to destroy powder-post beetles in the infested material.*

It is not certain that 130° F. is the lowest temperature fatal to Lyctus and its grubs, and experiments with lower temperatures and various periods of exposure and percentages of humidity are now being conducted by the Forest Products Research Laboratory at Princes Risborough.

The destruction of the insects by means of steam-kiln sterilisation is undoubtedly the most promising method of checking and preventing loss. Kiln seasoning of timber is being increasingly practised in this country, and if it can be carried out along with sterilisation in one process, as there is every reason to expect, the elimination of Lyctus in timber-yards and workshops will prove relatively simple. Meanwhile there is need for further study of steam-kiln seasoning both in relation to beetle infestation and to its effect on the timber itself. While the process may not, as practised at present, always be preferred to natural or air seasoning, it has many advantages. It renders unnecessary the storage of large stocks of timber, thus reducing the amount of capital employed and lessening the risk of loss by fire. Where sudden demands arise, kiln seasoning enables the manufacturer speedily to meet requirements.

Taking all these points into consideration, it is evident that seasoning by steam kiln is particularly suitable for adoption by the furniture trade—the trade which suffers most from Lyctus damage. By consistent sterilising of all timber brought into the yards, supplemented by regular inspection, infested depôts may be cleared of the pest. To keep them clear permanently requires the co-operation of all firms operating in any given locality, as sterilisation does not render the timber proof against further attack. Beetles emerging from infested wood fly readily in warm weather, so that any stores of timber in the vicinity are liable to infection. On this account the use of insecticides should receive consideration.

* Since this was written Snyder has advocated the higher temperature of 135° F. probably to allow for the "lag" in temperature between the wood and the atmosphere of the kiln. (U.S. Department of Agriculture, Farmers' Bulletin No. 1477. Washington, 1926.)

(3) *Insecticides.*

The use of insecticides against *Lyctus* beetles has long been advocated, largely because so much attention is paid to the ravages of these insects in manufactured articles. As explained above, it is much better, however, to apply control measures before the timber leaves the store-yards, and in this respect *Lyctus* differs considerably from the furniture beetles proper. Many of the methods previously recommended for dealing with *Lyctus* and other beetles where furniture is to be treated are too expensive or too dangerous for use in store-yards.

Insecticides containing essential oils and waxes are too costly for application on a large scale, the injection of such substances as paraffin and petrol into the beetles' exit holes is too elaborate, and the use of paraffin sprayed on stacked timber is impracticable because of the fire risk. So also the employment of such preservatives as lead arsenate and corrosive sublimate may ultimately involve the manufacturer in damages under the Workmen's Compensation Act or the Poisons Acts because of the highly poisonous nature of these substances. The same objection applies to many of the chlorine compounds and especially to tetra-chlor-ethane, while coal tar derivatives stain wood, and are thus unsuitable for many purposes.

For these reasons the choice of a suitable insecticide for the control of *Lyctus* is very limited and, in the present state of our knowledge, only a few substances appear to offer hope of a practical solution of the problem. These are zinc chloride, sodium fluoride and sodium silico-fluoride. None of these has been tested against insects on a commercial scale except zinc chloride, which has long been used as a timber preservative. Experiments with the above insecticides are being undertaken at the Princes Risborough Laboratory, particularly with a view to combining kiln sterilisation and impregnation in one main operation. Meanwhile, apart from the maintenance of clean timber yards and the careful inspection of any hardwoods likely to contain *Lyctus* beetles, the best preventive measures to adopt are the removal of sapwood and the seasoning of timber in steam kilns.

Methods for treating new furniture and such woodwork as shop fittings and panelling which has been made from *Lyctus*-attacked and *Lyctus*-infested wood are dealt with in the following section on the furniture beetles.

THE FURNITURE BEETLES (ANOBIIDAE).

Anobiid, or furniture beetles, inhabit seasoned timber and are best known as the cause of "worm-holes" in furniture, panelling, and roofing timbers. They are of relatively small size, ranging from 1/10th to 1/3rd of an inch in length. All our common species are brownish in colour, elongate, more or less cylindrical in shape, and in all of them the head is more or less withdrawn into, and hidden from above by the hood-shaped thorax. Except *Ptilinus*

pectinicornis, which has comb-like antennae (fig. 20), they have the last three joints of the antennae longer or larger than any of the other joints (figs. 17—19).

The full-grown larvae, or "worms," are curved, wrinkled grubs with three pairs of short 5-jointed legs, and strong biting jaws (fig. 16). On the folds of the body the grubs bear rows of tiny, reddish brown spinules which probably help them to move more freely in their tunnels. These spinules are not present on newly-hatched grubs.

The habits of the Anobiid beetles have received much attention from entomologists, but while the salient features of the life-histories of the commoner species are known, there are many important points relating to them still undetermined. While, for example, the life-cycle from egg to beetle appears frequently to last a year, or almost a year, in some circumstances it may be prolonged over two years or more, and we are still ignorant of the causes of such variation in the length of the life-cycle, a point of considerable importance when remedial measures come to be applied.

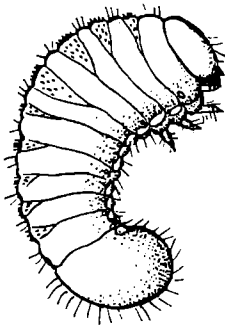


FIG. 16. Larva of *Anobium punctatum* (Magnified).

Unlike the Lyctid beetles, the Anobiids occur in both coniferous and hardwood timbers, and heartwood is attacked as well as sapwood. They also seem to prefer well-seasoned older wood, and this preference for thoroughly matured wood is so commonly believed in that the presence of "worm-holes" in furniture is frequently accepted as evidence of age. How far such evidence is trustworthy is uncertain.

Out of doors the Anobiid beetles are found in the dead and decaying wood of dying trees. Oak and beech trees which have been broken by wind or have passed their prime and have begun to decay are, in particular, the breeding ground of *Anobium punctatum* and *Xestobium rufo-villosum*. *Ptilinus pectinicornis* is most frequently to be found in old decaying pollard willows, but it also occurs in beech and sycamore. *Ernobius mollis* inhabits dead trees and branches of larch, spruce and pine and is often to be found under the bark of larch fencing posts or of posts and rafters of unbarked spruce. It is also common in "rustic" work made from spruce branches and tops.

In addition to the four species mentioned, several other Anobiid beetles occur in the wood of dead and decaying trees and shrubs. Hawthorn harbours three species, *Priobium castaneum*, *Anobium denticolle* and *Hedobia imperialis* and ivy is the home of *Ochina hederæ*. These species rarely infest furniture or woodwork in houses, but their frequent occurrence in hedges and shrubberies suggests that the Anobiid beetles are commoner than is generally supposed, in fact, in the south of England scarcely a hedgerow or fence is free from these insects. So, too, in out-houses, furniture beetles are frequently found, but, because their borings are unobserved until a lintel or rafter collapses or an old rake handle breaks into dust, their presence is rarely realised.

THE COMMON FURNITURE BEETLE (*ANOBIUM PUNCTATUM*).*

This is the species most frequently found in furniture and in the woodwork of dwelling-houses. It is a small beetle varying in size from about one-tenth to almost a quarter of an inch. Its colour varies from reddish brown to dark brown which, in freshly-emerged specimens, is lightened by the presence of a covering of short yellow hairs. In this species the hood-shaped thorax is well seen, and the rows of fine pits or punctures on the wing-covers are very distinct. (fig. 17).

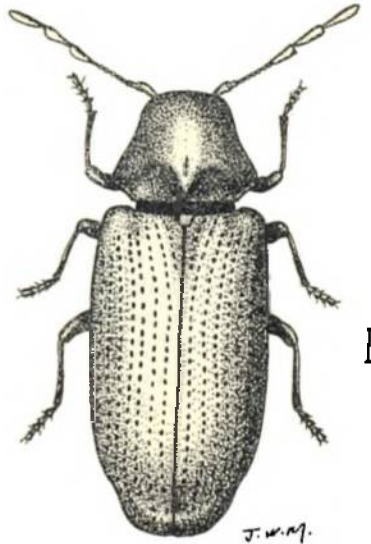


FIG. 17. *Anobium punctatum*.

The beetles commonly appear in June and July, when they leave their pupal beds or cells in the wood. During these months they are frequently found crawling on walls and ceilings or on

* Formerly known as *Anobium domesticum*.

the ledges of windows ; on sunny days they may be observed flying to such places.

Pairing takes place at this time and the female beetles seek out suitable places in which to lay their eggs, which are white in colour and shaped like a flattened lemon. The eggs are laid in cracks and crevices in the wood, sometimes singly but more often in groups of three or four laid along the line of the fissure. Smooth surfaces are not chosen for egg-laying. Thus, in an experiment carried out by the writer, beetles supplied with smoothly planed pieces of hawthorn laid no eggs but, on small incisions being made in the wood with the point of a pen knife, the chinks were soon filled with eggs ; in a control experiment, other beetles supplied with hawthorn showing numerous cracks, laid eggs in these several days earlier.

The young larvae soon bore into the wood, beginning more or less at right angles to the surface and then following along the grain of the wood. The tunnels, which become filled with dust, are at first small and enlarge as the grubs grow. The dust is granular, consisting in part of small oval pellets passed through the larvae and in part of more angular fragments of wood discarded in feeding. When the larvae become full grown they make their way towards the surface again and gnaw a small cell or chamber in which they pupate. Sometimes this lies just below the surface of the wood, separated from the outer air by a mere wafer of wood, or it may lie an eighth to a quarter of an inch below but communicating with the outside by a short tunnel closed by a fine layer of wood. In some cases the larva gnaws a minute hole in the thin wall of its pupal bed, which appears to simplify the work awaiting the beetle after pupation ; these minute holes often reveal to a careful observer the sites of the pupal beds.

The duration of the life-cycle of *Anobium punctatum* is commonly about a year, but it varies considerably and half-grown larvae, pupae and beetles may be found in one and the same piece of wood at the same time. Little is known concerning the rate of growth and development of the Anobiid beetles. Moderately high temperatures undoubtedly favour and hasten development, but how this is affected by the nature or species of timber has not yet been determined.

THE DEATH-WATCH BEETLE (*XESTOBIUM RUFO-VILLOSUM*).*

This is the largest of our Anobiid beetles, ranging from a quarter to a third of an inch in length. Its colour is brown to chocolate brown, but this is often concealed or altered by the irregular patches of short, greyish yellow hairs which occur in bands or spots on the prothorax and wing covers. These give the beetle a mottled, tawny colour. In old specimens these

* Formerly known as *Xestobium tessellatum* F.

hairs are frequently rubbed off. The thorax is broad and flanged and there are no lines of punctures on the wing covers (fig. 18).

The eggs of *Xestobium* resemble those of *Anobium* in colour and shape, but are nearly twice as large. The larvae of the two genera are also similar in appearance, but the *Xestobium* grubs live longer and ultimately attain greater size.

The life history of *Xestobium rufo-villosum* is, in general, the same as that of *A. punctatum* except that pupation occurs in spring and the beetles rarely come out of the timber until autumn or even the following spring. Thus some *Xestobium* beetles were found in a dead oak in Richmond Park in May, 1922, still within their pupal beds and again in August and September while, in October, some had crawled out and were sheltering under loose bark. The life cycle may be prolonged up to three years, apparently, although exact information is lacking.

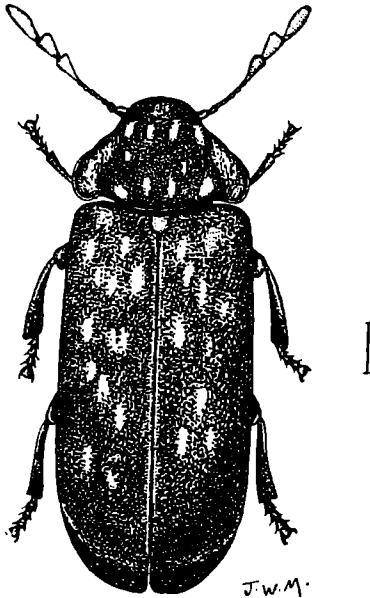


FIG. 18. *Xestobium rufo-villosum*.

X. rufo-villosum is less an inhabitant of furniture than *A. punctatum*, and is best known as the cause of damage to the roof of Westminster Hall and to the timber structure of other ancient buildings. Its work is easily distinguished from that of *Anobium* by the large size of the exit holes which it makes and by the coarser dust it leaves in its burrows in which the pellets are large and "bun-shaped."

ERNOBIUS MOLLIS.

This beetle, which is not sufficiently common to have acquired a popular name, is intermediate in size between the furniture

and death-watch beetles (fig. 19). It is reddish brown to dark brown in colour, the shade being lightened in freshly-emerged specimens by a covering of silky yellow hairs. As the name "*mollis*" implies, the horny covering of the body

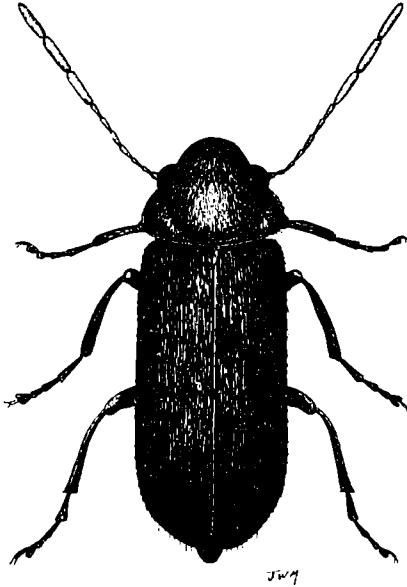


FIG. 19. *Ernobius mollis*.

and wing-cases is softer than in *Anobium* and *Xestobium*. The larvae are similar in general appearance to those of *Anobium punctatum*.

E. mollis is less common in furniture and in houses and buildings than *Anobium* and *Xestobium*. It prefers coniferous soft-woods and as a rule its attacks are confined to unbarked timber. The life cycle has not been studied in detail; in the open it normally occupies one year, the beetles appearing in April and May.

PTILINUS PECTINICORNIS.

This beetle is readily distinguished from the other members of the Anobiidae by its elongate cylindrical shape, the rounder, more globular thorax and the curiously shaped antennae which, in the male beetle, are comb-like (fig. 20), and in the female are saw-like. The grubs of *P. pectinicornis* are similar to those of *Anobium*.

P. pectinicornis resembles *Anobium punctatum* in its life history and habits but occurs less frequently in houses. It is found chiefly in beech and maple furniture. The beetles appear in May and June but in some cases they may not leave their pupal beds until late summer. The exit-holes made by the

female are larger than those made by *A. punctatum*, a point which, together with the finer dust produced, frequently serves to distinguish the work of the two species.

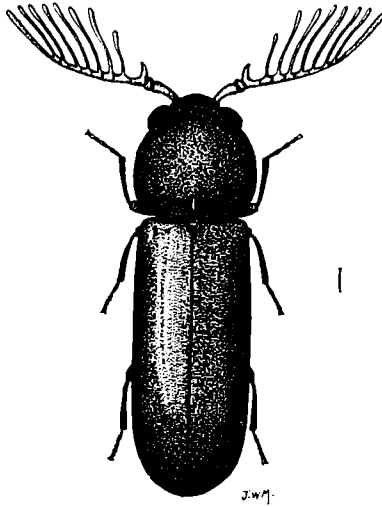


FIG. 20. *Ptilinus pectinicornis* (Male).

Damage Done by Anobiid Beetles.

The most important feature of the damage caused by the Anobiids is that seasoned, manufactured timbers are attacked and nearly always after they have been in use for some considerable time. The beetles are found in practically all timbers used in structural work, or in furniture, but oak, beech, birch and walnut, which are among the commonest furniture woods used in this country, are most frequently attacked.

As previously stated, there is some ground for the belief that the Anobiids prefer old furniture. What changes occur in the ageing of timber are still undetermined. According to wood technologists no structural changes take place which would account for a difference in character between recently-seasoned and old wood. The moisture contents of the two classes of timber do not necessarily differ, and it seems probable that such changes as occur are chemical, affecting the nature of the food available. A possible important factor is the presence of fungi, protozoa or bacteria in old wood, but a study of these organisms in timber and their relation to the attacks of Anobiid beetles has still to be made and may throw useful light on this problem.

An investigation into the losses caused by Anobiid beetles in timber in buildings and in furniture is now being carried out by the Forest Products Research Laboratory, Princes Risborough. Immediate work in this investigation consists of a detailed study of the bionomics of *Anobium punctatum* and *Xestobium rufo-villosum* with special reference to the relation between conditions of temperature, humidity and fungal infection of timber, and attack by these beetles.

Since the work of Sir Frank Baines and the late Professor Maxwell Lefroy on Westminster Hall called public attention to the extensive ravages of the death-watch beetle (Plate V), numerous cases of severe injury caused to the timber of other ancient buildings have been discovered and the serious nature of the pest is now fully recognised.

The damage caused by the common furniture beetle, occurring as it does in nearly all private houses containing old furniture, is familiar to every one (Plate VI). Apart from changes which may take place during the ageing of wood, making it more attractive to the beetle and its grubs, two factors render old furniture liable to attack. As the result of ordinary wear and tear, joints open, varnish and glue chip off, and so convenient sites are afforded for the egg-laying of the beetle.

The second factor is that during the many years which old furniture remains in use or is stored away in a lumber room it is frequently left in close proximity to worm-eaten wood for lengthy periods and it is not surprising that it becomes infected. The removal of worm-eaten furniture from one place to another obviously tends to spread the area of attack.

Preventive and Remedial Measures.

The question of preventing or minimising loss caused by the Anobiid beetles involves not only the study of a group of insects whose habits make them difficult of observation, but also necessitates grappling with the problem of preserving or impregnating timber often inaccessible for treatment.

The first and most obvious means of preventing attack is to ensure that no infested wood is introduced into houses and buildings either as furniture or in the course of repairs. Where practicable suspected timber should be sterilised. Treatment by heat is impossible where beams in roofs and other structures are concerned, and at present the only method of dealing with such material is the use of chemical preservatives or insecticides.

The usual insecticides recommended for the treatment of "worm-eaten" timber are turpentine, heavy paraffin oils, cresyl oils or creosotes, and poisons such as mercuric chloride and zinc chloride. Recently, experimental work conducted on the roof timbers of Westminster Hall by H.M. Office of Works and the late Professor Lefroy has called attention to the use of certain chlorine and benzene compounds.

Where all the surfaces of infested wood-work are easily accessible and where discolouration of the wood is not a drawback, turpentine and the heavy paraffin oils and creosotes are the best insecticides to use. Generally speaking, late spring or early summer should be chosen for their application. They must be applied in a painstaking manner and for at least two years in succession. Where *Xestobium* is the insect dealt with at least four annual applications are necessary to ensure that all the grubs are

destroyed. In course of time insecticides lose their strength and the duration of their efficacy has not yet been determined. Undoubtedly, the deterrent effects of the oils can be enhanced and prolonged by the addition of various chemicals, including metallic soaps, but much experimental work has yet to be done on this subject.

In buildings where it is necessary to retain the colour of the wood, turpentine, paraffin and creosote oils cannot be used. To overcome this difficulty Professor Lefroy carried out experiments with many chemical agents. Of these only one appears to satisfy all the conditions met with in treating antique or valuable wood-work in buildings ; namely, a mixture of ortho-di-chlor-benzene and cedar wood oil combined by means of pure castile soap. Professor Lefroy's formula is as follows :—

Ortho-di-chlor-benzene	91 parts.
Castile soap	7 parts.
Cedar wood oil	2 parts.

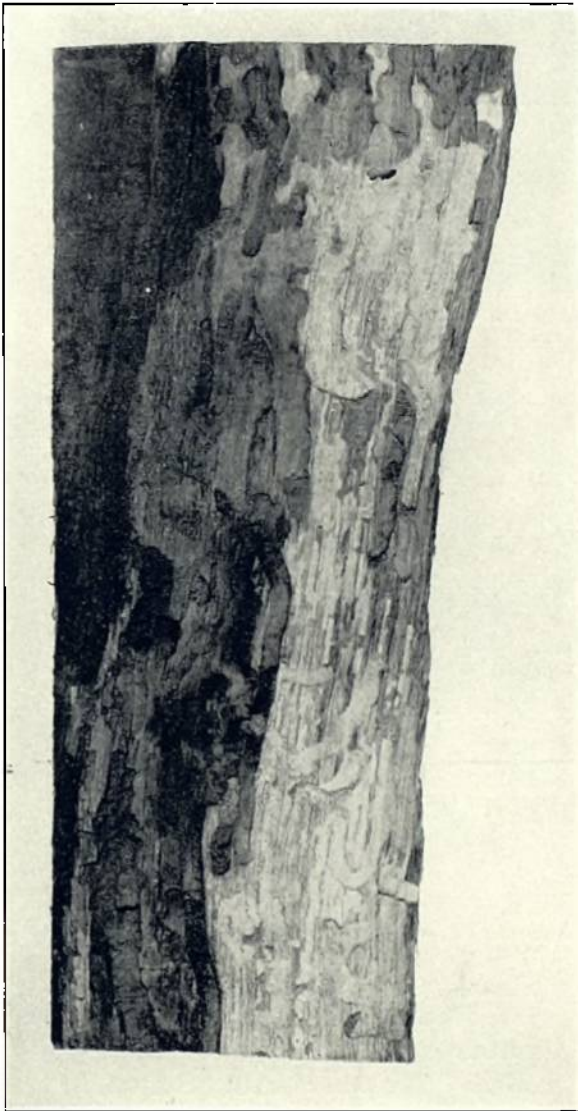
This mixture does not discolour even light-coloured wood ; it is not highly inflammable nor dangerous to use, and its odour is not objectionable.

All wood work before treatment should be thoroughly dusted, and where extensive operations are undertaken the use of a vacuum cleaner to extract dust and dirt from cracks and borings is to be recommended. The insecticide may be painted or sprayed on to the wood and must be carefully applied. Where spraying is the method employed a high-pressure sprayer should be used with a fine nozzle, and the container should be lined with acid-proof metal. Where the insecticide is painted or brushed on care should be taken that no crevices or joints are overlooked.

The success of any treatment for the control of death-watch and furniture beetles is dependent on the thoroughness with which the insecticide or preservative is applied, and can best be secured by periodic treatment extending over several years. There is no chemical preparation at present known which will eradicate "worm" in timber on first application.

With regard to the use of chloride of mercury, commonly known as corrosive sublimate, it may be said that it is much too dangerous a poison to be used in public buildings or dwelling houses. Zinc chloride, while effective when woodwork can be soaked in it, cannot be applied to roofs and such structures and is more likely to prove useful in the prevention of attack than in remedial measures.

PLATE I.



Portion of Polish oak board showing sapwood tunnelled by *Phymatodes testaceus*.

PLATE II.

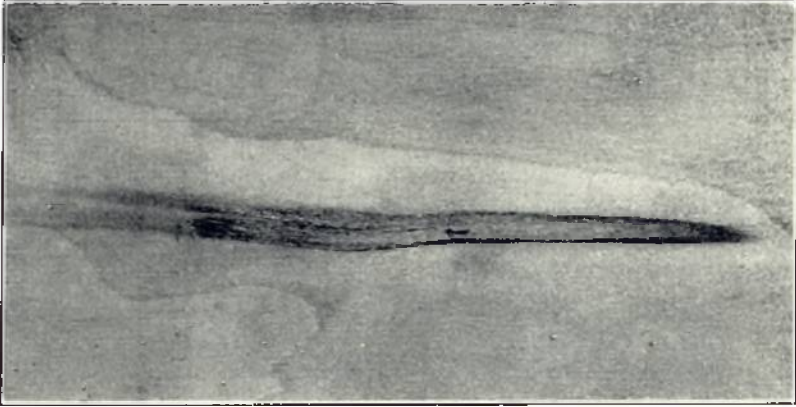


Fig. 3.

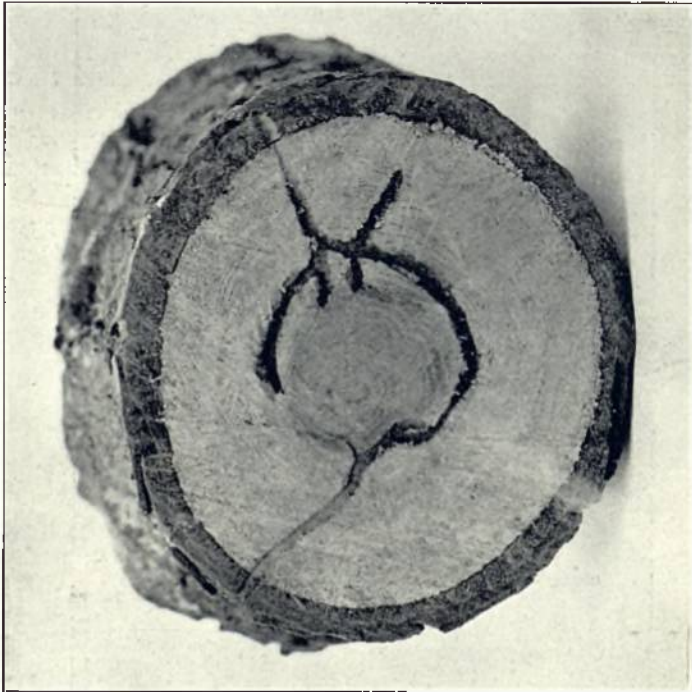


Fig. 2.

11



Fig. 1.



Fig. 1.

FIG. 1.

Oak board showing exit holes and dust of *Lyctus brunneus*. The "trails" are caused by beetles crossing over the dust.

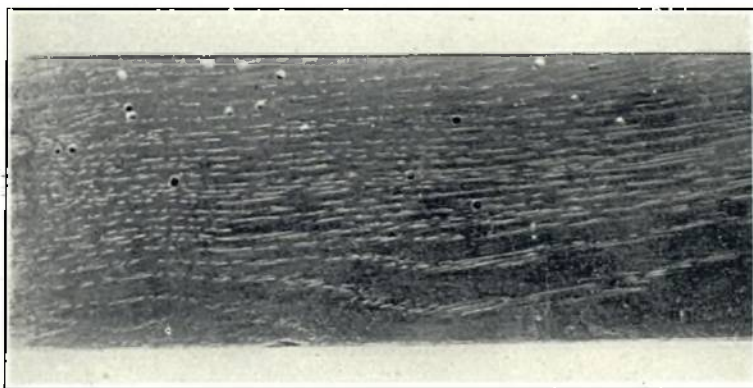


Fig. 2.

FIG. 2.

Portion of chair arm (American oak) showing apparently sound wood with a few exit holes of *Lyctus brunneus*. Compare Fig. 3.

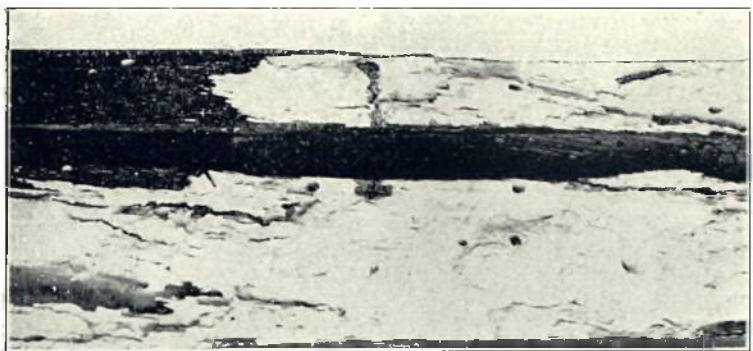


Fig. 3.

FIG. 3.

Portion of same chair arm showing work of *Lyctus brunneus*. Compare Fig. 3.



FIG. 1. Cabinet ornament in oak. The outer surface here seen is heartwood. Compare Fig. 2.



FIG. 2. Cabinet ornament in oak. The back shows the work of *Lyctus linearis*, which is confined.



Portion of oak beam showing damage by *Xestobium rufo-villosum*.

PLATE VI.



FIG. 2. Three-ply panelling of oak and alder showing inner surface completely tunnelled by the grubs of *Anobium punctatum*.

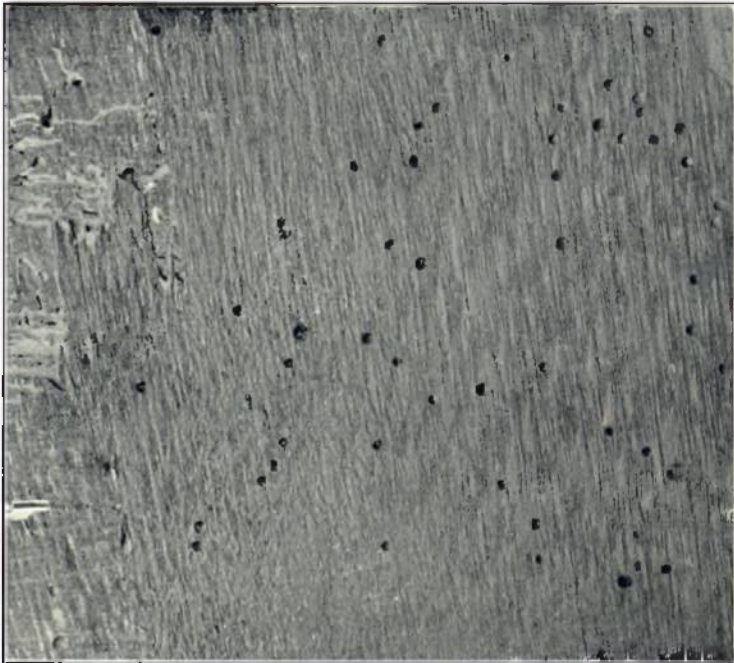


FIG. 1. Three-ply panelling of oak and alder showing outer oak surface with exit holes of *Anobium punctatum*. Compare Fig. 2.

PUBLICATIONS OF THE FORESTRY COMMISSION.

	Price.	Post free.
	s. d.	s. d.
BRITISH EMPIRE FORESTRY CONFERENCE, 1920	7 6	7 10½
BRITISH YIELD TABLES (Reprinted from Bull. No. 3) ..	<i>Out of Print.</i>	

BULLETINS :—

1. Collection of Data as to the Rate of Growth of Timber	0 4	0 5
2. Survey of Forest Insect Conditions	1 6	1 7
3. Rate of Growth of Conifers in the British Isles ..	<i>Out of Print.</i>	
4. The Douglas Fir Chermes (Chermes Cooleyi) ..	2 0	2 1
5. Poplars	1 6	1 7
6. The Phomopsis Disease of Conifers	1 6	1 7
7. The Silver Fir Chermes	1 6	1 7
8. British Bark-Beetles	2 6	2 7
9. Beetles Injurious to Timber	1 3	1 4

ANNUAL REPORTS OF THE FORESTRY COMMISSIONERS :—

Year ending September 30th, 1920—H.C. 128 ..	<i>Out of Print.</i>	
" " " 1921—H.C. 108 ..	1 0	1 1
" " " 1922—H.C. 50 ..	1 0	1 1
" " " 1923—H.C. 93 ..	1 0	1 1
" " " 1924—H.C. 107 ..	1 0	1 1
" " " 1925—H.C. 89 ..	0 9	0 10
" " " 1926—H.C. 72 ..	1 0	1 1

Copies of the above publications may be purchased through any bookseller or directly from H.M. Stationery Office, Adastral House, Kingsway, London, W.C.2. They cannot be obtained from the Forestry Commission.

LEAFLETS.

1. Pine Weevils.	13. The Larch Longicorn Beetle.
2. Chermes Cooleyi.	14. The Phomopsis Disease of Conifers.
3. The Pine Shoot Beetle.	15. The Felted Beech Coccus.
4. The Black Pine Beetle.	16. Larch Canker.
5. Conifer Heart Rot.	17. Chafer Beetles.
6. Honey Fungus.	18. Douglas Fir Leaf-cast Disease.
7. Chermes attacking Spruce and other Conifers.	<i>Published by the Ministry of Agriculture and now issued by the Forestry Commission.</i>
8. Douglas Fir Seed Fly.	103. The Pine Sawfly.
9. Forest Fires.	186. The Large Larch Sawfly.
10. Defoliation of Oak.	
11. Larch-shoot Moths.	
12. Income Tax and Death Duties on Woodlands.	

Copies of the leaflets may be obtained free of charge on application to the Secretary, Forestry Commission, 22, Grosvenor Gardens, London, S.W.1.

