The British Wood Preserving Association

Circular No. 2

# THE PRESERVATIVE TREATMENT OF BUILDING TIMBER


By

R. C. B. GARDNER

Secretary of the Association


*Price to Non-members*

**Sixpence**


Printed for the British Wood Preserving Association

48 Dover Street, London, W.1.

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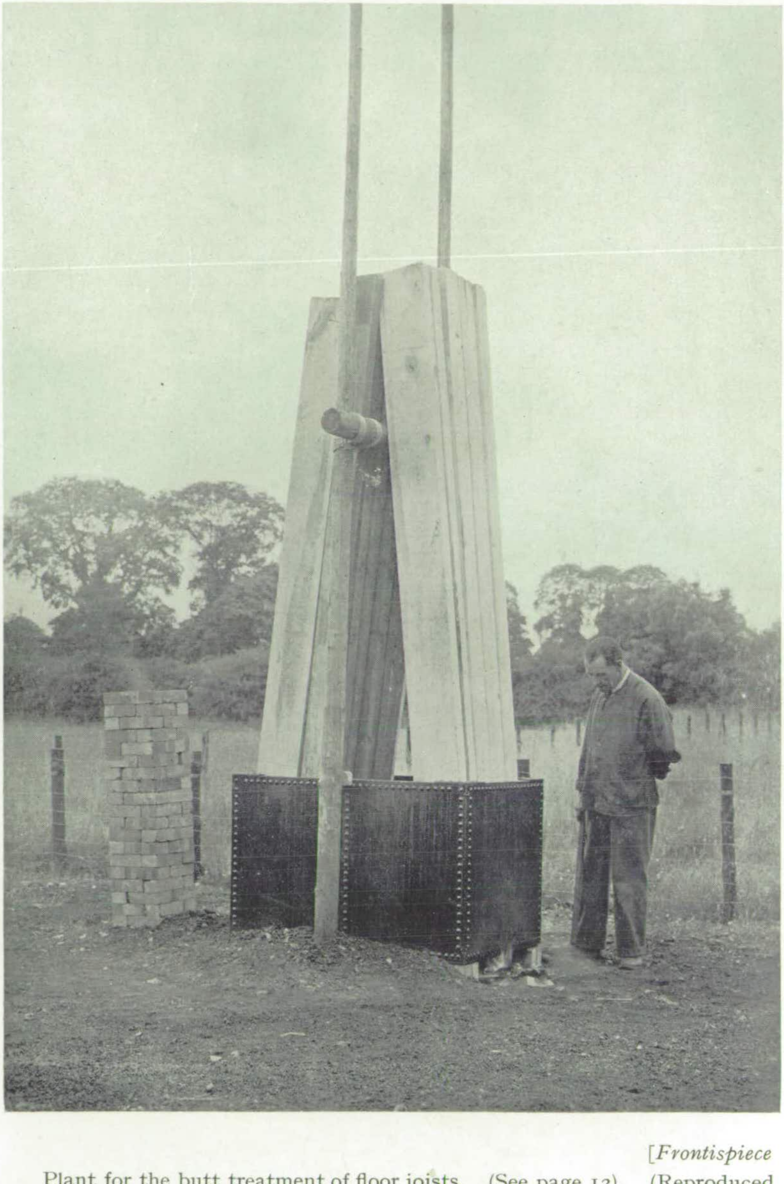

[*Frontispiece*

Plant for the butt treatment of floor joists. (See page 12). (Reproduced from Forest Products Research Records No. 9, by permission of the Controller, H.M. Stationery Office).

# Contents

# Foreword

The annual destruction of wood used for constructional purposes is enormous and the loss in money value almost unbelievable. Most of the decay is preventable if proper measures are taken, based on a knowledge of the biological principles involved.

The present pamphlet gives a simple account of the fungi and insects which bring about damage to timber and describes the methods of control which have been found most satisfactory. It has been prepared by Mr. R. C. B. Gardner, Secretary of the British Wood Preserving Association, in collaboration with various members of the Technical Committee.

The Council hopes that the circular will prove as useful as the previous one, which deals with the Preservative treatment of Estate and Farm Timber.

J. RAMSBOTTOM,

*Chairman, Technical Committee*

1937

# The Preservative Treatment of Building Timber

## GENERAL

It is safe to say that in every household timber is used in one form or another, either in the actual construction of the house, in its fixtures, or in furniture and other appurtenances. Timber is used also, and perhaps to a greater extent, in the outbuildings—garage, tool sheds, greenhouses, etc.—surrounding the house. Under certain conditions, all such timber is liable to the destructive attacks of fungi, insects, and fire.

The protection of timber in fencing and to some extent in outbuildings, has been dealt with in Circular No. 1, "The Preservative Treatment of Estate and Farm Timber," and it is the aim of this Circular No. 2 to describe the methods of protection of building and household timber generally against fungi and insects, and the steps to be taken to overcome actual infection and infestation.

The methods to be applied to eradicate an established growth of fungus will naturally be very different from those applicable to the destruction of a colony of insects, but the protective measures to be applied to new woodwork in order to render it immune from possible future attacks of these pests will generally hold good for each. Wood treated to resist the growth of fungi is extremely unlikely to be attacked by insects.

In order the better to appreciate the protective measures to be taken, the life history of the fungi and insects should be understood.

## FUNGI—LIFE HISTORY

The main portion of a wood-destroying fungus consists of fine thread-like filaments which penetrate the wood in every direction, bringing about great alterations and absorbing certain portions of it as food. As these portions become dissolved out the wood structure is broken down and becomes rotten. The fungus may in time grow out on to the surface of the wood to form fruiting bodies, and these take various forms, according to the species of fungus. In all of them, however, spores, so small that they can be carried long distances by currents of air, are formed by the million. If these fall on a piece of damp wood, and air and warmth are present, germination occurs and a new growth is formed. In this way, i.e., by the dissemination of spores, fungal attacks may spread to wooden structures at some distance from the original source of infection.

Infection can also take place by contact, where the fungus spreads from a piece of rotten wood on to adjacent sound wood. So greedy is the fungus for food that cases have occurred where the threads or "hyphae" from a piece of rotten wood have travelled ten feet along a steel girder to reach wood at the other end. They will also penetrate brick and plaster work, or even pass through stone if porous, in an effort to reach a timber feeding-ground.

Detailed descriptions of the five species of fungus chiefly responsible for causing decay in building and household timber are given in Appendix A. There is no need to describe them here—it is sufficient for the moment to know that they exist, and can be harmful to timber. It must be stressed, however, that the decay known as "dry rot" (caused by the fungus *Merulius lacrymans*) is more serious than that due to any other species, owing to the rapidity with which it can spread, and the consequent difficulty in controlling it, and to its liability, when once established, to attack dry timber. If the owner of timber be in any doubt about the nature of the particular outbreak of decay, and the species of fungus responsible for it, he should invite expert advice, so that he may know whether or not to take the extreme measures for eradication which are necessary with true dry rot.

For any one of these species of fungi to thrive, certain conditions must be present together at one and the same time. These conditions are moisture, air, food, and a favourable temperature. If one of these requirements be lacking, the fungus cannot grow. It must here be said, once and for all, that the best protection against fungal

FIG. 1.

Attack of Dry Rot (*Merulius lacrymaus*) on panelling of a badly ventilated basement room in house which had been unoccupied for six years, in N.E. London. The strands of fungus had penetrated the $4\frac{1}{2}''$ brick wall and formed fruit bodies on the far side.

attack is the provision of adequate ventilation, and the prevention of damp. Ventilation ensures that the timber is not surrounded by damp stagnant air from which it can absorb the moisture necessary for fungus growth. A current of air such as that which should play below the floor boards of a house, but very often does not, will effectively prevent the growth of fungus on the joists, etc., provided that the timber used is properly seasoned when put in, and that it is not allowed to become damp through defective drainage or leakage from water pipes and cisterns. Dampness may also occur through defective damp-proof courses, through soil being heaped above the damp-proof courses, and through leaky gutters. With this axiom as to the necessity for control of damp, and for effective ventilation, the householder should feel himself secure from trouble due to growths of fungus in his timber, but circumstances beyond his control may occur, which render it necessary so to protect the timber as to prevent any possible growth of fungus. For instance, where the floor is to be solid, constructed of battens laid flush in concrete which is screeded level and smooth, the battens should be treated under pressure with creosote by the empty cell process. A coat of creosote should then be brushed or sprayed over the whole surface, and a layer of hot coal-tar pitch or bitumen spread over the whole area. The floor boards should be brushed over, edges and undersides, with two coats of preservative before being put down, and the skirting boards should also be thoroughly treated in like manner.

Timber can be protected from fungal attack—in other words, be made durable—by treating it with a preservative which will prevent the growth of the fungus.

## INSECTS—LIFE HISTORY

In the British Isles, the insects most injurious to timber are wood-boring beetles. The life-cycle of a typical wood-borer may be summarised briefly as follows:—The adult beetles have wings, and can fly. During spring and summer months they lay their eggs in or upon wood in different parts, according to the habits of the various species. After a few days or weeks, the eggs hatch, and minute grubs emerge. They are so small—only about 1/25th of an inch long—that they look quite harmless, and yet, given the right conditions, they are able to bore their way into the timber, and to start damage which in the end may lead to the need for extensive repairs to the roof of a building. The grubs—or "worms" as they are commonly but wrongly called—feed as they bore, extracting their nourishment from the contents of the timber, or even from the wood itself. Their length of life depends upon a variety of conditions not yet fully understood, but the complete life-cycle may last one, two, three, or even more years. It is, therefore, in this grub stage of their existence, which corresponds to the caterpillar stage in the life of a butterfly or moth, that damage is caused to timber by most of the wood-boring insects.

When full grown, the grubs turn into pupae and lie near the surface of the timber. After a short time they change into adult beetles which bore through wood to the surface. The round exit holes which they cut vary with the size of the various species of insect, and the size of the hole may be some clue to the species causing the damage. These holes are exit holes—and not where the beetles have entered the wood. In this way the insects escape to the outside world, ready to establish a new cycle, and incidentally extend further the damage that they can cause. They can spread from infested to adjacent sound timber during their flight time.

Wood-boring beetles are most fastidious in their choice of wood. Some kinds will attack only green timber, whilst others are not attracted by wood until it has become partly dry or even decayed by some kind of fungus. Each type of insect causes a characteristic type of damage to the wood. The insects most commonly found to attack cut timber in the British Isles are the Common Furniture Beetle, the Death-watch Beetle, and the Powder-post Beetle. Detailed descriptions are given in Appendix B.

Timber can be protected from insect attack by treating it with a preservative which will either prevent the female beetle laying her eggs on it, or will prevent the development of the grub should the eggs be laid and hatch.

## DIAGNOSIS OF ATTACK

As there is often some confusion as to the appearance of timber damaged by fungi and beetles—so-called attacks of dry-rot often proving, on inspection to be nothing of the kind, but attacks of the Common Furniture Beetle—the following points may help towards identification:—

### Indications of Fungal Attack

A. Mouldy or musty smell and change of colour of the wood.

B. Dampness of the wood, together with crumbling appearance.

C. Sticky or "soapy" feeling of wood when rubbed between fingers.

D. Cracks over the surface of the wood causing the appearance of a network, or "chessboard," of cracks.

E. Pieces of whitish, brownish, yellowish or lilac felty-looking substances or threads spreading over the wood.

F. Warping of skirting boards.

### Indicating Insect Attack

A. Number of small holes from 1/25″ to 1/8″ diameter, often as many as 20 to the square inch.

B. Fine powder which, if seen on the floor, may have fallen from infested timber in the roof. Therefore look upwards.

C. Dry and prickly feeling of wood when rubbed between fingers.

## METHODS OF DEALING WITH ESTABLISHED FUNGAL AND INSECT DAMAGE

### Fungi

Steps should be taken to trace, as far as possible, the full extent of the attack and to remove the cause of the trouble. All decayed wood should be removed and burned, but where it is impossible to take this drastic but salutary step the decayed portions should be thoroughly drenched with an agent known to be extremely toxic to fungi, in order to prevent the spread of the attack. In some circumstances, creosote will be satisfactory, but where its smell is an objection, some of the water-soluble salts and certain proprietary brands may be used. It must be remembered that there is no means known of *strengthening* wood already decayed, and that treatment of such wood with preservatives can only achieve destruction of that part of the fungus which is reached by the preservatives. Owing to imperfect penetration by preservatives, complete eradication of dry-rot cannot be ensured. Brush application may not reach deep enough to kill the fungus.

Drenching with a toxic substance should not stop at the decayed portions—all adjacent woodwork should receive the same treatment, as also should plaster, brickwork, etc. Where it can be done with safety, the flame from a plumber's blow-lamp may be played over brickwork—this being a most potent means of destroying any hyphae and spores of fungi which may be hidden in cracks, and which might escape any subsequent treatment with liquid preservative.

Any new woodwork should also be treated with preservative, and steps be taken to ensure proper ventilation of that and of any other woodwork.

### Insects

In treating timber which has already been attacked by insects, perseverance is of as great, if not of greater, importance than the nature of the insecticide used. Many substances of everyday household use, such as paraffin and turpentine, can be applied to infested woodwork with every hope of controlling the attack, but owing to the period of several months, from early spring to late summer, during which the beetles emerge from the wood, treatment with these, *and all other insecticides* must be repeated at intervals throughout this period. One single application of the most powerful insecticide may do little good, as it may fail to reach the insect and grubs lying at a distance from the surface. Repeated applications are necessary for two other reasons—first,

FIG. 2.
Attack of Dry-Rot on roof timbers of a badly ventilated cellar at St. Albans.

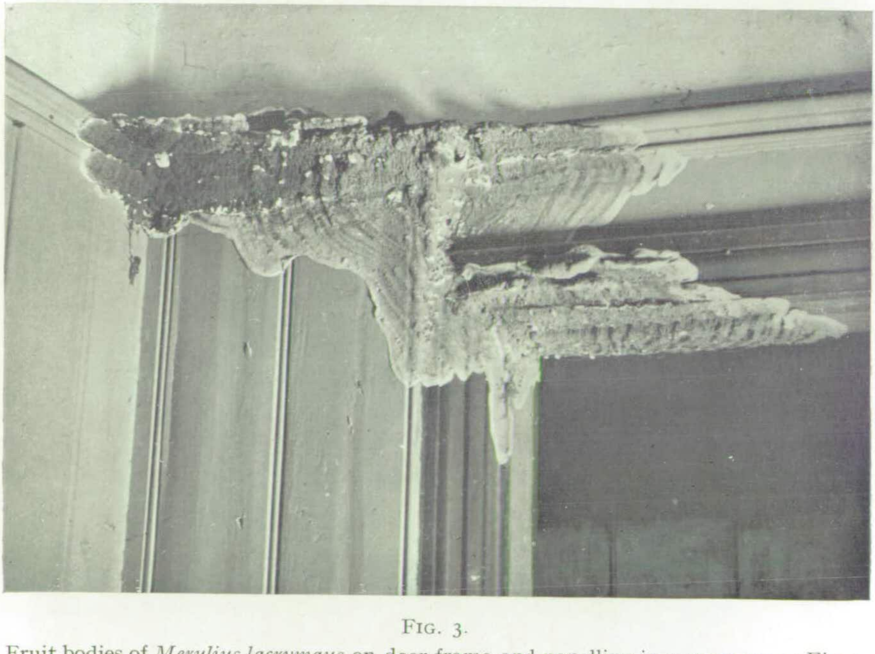

FIG. 3.
Fruit bodies of *Merulius lacrymaus* on door frame and panelling in same room as Fig. 1.

to maintain the surface coating during the egg-laying period, so preventing egg-laying; secondly, they are desirable in successive years, particularly with insects whose life-cycle extends over several years.

The material used should be put on with a brush or spray.

For structural timbers, rafters, joists, beams, etc., coal-tar creosote oil may be used, or one of the proprietary brands of coal-tar origin, or some of the other preservatives referred to in Sections (B) and (C.) Where it is desired to avoid discoloration of the timber, colourless creosote preparations may be used, or one of the several proprietary brands of insecticide which have come on to the market since the work carried out by the late Professor Maxwell Lefroy on the restoration of the roof timbers in Westminster Hall. These preparations vary in smell, and while none of them is truly objectionable, it is as well thoroughly to ventilate a room in which the fixtures have been treated, and to treat movable furniture either out of doors or in a room which can be set apart for the purpose for a few days.

Certain of the proprietary brands are made in two grades—one for ordinary woodwork, and one for highly polished furniture.

## METHODS OF APPLYING PRESERVATIVES

As described elsewhere, there are many kinds of antiseptic preservatives which may be used on timber. Generally speaking, the methods of applying these are the same for all.

There are five methods of applying preservatives to timber, namely, brush application, cold steeping, hot steeping, hot-and-cold steeping, and pressure. These have been described in detail in Circular No. 1, on "The Preservative Treatment of Estate and Farm Timber," and it is here only necessary to summarise them.

(1) Brush Application. This method is not recommended for exterior work in contact with the ground, as it gives only a skin-deep penetration. For interior

work, however, and for such exterior work as weather-boarding and wooden palings above ground, it may be quite suitable, but, particularly when using creosote and its preparations, two coats must be given, allowing two or three weeks between the first and second coats. It is advisable to repeat treatment every few years. In the brush application of creosote and its preparations they should be put on hot and liberally.

(2) Cold Steeping. This method has the disadvantage that most species of timber must remain in the tank for several weeks, to take up more than skin deep absorption. In any case, owing to the small absorption obtained, it is not to be recommended.

(3) Hot Steeping. This method is giving way to the hot-and-cold process, in which better absorption is obtained in a much shorter time, and at much less cost in fuel.

(4) Hot-and-Cold Steeping. This is carried out in the open tank, but whatever be the type of tank employed, whether vertical drum or horizontal rectangular tank, the treatment is the same—the timber is immersed in the preservative, which is then heated to about 200° F., or just below the boiling point of water. It is maintained at this temperature for about one hour, during which time the air in the pores is expanded, and driven from the wood. The preservative with the timber in it is then allowed to cool down, when contraction of the air in the pores draws the preservative into the wood. The timber is removed from the preservative when it is cold. ABSORPTION OF THE PRESERVATIVE TAKES PLACE DURING THE COOLING PERIOD, and the same results are not obtained if the timber is just immersed in preservative at uniform temperature. There is very little absorption during the heating.

By this method it is possible, with all but the most refractory timbers, to obtain highly satisfactory absorption of preservative in the sapwood. With many timbers the absorption compares very favourably with the amount obtained under the pressure process, and the method could easily be used for treating the ends of joists and other structural timber* where it is not feasible for them

* See frontispiece.

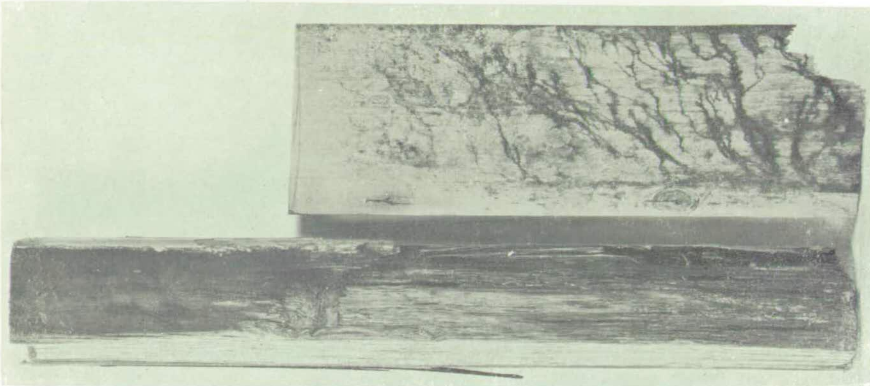

FIG. 4.
Board and joist showing decay by *Coniophora cerebella*. (Reproduced by permission of Director of Forest Products Research. Crown Copyright reserved).

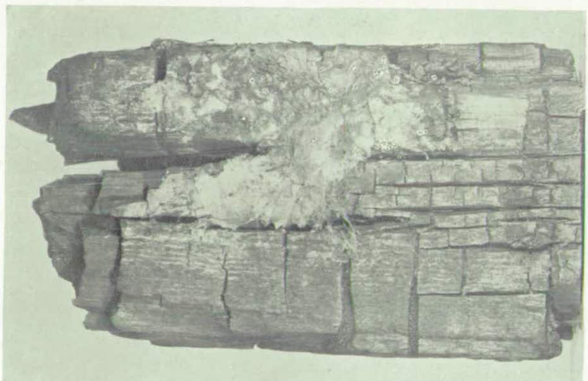

FIG. 5.
Portion of joist decayed by *Merulius lacrymaus*. Note the cubical cracking and the fungal growth.

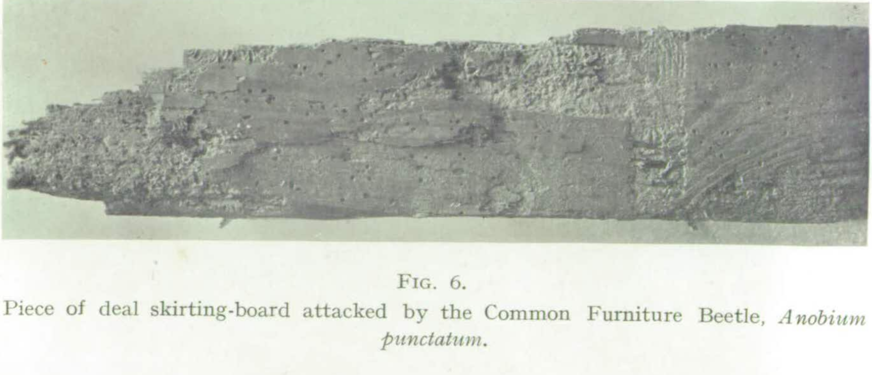

FIG. 6.
Piece of deal skirting-board attacked by the Common Furniture Beetle, *Anobium punctatum*.

to be treated under pressure, or where pressure treated timber cannot be purchased.

(5) PRESSURE. It cannot be too strongly emphasised that deep penetration of the preservative is absolutely vital and necessary. The reason for this is that timber in places where it is likely to be attacked by fungus or insects can only remain sound as long as the skin of preservative remains intact. If splits develop, or pieces are broken off, untreated wood may be exposed. The thicker the treated layer, the less chance there is of untreated wood being exposed. In other words, the thicker the layer, the longer the probable life of the timber. Timber can be given this deep layer of preservative by treatment under pressure, and it can thereby be guaranteed a far greater durability than when merely brush treated or dipped. Pressure ensures that the sapwood at least will be thoroughly saturated with the preservative, although in certain species of timber the sapwood is sometimes refractory.

Pressure-treated timber may be obtained at most of the principal ports in the United Kingdom, and at many inland towns, and there are at least 60 commercial treating plants in the British Isles. The price will necessarily be slightly higher than untreated timber, but it is an economy to pay the extra price in view of the long life which is given to timber by this treatment, and the elimination of replacement costs which are inevitably recurrent when untreated timber is used. Some firms carry out the pressure treatment of timber on such a large scale that they are able to supply this timber, treated, at a cost very little higher than, and sometimes actually below, the price at which small and local timber merchants can supply untreated timber.

Pressure treatment consists in placing the timber in a cylinder where, after a preliminary vacuum to reduce the air pressure in the cylinder, the preservative is introduced into the cylinder hot, and a pressure of about 100 lbs. to the square inch is applied, according to the "treatability" of the timber to be dealt with. This pressure is maintained for two hours or so, and a final vacuum is applied after the release of the pressure, in order to remove as much as possible of the excess preservative. The process as above described is known as the full-cell process, because the cells of the timber remain filled with preservative after withdrawal from the cylinder. Where the timber is to be subjected to the action of running water or very damp soil, it is advisable that it be treated by the full-cell process, but this method is not so suitable for the treatment of building timber as is the empty-cell or Rueping process, because there is likely to be a certain amount of bleeding of the creosote from the timber after the full-cell process, whereas after the empty-cell process the timber is comparatively clean to handle, with slight tendency to bleeding.

In the empty-cell or Rueping process the cells are left more or less empty, only their walls remaining coated with preservative. This result is achieved as follows:—the timber is subjected to an air-pressure of about 40 lbs. to the square inch in the empty cylinder, a "cushion" of compressed air being built up inside the timber. The preservative is then introduced into the cylinder until full without varying the pressure, and next, higher pressure is applied which causes the preservative to penetrate the timber and at the same time further compresses the air already in the timber. When the pressure is released a "kick-back" occurs, i.e., the cushion of compressed air in the timber expands, and much of the preservative in the cells is driven out. Application of a final vacuum removes a further quantity of preservative.

In addition to the advantage of cleanliness of handling, there is a further advantage that timber treated by this method has as deep penetration of preservative with perhaps not more than half the actual amount—there is just as much protection and no excess of preservative. It is consequently cheaper.

## WOOD PRESERVATIVES

The substances in common use for wood preservation in the British Isles may, apart from insecticides, be roughly divided into four main groups:—(A) Oil preservatives; (B) Water-soluble salts; (C) Solvent-type preservatives; (D) Paints and varnishes.

## (A) Oil Preservatives

The chief of these are (1) Coal-tar, (2) Creosote and preparations thereof.

*Coal-tar.*—Tar is not entirely a satisfactory preservative. It does not penetrate the wood, but remains on the timber as a thin surface coating. This may frequently assist decay by sealing up the moisture in the wood. Examples are frequently met with where weather-boarding has become quite soft and rotten on the inside, owing to leaks from a faulty roof, in spite of—in fact, because of—a thick coating of tar on the outside which has prevented the wood drying out. For obvious reasons, tar is not suitable for the treatment of floor boards or any other household interior work.

*Creosote and similar coal-tar distillates.*—The word "creosote" was originally applied to a distillate of wood-tar, and is still used in that sense in medicine. By extension, however, the word has been applied to the oils produced from coal-tar and used for wood preservation. In this sense the word "creosote" is understood to mean "coal-tar creosote oil" and is defined as a distillate of coal-tar produced by high temperature carbonisation of bituminous coal, and having a boiling range of about 125° C., beginning at about 200° C. (392° F.). It contains a little water which causes slight frothing at about 100° C. (212° F.).

Creosote, as used in wood preservation since 1836 and defined as above, is a highly complex mixture of various substances. Much discussion has taken place as to the part played by each of these substances in preserving wood, but it has been found that the efficiency of creosote depends upon the presence of them all. The most probable explanation is that the toxic portions, lethal to fungi and insects, are retained permanently within the wood and prevented from escaping by their solution in the various oils composing creosote, which block up the pores of the wood and sometimes form semi-solid substances which cannot be washed out by water.

Creosote may vary in colour and in character, according to the kind of coal from which the tar is produced, and the method of carbonisation used, whether in horizontal or vertical retorts, in coke-ovens, or in blast furnaces. As sold for wood preservation the specification of the British Standards Institution is a safeguard that it shall contain suitable quantities of tar acids, napthalene, etc. (See Circular No. 1 for this specification.)

Creosote oil, when first produced, is of a light colour, but darkens with age. The colour, however, is no indication of the wood-preserving qualities of the oil, and if purchasers buy their creosote from a tar-distiller or from other trustworthy source, insisting that it shall comply with the specification of the British Standards Institution, they need have no fear with regard to colour or other apparent variations in the oil. The purchaser of creosote is warned against buying from unscrupulous firms and dealers who may be selling, as creosote, oils of doubtful origin or dilutions of creosote with petroleum. The British Wood Preserving Association will be glad to supply enquirers with the names of firms producing reliable creosote.

It may be mentioned that there is no experimental evidence in support of the belief that creosote from coal carbonised in horizontal retorts is preferable to that from vertical retorts.

*Low Temperature Creosote.*—The most important published work relating to the use of low temperature coal oil and its products as a wood preservative has been carried out in America since 1922 by the American Wood Preservers' Association, in conjunction with the American Forest Products Laboratory. This investigation has shown that:—

(1) Low temperature tar creosotes have the same penetration and absorption as ordinary creosotes;

(2) their resistance to evaporation and leaching is greater;

(3) their toxicity is much higher; and

(4) they are even less corrosive to steel and brass than coke-oven or gas-works creosote.

In recent years supplies of creosote produced by the low temperature distillation of coal have become available.

Age tests are at present being carried out by the Department of Scientific and Industrial Research, Chemical Research Laboratory, Teddington, and results so far obtained suggest that the product is likely to be fully as efficient as high temperature creosote. It will be some years, however, before these tests are finally completed.

*Coal-tar Preparations—Proprietary.*—There are on the market several proprietary brands of wood preservative prepared from coal-tar products, for special application, some of which are tinted for decorative purposes. They are very suitable for brush application, for, possibly on account of their low viscosity, they have greater penetrability in timber than has crude creosote. Some of them are claimed by their makers to have great covering capacity, but this is no advantage in a toxic preservative, and is not compatible with claims of high penetrating powers. The main advantage of proprietary coal-tar-derived preservatives is that they contain a large proportion of high boiling constituents, and are clean, and have a low viscosity at normal temperatures. Directions as to the brush application of preservatives are given on page 11. Most of them are stocked by ironmongers and oil and colour stores in small decorative tins of pint, quart, gallon and larger sizes, and are therefore within the reach of every householder.

*Creosote and other Coal-tar Preparations—General.*—When used for outdoor timber, particularly that which is buried in, or is in contact with, the ground, creosote and similar preparations have this great advantage over some of the water-soluble salts to be described next—they are extremely toxic and are relatively permanent in the wood. Examples can be cited where creosoted timber has resisted decay for over 80 years. It can be used in the presence of moisture or immersed in water, for it is not leached out of the wood.

Among the disadvantages of creosote when used in its true form, particularly for interior work, are its smell, its dark colour, and its liability to creep onto and stain any adjacent timber or plaster work. To some extent the proprietary brands are free from these disadvantages, for some of them are comparatively odourless, and can be obtained in almost colourless water-white form. Crude creosote is, however, such a powerful and enduring fungicide that the above disadvantages should not be allowed to weigh with anyone who can use it with discretion as to the place of application.

It should be pointed out that creosoted wood is less easily ignited by spark or small flame than is untreated wood, although once fire has caught hold, creosoted wood burns more fiercely.

### (B) Water-Soluble Salts

For many years there have been in use, more particularly on the Continent of Europe and in the U.S.A. than in Great Britain, wood preservatives employing certain salts of arsenic, copper, mercury, sodium and zinc. Some of these—those of arsenic and mercury—are so extremely poisonous that they have no general use in Britain except in very special circumstances, and proprietary brands of them are made chiefly for export to countries infested with white ants.

Generally speaking, the water-soluble salts have these advantages over creosote, particularly for interior use:—

(1) They are purchasable in concentrated form, needing only dilution with water.

(2) They are odourless.

(3) They are comparatively colourless.

(4) They can be painted over.

(5) They do not creep and stain building material.

(6) Some of them—e.g., zinc chloride—are mildly fire-retardant.

The above advantages render these salts very suitable for the treatment of timber such as window frames, greenhouse and frame lights, greenhouse staging, etc., which can be painted over. Their presence in the timber, underneath the paint coat, will give an absolute guarantee that the timber will not rot from any water which may get inside the paint coat if and when the latter cracks.

They have, however, these disadvantages, particularly for outside work, such as fencing:—

(1) In their natural state, they are not permanent in the timber, and are liable to be leached out by excessive moisture.

(2) Some of them have a corrosive effect on metals, and require treating-tanks to be of wood. Zinc chloride is not definitely barred, but copper sulphate and mercuric chloride are definitely harmful to iron vessels.

The copper, sodium and zinc salts form the bases of several proprietary brands of wood preservatives, and in some of these an attempt has been made, with some degree of success, to fix the preservative principles in the wood so that they cannot be leached out by running water, rainfall, or damp. The salts chiefly concerned are copper chromate, copper sulphate, sodium fluoride, mercuric chloride, zinc chloride, zinc sulphate, zinc meta-arsenite.

### (C) Solvent-type Preservatives

These preservatives consist of a toxic chemical dissolved in a volatile oil or spirit solvent, which, after treatment, evaporates and leaves the dissolved toxic chemical in the wood. On the whole these preservatives, especially those containing solvent naphtha, penetrate the wood slightly better than other types, and are thus more suitable for surface treatment of the timber by brush or spray. In any case, the relative high cost of the solvent usually limits their use to this form of treatment. If, however, it is desired to carry out treatment by the well-known open-tank hot-and-cold process a word of warning is necessary if an open fire is used as most of the common solvents used are highly inflammable.

The toxic chemicals used are numerous, but common ones include metallic soaps or metallic (especially copper and zinc) salts of organic acids, such as naphthenic, abietic and oleic acids; phenols, such as $\beta$-naphthol, chlorinated phenols and chlorinated hydrocarbons, such as chlorinated naphthalene, all of which produce quite good preservatives. The relatively high price of these, however, tends to place these preservatives in the limited class as regards their application for general estate use.

### (D) Paints and Varnishes

The question of paints and varnishes as wood preservatives was dealt with very comprehensively by Dr. L. A. Jordan, Director of the Paint Research Station, Teddington, in a lecture given to the British Wood Preserving Association on February 22nd, 1933, which is reprinted in full in Volume III of the Association's Journal.

There need be no antagonism between paint and varnish on the one hand and other preservatives on the other hand, for under many conditions they can work together effectively for the better protection of wood. The essential difference between them lies in the fact that paint and varnish are surface coatings, while other preservatives are designed to penetrate the wood to a certain degree, dependant on the method of application. These other preservatives are, too, as a rule highly toxic to fungi and insects, which is not the case with paints and varnishes.

Where wood is thoroughly seasoned, and is used in situations where shrinkage, swelling, or movement can be depended upon not to occur, there can be no better protection against both fungi and insects than a coat of good quality paint. This will effectively stop the entry of fungal spores and prevent egg-laying by wood-boring insects. Unfortunately, however, wood has often to be used in places where it is subjected to such strains and movements that a coat of paint cannot for ever remain intact, and if then cracks appear there is grave risk of damp finding its way in and under the coat of paint, and forming an ideal breeding ground for the first fungal spores which settle upon it. This state of affairs is all too commonly seen in window frames and sills, the lights of greenhouses and garden frames, and even in fence posts, rails, and gates. Paint is usually applied to this type of woodwork as much for decorative as for protective purposes, and there is no reason why it cannot continue to be so applied, if steps first be taken to treat the wood underneath with a fungicidal and insecticidal preservative which can afterwards be painted over.

In the U.S.A. it is often a practice to treat window frames and lights with a toxic water-soluble salt such as zinc chloride or sodium fluoride, and then to paint them in the ordinary way. This method does not appear to be practiced to any extent in Britain, save on a few private estates equipped with the open tank for treating timber with zinc chloride by hot steeping. When this treatment is carried out prior to painting, no cracking of the paint need be regarded as serious except from the decorative aspect, as it does not herald a break-up of the woodwork.

It is one of the drawbacks to creosote that wood treated with it cannot be painted over satisfactorily, especially when the treatment has been under pressure, but there are so many other preservatives now on the market which are highly toxic to fungi and insects, and which can be painted over, that those who are anxious for thorough protection combined with highly decorative finish need have no fear in adopting this treatment before painting.

## FIRE-PROOFING

A very important branch of wood preservation is the fire-proofing of wood, or to write more correctly, the treatment of wood to make it fire-retardant or fire-resistant. Many lives have been lost through the burning of a staircase cutting off the retreat of persons from the floors above. Many horses, cattle and other stock have perished in the holocaust of a farm fire, and enormous damage done to property by the firing of wooden buildings. This loss of life and property could be minimised if not actually eliminated by the more general use of wood treated to resist and retard fire.

Wood can be rendered fire-retardant in three ways:—

(1) By impregnation under pressure with certain chemicals, of which the various phosphates of ammonium are the most usually employed.

(2) By brush application of a liquid having fire-retardant properties, of which a certain amount will be absorbed by the wood, though not to the extent achieved by pressure impregnation.

(3) By coating with a surface paint having fire-retardant properties.

For the pressure impregnation method, which is by far the most effective, it is, at the moment, necessary that the timber be sent for treatment to the works of a few firms equipped so to deal with it, or be purchased from them so treated.

For brush application certain proprietary preparations are on the market, and for the third method, surface-coating with a paint, several proprietary brands of fire-retardant paint have made their appearance within the last two or three years.

Whichever method is used, impregnation or painting, the timber can afterwards be given a decorative finish by means of any of the usual stains, polishes, or oil paints. Fire-proofed wood need not be unsightly, and can be as decorative in appearance as any other woodwork.

It is a fact, perhaps not generally appreciated, that fire-proofed wood is a far more efficient non-conductor of heat than is any metal of the same thickness. In the course of experiments to demonstrate the non-inflammability of treated wood, articles of fabric and paper have remained unburned and even unscorched on a wooden floor of $\frac{1}{2}''$ thick deal, treated to be fire-resistant, below which a fierce fire has raged for 25 minutes. Had the floor been of metal, it would have been red-hot in a few minutes, and the objects as soon set on fire and destroyed. Shields of fire-proofed plywood have been found to withstand the flames of "flammen-werfer," or flame-throwers, for an appreciably longer time than did metal sheets of equal thickness.

## USES OF TREATED TIMBER

In Circular No. 1, on "The Preservative Treatment of Estate and Farm Timber," it was mentioned that in a certain district of the West of England where beech has been used extensively for roof timbers and loft flooring in farm buildings, considerable damage has been done by a certain wood-boring beetle, *Ptilinus pectinicornis*, which sometimes has reduced the timber to a condition of

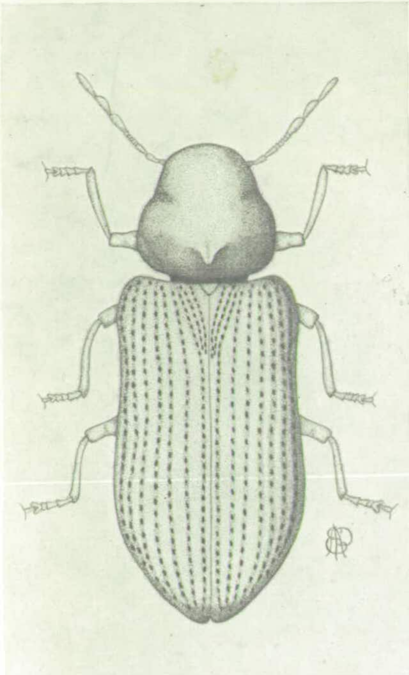

FIG. 7.
The Common Furniture Beetle.
( × 15 approx.)

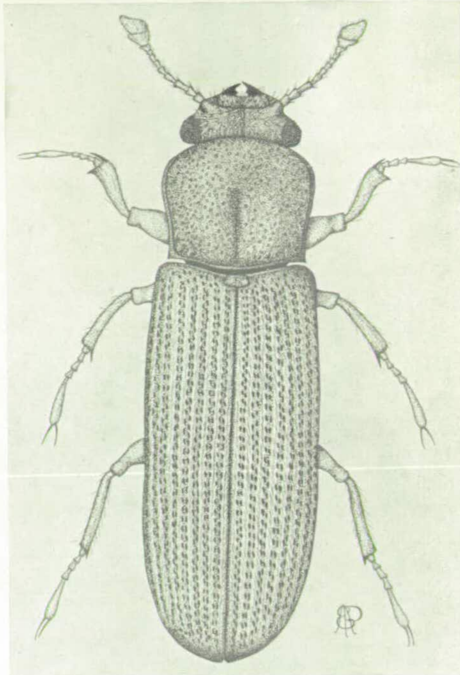

FIG. 8.
*Lyctus* Powder-post Beetle.
( × 15 approx.)

FIG. 9.
Grub (Larva) of *Lyctus* Powder-post Beetle. ( × 15 approx.)

Figs. 7, 8 & 9 reproduced by permission of the Controller H.M. Stationery Office. (Figs. 7 and 8 from Report of the Forest Products Research Board for 1929. Fig. 9. from Forest Products Research Bulletin No. 16).

powder, necessitating complete renewal, the damaged wood being fit only for firewood. Replacement has amounted sometimes to over £30 for a small loft floor—and this need never have been incurred had the timber been treated when first erected.

The preservative treatment of timber, and the use of treated timber, should therefore not stop short at fence posts and other timber which is actually in contact with the soil.

It has already been mentioned that pressure-treated timber can be purchased at many convenient points throughout the country, and the very small additional capital outlay involved—about £5 per standard—should ensure its being obtained and put into any work intended to be permanent. Brush treatment will probably serve for certain interior work as indicated below.

Again, treated timber can be used to replace other materials which either involve high initial outlay or are a constant source of expense in replacement and renewal. For example, the stripping of tiles and slates from roofs in houses and outbuildings by high winds can be avoided by the subtitution of a treated shingle roof. In place of leaky and perishable zinc or cast-iron spouting, pressure treated wooden spouting, or rhones, can be used, also pressure-treated wooden down pipes.

THE FOLLOWING ARE SOME SUGGESTED USES OF TREATED TIMBER, WITH THE VARIOUS METHODS OF TREATMENT RECOMMENDED:—

(F. and I. indicate attack by fungi and insects respectively.)

## DWELLING HOUSES

### 1. *Situations most liable to attack*

F.I. Ends of joists. Pressure with creosote or other preservatives.

F.I. Wall plates. Pressure with creosote or other preservatives.

F.I. Sleeper-joists. Pressure with creosote or other preservatives.

F.I. Floorboards. Brush with creosote; or pressure, or brush with other preservative.

F.I. Panelling. Pressure or brush with non-creosote preservative, painting afterwards if required.

F.I. Skirting-boards. Pressure or brush with non-creosote preservative, painting afterwards if required.

F. Window frames and guttering. Pressure or brush with non-creosote preservative, painting afterwards if required.

F.I. Rafters and Roofing Timbers. Brush with any preservative.

### Outbuildings and Garden

1. *Situations most liable to attack.*

F. Uprights of poultry-houses, garages, summer-houses, kennels, tool-sheds, etc. Pressure with creosote or other non-leachable preservative.

F. Garden edging. Pressure with creosote.

F. Garden steps and terracing. Pressure with creosote.

F.I. Fencing. Pressure with creosote.

F.I. Trellis work and pergola poles. Pressure with creosote.

2. *Other places and objects liable to attack.*

F.I. Walls and roofs of poultry-houses, garages, etc. Brush with creosote or other preservative.

F. Greenhouse staging. Brush or pressure with non-creosote preservative, afterwards painting if required.

F. Greenhouse lights. Brush or pressure with non-creosote preservative, afterwards painting if required.

F. Garden frames and lights thereof. Brush or pressure with non-creosote preservative, afterwards painting if required.

F. Wheelbarrows. Brush or pressure with creosote or any non-leachable preservative.

# APPENDIX A

## FUNGI CAUSING DECAY IN BUILDINGS

1. Merulius lacrymans (The Dry Rot Fungus).

*Appearance of Decayed Wood.*—Wood severely decayed by dry rot is slightly darker than normal: it is friable and breaks up readily between the fingers: when dry it splits up into cubical pieces owing to the formation of deep cracks along and across the grain. (See figure 5).

*Fruit Body.*—When fully developed it is shaped like a plate or thick bracket and is covered with a series of ridges or folds which at times give the appearance of wide shallow pores. It is of a tough, fleshy consistency but decomposes fairly rapidly when it is old. The colour of the young fruit body is greyish tinged with lilac, but soon the ridges become rusty red owing to the formation of the spores, the margin always remaining whitish. The spores in mass are rusty red, but, under the microscope, appear bright orange; their greatest length is about 1/100 of a mm. The spores are produced in vast numbers and may cover a whole room as a layer of red dust.

*Other Growths.*—Under very moist conditions, as in a damp cellar, the fungus produces masses of snow-white, cotton-wool-like mycelium.* (See figure 2). Sooner or later patches of a bright lemon-yellow coloration appear.

Under dryer conditions the fungus produces a felted skin or sheet of silver-grey mycelium which usually shows here and there patches of yellow and lilac. From these sheets there usually run strings or strands, which may be as thick as a pencil—these become *brittle* when dry. Frequently these strings are found penetrating brickwork which has been in contact with the decayed wood.

2. Poria vaporaria (Pore Fungus).

*Appearance of Decayed Wood.*—The appearance of wood attacked by *P. vaporaria* is very similar to that of wood decayed by *M. lacrymans*, but the cubical cracking tends to be less pronounced.

*Fruit Body.*—Shaped like small sheets or thin plates, white—spore-bearing surface also white, showing numerous small pores.

*Other Growths.*—The sheets and strands produced by this fungus and by the related species of *Poria* never become so stout as those of *Merulius;* they remain white or whitish and never show secondary colorations. When dry the strands remain flexible.

3. Coniophora cerebella (Cellar Fungus).

*Appearance of Decay.*—The rot caused by *Coniophora cerebella* renders the wood much darker in colour—it may become almost black. Splitting takes place mainly along the grain, causing the wood to break up into splinters. (See figure 4).

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* The term applied to a mass of fungal threads or hyphæ.

*Fruit Body.*—Inconspicuous sheet or skin covered with small lumps or pimples—dull yellow to olive-brown. Spores dull olive-green.

*Other Growths.*—Branching strands or strings dark brown or blackish, up to 1/8″ in diameter. No cushions or extensive sheets of mycelium ever formed.

*Remarks.*—This fungus and the two noted below occur only in damp situations where the wood is definitely wet, and they all cease growth as soon as the wood is dried out. They may cause severe rotting in solid floors laid directly onto concrete and covered with an impervious covering.

Cure of an outbreak of rot caused by any of these fungi is a very much simpler matter than where *Merulius* is present.

4. Paxillus panuoides.

*Appearance of Decayed Wood.*—In an early stage the wood shows a yellow discoloration, finally becoming a red-brown. Cracking mainly longitudinal with rather fine cross cracks.

*Fruit Body.*—Fleshy, soft, fan or shell shaped, spore-bearing surface with radiating ridges (gills), at first pale yellow, then ochre.

*Other Growths.*—Delicate yellow branching rather hairy strands and rather woolly, dull yellow mycelium, occasionally pale violet in colour.

5. Lentinus lepideus.

This fungus and the wood attacked by it have a characteristic aromatic smell. It causes an internal brown cubical rot.

*Fruit Body.*—When fully developed it is shaped like a mushroom, with radiating decurrent ridges (gills) beneath, rather tough and woody. Frequently abortive forms appear, particularly in dark places—these have no "cap" and consist only of cylindrical, branching out-growths.

*Other Growths.*—No strands are produced, but occasionally a purplish brown felted woolly sheet of mycelium may be present on the surface of the wood.

# APPENDIX B

## DESCRIPTION OF WOOD-BORING BEETLES (ANOBIUM, XESTOBIUM AND LYCTUS)

Furniture Beetles (*Anobiidæ*).

These insects are the most common cause of insect damage to old well-matured timber in furniture or buildings, and do not attack new, recently-seasoned wood. The two most important species are the Common Furniture Beetle (*Anobium punctatum*) and the Death-watch Beetle (*Xestobium rufovillosum*).

The following is a brief description of the insects and their grubs:—

Common Furniture Beetle (see figure 7).

The *beetles* measure from about one-tenth to one-fifth of an inch in length, are reddish or blackish brown and are clothed with a fine covering of short yellow hairs. The first body segment (prothorax)

FIG. 10.

The Death Watch Beetle. ( × 15 approx.) (Reproduced by permission of Director of Froducts Research. Crown copyright reserved).

is distinctly raised in the middle and when viewed from the side appears hood-shaped, overlapping the head which is not visible when the insect is looked at from above. The last three segments of the antennæ (feelers) are characteristic in length and shape (see figure 7).

Narrow longitudinal grooves or striæ in the form of small pits or punctures on the wing covers are well defined.

The fully-grown *grubs* are curved and white, with brownish head, and can readily be distinguished from those of the Death-watch Beetle by the absence of small brown hooks or spinules on the last visible segment of the body, although these are present on other segments.

DEATH-WATCH BEETLE (see figure 10).

This *beetle* is the largest of the British *Anobiids*, measuring from one-quarter to one-third of an inch in length. It is of a dark chocolate brown colour, but is coated with patches of short yellowish hairs which give the insect a variegated appearance. As in *Anobium*, the head is concealed beneath the first segment of the body (prothorax) which, however, is not so distinctly raised in the middle, although it slopes down gradually towards the broadly flanged sides. The last three segments of the antennæ are somewhat similar to those in *Anobium*, but are not so elongate. The wing covers are devoid of the longitudinal striæ, so distinct a feature in the Common Furniture Beetle.

The *grubs* resemble those of *Anobium* in shape and colour, but are slightly larger when fully grown and are more densely clothed with yellow-brown hairs. They can be distinguished at once from those of *Anobium* by the presence of numerous small brown hooks (spinules) on the last visible segment of the body.

LYCTUS POWDER-POST BEETLES (*Lyctidae*)

These insects attack the sapwood of recently seasoned hardwoods, and will not attack old well-matured timber. There are some half dozen species occurring in Great Britain, and although each species differs in the details of its structure, in general appearance all are similar.

*Lyctus beetles* are small, flattened and elongate insects varying in colour from reddish-brown to black and averaging one-sixth of an inch in length. The head is not concealed beneath the first segment of the body (prothorax) and the antennæ end in a very distinct club (see figure 8). The prothorax is not raised in the middle, but is flattened and rectangular. Longitudinal grooves or striæ are present on the wing covers of some species, but are not so well defined as in *Anobium*.

*Lyctus grubs* resemble those of the Furniture beetles in shape, size and colour, but can at once be distinguished from these and other wood-boring grubs by the large breathing pore (spiracle) visible as an oval brown spot on each side of the hind end of the body (see figure 9). Furthermore, they can also be distinguished from the grubs of *Anobium* and *Xestobium* by the entire absence on any part of the body of small brown hooks or spinules.

# APPENDIX C

Some references to published work on the treatment of timber, excluding general literature on timber preservation:—

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*Quarterly Journal of Forestry.*

Vol. I, pp. 49–52. "The Creosoting of Home-Grown Timber." W. B. Havelock. (1907.)

pp. 350–358. Ditto.

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Vol. XVIII, p. 69. "Creosoting Fencing." W. B. Havelock. (1923.)

Vol. XXVI, pp. 254–256. "Creosoting." (Reference to Durability of Ten Species of Timber, Creosoted, in one Fence.) F. Kemp. (1932.)

*Scottish Forestry Journal.*

Vol. 44, pp. 55–59. "Durability of Scottish Larch." John T. Smith. (1930.)

Vol. 46, pp. 158–62. "The Preservation of Timber." George Wood. (1932.)

*Empire Forestry Journal.*

Vol. 9, pp. 236–41. "Antiseptic Treatment of Home-Grown Conifers." J. Bryan. (1930.)

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Vol. 6, pp. 75–81. "Methods of Applying Antiseptics." J. Bryan. (1932.)

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Vol. V, pp. 65–70. "The Open Tank Process for Antiseptic Treatment of Timber for Estates, Farms, Collieries, etc." J. Bryan. (1930–31.)

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pp. 92–111. "Timber Buildings." I. J. O'Hea. (1934.)

Vol. V. pp. 89–93. "A Standard Laboratory Test for Wood Preservatives." W. P. K. Findlay. (1935.)

*British Wood Preserving Association Lecture Reprints.*

"The Control of the Lyctus Beetle." S. E. Wilson. (1936.)

*Transactions of the Chartered Surveyors' Institution*, LXVII, No. 4. (March, 1935).

"Decay of Timber in Houses." Part I. Fungi injurious to timber, by K. St. G. Cartwright, M.A., F.L.S. Part II. Insects injurious to timber, by R. C. Fisher, B.Sc., Ph.D.

*Forest Products Research Laboratory*

*Bulletins* (obtainable from the Stationery Office).

No. 1. "Dry Rot in Wood." 2nd Edition. 1s.

No. 16. "A Survey of the Damage caused by Insects to Hardwood Timber in Great Britain." (1932.) 2s. 6d.

*Leaflets* (Free, at the Laboratory).

No. 3. "Lyctus Beetles and their Control."

No. 4. "The Death Watch Beetle."

No. 6. "Dry Rot in Buildings: Recognition, Prevention and Cure."

No. 8. "The Common Furniture Beetle."

No. 11. "The hot and cold open-tank process of impregnating timber."

*Records* (obtainable from H.M. Stationery Office, Price 6d. each).

No. 9. "Methods of Applying Wood Preservatives." Part I Non-pressure Methods.

No. 14. "Dry Rot Investigations in an Experimental House."

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