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BLUE STAIN

A NOTE ON ITS EFFECT ON THE WOOD OF HOME GROWN CONIFERS AND SUGGESTED METHODS OF CONTROL

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Introduction

1. This paper describes briefly the effects of blue stain on the wood of coniferous trees. Its main purpose is to suggest harvesting, sawing and drying practices which should be employed to minimise those effects, at least until such time as further research on alternative (chemical) treatments is advanced far enough for improved practices to be recommended. The paper also discusses the research and educational aspects of the problem of minimising the effects of blue stain. Mr. J. G. Savory of the Forest Products Research Laboratory of the Ministry of Technology and Dr. D. H. Phillips of the Forestry Commission have helped with technical information in its preparation, and their help is gratefully acknowledged.

2. Several fungi cause "blue stain" or "sapstain" in coniferous sapwood. The best known of these is *Ceratocystis pilifera*. Certain hardwoods are also susceptible to blue stain.

The Effects of Blue Stain Fungi

3. These fungi live on the cell contents of the sapwood and cause no appreciable reduction in the strength properties of the wood which they invade, but they do affect its appearance. The fungal hyphae pass from one cell to another through the pits in the cell walls and, in doing so, destroy very little of the cell wall (wood) substance. Blue stained wood is more permeable to liquids than normal sapwood. Its susceptibility to attack by wood-destroying fungi is not affected, and the consumption of the cell contents by blue-staining fungi actually renders the wood less suitable for the development of the harmful wood boring insects, *Anobium punctatum* and *Hylotrupes bajulus*.

4. The main adverse effects of blue stain in the wood of home grown forest trees are found in pine sapwood. Douglas fir is affected, but the band of sapwood is narrower than it is in the pines. Spruce and larch are not seriously affected. Pine only is considered in this note, although the principles apply to any wood which shows susceptibility to blue stain. The problem is world wide.

5. Surface discolouration of infected wood can vary from the lightest shade of pale grey to a bluish colour or to almost black. The fungi do not produce blue colouring matter but the colour effect is due to the breaking up of light by the brown fungal hyphae which then reflect a relatively high proportion of blue light.

6. These visual defects are of practical importance in sawn timber only when it is used for example, for packing cases which have to be stencilled, or for other unpainted work which is to be displayed. They are of importance in chipboard whose surface may be exposed. Except that the presence of blue stain may obscure brown stain whose presence would indicate early stages of decay, it is of no practical importance in carcassing timber

for building or when the wood is to be treated with preservative which itself gives a stronger and more uniform colour to the surface, or when the wood is to be painted.

7. Surface discolouration does depreciate the value of wood. In British Standard 3819: 1964, *Grading Rules for Sawn Home Grown Soft Wood* exclude from Grade 1 any sawn softwood whose surface contains more than 5% of blue stain. A merchant who buys logs which are liable to show blue stain knows that this may limit the number of markets for the sawn wood that he is going to produce. He reduces his price accordingly.

8. The mycelia of the fungi which cause blue stain cannot enter the wood unless this is exposed. The bark, so long as it is intact, is, in effect a sufficient protection against the invasion of these fungi. In the case of roundwood logs or billets the fungi can penetrate through the exposed end surfaces. Moreover, beetles puncture the bark and carry the fungal spores with them to introduce blue stain at many points along the length of each log or billet.

9. In the case of sawn wood that has been inadequately dried, the whole surface of the sapwood in each piece can be exposed to infection.

The Current Research Position

10. While research work which is being conducted with the help of Forest Products Research Laboratory might provide us with practicable and economic ways of dealing with blue stain in the forest by the application of chemical sprays, this work is not sufficiently far advanced to enable us to give firm recommendations for such treatment. The aim is to find an economic and effective combined insecticide and fungicide. Similar lines of research are being pursued in Scandinavia and in other countries. Meanwhile those concerned with harvesting and using home grown pine need to observe the best practicable ways of controlling blue stain. Suggestions for chemical treatment of sawn timber are made in paragraph 14(b) (iv) opposite.

11. The limits of moisture content of wood in which blue stain can occur are understood to cover a wide range. A moisture content of about 24% of the oven dry weight appears to be the lower limit for growth of the fungi. The fungal hyphae do not immediately die in dry wood; it probably takes a few months of dry conditions to kill all species of staining fungi, so further development of stain may take place if newly-dried wood is re-wetted. Although clean re-wetted wood can be re-infected, the blue stain fungi do not normally stain dried and re-wetted wood so markedly as in the case of wood that has been infected and stained before it has been dried. The optimum temperature for their growth is between 22°C and 30°C (72°F to 86°F), but staining fungi will continue to grow at temperatures below optimum. Though growth ceases at temperatures near freezing point or below, the fungus will not be killed and will resume growth when more favourable conditions return. At about 35°C (85°F) growth of the staining fungi practically stops. Most of them are killed by prolonged exposure to temperatures of this order.

Considerations which Point to Sound Practice

12. Although the moisture content of freshly-felled pine logs might be about 150% of the oven dry weight, the exposed end surfaces of logs can soon dry to a much lower level and there might be a steeply rising moisture gradient from those exposed surfaces to the inside of the log. During the drying of wood its surfaces pass through a phase where the moisture content is suitable for fungal growth. If the temperature range happens to be favourable during that phase, blue stain is to be expected.

13. Wood felled in winter is less liable to staining than is wood felled in summer. Winter felled wood has a chance to dry somewhat before good conditions for fungal growth occur. Complete soaking in water also affords protection but only while the wood is soaked. Neither of these measures seems practicable on a large scale in this country. Both measures have hitherto been practised in Scandinavia, but the development of road transport and of year round logging are making it necessary

for the Scandinavians also to seek chemical methods for the control of blue stain. Climatic conditions in Great Britain seem to favour conditions for good growth of most fungi; blue stain fungi are no exceptions.

Suggested Practice

14. These few elementary considerations point to the only generally applicable solutions to the problem of limiting the effects of blue stain on pine logs and sawn timber in the present state of our knowledge and in the conditions prevailing in this country. The solutions appear to be as follows:

(a) **Saw logs**

(i) Fell, extract and transport the logs to the sawmill as rapidly as possible; i.e. practice "hot logging" technique.

(ii) Saw the pine logs without delay.

(iii) Practice normal forest hygiene measures which are aimed at preventing the build up of populations of pine bark beetles.

(b) **Sawn timber**

(i) Kiln dry the sawn wood at least to 20% moisture content immediately after sawing. This can have the added advantage of killing other pests.

(ii) If kiln drying is not practicable, air dry the wood in accordance with the best practices, including the provision of roofs.

(iii) Use any blue stained sawn timber as far as practicable (and if, in the circumstances it is more economical to do so) for markets which require it to be treated with any preservative whose colour will mask the effects of blue stain. One of the possible beneficial effects of an attack by blue staining fungi is that the permeability of the wood to preservatives appears to be slightly improved if anything; pine sapwood is in any case particularly easy to treat with preservatives.

(iv) Even the best of air-drying practices cannot give sure protection at all times against blue stain, and may even allow severe staining during an unfavourable summer season. If timber cannot be adequately kiln dried immediately after sawing it should, therefore, be sprayed or dipped in anti-stain chemicals, where necessary, as it leaves the saw. Aqueous solutions of sodium pentachlorophenate and borax are used for this purpose in other countries where a solution containing 0.8 lb of sodium pentachlorophenate and 2 lb of borax per ten gallons of water appears to be effective. Concentrations needed to provide effective protection under commercial conditions in this country have not been fully established, but the Forest Products Research Laboratory of the Ministry of Technology suggests that sufficient protection might be provided by solutions of about half the above quoted strength. Treatment should be under cover and sawn timber so treated should then not be left in the rain but should be dried in accordance with sound practice. It should be remembered that re-sawing of treated timber may expose untreated surfaces.

15. These suggested protective practices will provide a large measure of control; they will minimise the effects of blue stain. Their effect may be undone, however, if dry wood is re-wetted, as so often happens on uncovered building sites. Later, when wood that has not been preservative treated or painted weathers to the normal grey colour, the evidence of blue stain is less visible.

16. Although air drying of sawn pine timber is too slow under conditions in this country to afford sure protection at all times against blue stain, sound air drying under cover can reduce the amount of degrade, and should be practised where neither kiln drying nor chemical treatment is possible.

Small Roundwood

17. The effects of blue stain are harmful in small roundwood (or in any other wood) that is to be used for the manufacture of chipboard. There is no practicable way of drying such wood rapidly, nor would it be desirable to

dry it to 24% or lower moisture content for chipboard manufacture. The search for chemical methods of dealing with this problem must therefore continue.

Educational and Research Aspects of the Problem

18. The problem of dealing with blue stain can be resolved into its educational and its research aspects. There is a need to persuade timber merchants and users of wood to accept the fact that blue stain does not impair its physical strength properties. There is a need to encourage them also to make use of blue-stained, pine sawn timber and of similarly stained small roundwood for treatment, where practicable and economic, with coloured preservative. This appears to be particularly sound because pine sapwood takes preservative very satisfactorily, whereas it is not durable unless treated. There is also a need to persuade saw millers to accept the fact that it is essential to fell and extract trees throughout the year in this country, and that the main practical steps that they can take at present are to "hot log", to saw with minimum delay after logging, and to kiln dry. On the research side there is a need to pursue the work that is already in hand and to find economic and safe ways of treating logs and other roundwood with suitable chemicals and to obtain more information about treating sawn timber especially as to what type of chemicals are the best to use. If the results are to be used in practice, the chemicals will have to be cheap to buy, safe and easy to apply, and preferably effective both as a fungicide and as an insecticide. Apart from having low mammalian toxicity when first applied, the chemicals should have no residual toxic effects, because sawn wood or chipboard could, for example, be used to make packing boxes for food.

19. Imported sawn soft wood has been given one great advantage over home grown sawn softwood; in order to minimise the degrade due to blue stain developing in the ship's hold, the shipper is required to despatch sawn soft wood in "shipping dry" condition. (This usually implies a mositure content of about 25% to 30%). One result of this is that imported sawn softwood is in a relatively dry condition when it arrives in this country, although imported softwood is frequently blue stained on arrival or becomes blue stained later. In current practice the drying of most home grown softwood is quite inadequate. Anything that can be done to persuade and to equip home saw millers to dry their timber will be of great help in contributing towards a better service for home grown sawn softwood in the higher priced markets.

20. What has been said in this note points clearly to the need for the closest liaison between those engaged in research on blue stain prevention and those engaged in research on drying of wood and logging and sawmilling. Research into the control of blue stain is high on the list of priorities of work on utilisation research on home grown softwoods.

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