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of Irish Foresters
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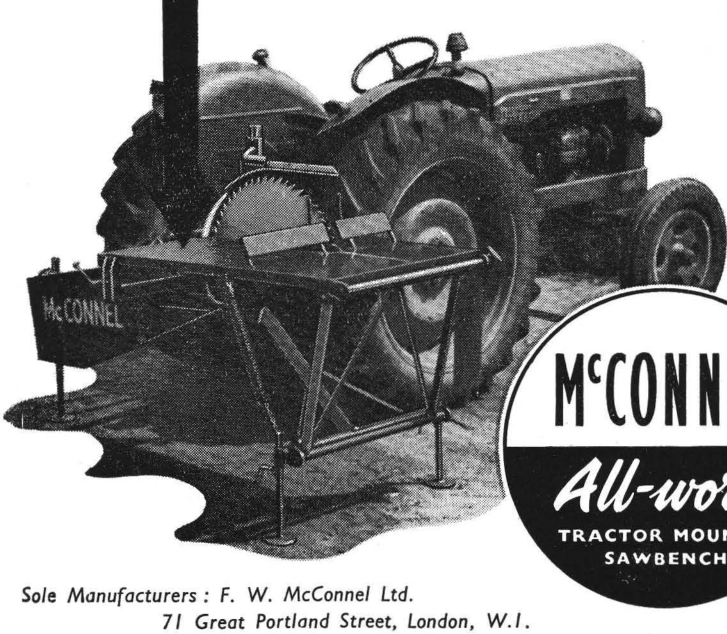

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IRISH FORESTRY

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IRISH FORESTRY

Volume 23 SPRING 1966 Number 1

Editorial

THE BOOK

The cover photograph of this journal is not new, it has appeared in print before now, in fact just a few weeks back—in "the book". Those of our members who have already got their copy of "the book" know what we mean, those of our members who have not are still, no doubt, convinced that "the book" is none other than THE FORESTS OF IRELAND, succinctly described as An Account of the Forests of Ireland from Early Times until the Present Day. And how right they are.

And why *this* photograph ? A photograph is a marvellous way of introducing a topic, and this photograph has precisely this merit, apart from its obvious suitability as a cover illustration. It synthesises, to a large degree, what forestry in Ireland is today. The same can be said for "the book". In fact, on examination of the photograph, we see (a) the type of ground coming more and more into the forestry scene, (b) how the problem of planting bogland is being tackled, (c) the impact of machines in forestry, (d) the product of our forest nurseries and (e) do we see the horizons of forestry?

These things "the book" also aims at and study of the text shows how really necessary it was for us to have, contained within the covers of a single, manageable book the pertinent facts of forestry in Ireland today. Not only is it a guide and ready reference but closer examination reveals, through the collation of all this information, some unsuspected facets, for example the placement and development of forests, which have gone unseen until now because that information has never before been gathered and presented in this way.

Even though we say so ourselves, a good day's work.

THE JOURNAL

With the introduction of editorial comment it became apparent that this column could well be used to try to activate latent literary talent. In support of this idea we felt that we should review earlier journals to see if any comment had been made previously about the supply of material for publication. It certainly did not take long to disclose the feelings of earlier editors and below are quoted relevent extracts :—

> "Many members are, unfortunately, reluctant to put pen to paper . . . . more contributors and more contributions will be required—a steady stream of material will be necessary so that new features can be introduced . . . . It is the Editor's hope that a state of affairs will eventually occur where he will be in the happy position of being able to pick and choose . . . ." (Vol. 2, No. 1, May, 1945).

". . . .at the moment, the main hindrance to what the Constitution terms the 'timeous appearance of the Journal' is the difficulty of obtaining in time sufficient material for the issue in hands, not to speak of building up a reserve for future numbers. The remedy is in the hands of the forester . . . If members are still diffident about authorship, may we at least hope for contributions couched in the more informal style of 'Notes' or even 'Letters to the Editor?' " (Vol. 4, No. 1, October, 1947).

"It is strange that while we foresters are well known for the cheerfulness with which we impart information on our work to others and while we may spend hours of our leisure together 'chopping wood' we are very much inclined to fight shy of going into print . . .
This journal, being the only periodical in the country devoted entirely to forestry, is the ideal vehicle by which the best ideas of to-day can be presented and by which objective observations can be passed on to the foresters of the future . . ." (Vol. 8, No. 2, Winter, 1956).

We were chastened. In fact our brght idea is not new at all and all that we wish to say has been said by these editors. It is rather poor comfort to think that at least we are not worse off than were the editors of the forties. This is a time of open expression of views, of comment and controversy, and yet the Editor of *Irish Forestry* is plagued by an acute shortage of material for the journal. Is there nothing to comment about in forestry? Have we no personal observations to make on what we see and experience in the forests, and in the world of forestry? Whatever else, it just cannot be said that there is nothing happening in forestry in Ireland.

The world is full of paradoxes. The bulk of material being published due to the ever widening horizons of forest science has got to the point where a variety of technical periodicals with but a tenuous association with forestry are taking the overflow of material which cannot find its way into the appropriate forestry journals due to lack of space—and here we are crying out for contributions when in fact we should be hardly able to stem the flood.

In reiteration of what has been said by other editors we would like to point out that long articles are not the only material acceptable. Short articles of a few pages, notes and observations of two pages, one page, or even less, interesting and instructive photographs for inclusion in the text, or as cover photographs and letters to the editor discussing matters of relevance to forestry can all be included. The format of the journal is such that all these matters can be included and yet we may maintain a publication worthy of its standing as a technical journal of repute. Also, it must be remembered that the function of the journal does not stop at the publication of new technical advances in forestry, though indeed this forms an important part of it, but it also acts as a platform for informed discussion and it serves as a link between the Society and its members by reporting Society activities, and it should serve as a link between the members of our Society which must obviously be forged by the members themselves actively contributing to the pages of this journal. Why not?

Nutrient Status of Boglands and their Microbiology with regard to Afforestation

J. J. GARDINER[1].

An early idea that the soil type which developed in any area was determined primarily, if not solely by the climate, though abandoned generally, still holds very true as far as peats are concerned. Not only is the formation of peat dependent upon climatic conditions but also the nutrient status within the different peats is influenced to a large extent by climate and topography. It can be said, that the great factors influencing the level of fertility of virgin peats are (a) climate and topography (b) the microflora.

In discussing the effect of climate and topography on the nutrient status of virgin peats it is interesting to consider peats as fen and bog peats instead of the more usual division into raised and blanket bogs. Fig. 1 will illustrate this type of classification, which is dependent upon moisture source during peat formation.

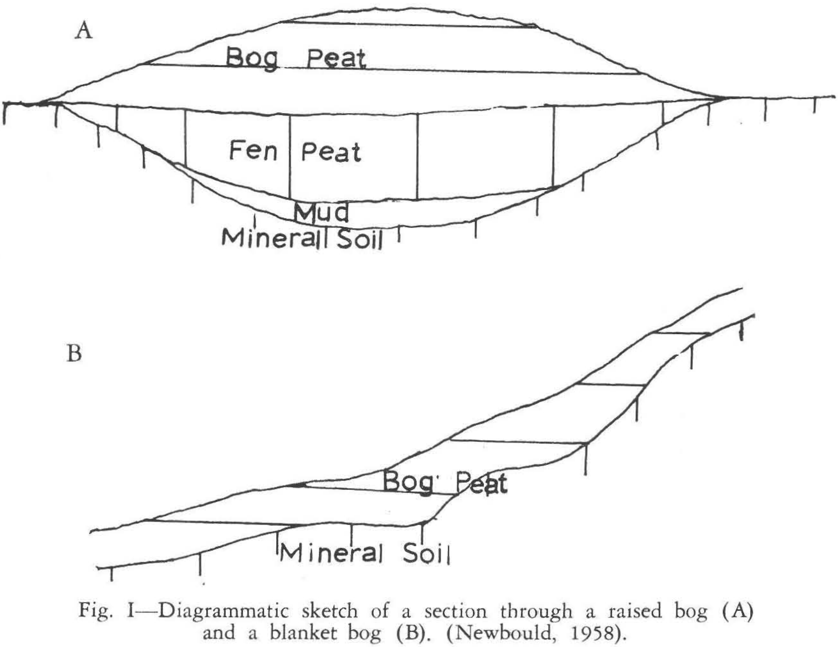

Fig. I—Diagrammatic sketch of a section through a raised bog (A) and a blanket bog (B). (Newbould, 1958).

The formation of both fen and bog peat is primarily due to the presence of excess moisture, but whereas the vegetation of the former is favoured by a combination of soil and rain water the

1. Dept. of Industrial Microbiology, University College, Dublin.

latter is solely dependent upon rain water for its additional nutrients. Table 1 therefore will serve to indicate the potential difference in the nutrient status of these two types of peat by reason of this difference in the water source.

TABLE 1.

Approximate Concentration of some Inorganic Ions in Rain and Lake Waters

	Rain Water (p.p.m.)	Lake Water (p.p.m.)
Calcium	1.00	21.00
Phosphate (P_2O_5)	0.04	0.46
Potassium	0.30	2.30
Nitrogen (NH_4)	0.70	0.96
Nitrogen (NO_3)	0.30	0.15
Magnesium	0.50	7.00
Sulphate	3.00	6.10
Chloride	5.00	19.00
Sodium	0.60	12.00

Where bog vegetation is dependent upon a mixture of rain and soil water any raising of the bog surface will alter the balance, until the surface vegetation becomes entirely dependent upon direct rain water. This leads to the formation of bog peat rather than fen peat with the resulting increase in dryness, acidity and poverty of mineral nutrients. The change in the type of peat formed becomes obvious when examining a profile consisting of fen and bog peat (Table 2).

Thus in fen peat because of the base rich conditions the production of plant material is probably greater, but the breakdown of carbohydrates and proteins and the subsequent utilisation of the end products by decreasing the organic content of the peat, increases its relative ash content, which is added to by mineral colloids and particles in suspension. In contrast, where acid conditions prevail, as in bog peat, the peat is often very fibrous and frequently has an ash content below 2% of the dry weight. In both cases the nett result is an impoverished medium for plant growth.

Anaerobic, waterlogged conditions prevail with a resulting restriction upon microbial numbers and activity. This does not prevent the growth of plants and a type of microflora adapted to that environment, but it does prevent the growth of fungi, actinomycetes, and aerobic bacteria capable of rapidly decomposing plant residues. The obligate and facultative anaerobic bacteria favoured by these conditions are capable of attacking only some of the organic residues leaving the other constituents to accumulate. Thus on fen type peat bogs, fungi and aerobic cellulose decomposing bacteria are found at or just below the surface but they diminish rapidly. Actinomycetes are also found in abundance at the surface. The acid sphagnum bogs contain an abundant flora of acid bacteria, largely anaerobic, which increases with depth (Table 3).

TABLE 2.

Mineral Constituents of Peat Types

(Walshe and Barry).

(*a*) *Raised Bog (Bog and Fen peat)*

Depth cms.	H_2O %	N %	Ash %	P p.p.m.	Ca p.p.m.	K p.p.m.	Decomp. %	pH
0-20	94.25	1.58	2.8	15.50	4.0	205.0	14	4.60
20-50				6.24	4.5	106.0		
50-100	94.75	0.96	2.3	1.75	3.5	75.0	24	4.65
100-150	95.40	0.88	2.3	2.15	4.5	72.0	16	4.60
150-200	95.20	1.04	2.4	0.75	4.0	29.0	14	4.80
200-250	94.75	0.78	2.16	0.50	4.5	33.0	13	5.00
250-300	94.15	0.80	2.6	0.50	3.5	25.0	17	5.00
300-350	93.80	0.92	2.6	0.50	4.5	24.5	37	5.15
350-400	93.60	1.20	3.2	0.50	4.5	19.5	35	5.40
400-450	92.80	1.42	5.1	0.50	6.0	24.5	31	5.70
450-500	92.50	1.42	5.1	0.50	6.5	25.0	40	5.70
500-550	93.35	1.70	6.4	0.50	7.5	25.0	40	5.80

(*b*) *Blanket Bog (Bog peat)*

Depth cms.	H_2O %	N %	Ash %	P p.p.m.	Ca p.p.m.	K p.p.m.	Decomp. %	pH
0-20	92.8	1.33	2.30	10.00	3.90	124.0	35	4.70
20-50				3.25	3.70	30.75		
50-100	93.4	1.44	1.60	2.30	3.60	36.00	42	4.70
100-150	92.7	1.12	2.46	0.50	2.60	36.60	43	5.00
150-200	92.4	1.08	2.70	0.50	3.00	33.00	44	5.00
200-250	92.2	1.08	2.70	0.50	3.00	39.00	45	5.16
250-300	91.4	0.98	2.70	0.50	3.00	31.30	53	5.26
300-350	91.2	0.70	7.70	0.50	2.30	27.00	55	5.20

TABLE 3.

Microbiological Activity in two Peat Profiles

(Waksman 1929)

(*a*) *Fen Peat*

Depth cms.	Bact. and Actinomycetes	Actinomycetes %	Fungi	Aerobic Cellulose	Nitrifying Bacteria	Anaerobic Bacteria
Surface	6,000,000	90	105,000	++	+++	+
30	350,000	40	250	+	++	++
45	450,000	25	175	0	++	++
60	40,000	20	150	0	+	++
75	35,000	25	33	0	+	++
90	20,000	15	0	0	0	++
120	110,000	2	0	0	0	+++
150	500,000	0	0	0	0	++++

(*b*) *Acid Sphagnum Peat.*

Depth cms.	pH	H_2O %	Aerobic and Facultative	Acid resisting Anaerobic Bact.
Surface	4.05	92.7	100,000	+
7.5-20	3.95	92.6	220,000	+
20-30	3.85	92.6	1,600,000	++
30-40	3.86	92.9	3,500.000	++
45-60	3.73	93.6	2,100,000	+++
60-75	3.90	93.6	1,500,000	+++
20-150	4.47	93.4	2,000,000	+++

+ Designates a few; ++ a fair number;
+++ abundance of microorganisms; ++++ numerous.

Because of this restriction upon the microflora a one sided decomposition is accomplished, the nature and extent of which is influenced to a large extent by the nature of the bog vegetation itself. The differences in chemical composition, shown in Table 4, illustrate this influence of vegetation upon the chemical composition of the resulting peat.

TABLE 4.

Organic chemical composition of peat types

(Waksman 1929)

Depth cms.	Ether sol. Fraction	Hemi Cellulose	Cellulose	Lignin	Crude Protein
(*a*) *Carex Peat.*					
12	0.66	10.31	0	38.35	22.48
18	1.10	8.95	0	50.33	18.72
160-180	0.49	7.02	0	57.82	14.81
160	0.78	7.51	0	42.10	19.81
Lake-Peat	0.67	12.14	0	33.25	19.38
Bottom Peat	0.36	5.92	0	15.62	9.81
Woody Material	1.54	8.15	6.12	65.02	5.37
(*b*) *Sphagnum Peat*					
1-10	1.76	26.30	16.43	19.15	3.97
15-20	2.53	25.51	13.33	22.23	4.04
20-30	2.45	25.51	16.23	25.43	5.72
90-120	2.97	22.68	12.07	25.83	5.53
150-180	3.63	15.78	10.84	35.75	13.15
240-270	2.60	5.93	3.20	52.79	13.44
270-330	2.73	4.78	2.70	54.94	12.07

Probably a more important aspect of the nutrient status of peats is the availability of these nutrients to crops. In this respect, the solubility in barium acetate is one of the best indicators. On this basis it is found, that, all the potassium, two thirds of the calcium and magnesium and only the inorganic phosphorus can be regarded as freely available. The inorganic phosphorus constitutes about one third of the total phosphorus present. Perhaps the most surprising thing about the nitrogenous material in peat is its unavailability. The top layer of peat may contain 4,000 lbs. of nitrogenous material per acre yet at any one time only two pounds or less may be available for plant or microbial growth (Table 5). The organic nitrogen in peat has its origin in plant protein, but during decomposition, is converted into various forms of microbial nitrogen and presumably by autolysis partly into residues therefrom. Several theories have been proposed to account for the apparent stability of this fraction, but it now seems that the unavailability is more apparent than real and is primarily due to the absence of available carbon to support a vigorous population of microorganisms. Thus, while many groups of organisms are capable of utilising the carbon of nitrogenous complexes, such organisms have not been isolated from or shown to exist in peat. Hence the indications are, that the incorporation in peat of decomposable material with adequate additional nitrogen to meet microbial needs in decomposition, causes some ammounia to be liberated from the organic nitrogen residues, that would not otherwise become available. This may well explain why true green manuring i.e. ploughing under of immature vegetation, even in considerable amounts rarely results in anything other than a transitory effect on the supply of available nitrogen. On the other hand plant residues of lower nitrogen content incorporated into peat may result in the liberation of a greater amount of available nitrogen than can be expected from the incorporated material alone.

TABLE 5,

Total Nitrogen in lbs. per acre

(Voznyuk, S.T., et al).

Depth (cms.)	0-10	10-20	20-30	30-40	40-50
Lowland Bog (Raised-Bog & Fen)	4404	4017	4570	4833	3419
Upland Bog (Blanket-Bog)	4783	4572	4332	4783	3890

The reclamation of peat for afforestation purposes presents many problems and from a microbiological view point the most urgent is drainage. Any successful development of peatland for forestry purposes must be preceded by the establishment of an efficient drainage system, to remove excess moisture from the upper horizons of the bog. Excess moisture is itself not detrimental to plant growth, but the concomitant effect of very limited aeration adversely affects root metabolism and inhibits the activity of micro-organisms which play such an important role in the nutrient cycle. The depth and spacing of drains depends to a great extent on the nature of the peat, its permeability, and local climatic conditions. In general, where a bog has a large catchment area which brings in a large amount of soil water, the bog is subject to alternate flooding and drought. Mineral matter, carried in the soil water, forms a heavy gritty peat which sinks and allows the development of canalised water flow composed of streams running through the bog. The bog has therefore a low retentive capacity.

The hydrology of fens follows the same pattern, though the soil water may be greater in amount or richer in basic ions. Where, however, the catchment area is small and the bog is mainly dependent on direct rain water with low concentrations of minerals, Sphagnum peat is usually found. This forms a plastic colloidal peat, which floats because of the buoyancy of the Sphagnum hyaline cells (Fig. 2) and prevents any channelling of the water flow. Where these conditions are found the retentive capacity of the bog is in most instances of a high degree. This property in Sphagnum peat, together with high rainfall and humidity necessitates an intensive drainage pattern.

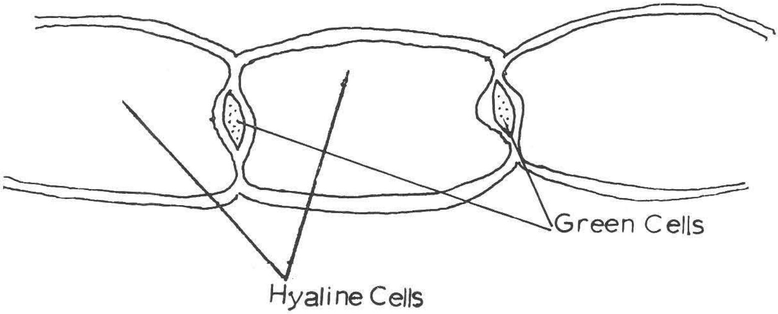

Fig. 2—Structure of Sphagnum moss.

Thus the results of experimental work indicate that if peats could be properly drained and then limed, the organic matter would be gradually decomposed with the liberation of ammonia. This ammonia would then be liberated to plants through nitrification, for while the acidity of peat is probably one of the factors hindering nitrification, the very wide carbon nitrogen ratio is undoubtedly the principal factor checking this process. With a wide C/N ratio the microorganisms use up most of the available nitrogen and store it in their protoplasm, therefore little is liberated as ammonia. When lime is added and the moisture content of the peat brought to agreeable proportions, conditions are made favourable for the activity of aerobic bacteria and actinomycetes and, since bacteria can get along with less nitrogen per unit of carbon consumed as energy than fungi, more nitrogen will be liberated as ammonia. With the improvement in aeration and a more favourable reaction due to liming, nitrification will take place though it may be advantageous to inoculate peats with a suspension of fertile soil as occasionally nitrifying organisms may be entirely absent. Upon draining and liming the actinomycetes become active also. Since these are thought to be the chief agents in the decomposition of the *x* fraction of organic matter and they are hindered by anaerobiosis and acidity, little decomposition of this fraaction can occur under the conditions normally found. This leads to the accumulation of lignins and nitrogenous complexes (Table 4). The effect of drainage and liming upon microbial numbers is shown in Table 6 and the importance of the presence of a vigorously active microbial population will be realised when one considers that microorganisms are involved in practically every process which takes place in the soil. Not only are microbes involved in the breakdown of organic matter but they also play an important role in such complex cycles as the nitrogen cycle the carbon cycle, and the transformation of phosphorus, potassium, manganese, sulfur, iron, zinc, copper, molybdenum, cobalt, boron, arsenic and selenium.

It now seems, however, that the addition of nitrogen salts and phosphates have practically no effect upon the rapidity of decomposition of peat because available energy and not nitrogen is the limiting factor. However a need for phosphate has been established, and a very strong positive interaction between nitrogen and phosphate has been noted. This holds true for both undisturbed bog surfaces as well as ploughed and drained peats. Some doubts have been raised as regards the advisability of using superphosphate on peats because of its possible reaction with ammonia. If superphosphate absorbs ammonia, a mixture of ammonium and calcium phosphates is formed, much of which is soluble. However it may be that this takes place more readily at a very low pH (3.0) and low calcium concentrations but not so readily at a pH of 5.0 and relative abundant calcium concentrations.

TABLE 6.

Number of microorganisms in soils of different moisture content and pH.

(Waksman, 1922)

Time of Incubation (Days)	No. of Microorganisms per gram of Soil. Waterlogged	Drained	Drained and Limed
26	1,050,000	1,935,000	233,250,000
61	533,000	1,963,000	193,624,000
88	680,000	1,450,000	143,650,000
116	415,000	1,545,000	136,725,000
150	652,000	1,760,000	49,650,000
181	1,012,000	2,796,000	22,600,000
239	910,000	2,825,000	60,330,000
291	995,000	3,320,000	101,833,000
Averages	781,000	2,199,000	117,708,000

Thus it has been clearly shown experimentally that for successful establishment of plantations on peat some form of drainage and an application of phosphate is necessary. No long term experiments with other fertilisers on peat have been reported but it is clear that although nitrogen, potassium, and other nutrients may not be limiting factors applications of these will give benefical results and they may become limiting as the plantations become older because of storage within the trees. In fact there is considerable evidence that calcium and potassium deficiencies do occur in older trees. It also seems that occasional or even annual top-dressings of phosphate are necessary even where plantations have been treated at establishment. Since as far as is known at present all the coniferous species are likely to give rise to raw humus on base-poor peats, the supply of mineral nitrogen is likely to be low, and mineral nitrogen supplied as fertiliseer is likely to become unavailable when it has been taken up by the trees and returned to the soil as litter, applications of nitrogenous fertiliser appear to be necessary also in established plantations.

The position then is that phosphate manuring, combined with other recent advances in forestry practice, results in the establishment of plantations on even the worst sites. A greater understanding of the processes of plant nutrition and the increasing appreciation of the microbiological and biochemcal principles involved give confidence that the level of fertility of peats can be improved sufficently to make afforestation of these lands a practical and profitable undertaking.

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Wood destroying fungi [1]

J. RISHBETH[2].

INTRODUCTION

These organisms are of outstanding importance to foresters. Their main natural role is the decomposition of woody tissues, involving the destruction of both cellulose and lignin, and some of the breakdown products are eventually incorporated in to the soil in forms available to higher plants. Familiar bracket fungi and some toadstool formers are examples of this group, which includes a number of parasites. In natural and semi-natural forests parasitic activity is restricted since opportunities for infection of standing trees are few and far between. In plantations subject to modern management, by contrast, the scope for parasites is greatly increased, and indeed in some circumstances they constitute a serious threat to timber production. Brief mention will be made here of four fungi which cause loss, and more detailed attention will be given to one other,, *Fomes annosus* which experience has shown to have the greatest potential for destroying conifer wood.

RHIZINA UNDULATA

Strictly speaking this is not a wood destroyer in the sense that only cellulose is attacked, but it is included here because of the interesting first record of its connection with group dying of Sitka spruce (McKay and Clear, 1953) and its importance in Irish plantations. Subsequent research by Murray and Young (1961) demonstrated the relationship between lighting of bonfires and subsequent attack on conifers, as had been reported for younger trees by other workers. In East Angia considerable losses are often sustained amongst replanted conifers or naturally regenerated seedlings on acidic sites where conifer felling, accompanied by bonfire lighting, has recently occurred. It would be prudent to consider the possibility of similar outbreaks occurring in Ireland after clear felling of conifers. If it is impracticable to ban lighting of fires or to resort to mechanical chopping of debris, as is now practised in the flat terrain of East Anglia, delayed planting might be tried. The ascospores of *Rhizina* survive several years in the soil and are stimulated by heat to germinate around the edges of bonfires: subsequent development only occurs if living conifer roots are present in the immediate vicinity (Jalaluddin, 1965). At clear-felled sites *Rhizina* initially invades root systems of conifer stumps, but it would be expected to die out if it experienced

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1. Paper read at the Annual General Meeting of the Society of Irish Foresters, Dublin, 19 March, 1966.
2. Botany School, University of Cambridge.

much delay in acquiring further substrates, such as would be provided by the susceptible roots of young planted conifers. It would appear more difficult to prevent development of group dying in standing spruce, though the severity of such attacks might well diminish with increasing age of the trees. If again fires cannot be banned altogether, methods might be devised to reduce the extent and period of heat received by the underlying soil. Soil disinfection at the bonfire margin might also be attempted, though existing evidence suggests that this approach is not too promising.

STEREUM SANGUINOLENTUM

This fungus by contrast is a wound parasite of standing conifers, especially larches and spruces. In a recent survey of decay developing from extraction damage, Pawsey and Gladman (1965) found it to be by far the commonest cause of decay associated with wounds, and it was also responsible for the fastest rate of decay recorded. Decay was more frequently associated with stem scars than with root scars and it followed fracture of wood tissue more often than mere removal of bark. Wound infection with *Stereum* leads to staining and often later to considerable heart rot, which may extend many feet up the stem. Affected trees cannot pass infection to adjacent healthy ones by means of root contact, so far as is known. *Stereum* is a ubiquitous fungus which colonises freshly cut conifer branches and logs lying on the ground, and also untreated conifer stumps. Sporophores, although to some extent seasonal, are so common that it is virtually impossible to prevent widespread dispersal of spores: control must therefore be aimed at limiting as far as possible the types of wound which favour its establishment.

POLYPORUS SCHWEINITZII

This also causes heart rot of standing conifers such as Sitka spruce and Douglas fir, but unlike the previous species entry to the butt generally occurs from the roots. The mode of initial entry is not known but possibly originates from infected stumps via root contacts. In Britain it is locally prevalent on sites formerly bearing pines or hardwoods; the rot it causes may extend up the stem more rapidly than that produced by *Fomes annosus*. Stem breakage and wind throw often result from its attack. No suggestions can be made as yet about its control, though treatment of freshly cut stumps might be expected to limit any colonisation by wind-borne spores that occurs.

ARMILLARIA MELLEA

The all too familiar honey fungus is often present at sites formerly bearing hardwoods, especially oak, and may cause damage if these are replanted with conifers. *Armillaria* is unusual in producing rhizomorphs looking like bootlaces: these permeate the soil and may infect trees at a distance from the food-base, commonly in the form of a hardwood stump. Scattered killing of young conifers often occurs but tends to cease as trees grow older. Butt rot caused by *Armillaria* seldom extends more than a foot or two up the stem, but other fungi causing more serious rot sometimes enter as a result of root killing by the parasites. Although the damage it causes in British plantations is as yet relatively small, we should be unwise to ignore it. Unfortunately control is very difficult, the practice of ring-barking developed in some tropical crops almost certainly being of limited value under temperate conditions. The role of spores, produced mainly in the autumn by the characteristic toadstools, is unsufficiently known but there is evidence that under some conditions they can infect freshly cut stumps (Rishbeth, 1964).

FOMES ANNOSUS

This is another stump and root inhabiting fungus with a very wide distribution. It differs from *Armllaria* not only in having bracket-shaped fruit bodies which can liberate spores throughout the year where winters are mild, but in being unable to infect trees by growing through the soil: local spread is by means of root contacts or grafts. Although characteristic of conifer stumps *Fomes* is sometimes present in those of hardwoods such as birch and ash. Stumps containing the fungus are by far the commonest source of infection of standing trees. Root invasion, where extensive, may lead to outright killing in a variety of conifers, though this is perhaps commonest wth pines. However in the case of susceptible trees, such as larches and spruces, by far the commonest result of root infection is butt rot, and this is the major source of economic loss in many countries. In Sweden losses up to about £90 per acre have been recorded in Norway spruce 60-70 years old, and the total loss for this species is estimated at some four million pounds annually. The forester may also have to reckon with wind blow and loss of increment, and his choice of species for subsequent rotations may be seriously limited by build-up of the fungus.

Operations leading to its establishment

Many aspects of the behaviour of *Fomes* are familiar by now and need not be described here, but it is perhaps worth stressing the variety of forest operations which may lead to its appearance. Felling a conifer stand and then replanting with conifers is one common example. It is not necessary for the previous crop already to have infection, because for instance development of *Fomes* has occurred quite early in a plantation of *Thuja plicata* established directly after felling a healthy crop of European larch. The probable explanation here is that the larch stumps became infected as a result of colonisation by windborne spores. Replanting after destruction of a conifer crop by fire can also lead to appearance of *Fomes* since charred stumps may also be colonised by spores. Attacks occasionally develop at sites formerly bearing broad-leaved trees, especially birch.

On sites devoid of stumps at the time of felling, such as former arable, pasture or moorland, plantations are free from *Fomes* infection in the early years. The first opportunities for such infection arise when trees are cut during weeding or cleaning, or for sale as Christmas trees. Remarkably small stumps may on occasion become infected by *Fomes* in the moist environment provided by stands at the "thicket" stage, when the young trees are specially susceptible to root attack. However by far the most serious opportunities for entry occur during thinning and rack-cutting.

It has been found that brashing wounds on standing conifers sometimes become infected, if the branches removed are still living. With pines killing from such infection is generally confined to heavily suppressed trees though very occasionally a dominant or sub-dominant tree succumbs. Infection through severe brashing wounds has also been recorded for spruce, but wounds caused by extraction are seldom colonised by *Fomes*, apparently. These avenues of infection created by wounds, though worth mention, are far less important than those provided by stumps. The emergence of *Fomes* as a major pathogen is in fact directly related to the increased demand for timber: even in naturally forested countries the damage it causes is increasing, most likely because of intensified felling in accessible areas and exploitation of districts formerly inaccessible.

Spore dispersal and competitive effects

Some idea of the potential risk of stump infection has been obtained by collecting samples of spores from the air at various places and testing them for the presence of *Fomes* (Rishbeth, 1959a). This was done by culturing the samples on freshly cut discs of pine stem, which are highly selective for the fungus. Over a period of about a year nearly 60% of the samples were found to contain viable spores of *Fomes*: they were detected at all the localities chosen, including the Shetland Islands which are nearly 200 miles from the nearest spore source. As might be expected, the largest catches were obtained down wind from major sources such as large areas of infected plantations.

Peniophora gigantea, a competitor of *Fomes*, was found in no less than 80% of the samples which suggests that the latter may be naturally controlled to some extent. Sampling of pine stumps at various periods after felling showed this to be the case: in East Anglia, for instance, where *Peniophora* is now very abundant it is usual in winter months for pine stumps first to be colonised by both fungi, but *Peniophora* generally gains ascendancy after the first few weeks and thereafter usually becomes dominant. Sporophores of *Peniophora* are much more subject to desiccation than those of *Fomes*, however, so that during spells of dry weather spore production of the former is often greatly reduced. Sampling of stumps has confirmed that this may lead to increased colonization by *Fomes*. In other districts *Peniophora* is as yet relatively uncommon and exerts little control. This is probably because the fungus persists for only three to four years in pine stumps after felling, by contrast with *Fomes* which may survive for decades. In new plantings of pine near land formerly bearing conifers stumps are thus more likely to be colonised by *Fomes* than by *Peniophora* during early thinnings, though later *Peniophora* may increase rapidly through colonisation of branches on the forest floor, much as *Stereum sanguinolentum* does.

Incidence of infection

Forest surveys in Britain show that *Fomes* has entered young first-rotation conifers established on a wide variety of soils as a result of stump infection (Low and Gladman, 1960). The most serious damage occurs as in other countries, where the soils were previously under cultivation, and especially where they have been limed. The potentiality for root infection in various soil types is not fully known, but though it is considerably lower in some than in others there is enough evidence to suggest that no type is entirely free from risk. The extent to which *Fomes* has developed in some first-rotation Irish stands within 25 years confirms the very general prevalence of the hazard.

Control

Eradication of *Fomes* infection, once established, presents formidable problems and is bound to be very costly; thus here is an outstanding case of prevention being better than cure. Fortunately in the majority of Irish plantations *Fomes* has not yet appeared or has not built up to any great extent. The case for attempting to prevent further stump infection by *Fomes* rests not only on saving timber in the current rotation but on retaining the freedom of choice to plant tree species susceptible to the parasite in the following rotations, if need be. Experience has shown that protection may be achieved by treating freshly cut stumps in various ways (Rishbeth, 1959b, 1963). In choosing between them the necessity for limiting spread of *Fomes* into stumps from any roots already infected at the time of felling must be considered in addition to the need for preventing colonisation of the stump by spores

Stump creosoting was the first method to be suggested, and evidence of its effectiveness was obtained in one set of plots established in Scots pine where, after first thinning, only 3% of treated stumps became infected as compared with 75% of the untreated controls. Six years later the number of trees affected by *Fomes* in these plots (3 and 63 respectively) was clearly related to the proportion of stumps earlier infected. In 1952 stump creosoting was introduced in East Anglia and by about 1960 it was in general use throughout Britain in conifer plantations managed by the Forestry Commission. By this time however it was evident that this treatment had some disadvantages mainly arising from its retarding effect on the entry of saprophytic fungi into stumps. Creosoted stumps tend to remain alive longer than untreated ones, and resulting from the exclusion of saprophytes there is a considerable risk of *Fomes* becoming dominant in stumps of trees already infected at the time of felling. Another consequence of delayed colonisation is that subsequent damage to treated stumps may permit entry of *Fomes*. Again many types of creosote are useless for protecting stumps and even satisfactory types give poor control when applied lightly. But despite the fact that by then something was known about the effects of other chemical treatments on pine stumps, it was decided not to introduce any new method until very extensive testing had been carried out. The advantages of creosoting were considered to outweigh its disadvantages, especially in uninfected or lightly infected stands.

By contrast with creosote, which barely affects the selectivity of underlying wood tissues for *Fomes*, many other treatments rapidly kill them. Ammonium sulphamate, applied as a 20% aqueous solution, has this effect and allows a wide range of fungi to become established because it is not especially toxic to them. Competition from other fungi near the cut surface is nearly always sufficient to exclude *Fomes*. Two disadvantages of this treatment, however, are the high cost of the sulphamate and the slight hazard to surrounding trees where root grafts occur, since this tissue poison is very effectively translocated. Other chemicals such as disodium octaborate, also applied as a 20% solution, not only kill wood tissues rapidly but are toxic to fungi: wood-destroyers are excluded until leaching by rain reduces the boron concentration to a tolerable level. By this time other fungi have colonised the wood sufficiently to prevent entry of *Fomes*. This treatment suffers from other drawbacks, namely that the octaborate tends to come out of solution in very cold weather and that, like urea, it does not favour development of organisms sufficiently competitive towards *Fomes* in any roots already infected. It is therefore unsuitable for use in areas where the parasite is already very prevalent but it has found some application elsewhere.

The most promising chemical protectant found as a result of further research at Cambridge is sodium nitrite (Punter, 1964). In subsequent trials set up by the Research branch of the British Forestry Commission in Scots pine, European larch and Sitka spruce, 10% and 20% solutions gave almost equally good results: a mean 0.4% stumps were infected by *Fomes* as compared with 20% in the controls. In Britain sodium nitrite is rapidly replacing creosote for conifers other than pines and it is also being used on Norway spruce stumps in southern Sweden.

Research into chemical treatments of pine stumps showed that their effectiveness in preventing spread of *Fomes* into the body of a stump from roots already infected depends largely on the extent to which *Peniophora* is favoured. It seemed reasonable, therefore, to test direct inoculation of stump surfaces with this fungus. As previously mentioned,, *Peniophora* exerts some natural control over stump infection by *Fomes* but is unreliable because the extent of its spore production varies greatly with locality and with weather. Experiments showed that inoculation with oidia (asexual spores, produced in culture) gives excellent protection at the cut surface: for example with pine stumps of about 8 in. diameter an application of 10,000 viable spores is probably adequate to control the largest dosage of *Fomes* spores likely to occur naturally. Growth of *Fomes* from any tissues infected at the time of felling tends to be checked and the parasite is even replaced to some extent. Whether such a method is practicable of course depends on the availability of a suitable Peniophora inoculum, and this problem has been resolved by using a concentrated source of spores in tablet form. This type of protection is now employed in East Anglian pine plantations and it is expected in due course to become general in other pine areas. So far it has only proved possible to use *Peniophora* for pine stumps, and research is proceeding in the hope of developing a suitable inoculation method for stumps of other conifers, especially Sitka spruce.

Experience has shown that the effectiveness of stump treatments often declines rapidly if they are delayed after felling. Especially with pines, resin may flow from the cut surface so fast that this is effectively sealed within a few minutes. Emphasis has therefore repeatedly been laid on immediate application, and in practice this is achieved by pouring the appropriate solution or suspension from a spouted can and distributing it over the cut suface by brush. A water-soluble dye is added to ensure that stumps are not missed. The cost of treating stumps is about 30/- per acre, equivalent in Britain to some 3% of the income derived from sale of thinnings from young plantations.

Several other methods have been suggested for reducing loss from *Fomes,* such as planting mixtures of conifers and hardwoods in order to reduce root contacts between susceptible species. Wide spacing and delayed thinning are other possibilities, and these are being tested in long-term experiments. Eventually we shall need to know much more about techniques for re-establishing conifers at sites where *Fomes* is very prevalent, and here again experiments set up by the Research branch of the British Forestry Commission may well yield useful information. At the present time in Ireland, however, the obvious need is to prevent as far as possible any further inroads by *Fomes,* and available methods of stump protection such as inoculation with *Peniophora* for pines and treatment with sodium nitrite for other conifers seem well suited to this purpose. Since a large proportion of first-rotation stands are at early stage of development, a fine opportunity exists for preserving them from serious damage.

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Britain's Veteran Churchyard Yews

E. R. YARHAM

One of Britain's famous veteran churchyard yews fell victim to one of the many severe gales of the extended winter of 1961-62. It stood in the churchyard at Duffield, near Derby. Boisterous winds so severely damaged it that it had to be felled. This ancient tree is reputed to have been planted in commemoration of the Battle of Crecy where the English long-bow archers played a memorable role, turning the tide to an ever-memorable victory.

It was with yew wood, of course, that the long-bows of England were made. Of late years cabinet makers have been scouring the country for yews, which with the exception of the oaks, are the most typical of all British trees.

A demand for furniture made of yew wood which has a beautiful grain, has revealed a serious shortage of this tree, once so common in Britain, but which (of any size), is now rarely found outside village churchyards. The tree is so slow growing that a specimen whose trunk is only six inches through may be over a century old.

Even small ones have been bought up, and the probability is that before long there will be even fewer yews to adorn the countryside. Fortunately there will survive those veterans of nearly incredible age—some among them reputed to have been standing since the days of the Druids—in churchyards up and down the land.

"A post of yew will outlast a post of iron", so runs the old country saying and none who have stood and gazed at the sombre majesty of some gnarled yew in a village churchyard, would feel inclined to deny the truth of the legends which are told of its ancient lineage.

One of the oldest yews in the world stands in Fortinghall churchyard, near Kenmore, at the extremity of Loch Tay. It is supposed to be the most ancient tree in Britain. Pennant the naturalist (Dr. Johnson said of him, "He observes more things than any one else does") and traveller, stated its girth was 56 ft., and the Swiss botanist, De Candolle, writing in the early part of the last century, pronounced it to be the "oldest authentic specimen of vegetation in Europe", and estimated its age at from 25 to 30 centuries.

This veteran has, not surprisingly, got even beyond the stage of mere hollowness, and most of the outside shell has disappeared, only two portions of it at about opposite sides of the tree, remaining. These are now so far apart as to look like separate trees with strange flattened trunks, the inner portions of which have no bark. These remains are growing comparatively vigorously, and as the tree is now scheduled as a national monument, and is surrounded by a stone wall it may well survive for further centuries.

Another ancient tree was much loved by Gilbert White, the curate-naturalist of Selborne. It still stands in the churchyard of the Hampshire village where he was born, lived, and died. With a girth of 27 ft., few can equal it in vigorous health and spread of branch and it is one of the tallest of all yews. Although there is no direct evidence as to its exact age, it was mentioned in Saxon records of at least a thousand years ago.

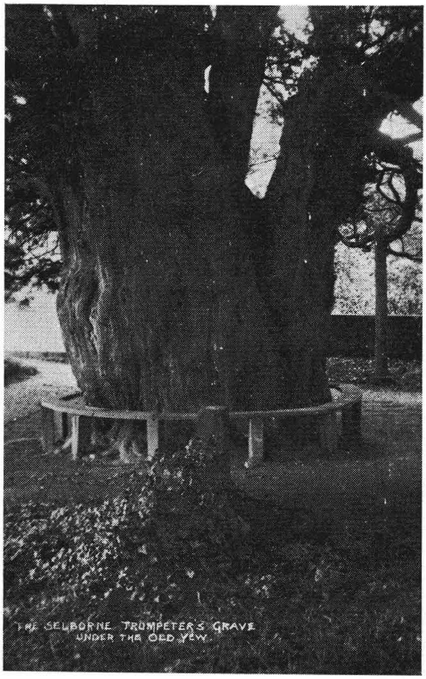

Fig. 1—1,000-year-old Yew at Selborne, England.

Beautiful Fountains Abbey, Yorkshire, was commenced during the early years of the twelfth century but there still stands a veteran yew which is reputed to have given the monks shelter during the building. Further south, the magnificent yew at Harlington, Middlesex churchyard, was for centuries one of the great trees of England. It began life at least a thousand years ago. At five feet from the ground the trunk was between 24 ft. and 25 ft. in circumference. The main tree fell in 1959 and it took the men of the church council nine months to saw it up, but a substantial stump remains about 20 ft. high. This has taken on a new lease of life and is growing vigorously.

There is another notable yew in Woxford Churchyard, Warwickshire, not least in its appearance. The branches have an exceptionally wide spread and, being horizontal, and supported by wooden props, it gives the appearance of a roof, under which worshippers walk to the church door. It is hundreds of years old; indeed, ten centuries is no exceptional age for a yew. One such veteran, in Gresford churchyard, North Wales, has a girth of 30 ft. and is still growing vigorously. One of its huge boughs spreads over the path and dozens of tombstones as well.

The old yew in Eastham churchyard Cheshire, was often visited by the American author Nathaniel Hawthorne, during the time he was American consul at Liverpool. It was also the goal of many nature rambles led by the famous churchman novelist, Charles Kingsley, when he was canon of Chester Cathedral. He founded the Natural History Society in Chester. The exact age of the tree is a matter of conjecture but it is probably between 1,500 and 2,000 years. In passing it may be said that the people of Darley, Derbyshire, claim that the yew in their churchyard are at least 2,000 years old.

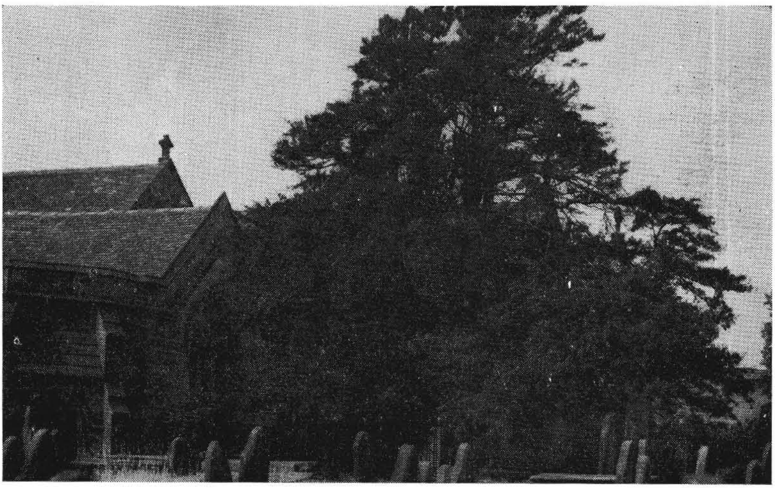

Fig. 2—Eastham Yew, Cheshire, 1,500-2,000 years old.

Reverting to the Eastham yew, when in 1152 the abbot and monks of St. Werburgh received the Manor of Eastham at the hands of Earl Randall of Chester, the villagers of Eastham entreated the new owner "to have a care of ye olde yew". The tree still flourishes, and when in 1898 the Royal Archaeological Society visited the village they considered that the yew had been planted originally against the east end of the timber-framed wattle and daub chapel, which was in being before the Norman Conquest.

"This great undertaking excited such universal and such natural interest that it may be worth while to place on record some few facts in connection with the removal . . . Sceptics and doubters are so numerous that in few years' time, many may be found who will doubt that such a tree was ever moved in the memory of man". That paragraph found its way into the parish magazine of St. Andrew's, Buckland-in-Dover, in March 1880, and it refers to a 1,000-year-old yew with a remarkable history.

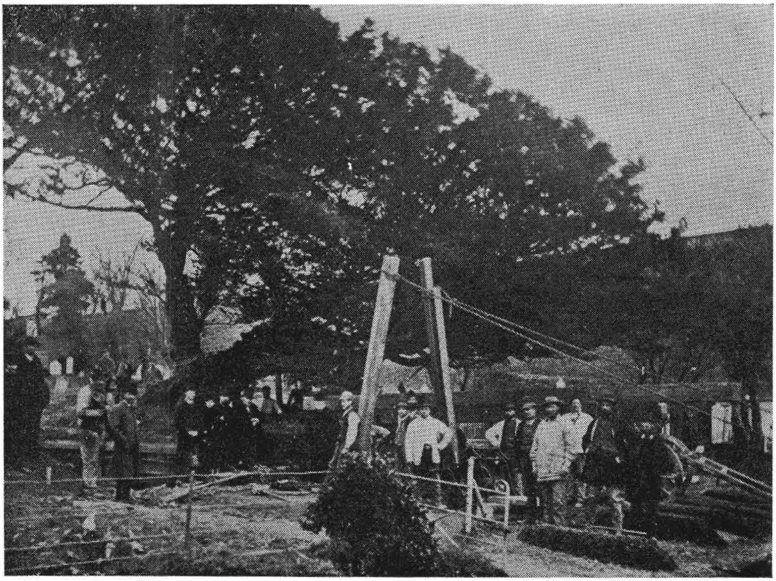

Fig. 3—Transplanting famous Buckland-in-Dover Yew, 1880.

The tree originally stood 62 ft. to the east of where it stands to-day and the purpose of moving it was to extend the nave of the church and so increase the seating capacity. No doubt the sceptics referred to were convinced that such an extensive operation would bring about the tree's decease. It is still in a flourishing condition and shows vigorous signs of new life each spring.

The account of 1880 continues: "The operation commenced on the 24th February when a trench was dug on all four sides, four feet wide and five feet deep, leaving a large block of earth 18 ft. by 16 ft. broad and a long cutting was formed from the old position to the new one". Much work with huge planks of timber, chains, six-inch rollers and windlasses took place before the whole mass of the tree estimated at 55 tons, began to move. It arrived within a yard of its destination at dusk on the 4th March.

That eminent student of British scenery, Dr. Vaughan Cornish, published a book on "The Churchyard Yew and Immortality." He says that the tree was not, despite popular tradition, planted to supply material for bows. It is true that in the reign of Edward I yews were ordered to be planted in churchyards but this was to protect the building. Hence in the south of England they are usually found on the south-west side, from whence blew the prevalent winds.

It is also stated that the trees were planted because yew leaves were much used for the services of Palm Sunday and other occasions, and because of this the trees gained a sacred character. There is also a lot to be said for the theory that because of its ever-greeness and long life, the yew was selected as an emblem of immortality.

Sir Thomas Browne the physician and metaphysical writer, touched upon this when discussing ancient burial customs, saying: "Whether the planting of Yews in churchyards holds not its original from ancient Funeral Rites, or as an emblem of Resurrection from its perpetual verdure, may also admit conjecture".

One of the reasons why the yew was long regarded as a symbol of immortality is that it was one of the few evergreen trees in Britain. Dr. Vaughan Cornish's thesis is that, before the conversion of southern Britain to Christianity, yews were sacred trees. The Chrstian missionaries, although the veneration of trees was forbidden by the Church did not destroy the yews, but adopted them as sacred symbols.

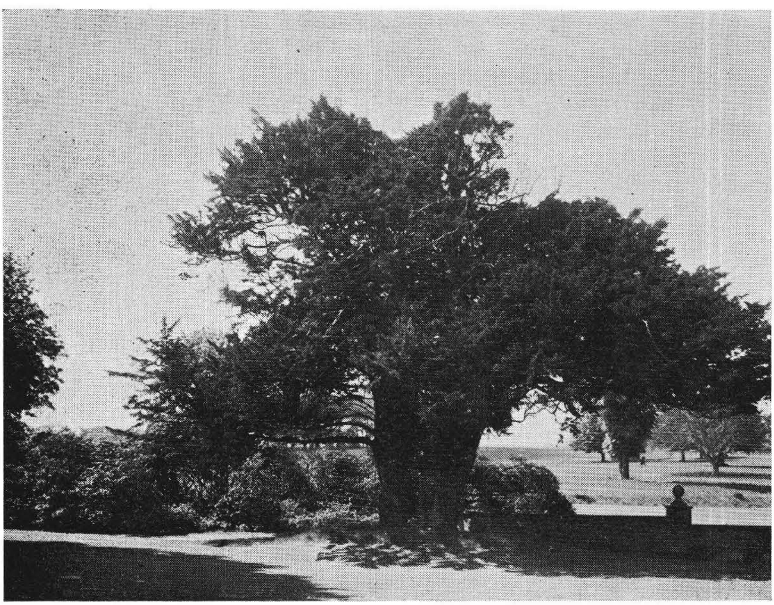

Fig. 4—Noted "twin" Yews at Cromer Hall, Norfolk, England.

Usually, he tells us, at least two yews were planted in a churchyard, one beside the path from the funeral gateway to the principal door of the church; the other by a path leading to a subsidiary door. Where there were no graves—as in a cathedral close—no yews were planted. That the yew was planted for symbolic reasons in some churchyards in Normandy seems to have been due to the close association of that Duchy with Britain.

Dr. Cornish notes that the established positions of yews in relation to the church doorways are the same in both countries; and in Ireland he remarked that churchyard yews are most frequent in the eastern part which was under the direct rule of Henry II, and also in the isolated area in the west round Galway, where there were many Norman, Saxon, and Welsh settlers.

Society's Activities.

Illustrated Lecture—Strabane

FEBRUARY, 17th, 1966.

The organisers of this meeting, expecting an attendance of about 30 or 40 members, had booked a comparatively small room for the occasion and were consequently overwhelmed by the 75, or so, people who turned up.

They were not disappointed by our two speakers, Mr. W. G. Dallas and Mr. W. J. Wright, both of whom had toured North America as part of their year's Kellogg Foundation Fellowship.

Through the medium of memorable transparencies the speakers kept up a running commentary on their travels, holding the audience's undivided attention for $1\frac{1}{2}$ hours.

Bill Wright started with the redwoods in California, took us through Arizona and Nevada to Las Vegas. Bill Dallas showed us Indian fire-fighters in Arizona and swept through New Mexico, Colorado, Wyoming, Montana and Idaho. He then crossed into Canada to Calgary in Alberta to show us the festivities and the rodeo. We had a glimpse of Prince Rupert in British Columbia and did not forget to stop for a moment at the wayside grave of some early Irish pioneers and of Deadwood Dick who said that the sheriff would never take him alive—and was proved right! All were very envious of the Alaskan foresters' selection of beautiful launches with which to view their vast forests. Our footsteps were then turned south to the World Forestry Congress at Seattle where we met an old friend in Professor Clear marching in a sort of "Twelfth" procession under the flag of the Republic. One slide showing Bill in similar pose had to be censored! Bill Wright who had by then regained his breath, continued through Minnesota and the Lake States to the Southern States and the Mississipi.

Both speakers were warmly thanked and congratulated on the excellence of their photography.

C.S.K.

Lecture—Castlebar

MARCH 5th, 1966

This Lecture, "The Reforming Landlords in Eighteenth Century Ireland" was given by Dr. L. McCracken, M.A., F.R.Hist.S., Professor of History at McGee University College, Derry, who, with his wife, has done considerable research into the forestry history of this country.

In introducing his topic Dr. McCracken reviewed succinctly aspects of the political and economic history of Ireland and England during the eighteenth century to illustrate the political climate and its impact on agriculture. This period heralded great agrarian improvements in England. Agriculture was fostered, was supported by premiums and, most important, became fashionable. In Ireland agrarian reform was closely linked with social reform.

It was in this period, in 1731, that the Dublin Society was founded for the improvement of "husbandry, manufactures and other useful arts". Amongst the useful works of this Society was the paying of premiums for the planting of over 55 million trees between 1766 and 1806, those initially being fostered were oak and beech but with a change of emphasis to larch and Scots pine towards the end of the eighteenth century.

The Irish parliament was very active in matters of forestry interest and between 1698 and 1791 a number of acts were passed designed to preserve existing woods and encourage planting. Eleven acts, between 1731 and 1791 were passed to encourage planting by offering tenants a share in the trees they planted. These measures achieved only limited success.

Even though there was "detestable tyranny and oppression of landlords" there were many who did a great deal for the improvement of their lands and the lot of the Irish tenant farmers. Dr. McCracken illustrated this by describing in some detail the work of various landlords in Ireland, notably such people as Richard Lovell Edgeworth, John Foster, Thomas Mahon and Henry Boyle, Earl of Shannon. These people, and others like them, contributed to relieve the forestless wastes of Ireland, and did so with considerable energy. They also were very fair to their tenants, gave them credit for improvements, built houses for them, and payed them premiums (or passed on premiums granted to them) for planting trees.

Dr. McCracken concluded with some interesting extracts from letters written to Henry Boyle by his agent describing the forestry work being done on the estate.

After discussion the Vice-President, Mr. O. V. Mooney, thanked Dr. McCracken for his most intersting lecture.

L.U.G.

Illustrated Lecture—Dublin

APRIL 23rd, 1966

The topic of this lecture, given to a sizeable audience, was "Forest Safety", and the lecturerer, Mr. G. Skaaret, Head of the Forestry Section of the Workers Protection Board for all Sweden was introduced by the Vice-President, Mr. O. V. Mooney.

Mr. Skaaret, introduced his topic by defining what precisely "accidents" are, how they occur and where the causes lie.

Unsafe machinery is responsible for 80% of forestry accidents occurring in Sweden, and unsafe working conditions account for the other 20%. The large number of accidents in the forests has led Mr. Skaaret to do research into the causes of accidents with a view to introducing preventive measures.

In many cases there is the problem of maintaining safe tools and conditions. For instance, it frequently appears to the men that the safety guards on chain saws reduce their efficiency, therefore they tend to remove them. Another cause of accidents is the noise level associated with machinery, particularly chain saws; where the noise of a chain saw becomes unbearable the workers' efficiency and alertness drops, leading to carelessness. Vibrations, when intense, cause numbness and pains which may lead to accidents. Such factors are important in planning for safer working conditions.

Mr. Skaaret went on to describe various safety measures that should, and could, be employed—teaching workers how to use tools safely, how to tackle a job in a safe manner (workers should *never* be left to learn from their own mistakes, they should be trained), the use of ear-muffs against noise and helmets as protection against falling branches, etc., and of vital necessity, the need to always have a first-aid kit available (at least 20% of accidental fatalities could be prevented if people knew how to apply first-aid).

A salutory lesson was learned when Mr. Skaaret informed the meeting that 1,000 injuries occurred in southern Sweden in 1965 associated with felling operations.

Mr. Skaaret's lecture concluded with three extremely interesting films illustrating safety in (a) felling trees, (b) dropping lodged trees and (c) snedding branches. These films, in colour, showed firstly how the job should *not* be done, and followed up with detailed illustrations of the correst, and safe, way of performing these operation—again stressing the reasons for employing safety measures — 850 injuries and 10 fatalities in felling per annum in Sweden and 300 injuries and 7 fatalities in freeing lodged trees.

Mr. P. O'Grady proposed the vote of thanks with great appreciation of the points illustrated by Mr. Skaaret.

L.U.G.

Recent Papers

The following is an extract from a list of papers published by the Forest Products Research Laboratory which are available in limited quantities as reprints or Laboratory reports and which may be of interest to readers of this journal.

166PP —,TWO-STAGE WINDTHROW IN SITKA SPRUCE, E. W. J. Phillips and D. G. Patterson (reprinted from *Quarterly Journal of Forestry,* October, 1965).

Investigation of brittle windthrow fractures following an easterly gale in a stand of Sitka spruce growing on a Devonshire hillside showed that the stems had broken off at compression failures induced by a westerly gale two years earlier, following the cutting of a roadway which increased the exposure. The "first stage" damage had become protected by wound tissue and rapidly developed compression wood giving rise to well-marked stem swellings which presumably saved some stems from second and final damage when the rest were broken. The term "compression swelling" is suggested for this defect.

189B—IMPROVING BRITAIN'S SOFTWOODS, J. D. Brazier (reprinted from *The Timber Trades Journal* Supplement, April, 1965).

At a time when there is an increasing demand for basic materials to be produced to a standard specification, the inherent variability in wood adds to the difficulties of advancing timber utilisation. This paper describes work in progress by the Forestry Commission and the Forests Products Research Laboratory to reduce variability and improve the quality and quantity of home-grown softwoods.

1815PL—PREVENTION OF BLUE-STAIN IN UNPEELED SCOTS PINE LOGS, J. G. Savory, R. G. Pawsey and J. S. Lawrence (reprinted from *Forestry,* May, 1965).

Blue-stain causes degrade of saw logs during the inevitable delays between felling and conversion. Chemicals of potential value in blue-stain control have been tested in the laboratory and trials have been made of their use on unpeeled logs stored in the forest.

118—A COMPARISON OF READINGS OF A COMMERCIAL RESISTANCE-TYPE MOISTURE METER AND MOISTURE CONTENTS DETERMINED BY OVEN-DRYING, D. D. Johnston and R. H. Wynands (reprinted from *Wood,* November, 1958).

The electrical method of determining the moisture content of timber, based on the fact that the resistance of wood increases as it becomes drier, has obvious advantages over the oven-drying method. There are, however, several possible sources of error in the electrical method and these are enumerated. There is appreciable variation in the resistance of timber at a given moisture content and this imposes a limit on the accuracy obtainable with a resistance-type moisture meter; test results are given to illustrate this point.

167c—THE EFFECT OF DRYING AND SUBSEQUENT RE-WETTING ON THE STRENGTH PROPERTIES OF WOOD, S. A. Covington (reprinted from the *Journal of The Institute of Wood Science,* October, 1965).

Strength values for timber in the green condition are sometimes derived from tests on over-dry material which is simply re-wetted until its moisture content is raised above the fibre-saturation point. It is assumed that this has no effect on the properties of the timber. Tests made on matched green and re-wetted material have shown, however, that re-wetting reduced most of the strength properties.

188c—RESEARCH IN SAWMILLING, W. T. Curry (reprinted from *The Timber Trades Journal* Supplement, April 1965).

The extensive softwood plantations that have been established by the Forestry Commission and private woodland owners since 1919 are now beginning to yield stems of sawlog size. The conversion of this substantial output of home-grown softwood will present problems to the sawmilling industry. Research work at present in hand at the Forest Products Research Laboratory which will provide information which should assist the industry in deciding what is the best type and size of mill for conditions in Britain and also in developing new techniques.

Copies can be obtained, so far as stocks permit, on application to The Director, Forest Products Research Laboroatory, Princes Risborough, Aylesbury, Bucks. It is sufficient to quote the reference number preceding each title.

NOTES

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