JOURNAL OF THE FORESTRY COMMISSION

No. 23 1952-54

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Continued on inside back cover.

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Contributions for the 1955 Journal will be welcomed. They should be sent, through the usual channels, to Mr. H. L. Edlin, Forestry Commission, 25, Savile Row, London, W.1. A note of the author's name, postal address, official rank, and station should be appended to each manuscript submitted.

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ACKNOWLEDGMENTS

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EDITORIAL

The Coronation

The Coronation of Her Majesty Queen Elizabeth on June 2nd, 1953, was commemorated by appropriate ceremonies in each of the three countries. In England, the former Buriton Forest, near Petersfield in the South East Conservancy, was renamed Queen Elizabeth Forest, the actual ceremony being performed by the Duke of Wellington, Lord Lieutenant of the County of Southampton. In Scotland, the forests of Loch Ard and Rowardennan, which together extend from the Trossachs to Loch Lomond, were constituted the Queen Elizabeth Forest Park, which was opened by the Rt. Hon. James Stuart, Secretary of State for Scotland. In Wales, where the forests of Rheola, Margam, Michaelston, Dunraven, and Cwmogwr have been united under the title of Coed Morgannwg, which means the Forest of Glamorgan, Her Royal Highness the Princess Royal personally opened an impressive highway, twenty-two miles long, built by the Commission's engineers, and named it *Ffordd y Frenhines*—the Highway of the Queen.

A Royal Visit

On 27th September 1952, His Royal Highness the Duke of Edinburgh visited Culbin Forest in the East Scotland Conservancy, where he was received by Lord Radnor, Sir Henry Beresford-Peirse, Mr. Frank Oliver (Conservator, East Scotland), and Mr. W. G. Milne (Head Forester, Culbin). The Duke saw the work of thatching the dunes, establishing the crops of pines, and harvesting the produce from the older plantations, and he also visited the fire tower. A picture of the Duke of Edinburgh and Lord Radnor, taken during the visit, appears in our central inset.

The Late Lord Robinson, O.B.E.

It is our sad duty to record the passing of Lord Robinson of Kielder Forest and Adelaide, O.B.E., who as everyone knows, was the guiding spirit of the Forestry Commission from its inception in 1919 until his death on September 5th, 1952, whilst leading the United Kingdom delegation to the Sixth Commonwealth Forestry Conference in Canada. An Australian by birth, Lord Robinson began his career as a forestry officer under the Board of Agriculture as early as 1909; he later became our first Technical Commissioner and subsequently, from 1932 to 1952, Chairman of the Forestry Commission. An obituary notice appears on a later page, and here we would only add that, among his manifold activities during a life entirely devoted to forestry, Lord Robinson found time to promote this staff Journal, serving for many years as chairman of its editorial committee.

Memorials to Lord Robinson

A memorial service for Lord Robinson was held on 21st October, 1952 in St. Margaret's Church, Westminster, and was attended by the Commissioners, senior officers, and representatives of all grades of staff in the Commission's service. The service was conducted by the Rev. Canon Charles Smythe, and the lessons were read by Lord Jowitt, a personal friend of Lord Robinson.

Lord Robinson's ashes were brought home from Canada and scattered at Kielder Forest, in Northumberland, the forest that he had done so much to create and from which he took his title. Subsequently, on 29th September, 1953, Lord Radnor unveiled a memorial cairn at Whickhope Nick, in the heart of the Kielder plantations, which are themselves a fitting reminder of the work of this foremost British forester. A bronze plate on the cairn bears the following inscription:

> "*To the Memory of Roy Lister Robinson, O.B.E., Baron Robinson of Kielder Forest and of Adelaide. A Member of the Forestry Commission from its inception in* 1919, *and its Chairman from* 1932-1952.
>
> *Born 8th March,* 1883
>
> *Died 5th September,* 1952
>
> *His ashes are scattered in this forest, which owes its existence to his creative energy and vision*".

It had been intended, before Lord Robinson died, to present to him a portrait painted by T. C. Dugdale, R.A., towards which members of the Commission's staff had subscribed. This portrait has now been presented to Lady Robinson, his widow; a reproduction of it appears as the frontispiece to this issue.

The Commission

Since the last issue of the Journal there have been a number of changes in the membership of the Forestry Commission. Lord Radnor succeeded the late Lord Robinson as Chairman of the Commission. The Rev. J. E. Hamilton and Professor Walton have retired, while new appointments are: Mr. A. P. F. Hamilton, a former Inspector-General of Forests for India; Major D. C. Bowser, a Scottish landowner who is also President of the Royal Scottish Forestry Society; and Mr. John McNaughton, who was a member of the Royal Commission on Scottish Affairs.

The Commission is now constituted as follows:

The Earl of Radnor, K.C.V.O. (*Chairman*)
Mr. J. M. Bannerman, O.B.E.
Lieut.-Col. Sir Richard Cotterell, Bart., J.P.
Mr. Lloyd O. Owen, J.P.
Major John Stirling of Fairburn, M.B.E.
Mr. W. H. Vaughan, O.B.E., J.P.
Mr. Stanley C. Longhurst, O.B.E.
Mr. A. P. F. Hamilton, C.I.E., O.B.E., M.C.
Mr. John McNaughton, C.B.E.
Major D. C. Bowser, O.B.E.
Mr. H. A. Turner, *Secretary*

Obituary

It is with much regret that we record the passing, in March, 1954, of Mr. W. D. Russell, Conservator for South Wales. Mr. Russell, whose service with the Commission extended over twenty-eight years, had served successively as a District Officer in South-West England, Instructor in charge of the Dean Forester Training School, as Divisional Officer on timber production work during the war, and as Conservator in South Wales since 1947; he was only 53 when he died, and will be greatly missed by his colleagues.

Retirements

Mr. W. H. Guillebaud, our Deputy Director General since 1948, retired in July 1953. Mr. Guillebaud's service to forestry began with his appointment, nearly forty years previously, to the Forestry Branch of the former Board of Agriculture. He became the Commission's first Research Officer on its inception in 1919, and was subsequently promoted to Chief Research Officer and Director of Research and Education. Lord Radnor, when presenting to him a bowl of Dean Forest oak, together with a cheque to which members of the staff had subscribed, aptly described Mr. Guillebaud as "the architect of our research organisation, which has the highest reputation in forestry circles throughout the world".

Mr. A. P. Long, Director of Forestry for Wales, retired in May 1954, after some forty years of service to British forestry. His first posts were as Inspector in the Forestry Branch of the former Board of Agriculture. and as Divisional Officer with the Timber Supplies Department of the Board of Trade, and later with the Interim Forest Authority, during the first world war. He joined the Commission as Divisional Officer in 1919, became Deputy Surveyor of the Forest of Dean in 1937, was Assistant Commissioner for England and Wales during the second world war from 1940 to 1946, and on the reorganisation of the Commission in 1946 was appointed Director of Forestry for Wales. Presentations to Mr. Long were made by his colleagues both in London and in Wales, and our good wishes go with him in his retirement.

Promotions

The following appointments to senior posts have been made since the Journal last appeared.

Deputy Director General: Sir Henry Beresford-Peirse, Bt., formerly Director of Forestry for Scotland, as from 3rd July, 1953.

Director of Forestry for Scotland: Mr. A. H. H. Ross, formerly Conservator for North West England, as from 3rd July, 1953.

Director of Forestry for Wales: Mr. G. B. Ryle, formerly Conservator at the office of Director, England, as from 27th May, 1954.

Conservator, North West England: Mr. C. A. J. Barrington, formerly a Divisional Officer in the North West England Conservancy, as from 3rd July, 1953.

Conservator, South Wales: Mr. J. Q. Williamson, formerly Deputy Surveyor, Dean Forest, as from 17th May, 1954.

Deputy Surveyor, Dean Forest: Mr. R. G. Sanzen-Baker, formerly a Divisional Officer in North West England, as from 17th May 1954.

The Commission's First Planting Recorded

In January, 1953, there was unveiled at Eggesford Forest in Devon a bronze plaque set on a granite stone, to commemorate the first tree planting done by the Commission. It records that token planting was undertaken by Lord Clinton, then a Commissioner (and later Chairman from 1927 to 1930), H. Murray (later Sir Hugh Murray) then Assistant Commissioner, Divisional Officer C. O. Hanson, and Forester T. Brown, on 8th December, 1919. Eggesford Forest now extends to 1,000 acres, forming an impressive sight on each side of the main road from Exeter to Barnstaple. Some of the Sitka spruce planted in those early days, though still only thirty-five years old, have already topped 100 feet. A photograph of this plaque appears facing page 47.

Fifty Years of the Dean School

In July 1954 the Forester Training School at Parkend in the Forest of Dean celebrated the fiftieth anniversary of its foundation. Established by the Office of Woods and Forests in 1904, the Dean School has produced a steady stream of trained men who are serving to-day in Commission and private forests in all parts of Great Britain, and also overseas. The jubilee celebrations were attended by the Director General, who was himself a student from 1919 to 1920, and by several senior officers, as well as a large number of past students. To mark the occasion, a special issue of the school magazine, *The Deansday Book*, was produced; copies may still be obtained from the school (price 2s. 9d. each, post free).

The Windblow in Scotland

The gale of January 31st, 1953, will long be remembered for the destruction it wrought to the fine stands of Scots pine, larch, spruce and beech in north-east Scotland, where over 50 million hoppus feet of timber were blown down. Most of the damage was done to private estate woodlands, the Commission plantations escaping serious harm only because, being younger, their trees were too small and too supple to feel the full force of the blast. A heavy burden of work fell on the Commission's staff in the East Conservancy of Scotland, in assessing the damage and helping to put in train arrangements for clearing it up. This "operation windblow" still continues, but the time is approaching when the replanting of the devastated areas can be considered.

Honours

We are happy to record the following honours that have been bestowed on members of the Commission's staff, since this Journal last appeared:

C.B.	Mr. A. H. Gosling, *Director General*
C.B.E.	Mr. A. P. Long, *Director of Forestry for Wales*
	Mr. James Macdonald, *Director of Research and Education*
O.B.E.	Mr. V. Bates, formerly *Controller of Finance*
	Mr. W. E. Coggins, *Principal in the Secretariat, Headquarters*
	Mr. F. C. Handford, *Chief Clerk in the Office of Director, Scotland*
	Mr. E. J. S. Hinds, *Chief Clerk in the Office of Director, England*
	Mr. A. D. Palmer, *Deputy Establishment Officer, Headquarters*
	Mr. A. H. H. Ross, *Director of Forestry for Scotland*

M.B.E. Miss Ann Brooks, formerly *Higher Executive Officer in the Office of Director, Scotland,* and now *Chief Clerk in the Office of the Director of Research and Education*

Mr. H. Charters, *Chief Executive Officer, Finance Branch, Headquarters*

B.E.M. Mr. C. W. Redford, *Head Forester, Thetford*

Mr. J. P. Macintyre, *Head Forester, Newcastleton*

Mr. F. J. Nelmes, formerly *Head Forester, Bedgebury*

Mr. A. N. Simpson, *Head Forester, Tulliallan*

Mr. A. E. Walker, *Head Forester, Forest of Dean*

25, *Savile Row,*
*London, W.*1.
December, 1954.

JOURNAL OF THE FORESTRY COMMISSION, No. 23, 1952-54

LORD ROBINSON, O.B.E.

By the sudden death in Canada on September 5, 1952, of Lord Robinson of Kielder Forest and Adelaide, Great Britain has lost its foremost forester. An Australian by birth and early upbringing, he was one of the first of the Rhodes Scholars and seldom, indeed, can the Rhodes Foundation have made a better choice. His academic forestry knowledge was acquired under that wise old forester, Sir William Schlich, then professor at Oxford, of whom Robinson often spoke in later days with affection and respect.

A public servant since 1909, the whole of Robinson's long career was devoted to the cause of British forestry. The Forestry Commission, of which he was successively Technical Commissioner and Chairman, owed its existence and policy very largely to his initiative and organizing ability.

Made a peer in 1947 in recognition of his outstanding services, he was the first forester to receive that honour. Characteristically, he took his title in part from the Border Forest of Kielder. The largest of the new forest blocks of his creating, it was also the one of which he was the most proud, partly perhaps because it exemplified the wisdom of his policy of proceeding step by step from the known to the unknown. It was not until the success of the pioneer afforestation at Smales in the Kielder area was reasonably assured that he agreed to the acquisition of the further large blocks which now comprise Kielder and the adjoining forests in the Border country.

Robinson's extensive tours of the forests in Great Britain and throughout the Commonwealth, as well as in many parts of Europe, reinforced by a remarkably retentive memory, gave him a uniquely wide experience of all branches of forestry. It was this wealth of experience which made him such a stimulating guide in the forest.

Robinson's approach to silvicultural problems was essentially scientific, and although administrative work took up a large part of his time, his own contributions to our forestry knowledge were of no mean order. We owe to his fertile mind the highly original basis of the construction of our British yield tables which were built up from the measurements of 1,000 sample plots recorded in woodlands in the process of being felled during the First World War. Had it not been, too, for his foresight, all record of the rate of growth of these woods would have been irretrievably lost. Moreover, he was probably the first forester in any country to realize the importance of statistical lay-outs and analyses in field experimentation; in the early 1920's, he enlisted the aid of R. A. Fisher, then at Rothamsted, in order to ensure that the techniques being developed there for agricultural experiments were applied also to appropriate problems in forestry.

Lord Robinson's fine physique and handsome presence made him a conspicuous figure in any gathering. Inclined to be austere in the office, his reserve melted almost magically as soon as he got among his trees, when he was extremely good company. It was not until about two years ago, when an accident on one of his inspections of the Border country led to a serious illness, that he was obliged to curtail his outdoor activities to some extent; though even then he continued to cover an astonishing amount of ground, using a 'land-rover' to get about over the forest tracks.

His many-sided gifts showed perhaps to the greatest advantage when he was presiding over a large meeting. Those who attended the Empire Forestry Conference held in South Africa in 1935 will long remember the tact and imperturbable good humour with which he conducted its affairs. It was while attending, as head of the British delegation, the Sixth Commonwealth Forestry Conference in Canada, that a sudden attack of pneumonia proved fatal. So at the height of his fame and at the end of his long and honourable career in the public service, a great man has departed; the nation is the poorer for his loss.

The above appreciation by Mr. W. H. Guillebaud appeared in the journal "Nature" *and is here reproduced by kind permission of the Editor.*

NOTES ON THE SIXTH BRITISH COMMONWEALTH FORESTRY CONFERENCE, 1952 AND FORESTRY IN CANADA

By G. D. ROUSE
Chief Education Officer

I was fortunate in accompanying Lord Robinson, Mr. Gosling and Mr. Laurie as a delegate to the Sixth British Commonwealth Forestry Conference held in Canada in 1952.

The opening sessions of the Conference were held in impressive surroundings in the Senate Chamber of the Canadian Houses of Parliament; after three days the Conference adjourned, and during the next sixteen days, in fine hot weather, we travelled over 3,000 miles in the Provinces of Quebec and Ontario. Here in brief are some of the things we saw and did:—visited Quebec forest nursery at Bourchierville, Laval University at Quebec, the Forest Ranger School at Duchesnay; drove through the Laurentide Park to Chicoutimi; saw the huge hydro-electric generating station at Shipshaw; spent two nights and a day on a boat travelling down the Saguenay River and up the St. Lawrence to Montreal; visited some privately formed plantations of *Pinus resinosa*, looking remarkably like Corsican pine, at Rockland; spent two days at Petawawa Forest Research Station; saw a demonstration of fire power by four Canadian tanks on the military ranges; spent a weekend on the shores of Lake Opeongo in the Algonquin Park, where plane or boat was the only possible means of travel; visited Parry Sound on the eastern shore of Georgian Bay, where we travelled in launches in a maze of broad and narrow channels between rocky islets; held meetings and stayed at Dorset Ranger School; visited the Seed Extraction Plant at Angus; the forest nursery at Midhurst; a young planted forest on sandy soil at Hendrie, not unlike Thetford Chase; the Muskoka Wood Products Mill at Huntsville; and the Research Station at Maple; passed through hundreds of acres of peach orchards and vineyards, and came to the Niagara Falls; saw the Canadian National Exhibition at Toronto where the exhibit of the Department of Lands and Forests consisted of a miniature zoological garden containing deer, birds, and the many types of fish which can be caught in the rivers and lakes of Ontario; and finally visited Ganaraska Forest where land, once forest, was cleared for agriculture but, after the peak period of settlement in this part of Ontario, was found to be sub-marginal and is now once again being put back into forest.

We then returned to Ottawa and from August 30th, to September 14th we got on with the more serious part of the conference. Notes of what we saw on many interesting excursions must necessarily be brief and omit much.

Seed Extraction

The technique and machinery used in dealing with conifers at the Angus plant differ little from our own, except that the cones are taken daily from the kilns and sprinkled with water to hasten their opening; in order to minimise mechanical damage during the de-winging process the seed is passed from the shaker to a mechanical concrete mixer. To each charge of a bushel of seed a pint of water is added and the machine is run for three minutes. It is then found that, on drying, the seed separates easily from the wing.

They also have an experimental infra-red oven through which the cones are passed in a few hours but, in its present stage of development, we were not impressed with either the efficiency or economy of this machine.

Nurseries

Even in Southern Canada it is normal for snow to lie from late November to mid-May, and the short growing season starting towards the end of May must be fully utilised. At Midhurst Nursery, therefore, the main period of activity is concentrated in the autumn. Seedbeds are prepared and the seed sown in October and early November. Before the snow comes the beds are protected with a thick mulch of straw. The seed germinates whilst the last of the snow is disappearing and the straw mulch must be cleared off the beds as the first seedlings come through. It is their practice to sow the seed more densely than is done in this country and the beds stand for two growing seasons. No lining-out is possible in the spring and the whole programme has therefore to be carried out in the late summer and autumn; when we visited the nursery on August 25th with a shade temperature of over 75 degrees F. the lining-out programme was already under way. The work is done mechanically using a machine working on the cabbage-planter principle; two men sit on the machine and feed the seedlings into notches on a revolving disc.

With work going on at this season irrigation is essential; one part of the nursery is permanently reserved for seedbeds and has water laid on to an overhead automatic sprinkler system. We had become accustomed to asking for details of all machinery we saw, and there was some surprise when we were told that a transportable sprinkler, watering about a quarter of an acre at one setting, was specially imported from England.

Planting

We saw planting being undertaken at Ganaraska Forest to prevent erosion on former arable land. Various mechanical planting machines are now being tried, and many members of the party, including Lord Robinson, showed their skill with them. The principle of all machines is that a double-breasted plough is drawn behind a tractor and the operator inserts a plant in the trench so formed. Small reversed coulters skim some of the mould off the furrow slices and throw it back into the trench and around the collar of the tree. The operator's seat is supported by two inclined pneumatic wheels which firm the soil as the tree passes between them.

Choice of Species at Ganaraska Forest

At Ganaraska the first plantings were made with line by line mixtures of white pine (*Pinus strobus*), red pine (*Pinus resinosa*) and Scots pine (*Pinus sylvestris*). Scots pine is considered the least valuable of these species, but it grows most rapidly in the early years, and bears fertile seed much earlier in life than the white or red pines. As it seemed likely that this species would dominate the first crop and be predominant in the second rotation, its general use was discontinued and it is now used only on the more difficult sites. The present system of line by line mixture of red and white pines is in some respects unsatisfactory since the red pine grows more rapidly in early youth; and in such a plantation which we saw at Hendrie, some 25 years old, all but a few of the white pine had been suppressed. The white pine is more valuable but pure plantations are not made because of the risk of failure due to the blister rust (*Cronartium ribicola*) and the attacks of the white pine weevil (*Pissodes strobi*). For such a mixture to survive it might be better to plant three rows together of each species, or perhaps small pure blocks of white pine in a matrix of the red, but there was no indication that any alternative method had been or would be tried.

Poplars (*Populus canadensis* var. *eugenii*) had also been planted at Ganaraska but the lower branches had been almost entirely defoliated by a horde of grasshoppers which could leap to a height of about three feet and then propel themselves for many yards on wings, not unlike a butterfly's, coloured purple-brown with a hind border of pale yellow.

Natural Forests of Eastern Canada

With the exception of the agricultural part of Southern Ontario and the Ottawa valley, the soils of eastern Canada are frequently poor and shallow, overlying the heavily glaciated pre-Cambrian rocks. The main tree species forming the forests of such regions are spruces—white spruce, *Picea glauca*, black spruce, *Picea mariana*, red spruce, *Picea rubens*, and balsam fir, *Abies balsamea.* With these are associated the eastern hemlock, *Tsuga canadensis*, the eastern white cedar, *Thuja occidentalis*, the tamarack, *Larix laricina*, and the jack pine, *Pinus banksiana.* Tamarack, black spruce and white cedar are generally associated with swamp conditions, white and red spruces and hemlock with better drained moist sites, and jack pine on dry sandy soils. None of these trees grows to large dimensions and the largest we saw did not exceed 60 feet in height and 15 inches butt diameter. The most valuable coniferous species indigenous to Eastern Canada are the red and white pines, which reach their best development on the more fertile soils of southern Ontario and the Ottawa valley. Like all pines, these tend to be light demanders, and when mature trees were cut out on a selective basis their place was taken by more shade-tolerant maples and other scrubby broadleaved species. As colonisation spread, the more fertile soils on which these pines grew were cleared for agriculture, and there are thus few natural stands of first quality mature white and red pine timber left. The best we saw, and in fact the only really big timber we saw anywhere in eastern Canada, consisted of a group about one acre in extent of over-mature white pine in the very pleasant and extensive gardens of Mr. Gillies—one of the lumber-kings of Canada!

Fire Protection

Practically all the accessible forests of Ontario are protected against fire with a system based on complete observational coverage by fire towers, of which there are some 400, most of them of steel construction. The earliest of these to be erected were connected to District Headquarters by telephone. There are still over 1,000 miles of such land lines which, for the greater part of their length, are just laid upon the ground, being hitched up on to trees only where they cross streams or canoe-portage trails. Nowadays all fire towers are equipped with radio.

Subaerial erosion of the ancient rock masses followed by heavy glaciation has resulted in a remarkably featureless countryside in which swamps (muskeg) give rise to slow moving streams, which in turn imperceptibly merge into broad lakes. This intricate system of waterways is ideally suited for the use of light flying boats, and the Ontario Department of Lands and Forests depends for its access to fires very largely upon its extensive and efficient fleet of light aircraft supplemented by launches and canoes. The present standard machine is the Beaver which carries a pilot and five passengers. A canoe can be lashed to the pontoon of a plane, which alights on a suitable water surface as near to a fire as possible; the canoe is then launched and paddled by two fire fighters who may also take with them a light pump and a supply of hose. When water is available at all, it is generally available in unlimited quantities, and the Canadian pumps are designed for light weight and compact size, because they may be transported by plane or canoe, combined with large output. It was for this reason that none of the pumps demonstrated to us was really suitable for our requirements in Great Britain. In a limited number of places access to the forests is possible by roads and tracks, and here mobile dam units are used.

Aircraft serve many purposes in fire fighting; when visibility from towers is bad, aerial reconnaissance is used, and aircraft now carry a photographic unit capable of producing a print of a photograph of a fire within a few minutes of the exposure being made. This is dropped at the nearest Forest Ranger Station and gives valuable information as to the exact locality of the fire, its size, the direction of the wind, water supplies etc. It seems to be a common feature of fires in these parts that they do not at first spread with the rapidity we associate with fires in this country and a highly promising technique is being developed whereby, if a fire can be attacked in its early stages, sticks of water-bombs are used to damp down the perimeter of the fire. The bomb consists of a latex-lined paper package which will hold four gallons of water, and a "stick" is composed of eight bombs. The package bursts on impact with the ground or trees and the water is sprayed on to the surrounding area, linking up with that from the next bomb in the stick.

A noteworthy feature was the very narrow width of the cultivated fire traces; the boundary trace at Hendrie was less than five yards wide, and even the main internal rides were less than thirteen yards wide.

Protection against Insects and Diseases

Foresters of eastern Canada are at present confronted with three main problems, the spruce bud-worm, the white pine weevil, and the dieback of birch. The white pine blister rust, *Cronartium ribicola*, is not considered to be a major problem, but widespread work of a routine nature is done on eradication of the alternate host, the wild currants, *Ribes* sp.

Spruce Bud Worm

The larval stage of this insect is spent, rather like that of *Evetria buoliana* on pine, in the buds of the spruce which fail to develop in the next season. The damage is not confined to the spruce, but is equally widespread on the balsam fir. In the Laurentide Park we inspected a very heavily infected stand of balsam fir growing at over 5,000 stems per acre on a very shallow peaty soil. The trees were about 25 ft. high and the majority were less than three inches diameter at breast height. I pulled up a few—no Herculean feat since most of the root system was dead. During the summer, competition for soil moisture must be intense and conditions are generally such that one might expect the trees to be predisposed to any form of attack.

The White Pine Weevil

At Petawawa we were able to see some of the research work in progress on the life cycle of this weevil which damages the leading shoots of the white pine at all ages. The Chalk River Atomic Research Station is close by, and radio-active substances are readily made available. Instead of studying the habits of the weevil, therefore, in the confined and artificial habitat of the breeding cage, the experimenters are able to release specimens, to which a "label" of radio-active cobalt has been attached, and follow their movements, which fortunately appear to be strictly limited, through the plantations by means of a Geiger counter.

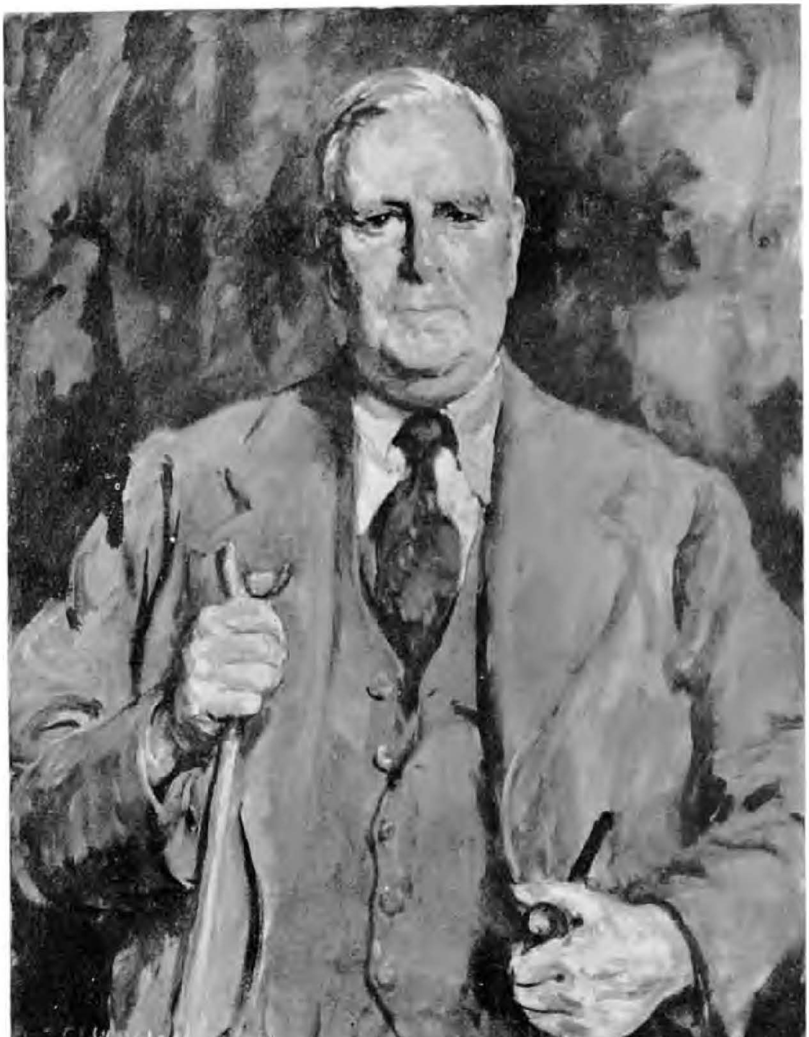
Birch Die-back

In our tour through the Laurentide Park and elsewhere, we saw fairly extensive areas with gaunt old dead birch standing out above young conifer regeneration. We were informed that intensive pathological research had so far failed to determine the cause of death. It seemed that the silvicultural approach has so far received scant attention. The virgin forest, when cut over for the first time, contained a high proportion of mature and over-mature trees, and this applies to the relatively short-lived birch as well as to the conifers; but at the time of the first exploitation of timber in the Laurentides the conifers were the only species of value and over large areas the conifers were cut leaving scattered old birch with their shallow roots damaged by extraction methods, and perhaps further damaged by slash fires; in addition the thin soil was exposed to all the drying effects of the summer weather. In due course a dense crop of natural regeneration of balsam fir and spruce sprang up, further affecting the soil moisture, and it had reached this stage when economic conditions and improved timber utilisation rendered yellow birch, *Betula lutea*, one of the most valuable of eastern Canadian hardwoods, and even the ubiquitous white birch, *Betula papyrifera*, became marketable for plywood and lumber. It was then noted that the old birch were dying back in the tops, and intensive pathological research was instituted; but silvicultural and ecological research on this problem has not yet been developed.

Thinning

Thinning, as we understand this operation, is not practised in the natural forests of Ontario and Quebec; but a start is being made in certain municipal Forests. With such vast areas of natural forest available, it would be unthinkable to make a thinning unless the operation showed a profit. At Hendrie Municipal Forest a first thinning had just been completed in a plantation of *Pinus banksiana* (jack pine) about 28 years of age. The area is first "cruised" (that is, its timber crop is measured) to determine the total basal area, and the result is compared with basal area/age curves for this and other species growing in North America and Europe, and, by the application of a formula, a figure is reached indicating the percentage of the total basal area which is to be cut; in this case it was 40 per cent.

Many of the eastern Canadian forests in the more accessible southern areas have an appearance akin to our own "derelict" woodlands. After the mature conifers have been cut out the area is invaded by relatively worthless broad-leaved species with only occasional regeneration of red and white pines. To clear such areas and replant with conifers on a large scale would be uneconomic, and the problem is therefore being tackled experimentally by the Federal Forestry Branch, by such measures as "improvement cuttings".



The Lord Robinson
of Kielder Forest and of Adelaide, O.B.E.

Historical Note on Utilisation

Eastern Canada was first colonised by the French. In the late 16th century interest centred in fur trading with the Indians and in fishing off Newfoundland, but it was not until the beginning of the 17th century that an effort was made to establish permanent colonies on the Canadian mainland. They selected the best land for agricultural development, and thus had to clear off some of the best quality hardwood forests; at that time there was no demand for these timbers in Europe. There was, however, a demand for potash as a fertilizer, and so forest clearance advanced, the timber being burnt and the ash collected; this was then washed and the liquor concentrated by boiling over open fires, and eventually a barrel of potash was produced from two acres of prime timber!

British interest in the timbers of eastern Canada was first centred in the suitability of the white pine for ships' masts; but the long sea voyage and the keen competition of the already established trade with the Baltic ports rendered the lumber trade of Canada somewhat precarious during the eighteenth century. However, the temporary closing of the Baltic ports during the Napoleonic Wars gave an impetus to trade with Britain, and in the first half of the nineteenth century the opening of canals linking the St. Lawrence with the Hudson River and New York gave a new outlet for Canadian lumber and the development of trade thereafter was rapid and continuous.

Current Production

Figures relating to production are astronomical compared to that of this country, and I will merely quote two: the production of sawn lumber in the two provinces of Quebec and Ontario was almost 2,000,000,000 feet board measure in 1949, and the quantity of pulp produced in 1950 was over six million tons; but a better mental picture of the quantities involved can be gained from the fact that there are over 130 units producing pulp, and the stocks of pulpwood held at the bigger units are so great that stocktaking is done by aerial survey, the heaps being plotted and contoured by exactly the same method as is applied to a range of hills!

Some Future Problems

Forest management is in its infancy but the need for its development is clearly seen by the Forest Service.

The following statement shows the general pattern of forest land tenure:—

Forest Land: Areas in Square Miles

Province	*Privately owned*	*Crown Lands Occupied*	*Crown Lands Unoccupied*	*Total Productive*	*Non-Productive*	*Total Forest Lands*
Quebec:	26,905	78,524	85,236	190,665	165,394	356,059
Ontario:	14,240	78,349	81,211	173,800	63,400	237,200

It will be seen that only 8 per cent of the productive forest in Ontario and 14 per cent of that in Quebec, is privately owned, the balance of Crown Lands is worked on a system of leases, licences, or concessions. Owing to the short growing season, particularly in northern Quebec, and the poor soils generally, the mean annual increment over large tracts of productive forest may be as low as 10 cubic feet per acre a year, though small isolated sites may rise to 40 cubic feet per acre a year. In theory, leaseholders are restricted to an annual cut not in excess of the annual increment, but in practice, with concessions of several thousand square miles, the whole of the permissible cut is taken by clear felling a few square miles. The cost of building roads is high and extraction is mainly by floating the timber or pulp wood lengths during the spring floods. Pulp mills have therefore been erected on river systems draining leased areas, but it is now possible to foresee a time when all the accessible areas within a drainage basin will have been cut over, and the pulp companies will be faced with very heavy capital expenditure either in erecting new mills, or in building roads over the surrounding watershed.

No silviculture is practised in the areas which are clear felled and the ensuing second growth contains a high proportion of inferior species. The passing of the progressive and far-reaching Canada Forestry Act of 1949 made it possible for the Minister "to enter into agreement with any Province for reforestation and improvement of growing conditions and management of forests for continuous production". Any work on a large scale on these lines would be costly, and it is natural to look to the companies exploiting the areas for the finance, either by placing upon them an obligation to restock the felled areas satisfactorily, or by the companies paying an increased rent, royalty or stumpage so that the restocking may be undertaken by the Forest Services. The companies however, state that they cannot afford such increased expenses in view of the possible incidence of heavy capital expenditure referred to above, in addition to increased labour costs, and keen competition in world markets. They also point out that in many cases they have no legal security of tenure to ensure that they will ever harvest the trees which they will have paid to plant.

This raises political questions which cannot be discussed here, though it was interesting to note that even in a country so closely wedded to the principle of free enterprise there are faint whisperings that a form of nationalisation may prove to be the only practical solution.

The Post-Conference Tour

The Conference ended in Ottawa on Saturday, September 13th, but many of us were able to take part in a post-Conference tour across Canada. For two days we travelled by train across the same pre-Cambrian formation of western Ontario and the south east corner of Manitoba. The original forest through which we passed had all been cut over or burnt. The second-growth forest consisted mainly of jack pine (*Pinus banksiana*) and aspen (*Populus tremuloides*) on the better drained sites, with some white spruce and *Populus grandidentata* and, very rarely, a white pine; in the swamps, the dominant tree was black spruce with occasional groups of tamarack. It appeared that railway-side fires most frequently started in the dense vegetation of the swamps in dry periods and then spread to the rocky areas. Away from the swamps any burnt area is rapidly colonised by aspen; on the dry sites, aspen is rapidly followed by jack pine which may become dominant, whilst on the moister sites with free drainage, white spruce comes in much more slowly beneath a vigorous crop of aspen.

Except for those in captivity I never once saw a beaver, though we frequently came across evidence of their activity in the form of beaver dams and lodges in the gently flowing streams, and felled poles of aspen, birch and alder near the banks of the streams. It is said that the beaver is the best silviculturist in Canada for by this felling of poles of broadleaved species he frees the slower starting but more valuable white spruce.

Further on we reached the prairies, and the aspen groves gave way to vast fields of golden stubble. The harvest was almost complete and in places a clear blue sky was obscured by a pall of smoke rising from burning stubble, from ranks of blazing straw left by combine harvesters, and from huge fires of brushwood and stumps where further clearance of forest land for agriculture was in progress.

As we travelled north-west from Winnipeg to Prince Albert the agricultural land became broken by aspen groves, and throughout the morning the proportion of aspen groves increased, until we were back into pure forest dominated by aspen but containing some white spruce and jack pine.

At Prince Albert we visited a saw mill, a box factory and plywood factory, a creosoting plant and the depot of the Provincial Forest Service. At this depot we saw the production of walkie-talkie sets, the adaptation of tracked vehicles for timber haulage and transport of men in deep snow; and the food store from which provisions are immediately delivered by plane to any fire fighting force in action in inaccessible country. The next day we had a long flight over vast tracts of the northern forests, inspected a saw mill at Big River and saw a demonstration of Smoke Jumpers (fire fighters) coming down by parachute.

The Province of Saskatchewan has over 86,000 square miles of forest and the permanent staff of the Forest Service is about 100, say, one man to every half million acres!

The journey from Saskatoon to Jasper was through magnificent scenery in perfect weather; the place of *Pinus banksiana* was unobtrusively taken by *Pinus contorta*, and the most eastern outposts of Douglas Fir were sighted. Here, as elsewhere, there had been immense forest fires and these areas, regenerated with *Pinus contorta*, produced almost even-aged forests, but here and there an old Douglas fir stood 40 feet above the rest of the crop, its thick bark having withstood the fire which killed its neighbours. It was surprising to see the trees growing at elevations of over 7,000 feet; the limiting factor did not appear to be exposure but a combination of a suitable rooting material and enough summer warmth for the seed to germinate. At elevations of over 5,000 feet contorta pine was 80 feet high, still putting on an annual shoot of about one foot and showing no signs of flattening off.

Here in brief are some of the things we saw and did in travelling from Jasper to Vancouver. We travelled along the new mountain highway from Jasper to Banff; went for a mile or more up the Athabasca Glacier in a "snowmobile" and saw, in the distance, a huge avalanche; saw moose, elk, black bear, coyote and chipmunk in their natural surroundings; visited the famed beauty spot of Lake Louise, surrounded by dark forests of Engelmann spruce and alpine silver fir (*Abies lasiocarpa*); raced over a rough dirt road high above Kicking Horse Pass, where we saw a few specimens of the comparatively rare limber pine (*Pinus flexilis*); inspected a forest sawmill, and had a demonstration of the Wyssen Cableway, bringing down large Douglas fir logs, approximately 50 cubic feet per load, from an otherwise inaccessible mountain side; bathed in the Radium Hot Springs where two open-air baths remain at constant temperatures of 114° F. and 96° F.; and travelled south between the Rockies and the Selkirks into a desert region with rainfall as low as twelve inches per annum, mainly in the form of winter snow, where scattered Douglas firs over 300 years old were not more than 60 to 80 feet high. Here economic timber production is considered out of the question and the Douglas fir is worked on a Christmas tree rotation!. Cutting of the Christmas trees is started in September, when day temperatures may exceed 70 degrees F., and with no special preservative treatment the trees are fresh enough to be sold in New York in December!

In desert conditions along the United States border we drove through vast areas of sparse yellow grass with occasional clumps of western yellow pine (*Pinus ponderosa*) and in the few moist sites black cottonwood (*Populus trichocarpa*) grew to heights of 100 feet.

We travelled up the Okanagan Valley, where, at a little over 1,000 feet above sea level, the natural desert vegetation consists of sagebrush (*Artemesia* *tridentata*), greasewood (*Purshia tridentata*) and dwarf cactus (*Opuntia fragilis*) but, due to irrigation from the surrounding high mountains, some of the finest orchards in the world produce cherries, peaches, pears and apples.

We thoroughly enjoyed a full day in the forests on the west side of Okanagan Lake run by Messrs. S. M. Simpson Ltd. under a Forest Management Licence. The open groups of yellow pine on the lower valley sides merged upwards at over 2,000 feet into a denser stand of yellow pine and Douglas fir. Here in a group of natural regeneration about 24 feet high we came across the only example of brashing which we were to see throughout Canada: it had been done under the instructions of Simpson's woodland manager, Alan Moss, a graduate of Edinburgh University. At an elevation of about 3,000 feet, *Pinus ponderosa* faded out and was replaced by lodgepole pine (*Pinus contorta*); at this level also a few moist valleys occurred and here more luxuriant growth included the western red cedar (*Thuja plicata*). Finally at an elevation above 4,000 feet we reached the forests now being logged, consisting of Douglas fir, spruce, silver fir, lodgepole pine and western larch (*Larix occidentalis*). The two last-named species were between 100 and 120 feet tall whilst the others reached to 160 feet. The system formerly was to cut trees above a minimum diameter limit of about 18 inches, but under the plan incorporated in the new licence everything merchantable in a two-chain strip is being felled, the intervening belts of four-chains width being left untouched.

Within its natural range, lodgepole pine comes in densely after forest fires. Near the driest limits of its range, on the eastern slopes of the Cascade mountains, one such area had gone into check; it carried up to twenty trees per square yard, 10 to 20 feet high, and ½ to 2 inches butt diameter. On a sample stem there were over forty visible rings to the inch, and there were probably more that we could not pick out.

In Manning Park (Cascades) we saw the best mature lodgepole pine, a straight stem with fine lateral branches reaching 115 feet with a butt diameter of 16 inches; on the lower mountain slopes, with the lodgepole pine and white spruce, there occurred some fine specimens of the western white pine *Pinus monticola*. On the summit of Windy Joe, a 6,500-foot mountain in Manning Park, an acre or two of timber had been cleared to give a magnificent panoramic mountain scene, and even at this level, timber—mainly Engelmann spruce and alpine fir—grew to 60 feet without any deformation of the crown.

We had four days on Vancouver Island during which we visited the Cowichan Lake Experiment Station of the Provincial Forest Service, logging operations, sawmills, cedar shingle factory, and pulp mills; saw gigantic old trees, and estuaries alive with salmon; and visited a commercial tree farm and the Sayward Provincial Forest.

The original forests on the better soils in the valley bottoms had produced immense trees, mainly Douglas fir, western red cedar and western hemlock (*Tsuga heterophylla*) but these were all cut between 1890 and about 1920, and logging operations have now moved on to the poorer soils of the more accessible mountain slopes. Old stumps up to eight feet in diameter were frequently seen, cut at any height up to twelve feet above ground level. The small amount of taper in the butt did not seem to justify this prodigious waste of timber, and we were given four alternative reasons, some more credible than others:—

(i) Extraction at the end of the 19th century was effected by teams of oxen; they were not capable of shifting the immense butt lengths and so these were left standing.

(ii) In the primeval forest the floor was covered with a mass of fallen timber, and these were the lowest heights at which the fellers could work on the standing trees!

(iii) The fellers preferred to swing their axes on spring boards, rather than standing on the ground.

(iv) At and near ground-level on an old tree the concentration of resin was so great that it made the work very much harder than that involved in cutting at 10 feet higher up.

British Columbia is more fortunate than eastern Canada not only in its climate but also in the fact that its principal timber trees regenerate themselves quite well without serious competition from inferior species. It was surprising to find that even on the optimum sites Douglas fir is, by our standards, slow in growth, and it takes a seedling about six years to become established and reach a height of three feet, thereafter it may grow about two feet each year. Regeneration presents no problems except on the really big burnt areas where no seed trees are left, and on the smaller burnt or felled areas over which a fire passes a second time, a few years later, after the adjacent seed trees have been felled.

The Sayward Forest was formed on an area where 75,000 acres of prime timber were burnt in 1938. Since that date 40,000 acres have been reforested, all with Douglas fir. Two-year seedlings are planted five feet apart, and no weeding is needed normally.

Natural regeneration may be delayed by the voracity of the seed-eating mouse, *Peromyscus* species, and experiments in its control are in progress at Lake Cowichan.

In the North Arm Forest at Lake Cowichan we saw a most pleasing stand. The primeval forest was cut in 1893, but a few "defective" trees were left. Some of these are still standing and I measured one 200 feet tall, with the top 30 feet now dead. Around these has sprung up a new crop reaching a height of 105 feet composed mainly of Douglas fir, with a mixture of western red cedar, western hemlock and a few *Abies grandis*. This had recently been thinned and after 4,000 cubic feet per acre, under bark, had been taken out there still remained 6,000 cubic feet of beautiful clean straight timber. Small sized pulpwood is not at present considered an economic proposition here, and there remained a further 1,000 cubic feet of such material left to rot on the ground.

The quality of the site is measured by a simple Site Index, the height to which the dominant trees grow in 100 years, and this thinning had been done on one of the very best sites, a Site Index of 172; average yields hereabouts, for a 100-year rotation, are 13,000 cubic feet per acre, under bark.

In MacMillan Park (Vancouver Island) some original forest was preserved; the trees were so dense on the ground that from within the stand it was impossible to see their tops. A big tree by the roadside, but not the biggest in the stand, was 240 feet high and still growing vigorously. Individual trees of Douglas fir, *Tsuga* and *Thuja* contained well over 3,000 cubic feet each, and a notice informed us that an acre of ground there carried 275,295 board feet, equivalent to about 46,000 true cubic feet.

In the same locality were scattered excellent specimens of *Abies amabilis*, and at higher levels in more exposed situations Nootka cypress was growing well; it seems that both these species might be given more extensive trials in Great Britain.

The greatest advance in administration of the forests of British Columbia since the war has been the introduction of Forest Management Licences. The object of this system is officially stated as enabling the licensee "to retain for the purpose of growing timber crops, the use of the lands on which he may now have only the right to liquidate existing mature stands; and the Government is enabled to give him the use of additional vacant lands he may need to bring the productive capacity of the lands controlled by him up to the amount needed to sustain his industry".

Two fundamental points bear great similarity to our own Dedication Scheme:—

(i) the area must be worked in accordance with an approved management plan, and

(ii) qualified foresters must be employed.

The main differences between the two schemes spring from the fact that the timber is originally the property of the Crown and the freehold of the land remains vested in the Crown; and the Forest Service is primarily a revenue-producing department.

For mature timber taken over at the time the licence is issued, a stumpage payment has to be paid, but for timber brought to maturity by the management of the licensee the stumpage rate is reduced to 16 per cent of the appraised value. In addition the licensee pays a rental of 1 cent per acre per annum, and he will also be called upon to pay a Forest Protection Tax unless he can prove that his own protective arrangements are adequate.

A small party spent one afternoon in the forests of the Capilano Water Catchment Area: a part of the system supplying Greater Vancouver. A party attending the Second Conference in Canada in 1923 had visited this site when the original stand of timber was being cut. They had rashly expressed the opinion that after such devastation they would never get satisfactory regeneration, and not unnaturally it now gave the Canadians great pleasure to show us a densely stocked area carrying Douglas fir, western hemlock and cedar, with lesser quantities of *Abies amabilis* and *Abies grandis*, up to 40 feet high. At lower levels there was also dense growth of Oregon alder, *Alnus rubra*, which overtopped the conifers by ten feet, and which in its early years puts on a much greater increment. This species is not looked upon with favour in the proximity of reservoirs and feeder streams because its abundant nitrogen encourages the development of bacteria tending to pollute the water supply.

Finally, on Saturday October 4th, Dean Besley of the University of British Columbia took three of us out to the 10,000 acre University forest at Haney, Vancouver. This is run by the Faculty of Forestry under a Forest Management Licence; and in ideal surroundings of mountains clothed with tall trees overlooking a clear blue lake is situated the log cabin camp from which the undergraduates do a large proportion of their practical work.

I cannot end these brief notes on our tour without reference to the kindness and hospitality which was shown to us both officially and individually wherever we went in Canada.

A VISIT TO DENMARK AND SWEDEN

By JAMES MACDONALD

Director of Research and Education

I visited Denmark in September 1952, to attend the meeting of the Permanent Committee of the International Union of Forest Research Organisations which was held in Copenhagen. I spent one day in Sweden, attending the Jubilee celebrations of the Swedish Forest Research Institute. The weather was extremely bad as heavy rain fell for four days without pause and was accompanied by strong, cold winds. It was therefore impossible to visit all the places which our Danish hosts had planned that we should see. The following are a few notes which I made as opportunity offered.

Journey from Esbjerg to Copenhagen

In this journey, the train crossed southern Jutland and entered the island of Fünen by the bridge over the Little Belt. From Fünen to the Island of Zeeland on which Copenhagen stands, the passage over the Great Belt was made by ferry.

The southern part of Jutland is a flattish windswept country, intensively cultivated but with little tree growth. The western part of this section of the peninsula has a deep sandy soil, originally strongly podsolised, as may be seen from sections on the outskirts of Esbjerg, and covered with heath from which the existing cultivations have been reclaimed. Such trees as are seen have obviously been planted for shelter; many of the farmsteads have clumps of trees round them and there are occasionally belts among the fields. They are all coniferous but one misses the pines, on which we should probably place most reliance in similar conditions. The only pine to be seen was mountain pine, which was used here and there as a fringe for other species, but there was neither Scots nor Corsican pine. Most of the plantations were of Sitka spruce, which did not appear to be growing very fast; but the blue Douglas was also in evidence. Norway spruce was occasionally seen planted in belts among the fields, while there had been some planting of a *Pyrus*, possibly *P. intermedia* but I could not be sure about this from the train.

Along the railway banks one saw small planted strips composed of one row willow, one or two rows mountain pine, and the rest Sitka spruce.

In the eastern part of south Jutland, the soils became heavier as there is more boulder clay, but the general pattern of planting was similar except that broadleaved species became a little more frequent. There were even one or two patches of oak scrub.

Milk production seems to be of considerable importance in south Jutland as elsewhere. There were numerous herds of the Red Danish breed, which at first glance resembles the Lincoln Red, although there is a tendency to a darker coloration. The tail is set at a peculiar angle which gives the beast a curious elevated stern. There were several herds of Jerseys and a few of black and white Holsteins; these looked to me to be the same as our Friesians.

The island of Fünen, a pleasantly undulating piece of country, is characterised by its beech woods. Here the soils are mainly derived from the glacial clays.

The beech was generally good, and from the train windows one could see some beautiful stands. Some of the older beech were not too good, however, and this seems to be general in Denmark. The excellent crops of middle-aged and younger beech seem to be the result of careful choice of seed and careful silviculture. There is a message of hope for us in this.

The Arboretum at Charlottenlund

This collection, on the outskirts of Copenhagen, was founded in 1838 as a National Forest Botanical Garden and, like the newer Arboretum at Hørsholm, it is under the management of the Royal Veterinary and Agricultural College. It is a little over seven acres in extent and is a very pleasant spot altogether. There is a very good representation of coniferous and broadleaved species, with nothing particularly outstanding, but with one or two specimens which may strike the visitor from England with surprise. Among those are the *Torreyas*, *T. californica* and *T. nucifera*, which were growing well in conditions which did not seem to be very suitable. There is also a specimen of *Taxodium ascendens*. It is only 20 feet high at 62 years of age but it was nevertheless interesting to see it. The western American conifers are generally quite good, but are not particularly impressive when judged by our standards; that is only to be expected under Danish climatic conditions. I had the impression, however, that the eastern American trees do better in this arboretum than they would in southern Scotland in a similar latitude; but it is easy to be misled on a brief visit to a place like this. The oldest tree is a specimen of the honey locust, *Gleditschia triacanthos*, planted in 1838 and now about 60 feet high, with a quarter girth of 14½ inches. There are also good specimens of *Ginkgo* and *Sciadopitys* which gave the impression of thriving better in Denmark than they do in Great Britain.

The Arboretum at Hørsholm

This arboretum was started in 1936 to give more scope for work than could be found at Charlottenlund, and it has developed along different lines under Syrach Larsen, its present Director. It is more a tree-breeding workshop than a formal arboretum. The appalling weather, which lasted for four days, kept our party from visiting all the outdoor work as we had intended. I was able to see more of it than some of my colleagues because, incautiously, I enquired what had happened to the descendants of the men who had discovered Greenland and had conquered England, that they were hesitating about going out on a wet day. I had the satisfaction of knowing that my guides were as wet as I was, when the tour was over.

The land at Hørsholm, which was formerly agricultural, is a rather sticky clay loam which is difficult to drain. It is not the best medium for tree growth but in spite of this many species were looking well. Larsen has used the place for testing his techniques of vegetative propagation in the open in contrast to some of the Swedes who have done their work under glass, and the numerous examples, which can be seen, are evidence of the success of his approach. Work is going on mainly with the following species, oak, beech, ash, alder, larch, spruce, pine, thuya and Douglas fir, but there were many other interesting pieces of investigation. The following notes were made of some of the more striking items.

A hybrid walnut (*Juglans sieboldii* × *J. cinerea*) was most impressive, with beautifully straight stems and strong growth. These trees had reached the height of 25 feet in 15 years and were going on vigorously. If the timber is satisfactory, this might be a valuable acquisition; in any event, it was growing as I had never seen walnut grow before.

Two comparative plots, side by side, of aspen (*P. tremula*) and of the hybrid (*P. tremula* × *P. tremuloides*) showed an astonishing difference. Planted in 1944 with one-year seedlings, the hybrid was double the height of the aspen, and was growing at a rate which we would regard as satisfactory for our best poplars. This was due to heterosis, the hybrid vigour, but also to the freedom from rust which the hybrid enjoys. It is resistant to the *Melampsora* rust.

Another hybrid was the cross between *Thuja plicata* and *T. standishii*. The latter, though not a particularly good tree, is winter-hardy, and the object of this work is to introduce into the western *Thuja* an element of winter hardiness which is necessary on the shores of the Baltic. The hybrid trees were nice specimens about 18 feet high at 16 years of age. Larsen's intention is to back-cross them to *Thuja plicata*. Blue Douglas fir grafted on green Douglas was an interesting exhibit. Here there were trees, the tops of which were blue Douglas and the lower branches, typically green coastal, and there was the curious effect of the presence of *Rhabdocline* on the tops and of *Adelges cooleyi* on the lower branches.

Among the collection of oaks raised by grafting, is a very good specimen formed by grafting a scion from a large old oak at Whiligh, Sussex, on a tall stock. This has been highly successful and the grafted tree is now about 20 feet high.

Syrach Larsen kept on telling me how fortunate we are in Great Britain in having such a variety of old trees, particularly of exotic species, from which material can be obtained for tree breeding and similar work.

The Forest Tree Breeding Station, Hørsholm

This institution is situated close to the Arboretum, but is under the management of the State Forest Service. The officer-in-charge is responsible to the Director of Forestry, but there is a board which advises on seed and tree-breeding matters, and on this the Arboretum people are represented. The links between the State Tree-Breeding Station and the geneticists at the Arboretum are close, and the arrangement, though dependent on personalities, works well.

The officer in charge of this station is responsible for the selection of seed-stands, the collection of seed for the State Service, its extraction, storage and distribution to individual forests. He has also to manage an area of land round the station on which various seed orchards have been established for the production of selected seed for the State Service.

The station was opened in 1946 and new buildings costing approximately £20,000 were erected. In addition to offices, there is a seed-extraction plant, a seed store and various small laboratories. The lay-out was quite good but I did not like the idea of an extraction kiln under the same roof as the seed store and the office with its records. Kilns are liable to catch fire and they are most effective producers and distributors of dust. It would have been better to have housed the kiln in a separate building.

The aim of the Danish Forest Service is to produce and collect all the seed they need from approved stands in Denmark. Their annual requirements are approximately as follows:

Oak	25,000 lb.	*Abies grandis*	125 lb.
Red oak	7,500 lb.	*Pinus contorta*	100 lb.
Beech	5,000 lb.	Birch	75 lb.
A. alba	1,000 lb.	Douglas fir	75 lb.
A. nordmanniana	500 lb.	Ash	50 lb.
Norway spruce	440 lb.	Alder	40 lb.
Mountain pine	375 lb.	Maple (Norway)	25 lb.
Scots pine....	200 lb.	*Abies procera*	25 lb.
European larch	150 lb.	Sitka spruce	25 lb.

As things are, it is not always possible to collect all that is needed in Denmark and imports of certain species are necessary from time to time. With the coming into production of seed-orchards, however, it is expected that the need for imports will become less.

In selecting stands as sources of seed, the opinion of the genetical experts, and, particularly, of the local forest officers is sought, but when a decision is made the tree breeding station arranges for the collection. A travelling party from the station collects the cones and sends or brings them back to the station. Careful records are made of the seed stand and these are filed along with the particulars of the cones and seed in the station office. At the same time, vegetative material is collected from the seed trees and the shoots are brought back and grafted on suitable stools. Thus there is a living record outside as well as one in the office files.

Specimens of the various ladders which are used in cone collection were shown. There was nothing unfamiliar about these. One novelty, however, was an air-gun which fires a captive bolt, attached to a long cord, used for bringing down shoots for subsequent grafting. This weapon will fire the bolt up to nearly 150 feet.

The cone-store at the station has space for from 15,000-25,000 lb. of cones, and it is situated on the top storey where a preliminary air-drying can be given. From there the cones pass to the kiln, which is of Swedish make, a drum type, and electrically driven. It has a capacity of 50 bushels per 24 hours.

When they have small quantities of cones from individual trees, the extraction of which is always a source of annoyance, they make use of a set of cylindrical metal containers with perforated sides and ends. The small lots are put into these, according to size, and they are kept back until there are enough of them to fill the kiln. They are then heated together and the seed can be shaken from each lot of cones later.

A small portable kiln of Swedish make, was seen in another room where it is used for small and out-of-season lots. It can deal with seven cubic feet of cones in eight hours. It weighs under a ton and costs about £450.

Seed is stored in cold chambers where it is kept at a temperature of about 40 degrees Fahrenheit. The chambers are roughly 14 ft. by 9 ft. by 7 ft. high and each was said to hold 5,000 lb. of seed. The Danes are giving up the use of round carboys which are wasteful of space in storage, and they are using straight sided glass or metal containers which can be stacked closely together. Private persons and commercial firms may store their seed in these chambers for a small fee.

It seemed to me that the Danish system of seed control and collection had something to commend it. Our own system here is not very well arranged as we have no proper seed stores, nor an effective control of collections.

Seed testing is carried out by the official seed testing station in Denmark, but the results are not satisfactory and the Danes were interested to hear that we had had to set up our own station.

Hørsholm Forest District

Visits were paid to two provenance trials in the series instituted by the International Union—European larch P.41 and Norway spruce P.44. The layout of the larch plots was reasonably good; that of the spruce was bad. Apart from Japanese larch and *L. gmelini*, the best larches were of Polish and Sudeten origins. Nine years after planting these were nearly 20 feet high. The worst were from Switzerland—both the Western Alps and the Swiss lowlands being poor. It was interesting to see a species like *L. olgensis* from Korea growing well and free from canker. The Scottish lot, ex Kirkhill, was not very distinguished. Height growth was below average and canker was strongly developed. Fortunately, Kirkhill larch is not typical of what Scotland produces.

No thinning had been done in the more advanced plots because no one quite knew what to do. There was some discussion about this. One school advanced the view that no thinning should be done until the slowest of the plots was ready; then the whole series could be thinned simultaneously. This strange opinion was opposed by others who said that thinning should be done as it was needed. In agreeing with the second view, I raised a further difficulty, namely, how to thin. I suggested that selective thinning in the conventional manner might destroy the character of the individual lots and that what was needed was a systematic thinning either by removing lines of trees or by knocking down every third or fifth tree as it came, starting at a random point. I felt that it was important to preserve the character of the different lots for as long as possible. This suggestion was received in silence but it was only too clear that when those provenance trials had been started, no one had fully realised all the implications.

The Norway spruce plots, naturally, were not so far advanced. The best growth was in the plots from Poland and Rumania, which were about 13 feet high, and the poorest in those from Finland.

The Game and Forestry Museum—Hørsholm

The stables of the ancient royal palace at Hørsholm, now no longer in existence, have been converted into a Game and Forestry museum which has become well known. There are two long ranges of buildings, one containing a very fine collection of sporting trophies and various exhibits dealing with natural history in relation to the forest. The heads, particularly, of red deer, were extremely fine; they were obviously all from forest or park-bred deer, quite different from the famished specimens on the Scottish mountains. The other range of buildings housed a fine collection of agricultural and forest implements.

Bregentved Estate

This property, the property of Count Chr. Moltke, is one of the best-known forest estates in Denmark, and is frequently visited by parties of foresters from abroad. It is an interesting place. The woodlands extend to about 6,400 acres of which 44 per cent are beech, 24 per cent conifers and 23 per cent oak, and the general impression is that of a well-wooded property in Britain, the basis of the woodlands being hardwood but with patches of conifer planted here and there. The place, of course, shows all the signs of competent professional management.

This estate has more oak than is usual in Denmark where the favourite hardwood tree is beech, and I learned, in conversation with some of the Danes, that there is an opinion in Denmark that more attention might well be paid to oak in future because some people feel that there are too many eggs in the beech basket.

The Bregentved woodlands, as recently as 1886, consisted mainly of old hardwoods, beech on the lighter soils and oak on the heavier land, with numerous subsidiary species. The beech were mostly over-mature and of very bad form, while the oak are said to have been short-boled (13-20 ft.) and with very heavy, spreading branches. Since 1887, these woods have been systematically worked over and about 80 per cent of the original forest area has been regenerated, mainly by artificial means, planting and direct sowing; and the result, which has been most encouraging, is an admirable lesson for us here. We did not see any of the remnants of the old crops except for a patch of beech 80 years old, resulting from the great mast year of 1869. These trees were growing on a site which was more suited to oak; they were short-boled and heavy-crowned and did not seem capable of improvement. The intention is to clear them and replace with conifers. Of the conifers we saw some interesting small plantations of Sitka spruce and *Abies grandis*. One plot of Sitka, growing on a good, moist loam with a rich herbaceous vegetation, was 75 feet high at 43 years of age, which corresponds to our Quality Class III. This is in accordance with expectations. This crop carried approximately 3,600 cubic feet per acre on 170 trees. The plot did not look at all open or understocked, but the stocking is lower than we recommend in the 1951 issue of our booklet entitled *The Thinning of Plantations*. There was some discussion about the past treatment of this plot and the view was expressed (by a Dane) that the thinning had been too heavy and that the site could well have carried a heavier crop. This remark, and several others of the kind, made subsequently, rather suggests that the pendulum in Denmark has reached the end of its swing and that a reaction to the recent extremely heavy thinnings may be beginning. This plot was being attacked by *Dendroctonus micans*, the formidable bark-beetle, which, fortunately does not occur in Great Britain. It seems to attack perfectly healthy trees, and the effusions of resin which mark its attack were present on some of the best trees in the crop.

A plot of *Abies grandis* 30 years old had reached a height of 67 feet. This is rather better than the *grandis* at Novar, but the soil and site of the Danish plot were better. It carried 300 trees per acre as against 529 for the heavily thinned plot at Novar, and its volume was approximately 4,000 cubic feet per acre, rather lower than in the Novar plot. The mean annual increment over the last nine years has been in the neighbourhood of 400 cubic feet. I was unable to discover how this compares with *Abies alba* and *A. nordmanniana* which are more frequently used in Denmark but, obviously, a plot like this will tend to encourage the raising of *grandis*. The spiral cracks and markings which are so common on *A. procera* in this country were prominent in this plot of *grandis* in Denmark.

Some interesting crops of oak were seen and it was in the stands of oak that the heavy thinning was seen in its most pronounced form. In one crop of pedunculate oak raised by sowing 44 years ago, a final crop of 24 trees per acre had been marked, and thinning was proceeding at frequent intervals to bring the number of trees down eventually to that figure. At the time of our visit, the crop was 51 feet high and had already been thinned down to 170 stems per acre. The trees were standing quite isolated, but growth was not affected, there was no flattening of the crown and no aggressive development of side branches. This crop gave rise to much discussion. Professor Burger, after genially referring to the stand as a *Baumgarten*, said that in Switzerland, to open oak out in that fashion would be to invite the development of heavy side branches, the flattening out of the crown and a reduction in height growth. I said that in England, there was a grave risk that the results might be as they were said to be in Switzerland, but Monsieur Oudin, from France, after a few critical glances, said he would be prepared to accept this as a suitable treatment for pedunculate oak but not for the sessile, which must be kept very dense. At all events, the trees were flourishing. The volume was low, only about 900 cubic feet per acre, and one could not but think that, instead of sowing a dense crop and opening it out, as they had done at Bregentved, it might have been better to have planted the oak widely and filled in the intervening space with conifers.

That heavy thinning seems to produce beautiful stands of well-spaced, well-shaped and strongly-growing trees admits of no doubt, but I am not sure how the economics of this form of treatment would work out, particularly in Great Britain. Most of the trees are removed when they are young and middle-aged, at a time, that is, when hardwoods have little value, and enthusiasts for the Danish way of thinning might bear this in mind.

One good stand of beech, 61 years of age, was most impressive. The trees were 80 feet high and 11 inches quarter girth at breast height; standing at 100 to the acre they had a volume altogether of about 3,300 cubic feet. The form of the trees was good and the whole crop was a tribute to excellent management.

Little red oak was seen on this estate, and what there was was not particularly good. One group of ash, however, was as fine as I have seen anywhere. The beautiful, long, symmetrical stems and the ample crowns made one think of Yggdrasill itself.

The Forest Research Station—Springforbi

A brief visit was paid to the State Forest Research Station at Springforbi, to the north of Copenhagen, where we were received by the Director, Mr. Henriksen. This is not a very large establishment but it has become well known through the work of Oppenmann and Bornebusch. The work falls into two sections, studies of growth and yield, and studies of the forest soil.

In the first section, we were provided with some interesting sample-plot figures. One lot referred to Norway spruce planted on ploughed heathland 49 years ago. Six grades of thinning were being studied and results, so far, are said to indicate that height-growth improves with heavy thinning and that the volume increment is significantly heavier. The incidence of butt-rot is higher in the heavily-thinned plots, which confirms our findings in Norfolk.

Sweden

I saw very little of Sweden as my journeys to and from Stockholm were made by night. From the train window in the early light, it was interesting, however, to see a little of the country to the south of the Swedish capital. It reminded me very much of the east and north-east of Scotland. There was the same closely-shaven landscape, the result of intense glaciation, the moraines, the occasional outcrops of rock, the small peat bogs among the fields. The main difference was that whereas in Scotland what is not arable is usually rough grazing, in Sweden it is forest. One could not but notice, also, how often the rock outcrops had been used as building sites. Most of the farm buildings were situated either on bare rock or where the rock was obviously near the surface.

The forests seemed to be almost always mixed. Scots pine was the principal species but there was a proportion of Norway spruce in almost all the woods which were visible, while rowan, birch, aspen and Norway maple were usually present, at least at the forest edges. The Scots pine was usually of a very narrow crowned form but here and there there were patches of an entirely different type, long branched, flat-topped specimens which must have had a different origin. The spruce showed quite a diversity of form, more than one would expect to see in Great Britain, and it was regenerating profusely under the pine in many places. It was curious to see how the forest faded out on the peat bogs; the pine became stunted round the edges of the bog and were absent from the centre. In the few bogs which I saw, the spruce did not appear, although it was present round about. The birch, which was fairly common, was generally much better than we get here, although there were one or two patches of really bad growth; the rowan was much as it is in Scotland, but the Norway maple was quite striking and appeared to be a strong-growing species. It was the aspen, however, which caught the eye; the country may have looked like Scotland, but Scotland it couldn't be with aspen growing like that. It was quite common; by roadsides, on odd patches of waste ground, in the forest, it seemed to be pushing up everywhere, making a fine straight stem and reaching a good height. I asked Syrach Larsen, who knows both countries well, why aspen should be so vigorous in Sweden and so poor (and so scarce) in Scotland. He did not have an answer but he did say that this is definitely a continental species and that one would expect it to thrive much better inland in Scandinavia than along the Atlantic coasts.

One striking difference between Denmark and Sweden was the scarcity of exotic conifers, especially round the towns, in Sweden; in Denmark, they are quite common.

FOREST TREE BREEDING IN SWEDEN

By J. D. MATTHEWS

Geneticist, Research Branch

The Swedish Forest Tree Breeding Association has three stations; South Sweden is covered by the parent establishment at Ekebo; there is a new fully equipped station for Central Sweden at Brunsberg while North Sweden is served by a unit at Sundmo. The Association commenced operations in 1936, and has as its object the breeding of improved strains of forest trees to raise the quality of the present growing stock in Sweden.

My first contact with the work of this thriving organisation during my visit in June 1951 was at Brunsberg in Vårmland (Latitude 59° 30′ N.—Orkney Islands), and I was able to see the new station, which is probably the most up-to-date and well-equipped tree breeding station in Europe. The main building houses the offices, laboratories for botanical and cytological work, a lecture room, photographic darkroom, seed extraction plant, seed testing laboratory, cold store, workshop, laundry and air raid shelter. Attached are the propagation houses, and a short distance away is a nursery for outdoor grafting and raising plants for progeny trials. The progenies derived from free and controlled pollination of selected Scots pine, Norway spruce, birch and aspen parents are planted out in replicated trials near the station and also in other trial grounds in South and North Sweden. Finally some experimental seed orchards have been established at Brunsberg.

Dr. Enar Anderson showed me some of his selected Scots pine and birch parents, which are being used in the breeding of these species. The pines were very fine vigorous specimens with excellent form of growth. Some of the controlled pollinations are made in the forest, and scaffolding had been erected around the best of the Scots pine parents to give free access to the flowers. Over 900 female flowers had been isolated and pollinated on one tree in 1951.

The parent station of the Tree Breeding Association is at Ekebo, about thirty miles north of Malmö, and a similar distance as the crow flies from the famous pioneer tree breeding station at Hørsholm in Denmark. Dr. C. L. Kiellander, who is in charge of conifer breeding, demonstrated the work in progress on pine, spruce and larch while Åke Junger showed us the latest developments in alder and birch. These latter two species lend themselves to breeding because they are early and prolific seed producers. Indeed it was pointed out that one acre of seed orchard is sufficient to supply all the annual requirements of birch for the whole of Sweden, and similar outputs are expected from alder seed orchards. New species of alder are being produced by cross breeding and polyploid breeding; a recent advance is the combination of hybrid vigour with polyploidy, and the growth of trees of this type is likely to be very fast indeed.

Four breeding methods are employed by the Association at the three stations in Sweden. These are termed "Strain Building", "Cross Breeding", "Polyploid Breeding" and "Inbreeding".

Strain building is employed for species with low seed production such as pine, spruce, oak and beech. The procedure is briefly to propagate clones of thirty selected trees at a time by grafting. The clones are planted in widely spaced rows on sites well isolated from stands of the same species, and they are treated to stimulate fruit production. When fruiting commences the progenies of the individual clones are tested in progeny trials, and those giving inferior progeny are removed from the seed orchard, as the resultant plantation is called. The seed orchards are managed solely for seed production, and it is estimated that when they are in full production Scots pine orchards will produce up to forty pounds of seed per acre.

Cross breeding is the term employed for controlled crosses made between selected individuals of the same or different species. This method is mainly used for aspen, birch, alder and larch. Once the best breeding combinations have been found, the parents are again propagated by grafting on a large scale and put into seed orchards. Examples of successful hybrids are *Betula verrucosa* × *B. papyrifera; Populus tremuloides* × *P. tremula;* and *Alnus glutinosa* × *A. rubra.*

Polyploid breeding is founded upon the observation that a higher chromosome number is often coupled with better growth, especially among the aspens and birches. Triploid individuals of *Betula verrucosa*, *Quercus robur*, *Alnus glutinosa* and Norway spruce have been raised at Ekebo, but conifers do not respond to increase in chromosome number in the same way as the broadleaved species.

Finally, there are indications that *Inbreeding* methods, which have been so successful in improving maize and other crops, may give similar results when applied to forest trees. Briefly the procedure is to self-pollinate selected parents, and to cross the best of the inbred progeny from two parents. The inbred progenies are generally poorly grown, but should produce very vigorous offspring when crossed with similar plants from another parent.

A visit was made to the nurseries of Mr. Holger Jensen at Ramlosa in South Sweden. Mr. Jensen is producing tree seed on a commercial scale in tree seed orchards. He is a private owner and was a pioneer in this method of seed production; he has succeeded, in co-operation with Professor Lindquist, in establishing orchards of alder, pine, birch and ash.

The ash orchard is well advanced, although not yet producing, and is a good example of the method. Scions from selected trees are grafted on to vigorous ash transplants, and the clones of grafted plants are put out at fifteen feet spacing. There are nine parent trees in this orchard, each represented by a clone of nine grafts, all intimately mixed to ensure that adequate cross-pollination takes place. The estimated production of such a unit is over one hundred pounds of seed per acre in a good seed year.

ITALIAN AND SWISS RESEARCH

As a delegate to the Ninth Session of the Permanent Committee of the International Poplar Commission, Mr. T. R. Peace of the Research Branch visited Italy and Switzerland during the spring of 1954, *and we give below some extracts from his report.*

Poplar Diseases

Dothichiza populea, a fungus causing dieback of young poplars, is now regarded as the worst enemy of poplars in most European countries. This is in strong contrast to its comparatively slight importance in Great Britain. It occurs *particularly* on newly transplanted trees, on large transplants, and after drought.

Most continental countries tend to use larger plants than we do, this is particularly the case in Holland and Belgium. Drought conditions may well be commoner on the continent than here. Both these factors may play a part in making the fungus so much more serious there.

Black-heart of poplars, which apparently is some kind of chemical stain, but which has never been properly studied, is now the subject of investigation under Dr. Van Vloten in Holland.

Poplar Nomenclature

A new system of nomenclature for poplars, based on the rules agreed at the International Horticultural Congress in London in 1952, for the nomenclature of cultivated plants, was discussed by the Committee. One of the main effects of its adoption will be that the names of the familiar Black hybrids, since they are in reality 'clones maintained in cultivation' will become cultivar names. Thus they will be shown in inverted commas without authorities, e.g. not *P. serotina* Hartig or *P. canadensis* Münch fm. *serotina* Hartig, but P. 'serotina' or *P. euramericana* Dode (Guinier) 'serotina'.

Chestnut Blight

Dr. Biraghi reported that the Chestnut Blight disease caused by *Endothia parasitica* is spreading steadily in Italy, but not with the rapidity or virulence that it did in the United States.

Florence. A heavily infected area of poor quality coppice was visited on Monte Senario near Florence. The disease was first recorded here in 1946/47; all the originally infected coppice has now been felled, but lesions are abundant on the shoots which have arisen since. There is no evidence of trees acquiring resistance in this area (see below).

Genoa. Two areas in the hills north of Genoa, one at Masone, and the other between Busalla and Voltiggio, were visited. In both these places most of the chestnut appear to have developed resistance to the fungus. Masone was always a coppice area, and was originally so heavily infected that all the coppice was cut. The shoots, which arose from the cut stools, became infected in their turn, but appear to have developed powers of resistance. Gum barriers are laid down in the bark, and in many cases the fungus has failed to reach the cambium. In most cases the fungus in these restricted lesions is now dead. New lesions are becoming rarer, because as the old lesions die out the production of spores becomes less and less. It is not hard to imagine that the next rotation of coppice may be virtually disease free.

Although Dr. Biraghi had told me of these recoveries, I had not really grasped either their generality or their definiteness, until I visited these areas. It is impossible to prophesy, of course, how they will affect the course of the disease, until their permanence has been better established and until the nature of the apparently acquired resistance is better understood.

I do not consider that the occurrence of this phenomenon, in quite a number of the older Italian outbreaks, justified any relaxation of existing precautions against the disease. We do not yet know whether this recovery will occur generally or whether it will last. In any case the loss of a whole rotation of coppice in the initial outbreak would be very serious, and even if resistance developed in the second rotation I believe the healed lesions would still seriously interfere with cleaving. It would only be a minor comfort in the case of timber trees if, after dying back, they produced healthy resistant sprouts from the base.

Pathologically this phenomenon is of exceptional interest, and I hope that it will prove possible to elucidate the underlying causes. At the moment attempts to propagate from the resistant sprouts in order to test their reaction to inoculation under different conditions have been dogged by misfortune. In the area itself individual lesions are under periodic observation, part of the area will be left uncut at the next rotation to see if recovery persists, and part will be cut soon to see what happens to the next rotation.

The second area differed from the first in two ways. Firstly, it was on much poorer ground, indicating that acquired resistance is not limited to the better sites. Secondly, it was originally under tree chestnuts, grown mainly for fruit, not under coppice. Some of the peasant proprietors are already singling the shoots in the hope that they can get back to nut production. It is a measure of the damage that was done in the original attack that hardly a tree-chestnut can now be seen, only the coppice, which arose when they were cut down.

Photo 1. Mature forest of lodgepole pine, 140 feet high, in Manning Park, Cascade Mountains, British Columbia.

Photo 2. Looking across the Athabasca River to the Stutfield Glacier in the Jasper National Park, Alberta. Lodgepole pine forest in the Rocky Mountains.

Photo 3. A transplanting machine in action in Midhurst Nursery, Ontario.

Photo 4. Helecopter used by the Ontario Department of Lands and Forests, for fire patrol work, at Lake Opeongo, Algonquin National Park.

There is fairly good evidence, based on inoculations, that the fungus has not lost its virulence in these areas, i.e. that the change is in the tree rather than in the fungus.

Tessin, Switzerland. A large area of chestnut woodland was traversed in the Valle di Colla near Lugano, in Switzerland, to the south of the main range of the Alps. It is apparently one of the areas which has still escaped attack, and formed a notable contrast to the other areas visited.

Owing to heavy rain no infected areas were specially visited in the Bellinzona area, but several were seen beside the road, where great damage had been done. The Swiss Forest Research Station has a nursery at Bellinzona, which is very fully occupied with inoculation. Before doing breeding work, Dr. Fischer is testing the resistance, not only of a number of Asiatic species and hybrids, mainly procured from America, but also of selections from various parts of Switzerland. The more promising are propagated first by grafting and subsequently by layering.

He is leaving those plants which have been successfully inoculated, with the idea of using them eventually for experiments on acquired resistance. This phenomenon has not yet been observed in Tessin, but, judging by Italian experience, the area has not been infected long enough for resistance to have developed.

Research at Zurich, Switzerland. Apart from carrying out routine inoculations for Dr. Fischer at Bellinzona, Dr.. Bazzigher is engaged particularly on discovering the full host range of *Endothia parasitica*, the fungus causing chestnut blight. It is easy to inoculate, on to most species of *Castanea* (other than Asiatic ones) and spreads rapidly. It also infects most of the species of *Quercus* tried, but spreads slowly after infection. On *Fagus*, infection is difficult, but if successful the fungus spreads nearly as rapidly as on *Castanea*. Other trees tried such as *Carpinus*, *Corylus* and *Umus* are virtually resistant.

Conifer Diseases in Italy

Dr. Biraghi described three interesting diseases, two of which have not yet appeared in the literature. In the first, small yellow spots appear on the needles of *Pinus nigra*. These spread up and down the needle, which eventually splits open and exudes resin. Eventually the needles wither and fall. It occurs near Trento in the Alps, and has increased steadily during the last three years. He has isolated two fungi, one of them a *Fusarium*, but is doubtful if they are major factors, because generally no mycelium can be found in the needles. The only internal signs are disintegration of the parenchymatous cells, which are replaced by gum.

Secondly he has observed a curious disease of European larch and Norway spruce. Some trees died completely, some had dead tops, others flushed very late, while a certain number remained dormant for a whole season and flushed the following year. Trees in all these different conditions were mixed with healthy trees. So far he has not a clue as to the underlying cause. I have not observed this phenomenon in Great Britain.

Thirdly *Phaeocryptopus gaumannii* is causing really severe defoliation to supposedly Coastal Dougals fir in one place in the Alps. It would be interesting to know why *Phaeocrytopus* has generally behaved more seriously in Central Europe than in Great Britain.

Forest Nursery at Masone near Genoa

This was a terraced nursery mainly devoted to the raising of Norway spruce for the Forest Service. It was manured with stable litter with a heather basis.

The quality of the plants, which were plantable as two-plus-two transplants, was very poor, and the general appearance of the nursery was reminiscent of the worst of our poorer, older nurseries.

Forest Genetics in Switzerland

Time only permitted a brief visit to the Forest Research Nursery outside Zurich, which is largely devoted to genetical and provenance work under the direction of Dr. Fischer. He is concentrating particularly on European larch and Scots pine. For other species, such as Norway spruce, natural regeneration still serves to maintain the forests. He had a collection of Scots pine raised from individual open-pollinated mother-trees, the seedlings from which were showing very uniform variations in resistance to the leaf cast fungus, *Lophodermium pinastri*. The best were quite green and the worst almost completely brown.

His European larch grafting is done mainly in unheated greenhouses. The stocks are brought in in January; and then, after grafting, the pots are tilted slightly, so that the graft is on the upper side. Using pieces of one-year wood, with four to five buds, as scions, he is getting 95% success. He is also trying, experimentally, the grafting of larch on roots of the same mother-tree; and also layering.

A small two-man posthole digger was in use for the larger plants. The nursery extends to about twenty-five acres, so that the staff can run preliminary progeny trials and have one or two seed orchards for demonstration purposes.

Dr. Fischer is doing some work on walnuts, mainly because agriculturalists are tending to give them up. He is also selecting good forms of yew (*Taxus*) for underplanting. Since yew in Switzerland occurs mainly in scattered isolated areas, he is hoping to get heterotic vigour in hybrids between different provenances.

His method of layering *Castanea* is to cut back the plants in the winter; in June the resulting sprouts are ringed with wire, and earthed up to a depth of twelve to eighteen inches. They are left like this to the end of the following season, by which time, when two years old, they should have rooted.

In the town forest of Zurich a P.47 European Larch international provenance experiment was visited. At this comparatively low elevation the alpine races were doing very badly, and some of them had practically died out. The best plots were lower elevation Swiss origins and some Polish lots. Scottish (Elgin) was about average. There was no proper replication and the site was rather variable.

Swiss Tree Bicycle

I was given to understand by Dr. Fischer that the price of this device, used mainly for climbing poplar trees when high pruning, has now dropped to £25 (approximately), and that it is gradually coming into more general use.

Larch Bud Moth

In the upper Inn Valley intensive research is going on, on the Larch Bud Moth (*Eucosma griseana*—earlier called *Semasia diniana*). This is very serious in that area; in bad years (every 7 to 10) it causes almost complete defoliation. This reduces growth, stops coning for several years, and upsets the tourists in late summer, because they do not like brown larch.

An accurate sampling survey of all the European larch stands in the valley has been made every year since the war; and the investigators are now trying to find out what conditions affect the build-up of the insect populations. The insect does not apparently spread from centres, but increases locally. So it is no good spraying the bad areas in the hope of preventing the increase of the insect in areas at that time less heavily infested.

To some extent the numbers are controlled by a virus disease. The virus can remain viable over long periods if dry. It may overwinter on the short shoots, where infected insects have decayed, and cause fresh infections the following year. The incidence of this disease from year to year is also being studied by systematic sampling of the insect population. I think this must be one of the most complete surveys of a forest pest so far carried out. The annual maps showing the incidence of the pest were most impressive and interesting.

FOREST PATHOLOGY IN EIRE

By J. S. MURRAY

District Officer, Research Branch

The main purpose of my visit to Eire was to see areas of Sitka spruce where trees were reported to be dying in groups. The information had come up in a conversation I had with Mr. Clear, Lecturer in Forestry at Albert College, Dublin, during his recent visit to Alice Holt. From his description, the trouble appeared to be very similar to the 'group dying' we are finding in a considerable number of our pole-sized Sitka plantations. My thanks are due to Mr. Clear who organised my visit.

The first area visited was in Glendalough Forest, Compt. 26, P.23, in County Wicklow, about twenty-five miles south of Dublin. The glen, running from north-west to south-east, is formed partly of granite, partly of mica schist. About 900 acres of conifers are planted here, 54% of them Sitka spruce, which is confined to the peat areas. Three groups of dying Sitka spruce were seen; the first was on a medium to steep slope, on a black amorphous peat, about 9 inches thick, over sandy, slightly podsolized mica schist. Rainfall 60 inches per annum, altitude about 1,500 ft., aspect north-east. About forty dead trees were standing in the centre of the group without any survivors among them. Surrounding trees had dead roots and typical lesions were found on living roots. These symptoms are characteristic of 'group dying' in Britain. The roots were largely confined to the peat, and had made little attempt to penetrate the mineral soil. Drainage was free both in the peat and in the mineral soil, but the area was water-receiving as it formed part of a large concavity on the hill. The rooting here was certainly shallow, but I could see no obvious reason why the trees should have died so suddenly from this cause. There were, as usual, long, once vigorous leaders on some of the dead trees. The depth of peat and rooting characteristics of healthy Sitka a little way off on the same contour did not appear to differ appreciably from those of the dying group.

The second group lay almost immediately below and was slightly larger. The site details were much the same as for the first, but the site was much wetter, being flatter. The third group lay farther down still, in the valley bottom. The ground here was waterlogged, with water lying on the surface. Heavy rain had fallen in the past week, but surplus water on this area must be the normal condition over a greater part of the year.

All three sites had the shallow rooting habit of the Sitka in common, but the dying groups were so well defined and local in extent that it is difficult to imagine this feature alone being responsible for the deaths. Also there were large areas of healthy spruce nearby with soil conditions and moisture relationships similar to those where trees were dying.

In Glenmalure Forest, which adjoins Glendalough to the south-west, dying Sitka spruce had been noticed in Compt. 8, P.29, of the Clohernagh property about 1949. This again was typical 'group dying', and dead roots on the outer fringe of live trees showed that it was still active. The soil was about nine inches of raw peat over granite and, at the time we saw it, was water-sodden. I should think the site quality was inferior to that at Glendalough. The slope was steep, aspect north, altitude about 750 ft., rainfall about 60 inches. The second group at Glenmalure occurred in the Ballyboy property, P.23. This was on an alluvial flat at about 500 ft., with a soil considerably deeper than the other examples seen. It was, however, watersodden at the time I saw it, but to what degree this was its normal state or merely the result of the heavy recent rain, was rather uncertain. The growth of the Sitka was good. Mr. Clear, who knows the local conditions well, said that he considered this a high quality for Sitka.

A visit was also paid to Dundrum Forest, Compt. 36, P.18, Co. Tipperary, where dying of Sitka spruce had also been reported. As the forest was approached a long strip of Sitka spruce about half a mile in length with a large percentage of dead individuals among them could be seen on the flat land bordering the forest, which then sloped upwards. The extensive area over which trees were dying was rather alarming, since one of the few reassuring things about 'group dying' so far observed, is its tendency to remain local in its effect. Inspection of the trees, however, failed to disclose the usual 'group dying' symptoms. No extensive death of roots occurred, even on trees whose crowns were so thin that in true 'group dying' there would have been the associaated death of roots up to the stems. No dead patches could be found on living roots. The site was extremely ill drained. The soil, derived from the upper Coal Measures, was a structureless clay with a gleyed horizon, providing very poor rooting material. It had at one time been drained, but drainage had been neglected. The vegetation was typical of ill-drained situations containing *Ranunculus lingua*, *Aira caespitosa* and *Juncus*. The crop had been grossly underthinned, as was evidenced by the slenderness of the stems compared to height growth, and the number of trees on the ground. I was unable to examine the crowns, but their general appearance was typical of *Neomyzaphis* attack. On this site also, some of the dead trees had long leaders and apparently undiminished growth up to the end, whilst others showed a reduction in height increment over the last few years.

This area of dying Sitka corresponds better to Day's explanation of restricted root depth than any other I have seen. It is the first I have seen without the typical root death and lesions, but I am not sure whether it is quite different from what I have described previously as 'group dying', or just another phase of the same thing. In this area, also, windblown trees were found, the deeper-going roots of which had obviously died before the blowing of the trees, but whose surface roots were quite healthy. This is exactly the condition Day has always described in his work, and the details of the site are very similar to the conditions under which he says 'group dying' occurs. The inconsistencies of the observations on these six Irish areas are typical of observations on our British ones.

According to the Eire Forest Service, no more 'group dying' is known; but it is perhaps significant that of the six areas I saw, three were found by Mr. Clear when doing enumerations of plantations with his students, one we came across by accident, and two were reported by the Eire Forest Service. In Eire there are large tracts of Sitka, for example in the Slieve Bloom Mountains, and some of the plantations are now approaching forty years of age. Now that the disease is known and described it is probable that other examples of it will be found.

Phaeocryptopus on Douglas Fir

During the period from about 1930-1935, a great deal of Douglas fir was planted in Eire, not all of it on sites which were really suitable for the species. In many cases the new plantations went into check several years after planting, and were unable to form canopy over the weed growth. This was particularly the case where the Irish furze, *Ulex gallii*, predominated in the vegetation. Cleanings were neglected. Later, and probably as a result of this poor start, a heavy and fairly general attack of *Phaeocryptopus* occurred. A German pathologist, Dr. Liese, visited the affected areas in May 1939 to see the effects of *Phaeocryptopus*, and was pessimistic about the future of the plantations. In the mid-forties some stands were cleared and replanted, some were cleaned and beaten up with a variety of species, others were cleaned and heavily thinned. The effect of these measures in freeing the Douglas from its moribund state is said to have been remarkable. In the beaten up and underplanted areas the Douglas grew vigorously and completely suppressed the later planted stock. Where it was heavily thinned it recovered health and vigour and ousted competing vegetation. Subsequently the intensity of the *Phaeocryptopus* attack decreased so that now, though the parasite is almost ubiquitous, it is not regarded as serious. This corresponds to its status in Britain today.

I did not see any *Rhabdocline* on Douglas in Eire, though one occurrence was reported by Liese.

Very little Douglas fir is being planted in Eire now. In the Report on Forestry for the period 1943-1950 the plantings of 'other conifers', which includes Douglas, varies from 1-2¾% of the total species planted. It is probable that the unfortunate early experience is partly responsible for this low proportion.

Scots and Lodgepole Pines

Scots pine can be grown satisfactorily in Eire at low altitudes up to about 600 ft. Above this level, however, growth is generally very slow and *Pinus contorta* is being widely planted, especially on the higher ground. Typical areas where Scots pine was failing are the large, convex shaped 'bulges' on the sides of hills or mountains, whose shape and steepness causes the water to be easily shed and which have a thin soil over rock. The soil thus tends to be very dry, with a heath-type of vegetation and no tendency to form peat. Mr. Clear thinks that Scots pine is highly intolerant of its enforced shallow rooting habit on these dry soils. *Lophodermium* causes considerable needle cast of the Scots pine, but is probably secondary. In such situations *Pinus contorta* has been used with great success both as the original crop and also to beat up the Scots pine. On the slopes of Glen Chree, adjoining plantations of Scots and contorta pine can be seen. Although both were planted in 1926, the Scots are fifteen feet high and have failed to form canopy, so that the brown of the heather can be seen as a matrix for the crop while the *Pinus contorta* is about thirty-five feet in height and presents a solid green mass on the hill.

The coastal type of *Pinus contorta* is preferred as its heavier branching habit enables it to suppress the existing vegetation better than the more lightly branched inland type. The faith the Irish have in *Pinus contorta* is shown by the fact that to date they have planted about 15,000 acres of it.

Fire Damage

An interesting case of the effect of fire on different species was seen at Glenmalure where, on the side of a mountain, a ground fire had swept through plantations of Sitka spruce, Scots pine, *Pinus contorta* and Japanese larch. The pines and most of the Sitka had been wiped out, but most of the larch had survived and could be seen as isolated green stands among the blackened skeletons of the other species. The determining factor, apparently, was the ability of the larch to form canopy early and suppress the vegetation, chiefly bracken and heather. This was a good illustration of its value for a fireline species in coniferous areas.

Top Dying in Norway spruce

At Powerscourt, near Bray, a small patch of Norway spruce, by the roadside, was seen with symptoms similar to those of Norway spruce with 'top dying' in this country. A broadleaved stand adjoining had been felled about fifteen years previously. This had resulted in an invasion of aggressive vegetation such as nettles and elder on the opened side, and it was very noticeable that the browning of the crowns was worse on this side where the vegetation was, than in the centre to which the vegetation had not penetrated. The top dying here may be due to a combination of exposure following removal of the shelter, and drought caused by competition with the invading weeds.

PINUS CONTORTA IN COUNTY WICKLOW, EIRE

By W. H. GUILLEBAUD

Deputy Director General

In May 1953 I spent two days visiting state forests in the Wicklow Mountains in company with Mr. O. V. Mooney, a senior Forestry Inspector of the Forestry Division of the Department of Lands. The main object of my visit to Ireland was to take part in an international conference on seed testing in Dublin, but it seemed a good opportunity to see some of the older stands of *Pinus contorta*, which form fairly sizable belts along the highest parts of many of the state forests in this region.

The Wicklow Mountains lie to the south of Dublin. In elevation, contour and valley-width they closely resemble the hills of Central Wales. There are the same long smooth slopes and grassy vegetation, though dwarf gorse is very prominent on the harder and poorer ground. The rainfall is about 40 to 50 inches per annum; the climate is generally mild but heavy snowfall in winter is not uncommon.

The higher hills are mostly granite, but there is a belt of Ordovician or Silurian shales on the east side and it is on these rocks that many of the plantations are situated.

Over 60,000 acres in the Wicklow Mountains have been afforested; there are one or two large forests with areas of about 10,000 acres and a number between 5,000 and 6,000 acres, but the majority run about 2,000 acres in size and there are many scattered blocks of 300-500 acres apiece; none of the older areas was ploughed prior to planting.

The principal species used have been Scots pine, Norway spruce, Japanese larch, Douglas fir, Sitka spruce and Corsican pine. By and large they have used much less Sitka Spruce and more Scots pine than we have on similar ground in Wales, and very much less Japanese larch, though the use they have made of hat species—as a ride-side tree—is interesting.

In the older of these forests, Scots pine seems very largely to have taken the place we have normally given to Sitka spruce or Japanese larch in Wales, that is to say the upper middle slopes were usually planted with Scots pine, mostly pure but sometimes in mixture with European larch, while spruce has been used here only in the wet flushes. Below the Scots pine zone Douglas fir, European larch and the spruces are the usual species.

Almost without exception in the forests I saw, the Scots pine plantings have failed. It appears that the trees started normally but after a few years shoot growth fell off, the older needles died and the trees made little further development. The result is that there are extensive stretches of Scots pine scrub on most of the slopes, diversified only by the scattered patches of spruce which have mostly done well in the flushes.

Why the pine has failed in this remarkable fashion is still largely a mystery to the Irish foresters. The records show that most of the seed was bought over a long period of years from reputable Scottish seed merchants, so the assumption is that much of it should be of Scottish origin. The only explanation offered was exposure, but this seemed to me quite inadequate to account for the widespread failures because many of the areas I saw were reasonably well sheltered from the west; also here and there, where there were Scots pine in the lee of thriving plantations of other species such as *Pinus contorta* and Japanese larch, the pine showed no signs of improvement along the edge of the taller crop.

The Wicklow story can, it is true, be more or less duplicated in some of our western forests, notably Hafod Fawr in North Wales, but there exposure from the sea is definitely extreme.

One feature of the Irish climate is the very mild weather before Christmas and I am inclined to seek the explanation of the trouble in some failure of the pine to adapt itself to these exceptional conditions. I should add that there are plenty of good old Scots pine in the policies in the lowlands of Ireland. The die-back seems to affect only these new plantations in the upland regions of the country.

European larch has generally gone the same way as in Wales and in many other parts of Britain, and the die-back adds substantially to the sorry picture presented by the Scots pine stands. Up to the present little or no attempt has been made to restock the failed areas.

Douglas fir has proved on the whole a valuable and successful species, though one stand I saw was very thin in the crowns and looked unhealthy.

Until recent years comparatively little Japanese larch was planted, except in the form of a single row of trees bordering the rides. Grown in this way the trees are mostly rough and ugly but they almost everywhere stand up above the adjoining crop and provide convincing evidence of the suitability of this species for all except the most exposed sites in the Wicklow Mountains. The success of these ride-side rows where they border Scots pine is a further indication that exposure is not the primary factor in the malaise of the pine.

I saw relatively little spruce except at a distance, but I am sure that most of the slopes which now carry Scots pine scrub or larch affected by die-back could have been successfully planted with Sitka spruce which, by now, would have been highly productive plantations. Latterly much more use has been made of Sitka than in the early years of the Department.

I did see an interesting 48-year-old stand of Sitka spruce in the Forest Garden at Avondale. This was originally planted in mixture with Japanese larch which soon took the lead. By the time the trees were about 30 years old the larch was completely dominant, the Sitka forming a very weakly understory apparently doomed to speedy extinction. However, Mr. A. C. Forbes took his courage in both hands and removed all but 13 of the larch from the two-acre stand. The Sitka now form a magnificent, fully stocked, crop, the trees being from 90 to 100 feet high, and it is hard to realise that they were ever in an advanced stage of suppression. Incidentally, one of the few surviving Japanese larch had a quarter girth of 13½ inches, and a height of some 90 feet, sufficient evidence, if any were needed, that this larch is capable of growing to large timber size in our part of the world.

Other species of interest which I came across included a large 40-year-old stand of *Cupressus macrocarpa*, fully stocked and much taller and bigger than any of the surrounding crops. There had been no windfall in this area which was at a relatively low elevation and on good soil.

I saw patches of *Eucalyptus* species towering above everything else and seeming quite at home on poor gorse/*Calluna* land. The trees which have proved hardy are the Tasmanian species *E. urnigera*, *E. johnstoni*, and *E. mulleri*, also the blue gum, *E. globulus*. Some of the Irish foresters are thinking of trying the use of soil blocks for raising eucalypts, as well as *Pinus radiata* and *Cupressus macrocarpa*.

Lastly, mention should be made of a very pretty stand of 30-year-old *Pinus peuce* at Avondale, the trees were straight and clean, very uniform in size, and seemed quite immune from blister rust. This is a species which might be tried in our west coast forests, possibly in strip admixture with *Pinus contorta*.

Pinus contorta

The main purpose of my short tour was to see some of the older plantations of *Pinus contorta* which are of special interest from several points of view. In the first place, the Irish foresters started to use this species for planting at high elevations long before we did in Britain, and on a relatively large scale. They have well over 2,000 acres of plantations over 18 years of age.

Traversing the valleys in the Wicklow Mountains one's eye is continually struck by the solid black contorta belts capping the plantations. Usually they run just below the crest of the hills but in some places go right over the top without any marked signs of distress. These belts stand out the more dramatically in contrast with the Scots pine scrub which usually occupies the slopes below.

A second point is that most of the *Pinus contorta* used is of typically coastal origin, i.e. it is the shore pine, and not the lodgepole pine variety which until quite recently has been our mainstay over here. I understand that the Irish have tried the lodgepole pine though I saw none of it in the course of my tour, but the opinion of many foresters, strongly held by Mr. Mooney himself, is that the shore pine is outstandingly the more vigorous and healthy variety especially where exposure is severe. There is no definite information as to the origin of the shore pine seed which was bought from Mannings and other United States seed merchants, but the presumption is that it mostly came from the coastal region of Washington.

A final point, which is not unimportant, is that success with *Pinus contorta* has been so consistent and general, that at the present time this species accounts for 30 per cent of all the plant requirements of the Forestry Division.

I was able to visit stands of *Pinus contorta* at the top of Rathdrum and Aughrim forests in the Wicklow Mountains. Elevations ranged from 1,000 to 1,500 feet, mostly over 1,200 feet, and the dates of planting from P.24 to P.28, making the age 25 to 29 years.

At Rathdrum there were two blocks, one (Compts. 4 and 5) at about 1,200 feet, and the other (Compts. 6 to 8) between 1,400 and 1,500 feet elevation.

I was given the following particulars of these stands.

	Compartment 4.	*Compartments* 6, 7 *and* 8.
Elevation	1,150 to 1,250 feet	1,400 to 1,500 feet
Soil	Shaly, with 2 in. peat	Shaly with 3 to 4 in. peat.
Age	27 years	25 years
No. of stems per acre	1,000	1,000
Percentage straight	40	35
Average height of dominants	26 feet	20 feet
Average quarter girth	4 inches	$3\frac{1}{2}$ inches

Similar data for two rather better stands in Aughrim Forest were as follows:—

	Compartment 9.	*Compartment* 14.
Elevation	1,000 to 1,200 feet	1,000 to 1,200 feet
Soil	Thin peat over shale	Thin peat over shale
Age	28-29 years	28-29 years
No. of stems per acre	710	780
Percentage straight	54	45
Average height of dominants	32 feet	37 feet
Average quarter girth	5 inches	5 inches

These stands had had one light thinning in F.Y.46.

As will be gathered from the figures giving the percentage of straight stems, the majority of the trees are crooked and one's first impression of the stands is that they are an ugly mess, indeed I was inclined to think that the assessing foresters had been unduly lenient in their standard of straightness for there seemed very few stems with which some fault could not be found. However, we know from experience how greatly crops of this sort improve in appearance as time goes on and the bad trees are eliminated in the thinnings, and I have no doubt that these stands will eventually produce passable crops.

Even in the most exposed sites there was virtually no sign of windblast, and for the past five or ten years the trees had put on good leaders. I got the impression that some of the crooked growth may have been due to snowfall which is often heavy in this part of Ireland. I was told that on the very poor and exposed Old Red Sandstone soils of the hills in the west of Ireland the contorta stands were almost 100 per cent straight and at least equal in growth to those in Wicklow. Whether the strains of *Pinus contorta* used were the same in both regions it is impossible to say and I think a study of the types in different parts of the country would be well worth while.

Mr. O. V. Mooney, of the Irish Forestry Division, has kindly added the following note on the two types of *Pinus contorta*:

"The fine-branched inland type has not been found effective in Eire where poor and exposed conditions require the use of *Pinus contorta*. It behaves in a manner somewhat like Corsican pine at high elevations and ultimately loses its needles and peters out as does the Corsican pine. It is found also that, in close plantations, the coastal types seem to develop a high proportion of fine or shade type trees.

The inland type is ineffective in killing *Calluna* even after twenty years, and at a height of seventeen to twenty-seven feet.

The coarse or shore type of *Pinus contorta* can be grown effectively with Sitka spruce in band or even intimate mixtures, though great difficulty in handling is experienced with the latter.

PICEA OMORIKA

This Note by Oberforstmeister Dr. Splettstosser, which appeared in Forst und Holz. *Vol. 7. No.* 19., 1952, *has been translated by Mr. W. H. Guillebaud.*

Picea omorika was first identified as a new species in 1875 by a Serbian botanist who found it on the borders of Bosnia, Servia and Montenegro. It occurs naturally only on limestone and on the north-east-facing slopes of valleys between an elevation of 2,700 and 5,000 feet, i.e. on sites which get little direct sunlight. There are no pure stands, and it occurs in single or group mixture in mixed forest of beech, sycamore, silver fir, common spruce, and *Pinus nigra*. Height at 100 years of age ranges from 80 to 165 feet.

The timber is said to be much more durable than that of common spruce and in former times was much sought after for ship masts.

The botanists believe *Picea omorika* to be a relic of the Tertiary age, and pollen analysis shows that it formerly had a much more northern distribution. The narrow crowned habit of the tree also suggests a more northerly origin where snowfall would have been heavy.

Picea omorika has been planted very sparsely in Germany, but a study of the plantations which do exist leads to the following conclusions.

(1) Outstandingly hardy to late frosts.

(2) Much more drought-resistant than the common spruce. Newly-planted trees survived in long droughts which were fatal to Norway spruce and Scots pine.

(3) Production greater than that of Norway spruce.

(4) Recommended especially for planting on shallow chalk soils which normally yield only a very indifferent crop of beech, and as an 'enrichment' species in broadleaved woodlands.

THE BRITISH ASSOCIATION MEETING IN LIVERPOOL, 1953

By G. M. LOCKE and R. LINES
Research Branch

The President of Section K (Botany) was Professor Walton, who being Forestry Commissioner formed an ideal link between the parent section and its offspring Section K* (Forestry). In fact during the whole meeting, which was held in Liverpool, there was much useful intercourse between foresters and botanists, especially during the joint sessions on the Afforestation of Sand Dunes and on Smoke Pollution.

Mr. A. P. Long, the Director of Forestry for Wales, who was Chairman of the Forestry sub-section, gave his address on *The Place of Forestry in Britain's Economy*. He first traced the history of forestry from 1800 to the present day, and the factors which have led to Britain being the largest importer of timber in Europe. Timber consumption was liable to increase in the future so that by 1960, at present prices, we would be paying £100 million for our timber imports; thus a home forest industry was justified on economic as well as on security grounds. He stressed the importance of timber by revealing that timber now came second on our list of imports, and that during World War I the shipping space saved by home timber cutting equalled the entire tonnage sunk. He said that forestry had no deep conflict with agriculture, but showed that much greater returns came from afforestation than sheep farming on the poor hill lands. It was either nine pounds of mutton or two tons of timber. In some cases afforestation did not even cause a drop in the numbers of sheep: in Argyll some 57,000 acres had been planted, yet the sheep population rose from 480,000 in 1930 to 503,000 in 1952. The importance of private forestry was recognised by the Forestry Commission; help was given in many ways and many landowners were beginning to realise the need for running their forest estate as efficiently as many already run their farms. The woodland surveys in Wales were helping to ensure the best use of the land. Amongst the numerous benefits of afforestation was the effect on the population of rural areas. Forestry was infusing new blood into the country and Mr. Long gave the case of a forest of 9,000 acres where £43,000 had been paid out in one year as wages. This would affect the whole community and in fact the aim was a balanced combination of agriculture and forestry with each helping the other.

The first paper to be read to the section was by Mr. W. T. Smith, Private Woodlands Officer of the North-East England Conservancy, on the Preparation, Conversion and Marketing of Produce in Private Woodlands. The speaker dealt with the various types of produce yielded by the crop throughout its rotation, and the uses to which the produce could be put. The speaker laid emphasis on the point that to make forestry pay, particularly in young crops, the markets must be studied and pursued in order to obtain the maximum financial return. Careful preparation of the produce and attention to the desired specifications could do much to offset the heavy early financial outlay in establishing and tending the plantations.

The next day the main theme was Private Woodlands. Mr. Lloyd O. Owen, Chairman of the Welsh National Committee, gave a talk on *Co-operative Woodland Societies* with special reference to Wales. Now that private owners are being encouraged to rehabilitate their woodlands, the need for co-operative woodland societies has become pressing, since few owners have the time, labour and technical knowledge to do the work themselves, and many areas are outside the orbit of forest contractors. These societies have the support of such bodies as the National Farmers' Union and the Royal Forestry Society of England and Wales, as well as being helped by the Forestry Commission. Their initial difficulties are great and an operational loss is to be expected for the first couple of years. They are chiefly financed by shares subscribed by the various owners in proportion to their area of woodland. In one society with 78 members, holdings range from 1½ to 300 acres, so that the variety of work to be done can be anything from weeding an acre to clearing 50 acres of scrub. The job of a forest society manager therefore needs considerable organising ability, a strong commercial sense, and a fair amount of tact. Initially all forest work is done by the Society's workmen, but some farmer-owners are already beginning to do some of the jobs themselves, so that a forest sense is being built up. It is expected that eventually the co-operative societies will function chiefly as marketing agencies.

Mr. W. D. Evans, speaking as an agent for a number of estates, stressed the problems of the small woodland owner. The crux of the problem was the size of the estate: with less than 250 acres of woodland, forestry cannot pay, he insisted, except under favourable circumstances. The woods must be managed intensively on strictly business lines, and taking full advantage of all governmental grants. He also urged the formation of co-operative woodland societies, or at least a produce marketing board like that for milk. There is a fount of knowledge on how to grow trees but this is of no avail unless owners can see that it is a paying proposition.

There followed a session on shelterbelts. The first paper was by Mr. R. W. Gloyne, a Meteorological Officer of the Air Ministry, on *Some Effects of Shelterbelts upon Local and Micro-climates*. After discussing the effects of permeable and impermeable barriers on windflow, and the effects of barriers in general in producing shade and reducing evaporation, he concluded that areas subject to average annual wind speeds of 12½ miles per hour or above require some measure of protection from shelterbelts if crops are to be grown and stock reared successfully. He also drew the distinction between shelterbelts in hill districts and those planted in the plains.

He was followed by Mr. W. A. Cadman, a Commission Divisional Officer, who dealt with the *Forestry Aspects of Shelterbelts for Hill Farms*. He showed how the old type of thin strip shelterbelt was inferior to a series of Manx leg, kidney-shaped or rectangular blocks, correctly sited so as to use the existing contours. He also dealt with the choice of species and the practical details of ploughing, planting and fencing.

Finally, Professor J. E. Nichols' paper was read by Professor Ellison. It suggested that the shelterbelt problem should be looked at in terms of animal behaviour, using the latest methods of grazing research. The effect of shelter on grazing behaviour of sheep had been little studied. It might be more useful to plant trees round steadings and other places where animals congregated naturally rather than straggle the belts over the hills. The need for research on shelterbelts in hill districts as opposed to those in the lowlands was pressing. The subsequent discussion brought out clearly the need for joint efforts on this problem, with meteorologists, pastoralists and foresters pooling their knowledge and experience.

The following day the Forestry and Botany Sections came together for a joint session on Sand Dunes. This was started by a paper from Mr. J. Macdonald, Director of Research and Education, on the *Afforestation of Dunes*. He traced the history of dune planting back to the Continental pioneers. The Landes scheme had captured the imagination of foresters, as it had been shown that not only could dunes be stabilised but a useful crop obtained as well. Dune planting in this country started more than 100 years ago, but modern techniques such as thatching have improved the speed of establishment. He divided dune areas into three types from the planting point of view: fixed flat dunes, hilly semi-fixed dunes and moving sand. It was essential to fix the last named to cut off the supply of blown sand. Thatching was used in France as early as 1804, and in this country this had proved more satisfactory than planting marram grass. Dunes were a unique habitat for tree growth, poor in nutrients and available moisture, though never completely dry below two inches from the surface; they quickly showed up mistakes by the forester, which on a more fertile soil might go unnoticed. They also provided a useful opportunity for the study of a soil in the making.

The film *The Culbin Story* was next introduced by Dr. T. W. Wright, who is working on Culbin soils. He traced the history of Culbin from the disastrous storms of 1694 to the present day when afforestation is nearly complete.

The rest of the morning was devoted to two ecological papers on the flora of sand dunes, and the address by our foreign guest, Professor P. Thaarup, Director of the Danish Dune Service, on the *Afforestation of Dunes in Denmark*. He concentrated on the dune areas of Jutland where there are 185,000 acres of dune lands. As at Culbin, invasion of sand followed overgrazing and pulling marram grass for thatch. First attempts to control it were made in 1779, and by about 1815 the coastal areas were controlled. The State began its real work in 1853, planting first directly in the sand and then through a heather mulch. Austrian, mountain, Corsican and Scots pines were all tried. Corsican pine was badly attacked by fungi, and mountain pine proved the healthiest and most adaptable species. It is now used exclusively as a pioneer crop. When it is about 6 to 10 feet high, strips 10 yds. wide and 30 yds. apart are cut at right angles to the wind and planted up with Scots pine or Sitka spruce. When this is about 6 feet high, the strips are extended until a pure crop of the more valuable species is obtained. Great attention has to be given to the provenance of the mountain and Scots pines. Briançon seed being preferred for the former, while Scottish strains give the best volume production of the latter. The climate of West Jutland is so severe, however, that Scots pine loses all its second-year needles, and even mountain pine is not planted nearer than 1½ miles to the sea. Sitka spruce was first planted in 1885; it gives the biggest volume production but is liable to insect and fungal pests on poor land. It is used chiefly on areas where sand overlies peat or clay. It is difficult to regenerate naturally and it is hoped to underplant with silver fir. Due chiefly to the wind, conditions for growth in West Jutland are poor, with an average increment of only 70 cubic feet per acre per annum. Nevertheless the plantations produce an annual profit of £20,000.

The final day was spent in considering smoke pollution. This is an important factor for tree growth in industrial areas, and even in the country where metal smelters are found such as that at Fort William in Scotland. Dr. Metcalfe of Kew showed how conifers were particularly susceptible, hence the establishment of the National Pinetum at Bedgebury, away from the smoke and fogs of Kew.

Mr. T. R. Peace, Forestry Commission, described the effects of brickworks on a Bedfordshire estate, and showed how freak meteorological conditions could cause heavy local concentration of toxic substances with resultant large scale defoliation. Fortunately most trees possess considerable powers of recovery.

He was followed by Dr. Bleasdale who stressed the need for considering all factors together, for example, crops grown in polluted air on a good soil gave the same yield as crops grown in purified air on a poor soil. Foresters are often called on to grow crops in polluted air and here the soil fertility may be limiting.

The first outdoor visit was to the Ince Blundell plantations at Freshfield, north-west Liverpool. The area is composed of sand dunes which, until the end of the 19th century, were unstabilized. In 1887 the dunes were first planted with marram grass and different species of trees planted. As a result of these experiments Corsican pine was found to be the most satisfactory tree, and has now been planted extensively. The area of the dunes is approximately 2,000 acres of which some 750 acres have been planted. The plantations have been established only on the sandhills, and little attempt has been made to plant the low lying wet patches. It is interesting to note that the area was not planted with a view to providing a timber crop, but only to fix and stabilise the sand and to provide an amenity area. Later in this excursion the party was taken to Formby Point where, due to an alteration of the coast line, a considerable area of plantations had been engulfed by the sands.

A visit was made to Messrs. J. R. Gordon's sawmill at Queensferry in Flintshire. A major portion of this mill is devoted exclusively to the utilisation of thinnings. These were mostly sawn up by gang saws for box shooks; but flexibility was the essential thing and production could be quickly switched to serve other markets. A very high degree of utilisation was achieved, as with 7,000 to 8,000 cubic feet coming in per week, about 5,000 feet was sent out as prepared produce. Sawdust, odd ends, and even bark were utilised. The machine which attracted most attention was a bark peeler, which is still being developed. It has been designed so that it can be set up in the forest and the motive power supplied by a tractor.

On Saturday there was a full day visit to Clocaenog forest, Denbighshire. The nursery was visited first. It is partly on old agricultural land, although a heathland section has now been added. Weed growth in the older section was becoming a problem, but is now being controlled by use of oil sprays.

The experimental plots at Marial Gwyn were then visited. The purpose of these experiments was to try various species and planting techniques, and the use of fertilisers. Although deep ploughing has now to a considerable extent rendered less valuable the information obtained from these experiments, they are interesting as a display of the techniques employed in the earlier years. *Pinus contorta* has shown good growth, and Japanese larch has also succeeded in closing canopy, despite being at an elevation of about 1,450 feet on an exposed situation; its increment is however low. The party then moved to the experimental plots at Tal y Cefn where much the same experiments were carried out at, however, a considerably lower elevation. The excellent growth of *Pinus contorta* is noticeable in comparison with other species. There is a wide variety of provenances present, of which the inland varieties appear to be the most successful. The forest is served by an excellent system of recently constructed roads, which aid fire protection now, and will in future years serve for the extraction of produce.

On Sunday, Delamere forest in Cheshire was visited and again the first stop was at the nursery. There *Pinus strobus* is grown free from blister rust and even when planted in the forest appears to escape attack despite fairly intensive currant growing in the neighbourhood. Considerable quantities of red oak seedlings are grown for planting on the poorer soils in mixture with pine or birch. Seedlings grown from seed collected in Warwickshire from oak of outstanding quality were also inspected.

A Scots pine area in one of the deep peat bogs was visited, where, due to the poor growth of the trees, heavy thinning and underplanting with Norway and Sitka spruces and *Tsuga heterophylla* was undertaken. The outstanding growth of the *Tsuga* was commented on, and it would appear that this tree is the answer for this type of ground here.

The afternoon was devoted to the study of utilization. The party visited some recently thinned compartments in which the actual produce extracted from one acre plots was stacked on the rideside for inspection, neatly divided into pitprops, poles, boxwood and timber. The costs of extraction and preparation, and the prices obtained for each class of produce, were tabulated for pine crops of different ages from four compartments. Mr. Long had himself been responsible for the planting of some of these areas, and from his figures it was estimated that the net profit, even after a first thinning, easily cleared the compounded cost of establishment, though it should be borne in mind that a good local market exists for most classes of produce.

Next afternoon the party went to the Duke of Westminster's estate at Belgrave, Chester. Although the grounds of the house and the local nursery were visited, most of the time was spent in inspecting the sawmill. The nursery supplies about half of the planting requirements of the Duke's estates and produces some high-class plants. The mill is the largest on the estate and is run as a commercial mill, converting not only timber from the estate but also timber bought from outside. The two drying kilns are used mainly for seasoning oak, for high grade flooring timber and general constructional work.

The final excursion was to the Widnes sawmill of William Evans, Ltd. This firm is a large timber importer of both softwoods and hardwoods, and as well as dealing with conversion in all its aspects also deals with seasoning, and timber impregnation by the Wolman process. Sawmilling today is an urgent business, with timber handling highly mechanised by Straddle Carriers and Fork Lift trucks; even electrical braking is used on the large band saws, so that the time for the saw to run down is cut from 10 minutes to 40 seconds. This is necessary because the saws are changed at intervals of between ½ and 1½ hours, depending on the material being cut, so that saw changing time would be a large item of cost without this device. Another modern development is the manufacture of battery boxes from wood shavings. The bonding material is urea formaldehyde, which is 'set' by radio-frequency heating.

PRESERVING SCOTS PINE STRAINS AFTER THE 1953 WINDBLOW IN NORTH-EAST SCOTLAND

By C. McLEAN
Foreman, Research Branch

During the summers of 1951 and 1952 surveys were made of the North and East Conservancies of Scotland to find the best stands of forest trees for seed collection and also the best individuals for more intensive breeding; these individuals are hereafter referred to as "plus" trees. As a result of this work 165 Scots pine were selected as "plus" trees for breeding, and about twenty Scots pine stands classified by measurement and a visual scoring for form, as being good enough for intensive seed collection. A number of other species were dealt with in a similar manner.

On January 31st, 1953 an area extending from Nairn to east Perthshire suffered from a gale of terrific force, and many of the "plus" trees and stands were blown down. Thus if the character inherent in these woods was to be saved, quick action was needed. It was decided to collect cones and scion material for grafting from every blown "plus" tree and from a proportion of the largest and best-formed dominants in every worthwhile stand, and in addition to assist the Conservancy staffs in making a large general cone collection. The work began at once.

Normally the collection of seed and vegetative material from mature trees presents some difficulty and many tools, including ladders, tree-bicycles, and, shotguns, have been used. In this case no such difficulty existed, but it was not easy to select the best stems from amongst the wreckage. On arriving at a wind-blown stand the first operation was to pin-point the position of any marked "plus" trees. Sketch maps had been made previously and these indicated possible landmarks. Once found, the tree was stripped of cones. The cones were counted, bagged and labelled with the tree number, and as many suitable current-year's shoots as possible were cut off as grafting material, and also labelled with the tree number. Then from five to twenty of the next best dominants had to be found, the number depending on the assessment of the stand. The better stands, such as the Scots pine woods at Altyre (Moray) and Crathes (Aberdeenshire) being allotted the full number of twenty trees.

In order to avoid indiscriminate selection it was necessary to fix a minimum girth and height limit, below which no tree would be considered. Usually the girth limit was not more than four inches (true measure) below the breast height girth of the biggest plus tree. Then having climbed to a vantage point in the timber one tried to pick out trees above this girth by eye. If on inspection these trees proved to be of the required girth and height, and were straight, healthy, had stems which were circular in cross-section, with a good branch habit, they were allotted a number for identification, measured, their form described, and then their cones were collected.

The vegetative material resulting from such a collection was sent off immediately by post to one of the propagation sites at Alice Holt, Bramshill or Grizedale, where they were grafted, or else stored in peat for later grafting at Newton Nursery, Elgin. In addition, the cream of the selected trees were propagated at Horsholm, Denmark, and the Northern Irish Tree Breeding Station. This wide dispersal of material will act as extra insurance against any clone becoming extinct.

Seed was extracted from cones at Alice Holt and the resulting plants will be planted out tree by tree in progeny trials. These plots will themselves become useful sources of seed, as well as good sources of material for back-crossing.

In all about 180 clones—or series of vegetative plants, all emanating from plus trees—were started as a result of the gale; representing 15 woods severely damaged or flattened.

Thus the qualities of these woods have been preserved by general seed collection, by a collection of clones from the best dominants and by separate seed collection from these dominants. It is hoped to establish seed-orchards from the clones propagated, and thus to ensure that the best strains existing in East Scottish woods do not become extinct.

THE KINVER NURSERY

By G. H. STOCKLEY
Forester, North-West England

Kinver Nursery was opened in January, 1949, an additional area being utilised in 1950; the total area now enclosed is twenty-five acres. It is situate at Kinver Forest in the extreme south of Staffordshire, about fifteen miles west of Birmingham. The site faces south and is fairly exposed to predominant south-west winds in spring and summer, also to the cold dry east winds of winter. The soil is chiefly a sandy loam of pH 4.5 to 5. Parent rock is Bunter Sandstone, parts of the nursery are extremely stony, producing large smooth pebbles of marine deposit type. The soil dries quickly after rain. Annual rainfall is very low for the West Midlands, being approximately 20 to 25 inches.

The annual out-turn of seedlings and transplants reached 12 million in F.Y. 53. Nearly all seedlings are moved as first-year stock, and most transplants as one-plus-ones.

The total regular staff employed at present is seven men, three women and one boy; this total is increased from January to March by three or four part-time workers. The regular staff are not continuously employed in the nursery, as all maintenance work in the young plantations has also to be done by them.

Preparation

The site was first cultivated by rotary hoe (Fordson attachment) until the surface grass and bracken was reduced to a consistency resembling dry compost. This was followed by a deep ploughing (10 to 12 inches) in order to bring the bracken roots to the surface. These roots were removed by spinning them out on to the top of the soil by a Fishleigh Cultivator; the roots were later collected and burnt.

Final preparation was done by ploughing the humus back to the surface and replacing the sand to its original lower level; a shallow ploughing followed in order to place the humus a few inches under the surface.

Roads and Paths

When the layout of the nursery was agreed, ample roads were provided between sections, plus a perimeter road of earth inside the boundary fences; this perimeter track is disced frequently during dry spells and weeds are checked at this point. Of the remaining roads, those required for transport are stoned in all doubtful places. On the main drive into the nursery from the main road, and on the road to the stores and implement sheds, ample room has been provided for a tractor and trailer to turn.

Storage of Manures and Composts

The site for storage of compost and hops is located outside the boundary fence. This has been organised so as to have a hard centre road through the area, with hop bays leading off from each side, with side walls of baled bracken. Use of straw is avoided in view of the heavy weed it carries, bracken being used instead. Cutting, hauling and baling of bracken can be done for approximately 70/- per ton; this compares very favourably with straw purchases, and the bracken is weed-free.

After one year's use as side walls the old bracken is stacked in six inch layers with alternate layers of fresh hops—built up to form a rick—and allowed to decompose without any further attention. No watering and no turning is necessary. This produces a very good humus. The inorganic content will be low, but can be rectified with fertilizers when the material is used in the nursery. The organic value of such a manure can be rated high, if only as a moisture-retentive humus. The complete stack is built for approximately 13/- per ton.

Water seeping from stacked hops presents a problem, as surrounding soil becomes water-logged, with consequent bogging of transport.

Fresh hops stacked in bays are allowed to remain, if possible, nine months or more, this ensures a complete break down and renders the compost ready for direct application to nursery and early cropping.

Treatment of Fallow Ground

When possible one-third of the ground at Kinver is retained under summer fallow; this being one of the essential factors in maintaining a weed-free site. This fallow is disced frequently during the summer, on warm dry days.

Manuring of fallow, by applying compost, is carried out during June-July-August, and the land is shallow ploughed ready for winter lines and seedbeds. This method gives a good working tilth for all operations. Fallow treated in this way is ready for the application of chemical fertilizers in October for lines, or in January for seedbeds. Green-cropping is not favoured because the necessary lime application would upset the desired pH for heathland culture and weed growth might be increased. Summer fallow plus early application of compost appears to give excellent results here. Overcropping of the heathland site can be, ultimately, the cause of weed encroachment and general lowering of hygiene, perhaps more than any other factor.

To select a rotation and apply a compost accordingly is not always possible. A rigid rotation would only be feasible where the nursery was producing seedlings and transplants for local use, and where the amount of seed sown was restricted to the numbers of transplants required to be grown within the nursery. Where large exports of seedlings and transplants are the regular practice, the proportion of seedbeds to lines in terms of square yards is often quite out of balance for a strict rotation. But if rotation were possible a sound one for Kinver would be:

(1) (*a*) Fallow manured at 1,500 cubic feet of compost per acre.
(*b*) Seedbeds.
(*c*) Lines (no manure).
(*d*) Lines manured with compost at 500 cubic feet per acre.
(*e*) Fallow manured with compost at 1,500 cu. feet per acre,

or

(2) (*a*) Fallow manured with compost at 750 cubic feet per acre.
(*b*) Lines
(*c*) Seedbeds manured with compost at 1,500 cubic feet per acre.
(*d*) Lines (no manure).
(*e*) Fallow manured with compost at 750 cubic feet per acre.

Manuring in each case would be approximately 40 to 46 tons of compost per acre every five years; but the movement of plants during winter makes such a rotation rarely possible. Where seedbeds are to follow lines and the transplants are not sent out before March, it is not possible to manure this land and make *good* seedbeds in time for sowing. The same problem arises where lines are to follow seedbeds, this may mean lining out in April or May.

All applications of manures are turned into the soil with the Power Rotary Hoe and Ferguson tractor.

Preparation of Seed Beds

The work of preparing seedbeds is entrusted to the tractor driver alone, who with the Ferguson tractor and implements prepares up to six acres or more of seedbeds ready for sowing. The whole operation is very economical. This is not a great task providing that ample fallow is available to make an early start.

Ridging of the beds is carried out and if possible completed as early as October. A locally-designed attachment fitted to the ridgers also levels the bed in one operation. The implement used comprises two Ferguson ridgers mounted to its frame. The shell boards are drilled so that two extensions can be bolted to them; these extensions are of wood, 2 inches by 2 inches with bent tips of steel projecting at right angles from the ends of the wood strip towards the centre of the bed, leaving a narrow gap between the steel points, of three to four inches. This allows surplus soil to flow through without building up in front of the blades. This complete ridging attachment is then fitted to the hydraulic lift of the Ferguson with the ridgers spaced to give a bed of 3 feet 6 inches. The extending arms roughly level the beds when ridged. Manuring of the fallow ground for seedbeds has been previously carried out in August. The roughly levelled beds will then lie and settle until January, when potassic super-phosphate is added at 14 lb. per 100 square yards, by means of the Coultas Distributor, hitched to the towing bar of the tractor. This fertilizer is turned into the top three or four inches of soil with the Power Rotary Hoe (Ferguson mounted). At the same time the beds are receiving the final tilth ready for rolling. The roller in use is one-half of a farmer's flat roll; this is exactly 3 feet wide, and has been fitted with a towing attachment that allows it to be drawn by the Ferguson Tractor. The power lift raises the roller at the ends of the beds for turning. The roller is weighted to eight cwt. by fitting two five-gallon oil drums, filled with cement and sand inside.

After this rolling the beds are then left to absorb as much spring rain as possible and are not again disturbed. This early preparation of beds allows large quantities of moisture to be stored which would not be possible if late cultivation were the rule.

Preparation of Lines

Preparation of lines requires very little mechanical attention after the manuring and discing of the fallow in autumn or preferably late summer. Fertilizers are applied in October—again potassic superphosphate at 14 lb. per 100 square yards—and disced in. Removal of stones is the responsibility of the teams on lining-out, and the stones are placed in the alleyways ready for collection. No extra cultivation should be necessary unless rain has packed the soil, when this can be broken in a short time with the rigid-tine cultivator.

Seed Treatment prior to Sowing

The majority of seed received arrives in good time for sowing, with exception of Douglas fir. In order to carry out stratification of Douglas fir, this seed is required as early as January or February. The majority of seed needs only a warm dry store, free of mice. All coniferous seed received at Kinver is stored in the Forester's Office, this ensures constant inspection and more regulated temperature conditions.

Seed for soaking, in order to get pre-germination, is placed in wooden wheel barrows, or shallow boxes. The wooden containers are first lined with hessian, the seed tipped in and the whole covered with water, when the water quickly drains away leaving a damp mass of seed. This can be kept moist by spraying with a watering can daily. The containers are placed in a galvanized iron shed, where usually in May the sun is sufficiently warm to create a humid atmosphere; this method has been found to be far more satisfactory than simply dumping the seed bags in tubs of water. The length of time for soaking seed at Kinver is governed by the texture and condition of the seed and not by a definite number of days; at no time is the seed immersed in water and left to soak. Red-leading at 1 lb. red lead to 10 lb. seed is the rule for all coniferous species with the exception of Douglas fir.

Stratification of Douglas fir seed takes approximately six weeks; this needs regular attention, as drying out of the sand can be very rapid. Care is also taken that the pit used for stratifying is well drained, otherwise mould forms freely on and around the seed.

Although comparatively few oak are sown, good results have been obtained from storage and spring sowing, but sowing immediately after collection is more usual. If the acorns are sown to a depth of six inches, and top soil removed in spring, mice and birds do not as a rule find the seed; should this happen however, a spraying of tractor vaporising oil from a watering can rose is sufficient to discourage birds or mice for several weeks.

Seed Sowing

Seed sowing is always a difficult operation at Kinver, as winds are troublesome during spring. There is no natural protection from south-west breezes, the nursery site slopes towards the south and lath fences provided for protection do not in practice shield more than two beds in each section of twenty or thirty. Nearly all sowing, therefore, has to be done in these stiff breezes, and inevitably some seed is blown into the alleyways and roots there.

Seed is sown by means of the Coultas Distributor. Whilst the machine is sound in principle, in its present form it has a number of disadvantages over hand sowing. The canvas belt is too smooth to retain an even covering of seed when the driving wheels bounce over stones in the alleyways. Even the smallest pebbles can create this bouncing effect, and where fine seeds are used bare patches on the sown bed are not easily detected until germination. During sowings in F.Y. 53 it was also found that the wooden shutter controlling flow of seed was warped and had to be pegged open to counteract the warp. The box containing the seed, travelling as it does six inches or so above the bed, also provides a draught between the wheels, which carries the seed to one side more than the other. In addition it was found that the revolving brush had worn down considerably during the first half of the sowing programme. However, most of these faults can be rectified; the brush can be adjusted, and the setting of the shutter can be half or quarter the normal for individual types of seed, whilst traversing the bed two or four times can be done if necessary, in order to achieve an even cover. An aluminium shutter would be of great help in controlling seed-flow.

Once the seed is on the bed, covering by 3/16 inch washed chippings is carried out. This is done by tractor and short-wheel-base trailer, carrying sufficient chippings to complete 100 yards of bed in one operation. A man in each alleyway at the rear of the trailer puts the chippings on the seed with a riddle. It is occasionally necessary to supplement transport by wheelbarrows. Sowing has usually been in May, between 1st and 12th as a rule. This is chiefly because lining-out and lifting for export occupies all the months up to the end of April, but in view of the large seedlings turned out at Kinver from May sowings, earlier sown seed may produce excessively large transplants, which is not desirable. One-plus-one transplants of Sitka spruce at present average eighteen inches, with May sowings. Larger stock would inevitably increase handling costs, and might be less suitable for their intended use in the forests.

Seed Treatment after Sowing

It is the accepted practice at Kinver to water beds of Sitka spruce and *Tsuga* if a period of dry weather follows sowing, as sudden drying-out of pre-germinated seed can produce disastrous results. Not only does the seed dry in a warm spell, but the surface of the bed and the chippings dry also. Surprisingly warm weather is often experienced in March, April, May. The beds contain ample moisture once the seed begins to root, but this type of moisture is not often of benefit to the small type seeds such as Sitka spruce or *Tsuga* during the first week or so of germination. Much depends on the frequency and amount of showers immediately after sowing. When watering is considered advisable, it is only carried out once every three days, and a quarter of an inch of "rainfall" has proved quite sufficient to keep the seed from drying out. When the seedlings appear above the chippings, watering is discontinued, the moisture stored in the beds has been found to be quite satisfactory and sufficient to keep the seedlings moving.

Neither rolling of seed after sowing, nor watering of beds before sowing, is done at Kinver. This may be desirable where only a few hundred square yards are sown each year, but when acres have to be handled watering and rolling at time of sowing is not possible; therefore we rely on the early, well-consolidated bed.

Nitrogenous Top Dressings

Nitrogenous top dressings are not considered necessary at Kinver unless excessive rainfall lowers the nitrogen content. It has been found that where seedbeds have received potassic superphosphate only and no hops, nitrate deficiency is very marked early in the season and has to be rectified by applying 6 lb. of "Nitrochalk" per hundred square yards. A deficiency of nitrogen is also noticeable in transplant lines where bracken/hop compost has been used, and has been ascribed to the much slower breakdown of this material compared with pure hops. When patches of yellowing denote nitrate deficiency, it is rectified provided it is not too late in the summer to do so safely. If such deficiency appears in late August it is better to accept the condition which will be automatically rectified when the plant commences growing in the forest, rather than top dress and risk the tender shoot growth that will possibly follow, to be almost certainly nipped by frost; if August applications are made, the rate is reduced by half. Experience shows that the more exposed the nursery site is, the safer it is to top dress. The spruces tend to suffer before the pines from nitrate deficiency. Where seedbeds are on fallow manured at 1,500 cubic feet per acre, there appears to be no nitrate deficiency, even during a wet season, always providing that the manure was applied early in Autumn on beds prepared early.

Lifting Seedlings and Transplants

The lifting of seedlings has proved one of the simpler operations at Kinver, where use is made of the Ferguson tractor and lifting blade attachment. Sufficient beds can be lifted in this way, in approximately 20 minutes, for a complete day's work of packing for all staff. Seedlings are then pulled from the loosened soil by hand, and counted for export. The same procedure applies to lifting seedlings for lining-out except that no counting is done at time of lifting. Sufficient only to fill a wheelbarrow are taken to the lining-out site and numbers are calculated "as lined out".

The lifting of transplants in the past has of necessity been a hand operation, but it was found that owing to the rapid growth of one-plus-one transplants, stock often had to be handled at eighteen inches and over. This larger stock also called for a higher lifting price per thousand, when the work was done entirely by hand. In order to counteract this, the lifting bar has ten one-inch extensions welded to its trailing edge and slightly inclined upwards. It has been found that with this modification the lifting bar loosens the seedlings and eliminates most root stripping of the transplants, which can be lifted to the point where easy pulling by hand brings the complete root up. As the transplant beds are six feet four inches wide, it is necessary during the first part of the day either to (*a*) take the centre out of the bed by hand digging a strip approximately fifteen inches wide or (*b*) to lift *half* the bed by hand, digging along its entire length. The remaining portions are then lifted by Ferguson. The cost of lifting with the aid of the Ferguson tractor adds approximately ½d. per thousand plants. Price for lifting seedlings total 1/7d. per thousand; those for transplants 3/6d. With this method of lifting transplants a price of 3/- or 2/10d. would be reasonable if the stock was in the grade of six to twelve inches, and correspondingly smaller in branch spread; but a higher rate is the rule, owing to the large stock produced in all species.

Lining-out

Results of lining-out at Kinver are usually very good due to a large extent to the lining-out of stock within an hour or so of lifting. This has proved particularly important when handling Corsican pine. All species handle well and give excellent results with the exception of Japanese larch and Douglas fir.

These two species tend to give varied results, especially the Japanese larch, which produce tall weak plants with unbalanced roots, possibly due to the high acidity of the soil. Slower-grown plants on less acidic sites do not have these characteristics. Lining-out is done with a board six feet four inches long; each team comprises a man and girl, who share the proceeds, on piece work, in the ratio of two-thirds to one-third. Minimum spacing is two by eight inches. It has been found that using 1½ inch spacing for sturdy seedlings is not sufficient where eighteen-inch high transplants, aged one-plus-one years, are expected. Observations on previous 1½ inch spacing show that an average of eight to ten plants are smothered and lost out of the fifty plants per row, and mineral starvation is evident towards the end of the season. But, using a two-inch space only two plants on average are lost, and often only one. Thus the saving of plants alone justifies two-inch spacing. The current piece work rates for lining-out are: at 1½ × 8 inch spacing, 4/6d. per thousand (now rarely used); at 2 × 8 inch spacing, 5/4d. per thousand. Both these prices include the clearing of stones into the alleyways.

Protection against Wind

Protection from wind at Kinver was thought to be very necessary at first, but experience has shown that the lath fences erected are of no value at all. They give little protection at seed sowing and are invariably blown flat during winter gales. The nursery slopes towards the south and it is from the south-west that the strongest winds come. Cold east winds have a severe drying effect on stock, but plants are mostly completely hardened by January when these winds are most troublesome, and moisture storage of the soil during winter is quite satisfactory to cope with the drying effect. Also, rapid movement of stock for lining-out lessens the risk of drying out.

The most annoying winds come from the south or south-west in April and May and although these winds are moderate, seed sowing is always affected. Seedbeds, however, are not affected by wind blow.

Sun Scorch

Damage from sun scorch is rare at Kinver. Even where temperatures exceed 75 degrees the early preparation of beds when possible and possibly the early storage of moisture in the soil counters any tendency to sun scorch. The danger of excessive heat lies not so much in the heating of the chippings that comprise the seed cover, but more probably in the excessive transpiration which is caused within the seedling itself. Newly sprouted *Sequoia sempervirens* and *Tsuga* at Kinver have not suffered in temperatures of 75 degrees without shelter, where this moisture has been available in early-made beds.

Frost

Damage from frost at Kinver is largely avoided by removing lath shelter from seedbeds early in the summer or late spring, when seedlings have appeared above the surface of the beds, and re-covering again not later than the end of August. This policy has been found to provide ample protection to newly sown seed and also to counter the early autumn frosts. Where species such as Douglas fir and *Tsuga* require longer hardening off, the lining-out of such species is usually delayed until mid-winter or spring, when a complete hardening off has been achieved under the shelter. Kinver is not troubled with frost lift. Frosting of stocks in late autumn and early winter is often due to late applications of nitrogen and prolonged summer rain; this combination can force plants to a very tender shoot. As a precaution against frost at Kinver late nitrogen dressings are avoided, even though some loss of colour is evident.

Drought

There is little protection against drought once it has arrived, and on large seedbed areas damage is often evident before protective measures can be applied. In following the policy of early-made beds with a high moisture content, early lining-out as opposed to late spring lining-out, and generally by avoiding disturbance of the soil in any way, the dangers of drought may be offset.

Weeding

Weeding at Kinver nursery has from the first season of operations been entrusted to three girls, who at intervals during the summer come into the nursery and hand-pick every visible weed, section by section. It has been found that two or three days a fortnight are sufficient to maintain a weed-free site. The amount of time devoted to weeding during future summers will no doubt have to be increased.

The first five years has cost approximately £380 for 25 acres of land, or just over £3 per acre per year. Included in this acreage are from 14 to 16 acres of crops, the remainder fallow, roads or paths. The cost of £380 is a total cost for the five years and has resulted in a weed-free nursery. This policy of removing the weeds as they appear has proved correct, and will be continued. Weeding costs for F.Y. 53 on sixteen acres of cropped land and remaining nine acres of fallow etc., have been £80.

Four other factors also contribute to the weed-free condition:—

(*a*) the normal low rainfall, (*b*) the relatively acid soil, (*c*) avoidance of imports, in fact no stock from other, possibly more weedy, nurseries is brought in for lining-out, (*d*) the exclusive use of hop or bracken/hop composts as manures.

Summary of Operations at Kinver

The following is a brief summary of operations as now practised:—

(*a*) *Storage of Hop-waste*

This is stacked in bays enclosed with bracken bales to avoid weed infestation. Hops are allowed to rot for one year if possible. Old bracken is eventually ricked with alternate layers of fresh hops to form compost. No watering and no turning is necessary in forming a humus-rich compost. Mineral deficiencies are adjusted at time of cropping.

(*b*) *Manuring Rotation*

When possible a rotation of (i) fallow, seedbeds, lines, (ii) lines or fallow is carried out. One-third of the area is maintained under fallow. The fallow land is disced in the summer, and manured as early as June or July ready for winter cropping.

(*c*) *Preparation of Beds*

Prepared by one man and a Ferguson tractor. All operations are mechanised, beds are prepared in early winter whenever possible. Fertilizers are applied in January.

(*d*) *Preparation of Lines*

Little cultivation is necessary after fallow has been summer disced. Fertilizers are applied before lining-out commences.

(*e*) *Seed Treatment*

Soaking of most species by keeping seed moist in a wooden wheelbarrow, applying a spray of water occasionally with a rosed can. Surplus water drains away. Douglas fir seed is stratified; all seed except Douglas fir is treated with red lead.

(*f*) *Seed Sowing*

By means of Coultas Distributor. Cover of 3/16 inch washed chippings carried along beds by tractor-trailer and applied by riddle.

(*g*) *Top Dressings of Fertilizers*

Avoided unless essential. Where needed, nitro-chalk at 6 lb. per 100 sq. yds.

(*h*) *Lifting seedlings and transplants*

Mechanized with Ferguson undercutter. With seedlings, complete bed lifted; transplants half bed only, remainder by hand.

(*i*) *Lining-out*

By 6 foot 4 inch board. 2 × 8 inch spacing. Early lining-out, October onwards.

(*j*) *Protection*

Dry winds, sun scorch and drought all countered by early-made beds and early lining-out. Minimum late disturbance of the soil aimed at.

(*k*) *Weeding*

Measures taken to keep weed growth at a minimum include removing weeds as soon as visible, avoidance of imported stock, use of weed-free manures.

A METHOD OF WORKING HEAVY NURSERY SOILS WITH A RIDGE PLOUGH

By R. J. JENNINGS

Forester, North Wales

The heavy soil of Dwilig Nursery of St. Asaph Forest, Flintshire, in the fertile Vale of Clwyd is particularly difficult to work at any time. Consisting mainly of Boulder Clay containing a high proportion of silt and being retentive of moisture it is very subject to consolidation and caking. A moderate shower of rain can quickly convert the finest tilth to a muddy intractable mass and any attempt to recreate the workability by mechanical means with plough, disc harrow, or rototiller will make matters worse. The plough will turn up a furrow of tightly packed soil with a polished surface which will dry out like a concrete slab, and the rototiller or rótohoe will throw up lumps of soil which vary in size from that of a man's fist to smaller pieces the size of walnuts. The lumps if moist will preserve a cheese-like consistency, and when dry harden up like stones. Once the soil structure has been reduced to this state it is quite impossible to carry out nursery operations successfully, such as lining-out or seed sowing, until the slow weathering which comes with successive sun, wind and rain, has pulverised the soil naturally again.

When dealing with small areas on soils of a similar type it is usually possible to avoid working the land in conditions just described by picking favourable periods for cultural operations, but with 50 acres of nursery—9 million trees to line out and 16½ thousand pounds of hardwood and coniferous seeds to sow, which was the programme for 1953 at this unit, work cannot be halted because of unfavourable weather, operations must be pressed on in all but impossible conditions, or the year's work will not be completed.

Photo 5. The Duke of Edinburgh and the Earl of Radnor talking to members of the staff at Culbin Forest.

Photo 6. Wire-mesh suspension footbridge at Glen Brittle Forest, Isle of Skye.

Photo 7. Rafting logs from Inverliever Forest across Loch Awe, Argyll.

Photo 8. Forest road bridge constructed with tramrails.

Photo 9. Lining-out on beds previously "ridged up" with a plough at St. Asaph, North Wales.

Photo 10. Plaque commemorating the Commission's first planting at Eggesford Forest, Devon.

Photo 11. The first trees to be planted by the Commission. Eggesford Forest.

Foresters who experience difficulties in working heavy soils may be interested in a simple technique developed at St. Asaph, through sheer necessity, which during the past four seasons seems to have been the answer to most of our original cultivation and consolidation problems. Since put into practice, the method has increased the workable period of the nursery by four weeks, and if the operations are put in hand at precisely the right moment, which can only be decided on the spot by considerable first-hand experience, the soil may be kept in first-class condition from September until March. This method is now accepted as normal practice in several North Wales nurseries.

At the end of September or mid-October, when all bare fallow cultivation has been completed, and any green crop or compost dug or ploughed in, all land is ridged up with the Ferguson tractor and ridger, with points set exactly 2½ feet apart. If the land is rough and lumpy before ridging, so much the better. The ridges, which are as deep as the implement can make them, run as far as is possible from top to bottom of any hilly or undulating sections, to assist surface drainage; the ground is left in this condition until it is cropped with seedbeds or transplant lines.

All lining-out is undertaken with the short 6 foot 4 inch boards, and the rows of trees run at right angles to the ridges; the workers stand in the bottom of the ridges when lining-out and only level the soil as it is required for laying the boards, as shown in Photograph 9. By working from the bottom of the ridges, which may sound an awkward business but in fact presents no difficulty whatsoever, all treading of soil is avoided; and the consolidation of the surface soil, which is fatal to a decent working condition but which is unavoidable when normal methods of practice on flat ground are in use, does not take place. Furthermore, a heavy shower of rain, instead of packing down the soil, simply runs down the ridges, and operations are not held up.

What of the seedbed ground? This too remains ridged all through the winter, and when required for sowing in March will be in the ridges in a fine workable condition. The seedbeds, 3 ft. 6 in. to 4 ft. in width, with alleys 12 to 18 inches wide, depending on local requirements, run lengthways with the ridges; the bottom of every alternate ridge will be the centre of an alley between beds, and every bed will be made up with two levelled-down ridges. It will be found that on the heaviest soil these ridges break down, with a minimum of raking, to a beautiful tilth, particularly if the land was rough before throwing up in the autumn. In addition, any land from which a crop of trees has been lifted, and which is scheduled for a successive crop, is immediately ploughed, disced, and ridged; when required it is usually in a workable condition.

It is well worth insisting on the tractor driver throwing up his ridges in dead straight lines, at least on the seedbed ground, as it facilitates the marking out and raking down of the beds.

As the nursery is situated in a fairly warm climate at an elevation of only 50 ft. above sea level, considerable weed growth occurs on fallow ground during the winter months. Groundsel (*Senecio vulgaris*), sun spurge (*Euphorbia helioscopia*), charlock (*Sinapis arvensis*), chickweed (*Stellaria media*), shepherd's purse (*Capsella bursa-pastoris*) and annual meadow grass (*Poa annua*) frequently flower here in mid-winter, and appear in extensive patches on fallow ground, especially on the south side of the ridges. In general, however, these weeds cause little trouble, and in the spring before the beds are made up the sides of the ridges are skinned with a sharp spade on a dry sunny day, and the weeds turned under in the bottom of the ridge.

In dry spells the temptation may arise to level off the ridges with a disc harrow, but this should not be done because, no matter how well the ground is working, once it is left flat, a slight rainfall will pan down the surface; it is unwise to level the ridges until the ground is actually utilized.

Ridging on agricultural land is a very old practice, and although it is not usual in forest nurseries the technique described above has enabled us to carry out a considerable programme on land which when first put under tree crops appeared hopelessly unworkable in all but ideal weather.

SEEDBED ROOT PRUNING MACHINES

By R. FAULKNER

District Officer, Research Branch

Three machines for root pruning seedlings while still in the beds have recently been constructed to the designs of members of the staff. The performances of these machines, which were evolved independently, were tested under similar working conditions at Newton Nursery in September, 1952.

The machines tested were:—

(1) The Blair Atholl Sledge-type Root Pruner.

(2) The Blackstand Oscillating-type Root Pruner.

(3) The Ledmore Twin-Blade Root Pruner.

Short descriptions of these machines and the results of the trial are given below.

Descriptions of the Machines

(1) *The 'Blair Atholl' Sledge-type Root Pruner*

This machine was produced at Blair Atholl Engineering depot for the Research Branch and was made primarily for precise root pruning experiments. Its design is based on suggestions by Messrs. Faulkner, Blane (Mechanical Engineer, Scotland), Rose (Forester, Ledmore Nursery) and Johnstone (Blair Atholl).

The body of the machine consists of two short steel runners, made from an old car chassis and set 3 feet 9 inches apart (to run in the alleys separating seedbeds). A thin 1½-inch wide 'Vee'-shaped blade, set in a horizontal position, with the point of the 'Vee' facing the direction of pull, forms the cutting device. This blade can easily be adjusted to control the depth of cutting. A vertical prowed-blade is welded on to the point of the 'Vee'-shaped blade to give support to the latter. The pruner is fitted with three lifting points which enable it to be fixed to the hydraulic lift on the standard Ferguson tractor.

(2) *The 'Blackstand' Oscillating-type of Root Pruner*

This pruner was made at Blackstand Engineering depot for Conservator, North Scotland, for use in nurseries on the Black Isle. Its design is based on suggestion by Mr. Dickson (State Forest Officer, North Scotland) and his staff, and Mr. R. Ross (Assistant Engineer, North Scotland).

The machine comprises a horizontal blade approximately 3 inches wide, mounted immediately behind a Ferguson tractor. In operation the blade oscillates from side to side (approximately 1 inch) by means of an eccentric and crank fitted to the power 'take-off' connection at the back of the tractor. Two small plough breasts can be fitted to the sides of the pruner to prevent the sides of the beds collapsing when the pruner blade is oscillating. A hollow metal roller above the blade can be set to run approximately 3 to 9 inches behind the blade. The height setting of the roller above the blade governs the depth of pruning and also re-compacts the bed. The pruner is attached to the hydraulic lift of the tractor.

(3) *The 'Ledmore' Twin-Blade Root Pruner*

This type of under-cutter was designed by Forester Rose of Ledmore Nursery and made by a local blacksmith. It is designed to root prune three-foot wide drill-sown seedbeds.

The machine consists of a tractor tool-bar fitted to the hydraulic lift of a Ferguson tractor. To the tool-bar are attached two cutting units spaced 3 feet apart, each consisting of a vertical steel member 4 to 5 inches wide, sharpened on its leading edge; these units are preceded by discs which in operation cut into the seedbed alleys and so provide an easier passage for the members. Welded to the base of the vertical member is a blade 1 foot 6 inches long, which tapers away from 4 to 5 inches at the edge of the alley to $\frac{3}{4}$ inch in the centre of the bed. The cutting edge is directed backwards at an angle of 40 to 45 degrees. At the moment, depth control is by means of the hydraulic lift, but it is intended to fit small balloon tyres (bomb carrier type, size 4×9 inches) to the pruner, and also a winding mechanism for controlling the depth of cutting.

The subject of the Test

The machines were tested on beds of rising 1+0 broadcast sown Scots pine seedlings on a sandy loam type of soil in a moist condition. Alley depth was approximately 2 inches. The beds had not been covered with grit.

Result of Tests: See Summary Table overleaf.

Conclusions:

The trials indicate that root pruning machines capable of doing satisfactory work under suitable nursery conditions are practicable, and that with some slight modification the 'Blair Atholl' or 'Ledmore' types should prove themselves to be suitable in the majority of nurseries. The limitations of the Blackstand machine are such that it can only be used on one-year-old seedbeds, but even so it could be used to advantage after modifications to the roller have been made.

SUMMARY OF RESULTS OF TESTS OF SEEDBED ROOT PRUNERS. Newton Nursery, September, 1952.

Factor	Blair Atholl Type	Blackstand Type	Ledmore Type
(1) Efficiency of cutting	Satisfactory	Satisfactory	Satisfactory
(2) Type of stock for which suitable	1 + 0 and 2 + 0 seedlings of conifers and hardwoods in all stages of development	1+0 seedlings of most conifers only. Tall seedlings, 2+0 seedlings and hardwoods, and seedlings with lammas extensions are liable to severe damage by the roller	1 + 0 and 2 + 0 seedlings of conifers and hardwoods in all stages of development
(3) Suitability for drill sown beds	Suitable	Suitable	Suitable
(4) Suitability for broadcast sown beds	If beds are sown less dense than normal, then the pruner is suitable without modification. Alteration to the design of the central vertical prow is required to reduce the present slight damage caused in operation, this should not be difficult.*	Suitable	Suitable
(5) Control of depth of cutting	Very easy. An equal depth of cutting depends on having uniformly deep alleys; this depends on nursery technique. Slightly wider runners will also prevent the machine sinking in the alleys in wet conditions. This fault is not serious even now.	Very easy. Controlled by the bed surface and is independent of the alley depths.	As at present constructed this is not very satisfactory, but with the fitting of a winding mechanism it should be easy
(6) Minimum cutting depth	Depth of the alleys	Around 2 inches	Around 2 inches (i.e. when proposed new attachments are fitted)
(7) Condition of the bed after pruning	Soil well loosened; this possibly gives some benefit by breaking soil crust and admitting oxygen. Shown in 1952 by Research Branch not to be detrimental	Recompacted by roller, but under the conditions at Newton the roller tended to skid slightly, leaving open wedge shaped cracks extending 1″–1½″ into the soil	As for Blair Atholl type.

Factor	Blair Atholl Type	Blackstand Type	Ledmore Type
(8) Appearance of seedlings after pruning	Excellent	Bent over and partially compressed into the soil by the roller. Although the plants will probably recover, the treatment received from the roller cannot have helped them. On grit-covered beds the grit would undoubtedly cut the seedling badly above the root collar	Excellent
(9) Performance on stony soils (from previous reports)	Satisfactory	Satisfactory	Fairly satisfactory. The width of the blade near the outside of the bed causes quite a degree of soil disturbance when the blade meets a stone and forces it upwards over the blade. The effect is more pronounced when shallow root pruning is being done
(10) Cost of Maintenance	Negligible	Highest	Negligible
(11) Materials for construction	All materials easy and cheap to obtain	All materials easy and cheap to obtain	Materials easy and cheap to obtain
Design	Intermediate	Complicated	Simple

* Since the trial a highly satisfactory modification has been made.

RAISING HARDWOOD PLANTING STOCKS BY UNDERCUTTING

By A. ROSE
Forester, East Scotland

In recent years the planting of hardwoods has increased and there is a demand for large plants to compete with rank weed growth and to withstand damage by vermin.

The raising of hardwoods is expensive especially where seedlings are lifted and lined out at a wide (three inch) spacing, but this laborious and costly practice can now be reduced to a minimum, and the yield per pound of seed sown increased to a maximum by undercutting instead of transplanting. The details of this method are set out below; the actual undercutting can be done quickly and cheaply by the use of a special blade drawn behind a tractor.

(1) **Treatment—First Year.** Sowings should be carried out when seed is harvested in autumn, or in early spring, whenever soil conditions permit.

Densities should be reduced to half that shown in the normal tables. Seed may be drilled or broadcast as desired. Only normal cultural operations are required in the first year.

(2) **Treatment—Second Year.** Stocks that are not lifted as one-year seedlings for planting in the forest should be undercut in the spring of the second year to a depth of three to four inches and left to stand over in the bed. This produces a "one-undercut-one" plant, if lifted for planting in the subsequent season.

(3) **Treatment—Third Year.** Plants that require to stand over to produce larger stocks should again be undercut. This will be at a slightly greater depth than for the previous year. The more vigorous plants may be selected at this stage for *use* if required, thus gives the remaining plants more elbow-room.

(4) **Older Stocks.** Undercut each spring at progressively greater depths, as determined by inspection, and lift as required until stocks are exhausted.

Root System. When undercut in the first year, the tap root is severed and the first natural reaction of the plant is to re-establish root hold. During this process of re-establishment the *tap root,* where cut, takes the form of an "umbrella", developing a fibrous root system from soil level. With each subsequent undercut the fibrous formation is maintained and increased, producing a well balanced plant for each age group.

ERADICATION OF RHODODENDRONS

By A. D. MILLER
District Officer, Research Branch

Dense thickets of rhododendrons present a most difficult subject for afforestation and one which has not as yet received much systematic study. However, during the past twenty years a good deal of experience has been accumulated from scattered instances on the results of different methods of eradicating rhododendrons, and because the 1947 Census of Woodlands shows that this species now occupies a considerable acreage of potentially useful forest land the time appears ripe to review work already done.

A. The initial cutting and preparation for planting

i. **Hand-cutting Methods.** The costs of initial clearing and burning naturally vary with the density of the rhododendron thickets and costs ranging from £10-£50 have been recorded from different parts of the country. Where birch forms an overstorey or where the larger rhododendron stems reach 3 inches diameter, sales of firewood reduce the net costs of cutting. In South-East England, allowing for the sale of firewood, dense thickets have been cleared and burned for £15 per acre, while at Wigsley in East England, local people are allowed to cut the rhododendron and small numbers of birches to provide their own firewood, leaving the Commission to burn the tops at a cost of £5-£10 per acre; so far only 4 or 5 acres have been cleared this way.

In an attempt to reduce the initial costs of clearance, cutting in groups and strips was done at Glen Garry, North Scotland, between 1930-36 and this is described in detail in the Journal of the Forestry Commission, No. 21 of 1950. Unfortunately costs were not kept separately for each method, but the forester who supervised the work states that there was little economy in the small groups because of the difficulty of forming them; it was very much cheaper to cut strips about 30 feet wide leaving hedges of standing rhododendrons some 20 feet wide between strips; the saving from this method was due partly to the fact that only 60% of the area was cut over and partly because all the cut material was thrown on top of the standing hedges and the costs of burning were saved. There is little doubt that the standing hedges should, as regards efficiency in eradication, be less than 20 feet wide, but with this proviso the strip system promises to be useful.

ii. **Mechanical Methods of Clearance.** A number of different types of machine have been tried with varying results; some sites have proved so boggy that even tracked-tractors have been unable to operate, while on firmer ground the machinery has usually interfered with the drainage system.

Winching out whole bushes has been found to cost from £30-£46 per acre, but of course this eliminates regrowth. Bulldozing with a D4 or TD18 has cost from £12-£60 depending partly on the size and density of growth and partly on whether the debris is piled into windrows or burned. At Wigsley a grubber blade was found unsatisfactory because the teeth continually bent on old tree stumps and because the uprooted bushes carried so much soil with them. One of the important characteristics of rhododendrons is that when a normal bulldozer blade is used the stems break at about ground level leaving the roots more or less undisturbed.

The giant rotovator was found satisfactory at Wheldrake in North-East England when operating in rhododendrons up to 6 feet high; the growth was first cut at ground level then the blades were lowered so as to cultivate to a depth of 10 to 12 inches to break up the root systems. The same results in small growth were found at Ringwood in the New Forest, but in tall, dense clumps it was found better to bulldoze the stems away and then to break up the roots by rotovation; the costs of the two operations totalled £22-£30 per acre. In general it seems a mistake to rotovate the stems into the grounds as this produces a difficult planting medium.

At Cropton in North-east England, in small growth, hand cutting was followed by R.L.R. ploughing which effectively uprooted all the main root stocks; apart from the disruption of drains this combination was considered very satisfactory and the total cost was £12 per acre.

B. Weeding

Following hand cutting and burning the rhododendron stumps make new shoots about 15 to 20 inches each year for several years, and annual weedings costing £2-£4 per acre are necessary until the planted crop is well on top of the regrowth; it has seldom been necessary to weed twice in one season.

One effect of mechanical treatments, even a single bulldozing, is to bruise the root systems so severely that regrowth is very much less vigorous. At Ringwood, parts of the areas bulldozed once would have needed a light weeding during the first season, but those areas given more than one mechanical treatment would have needed no attention for at least one season after planting, and the very scattered regrowth which developed during the second season would scarcely have needed cutting back.

However, it was noticed during the second growing season after mechanical clearance that broken pieces of root and shoot buried by the machinery were starting to produce new root and shoot systems, and there can be little doubt that in a relatively short time the rhododendron regrowth will become dense. Nevertheless on such infertile sands mechanical clearance does give two seasons during which little or no weeding is necessary, and probably two more before the regrowth becomes really dense. On fertile soils, however, the regrowth usually becomes quite vigorous during the second season and a profusion of herbaceous weeds quickly becomes established.

At Benmore and Carradale in West Scotland maiden plants of considerable size were totally eradicated by pulling them out by hand.

C. The Choice of Tree Species

The choice of a crop species which will cast a very heavy shade is essential if regrowth from the stumps, or invasion by seedlings, is to be prevented. Many sites on which rhododendrons are rampant are well suited to Scots or Corsican pine but rhododendrons thrive under the relatively light shade cast by these species and costs up to £20 an acre have been incurred in cutting the rhododendron to give access to pine plantations which needed thinning. It is almost always possible to find a species suited to the site which will cast a shade heavy enough to kill rhododendrons, and unless the rhododendrons are completely eradicated before planting, say by removing or poisoning the root systems, the use of species casting only a light shade seems certain to bring trouble later.

Sitka spruce is rather more effective in suppressing rhododendrons but at Crynant in South Wales and at Quantocks in South-west England, weeding Sitka spruce plantations stopped too early, rhododendrons were able to get into the canopy and survived the thicket stage; considerable expense was necessary to clean these areas and now that the spruce has reached the thinning stage it is in places doubtful whether its canopy will entirely kill all the stools. Thus it is not sufficient to weed until the trees are free from danger of suppression but weeding should be continued until the crowns are forming canopy over the rhododendrons.

Tsuga, *Abies grandis* and *Pinus radiata* promise a complete kill of rhododendrons and Douglas fir has achieved it in several places, notably Quantocks and Glen Garry. The shade cast by Douglas fir is, in fact, so dense that in the P.30-P.36 strips and groups at Glen Garry not only has the regrowth been entirely suppressed, but where not more than about 12 feet of uncut rhododendrons separated adjacent groups or strips, the Douglas fir has already closed canopy over the intervening hedges of rhododendron and has killed them. Thus the strip system followed by planting a heavy-shade-casting species appears to have many advantages and should be considered seriously on new areas.

D. The Use of Plant Poisons

Our knowledge of the effects of plant poisons on rhododendrons is by no means complete, but it is already sufficient to show that this species does not succumb at all easily.

We are quite unable to kill large areas of standing thickets; various types of mist generators have been designed for agricultural uses, but these have not been tested on rhododendrons.

There are two possible methods of applying poisons after the thicket growth has been cleared, first by application to the cut stumps, and secondly by spraying the foliage of young regrowth preferably during the first season after clearance. Application to cut stumps is possible only after hand cutting, as mechanical clearance disturbs the soil and conceals many of the stumps.

At Ringwood the growth substances 2,4-D and 2,4,5-T were not effective when sprayed on to regrowth early in the first season but very high concentrations of sodium T.C.A., ammonium sulphamate, and sodium arsenite killed back practically the whole of the aerial growth; however, even from these stools new and fairly vigorous shoots appeared during the second season showing that the poison had not been properly translocated throughout the root systems which were obviously still alive. Moreover the broken and buried pieces of root and shoot mentioned under B. were not making new shoots during the first season and thus received no poison, so that even a successful spray which killed the roots bearing the first year's regrowth would not have eliminated rhododendrons from the site. These results combined with the practical difficulties of hauling into the forest and applying from 100-300 gallons per acre make it impossible to recommend any of the materials available at the present time to be applied as foliage sprays.

At Bramshill, however, very large doses of ammonium sulphamate applied to the stumps immediately after hand cutting appears to have killed the entire root systems, though 2,4-D, 2,4,5-T, and sodium arsenite applied in the same way were not effective. Watering the cut stumps with a solution of sodium chlorate was tried in North Wales and was found to weaken appreciably the vigour of the first year's regrowth; however the root systems are still alive and during the second season after application it seemed doubtful whether there was any deterrent effect on rhododendron growth. However, the effects of different concentrations of this substance were not tested.

NATURAL REGENERATION AT 1,200 FEET ABOVE SEA LEVEL AT GLASFYNYDD FOREST

By F. H. DAVIES
Ex-School Ganger, South Wales

Glasfynydd Forest lies on the borders between Breconshire and Carmarthenshire on the flanks of the towering mass of the Carmarthen Van (2,632 ft.). The area is bleak, mountainous, exposed and windswept. Some shelter is afforded to the south-west and west by surrounding hills and by the Van, but the north and east sides are fully exposed. Rainfall is heavy, between 80 and 90 inches a year. During January and February snow lies for prolonged periods when neighbouring country is clear. The forest ranges in altitude from 1,000 ft. to 1,793 ft. above sea level.

The main rock of the forest area is Old Red Sandstone. On the west it merges into Llandovery Shales, whilst to the south it bounds on the Carboniferous Limestone and Millstone Grit. As a whole drainage is difficult owing to large areas of rock quite close to the surface, heavy blue and yellow clays, and also pan formations. Peat is also found in considerable quantities ranging from an inch or so to several feet.

This article deals with the considerable natural regeneration of three coniferous species:—Scots pine, European larch and Sitka spruce, and also a prolific regeneration of rowan, birch, goat willow and sycamore.

Compartment 48 lies at an altitude of 1,200 ft. with a south-west aspect and an area of 18 acres. Apart from a small boggy patch, ¼ of an acre, there is a good depth of mineral soil (Old Red Sandstone) with pan in places at 8 inches. Vegetation consists of *Calluna*, *Potentilla*, *Molinia*, *Ulex*, *Vaccinium*, *Hypnum* species, *Polytrichum*, *Galium saxatile*, *Agrostis canina*.

Originally Sitka spruce was planted on ploughed ground in F.Y.1939, with a fire belt of Japanese larch around the eastern and southern boundaries. To the east are the remnants of an old shelterbelt of Scots pine and European larch planted some 80 years ago by a previous owner named MacTurk. From this old shelterbelt has sprung up amidst the Sitka a remarkable natural growth of Scots pine, up to a depth of 150 yards from the shelterbelt. The young Scots pines are vigorous, the majority being clean, straight and finely branched, and ranging in height from 1½ to 23 ft. Mixed amongst these are a few sycamore and European larch.

The area known locally as Bryn Du lies at an elevation of 1,289 feet. Here in Compartment 6 we find the remains of an old shelterbelt planted by MacTurk. In this area generally, the mineral soil, chiefly Old Red Sandstone and clay, lies close to the surface with little peat. Bryn Du is fully exposed to north and east. Vegetation consists of *Molinia*, *Calluna*, *Agrostis*, *Aira* species, some finer grasses, *Vaccinium*, *Galium*, *Digitalis*, *Asplenium filix-foemina*, *Aspidium filix-mas*, *Juncus*, *Polytrichum*, *Hypnum*.

The shelterbelt has been thinned by the Commission, the remaining Scots pine and European larch being spaced some 20 feet apart. Beneath these older trees over an area of about 1½ acres has sprung up a healthy growth of European larch, Scots pine, and rowan. The European larch are clean, straight and free of canker, and range in height from 1½ to 36 feet. Some Japanese larch and Norway spruce have been planted to fill gaps in the natural growth and the whole underplanted with beech.

Compartment 3 nearby, which was planted with Sitka spruce in 1929, has been partially thinned, and to help extraction every tenth row has been cut out. In these tenth rows, on peat and undecomposed needles, have sprung up a large number of Sitka seedlings, and in the mineral soils of the drains along the adjacent rides quite a number of Sitka seedlings have appeared. The seedlings are healthy and up to 4 inches in height at 2 years old. I have counted from 15 to 18 seedlings on a square yard.

Glasfynydd is fortunate in being free of rabbits. Mountain hares are present and recently grey squirrels have been observed. Apart from these, pests are few.

The natural regeneration appearing on such exposed areas is interesting particularly when one recalls that the Sitka seedlings are from trees planted only 23 to 25 years ago.

A GRAZING EXPERIMENT IN REDESDALE FOREST

By W. L. McCAVISH

Forester, North-East England

I have had the opportunity as forester to observe the advantages and disadvantages of grazing cattle in coniferous plantations, with the aim of decreasing fire risk. An experiment of this nature was carried out at Redesdale during F.Y.50 and 51, and I trust that my views on the results, and on possible future lines of development may be of interest.

In the majority of cases grazing was allowed in areas where the crop was about sixteen years old, being planted between the years 1934 to 1939. The species planted were 50 per cent. Sitka spruce, 30 per cent. Norway spruce, 10 per cent. Scots pine and 10 per cent. European larch and Japanese larch. The latter three species were, in the majority of cases, brashed between F.Y.49 and 50. The ground vegetation is mainly *Molinia* with patches of *Calluna* throughout.

From my observations, I would say that grazing cattle in areas of this age where the majority of the crop is spruce at the stage when the lateral branches are beginning to form canopy, yet were not sufficiently advanced to brash, showed that the disadvantages outweigh the advantages from the point of view of lessening the fire risk. The disadvantages seem to be:

1. The cattle would not penetrate into the compartments, and grazed solely upon the rides, which in view of the age of the crop did not contribute to lessening the fire risk, as a fire would cross a ride in a crop of this age, whether grazed, or ungrazed.
2. Owing to the cattle keeping continuously to the rides, wet parts had a tendency to become puddled, and one puddled area in a ride might mean that a wheeled vehicle towing a trailer pump would get bogged, and the loss of time in getting to the fire would be serious.
3. Ride-side drains tended to get trodden in, and this contributed to making parts of the rides boggy, due to overflowing. This means extra work in keeping drains open.
4. In areas of this age, the collection of the cattle permitted to graze is difficult, and the farmer may have to visit the area three or four times before getting all the cattle rounded up.

On the other hand the cattle throve immensely during the period they grazed in the forest, which was from mid-May to early November. The number of cattle per 200 acres averaged thirty-six.

I am in no way against grazing of the forests, and I venture to suggest that this experiment could be carried out to greater advantage.

It was noticeable that the cattle grazed in any small areas where the crop allowed them to penetrate, such as checked areas, and that no damage to the trees was noticeable, due, no doubt, to the amount of ground vegetation available.

My opinion is that the advantages would outweigh the disadvantages if we graze our forests in cycles, commencing to graze in areas where the crops have become established, say five years after planting; grazing would be allowed for four years, by which time the crop would be closing in, and grazing would be of no further use from a fire protection point of view.

From then on, each year an area can be added to or taken off the cycle, providing that the planting programme is still being continued.

In many cases areas can be brought back into the cycle after thinning has been carried out, for example in areas planted with Scots pine, European or Japanese larch, etc., and possibly other light demanders, as a certain amount of vegetation is found under the canopy.

The advantages of regulating grazing in this manner would be:

1. Cattle could graze throughout the compartment, thereby diminishing the spreading powers of the fire and possibly limiting it to a ground fire. Where the areas are too large for the number of beasts available to keep down the grass sufficiently to prove effective, an electric fence could be used to restrict them to an area where their grazing would give the best results from our point of view.
2. For the greater part of the grazing area the cattle would be easily seen and easily collected by the farmer.
3. Strip grazing could be carried out with the aid of the electric fence, thereby dividing the area into blocks, and doing away with auto-scything. This method I feel sure would be the more effective, but it would need a bit more planning, and the electric fence would need adjusting periodically, to increase or decrease the intensity of grazing.

In conclusion, arrangements on these lines would nullify the argument of the farmers, that the Forestry Commission are doing away with good grazing for the sake of planting trees. I can quite understand why the particular farmers who had the grazing of our areas had extremely happy countenances during round-up time in November, as I myself witnessed the carcasses of skin and bone, which were placed to graze upon the area in May, come out of the forest in November as cattle which would bring in the finest fat stock prices.

A HYBRID LARCH STAND AT STAINDALE, ALLERSTON FOREST

By J. M. MARTINDALE
Forester, North-East England

There is an interesting stand of 16.2 acres of Japanese larch at High Staindale in Allerston Forest, Yorkshire. Unfortunately, little is known of the origin of the seed from which this stand has been grown; but there is reason to believe that the transplants came from Dunkeld in Scotland as one-plus-one stock. They were planted in the spring of 1927, at a spacing of $5\frac{1}{2} \times 5\frac{1}{2}$ feet as a stop-gap, as the desired species, presumably European or Japanese larch, was not available. The ground slopes steeply, approximately 35-40 degrees, with a south-easterly aspect; elevation varies from 525 to 675 feet. The soil is a moist, naturally drained, sandy loam, derived from calcareous grit and Oxford clay of the middle oolite (Jurassic). Planting was done with mattocks, one-foot squares being screefed before planting in a single notch.

The trees were weeded annually for the first five years; the vegetation consisted mainly of bracken and heather—about two-thirds bracken to one-third heather on the upper part of the slope. Limited beating up was done on the top half of the slope only, using Scots pine; several of which can still be seen in a suppressed state. No cleaning was necessary and the stand was brashed with slashers just before the first thinning.

The first thinning was done in 1943 (13.6 acres) and 1944 (2.6 acres) and yielded 3,877 hoppus feet—approximately 240 hoppus feet per acre. A second thinning was carried out in 1949, after an interval of five to six years, and yielded 6,112 hoppus feet (approximately 380 hoppus feet per acre, being an increase on first thinning of 140 hoppus feet per acre.) The third thinning was completed in 1952, and the yield over 15.6 acres was 7,292 cubic feet. The yield per acre over the 15.6 acres was 467 hoppus feet; this includes all the thinnings of less vigorous growth from on and above the 650 foot contour. Four one-tenth acre sample plots were started, placed at random, more or less halfway up the slope; the average yield per acre over these four plots was 585 hoppus feet. The present stocking, after the third thinning is 300 stems per acre; average quarter-girth at breast height, 5½ inches. Upper height is 50 feet and average height 43 feet; average mid-quarter girth is 4 inches and average length of marketable produce 37 feet. Approximate volume left standing per acre equals 1,200 hoppus feet at an age of 25 years. (All measurements are over bark, and poles were measured out to 2 inch tops).

The third thinning was a rather heavy one, aimed at isolating the crowns of the trees (Grade "D"). The quality of this stand is very pleasing, as some 95 per cent of the present standing trees are clean, straight and with only a small taper.

A MODERN APPROACH TO THINNING PRACTICE

By W. H. GUILLEBAUD

Deputy Director-General

In a recent article in the *Allgemeine Forst und Jagdzeitung* (Vol. 123, 1952, No. 6) E. Wohlfarth of Neustadt in the Black Forest reviews the history of thinning theories over the past 160 years. The first recorded pronouncement on the subject is ascribed to G. L. Hartig in 1791, but in those early days the term was more or less restricted to the process of removing, for purposes of sale or otherwise, those weakly, suppressed, and dead and dying stems which could be profitably utilised. It was only gradually that the idea of thinning for the benefit of the remaining trees in the crop developed, and for a time at least the operation was only considered necessary where the trees were very thick on the ground.

Wohlfarth states that in the past 100 years at least 40 different thinning systems or techniques have been produced, not one of which, however, has yet found its way into general use over large areas or found acceptance both in forestry science and among practising foresters. But he draws attention to the way in which the views on thinning have gradually been changing and traces three main lines of development.

1. The focus of attention is passing from the trees to be removed in the thinning to the trees that are to remain. In other words foresters are less concerned with defining the stem classes (co-dominants, sub-dominants and the like) which ought to be removed and are thinking more in terms of thinning as an operation for the betterment of the remaining crop.
2. There is less concern now as to the precise grade or intensity of thinning to be prescribed. Instead the handling of the elite trees in the stand comes into the forefront.

3. Lastly there is now a widespread recognition of the truth that the all-important thinnings are the earliest ones, i.e. those which take place during the first two to three decades of the life of the crop.

I do not propose to weary readers of this Journal with the details of the various thinning systems which Wohlfarth describes, but to proceed at once to the last part of his article where he sets out, in what seems a rather fresh and illuminating way, what he regards as the main object of that continuous process of tending to which we British foresters apply the two terms 'cleaning' and 'thinning'.

The following stages are distinguished:

1. **The Pre-canopy Stage.** (Cleaning)

Primary Object Control of composition of mixed crops.

Secondary Objects Singling out over-dense groups; cutting out undesirable advance growth, pruning valuable hardwoods, singling leaders, etc.

Notes. In most cases of natural regeneration, and wherever a mixture of species is planted, this is one of the most crucial operations in the whole series, because it gives the forester what may be his only opportunity of preserving a desirable mixture. Neglect at this stage can seldom be rectified later. The operation will cost a lot of money and as a rule give no return, so it should only be undertaken where there are very good reasons for wanting to preserve the composition of a mixture, or, in other cases, e.g. invasion by shrubby weed species, or Pine Shoot Beetle damage to pine, where it seems certain that the objects of management cannot be secured without this early intervention.

2. **The Thicket and Small Pole Stage.** (First and perhaps second thinning)

Primary Object Collective care of all well-formed desirable stems. The slogan must be: 'Get rid of the rubbish'.

Secondary Objects Preservation of mixture, singling out of dense groups, pruning, etc.

Notes. At this stage attention is almost exclusively concentrated on the removal of the bad trees in the crop, especially trees of the wolf type, whips etc.

3. **The Pole Stage.**

Primary Object Selection and encouragement of the best stems which are to go to make the final crop.

Secondary Objects Such treatment of the subsidiary (filling-in) members of the crop as is desirable for the proper development of the final crop trees; maintenance of the mixture; removal of backward trees; thinning out over-dense groups; pruning.

Notes. There is a complete change of emphasis. Attention is now directed primarily to the selection of a relatively small number of evenly spaced trees which are to form the final crop. These must be freed from threatening competitors before anything else is done.

4. **The Semi-Mature Stage**

Primary Object The crown development of the selected final crop trees.

Secondary Objects Removal of the inferior trees; maintenance of the stocking of the stand as a whole at the desirable density; if necessary under-planting.

Notes. The trees which are to form the final crop are now clearly differentiated from the remainder of the stand and it is a case of giving the selected trees progressively more room for crown development.

There are several points of interest in the above statement of thinning principles, which incidentally is a very free and somewhat amplified version of the relevant section of Wohlfarth's article. Firstly, the division of the life of a crop into four stages, and, secondly, at each of these stages a *Primary Object* is distinguished which gives the key as it were to the operation, while the other matters which have also to be borne in mind are relegated to a secondary place.

It will also be noted that, following the modern trend of forestry thought, no reference whatever is made to the usual sociological classification of the trees (dominants, co-dominants, etc.) which bulks so largely in most technical discussions on thinning.

Finally, it should be remembered that Wohlfarth is a forester working in the Black Forest where naturally regenerated crops are the rule, hence perhaps the stress laid on the importance of the pre-canopy stage.

SMALLWOOD FROM CONIFER THINNINGS

By J. M. CHRISTIE

Forester, Research Branch

In Great Britain there are now large areas of coniferous plantations in both Commission and Private Woodlands reaching the stage where a first thinning is necessary. While there is usually a ready sale for all produce suitable for pitwood, concern has been expressed over finding suitable markets for material that is too small or crooked to go to the mines. There has been a very limited demand for this produce in the past, and, although it is utilized in some areas for such purposes as rustic work and boardmill material, a large proportion of the potential production is still wasted. In these early thinnings "smallwood" between three inches and 1½ inches over-bark diameter usually accounts for about one-quarter to one-third of the total thinning volume, and in very small trees, with a breast height quarter girth of 2¼ inches or less, it may contain the whole volume. Where girths are small it is found in lengths up to twenty feet and in some cases more, but for larger girths the length of "smallwood" seldom exceeds ten feet.

The creation of new markets for boardmill material and pulpwood depends very largely on a knowledge of the amount of timber that can be made available annually over a long period of years. The object of this note is to give some data which may help in making estimates of the potential supplies of produce of from three inches down to 1½ inches over-bark diameter, which might become available from coniferous thinnings for use in pulp and board mills.

More than 500,000 trees were measured in approximately 1,800 one-tenth and one-twentieth acre sample plots, representing returns from all conservancies in England, Scotland and Wales, and coming from 125 separate forests. These plots were laid down in plantations as they reached the thinning stage. The first of these was established in 1948. The plots were more or less evenly spaced over each area to be thinned and the sampling intensities were usually as follows:—

In blocks of from 1-10 acres—2 plots.
10-20 acres—4 plots.
20 acres and over—6 plots.

Any obvious differences in the rate of growth or stocking within a block were sampled separately. Fifty per cent. of the sample plots used in this estimate were measured in first thinnings, 29 per cent. in second thinnings and 20 per cent. in third and subsequent thinnings, thus the data adequately cover the field of all early thinnings. The thinnings were measured by produce classes as outlined below:—

1. *Timber*, with an over-bark top diameter of nine inches, and a minimum length of ten feet.

2. *Pitwood*, all reasonably straight lengths below timber size, measured down to an over-bark top diameter of three inches.

3. "*Smallwood*", from three inches to 1½ inches top diameter over bark, the minimum length to be six feet.

4. *Firewood*, any wood that owing to its bad shape is unsuitable for other use. Minimum top diameter 1½ inches over bark.

In the present study only "smallwood" is being considered.

It was early suspected that the volume of "smallwood" per tree varied little with species, and moreover did not vary significantly between either height or girth classes, and that a fairly reliable estimate of "smallwood" volume in any one thinning could be made by multiplying the number of poles by a constant factor. This has proved to be the case and the results are summarised in Table 1.

AVERAGE VOLUME OF "SMALLWOOD" PER POLE

Table 1

Volumes in hoppus feet, over bark.

	Main-crop Top-height Class*					
	20 feet	30 feet	40 feet	50 feet	60 feet	Average for all Height Classes. 20 to 60 ft.
Scots Pine	0.22 *17,128*	0.30 *110,971*	0.34 *23,950*	0.27 *1,610*	0.05 *150*	0.30 *153,809*
Corsican Pine	0.25 *10,780*	0.25 *24,864*	0.27 *16,120*	0.32 *2,748*	0.30 *330*	0.26 *54,842*
European Larch	0.21 *3,240*	0.28 *21,590*	0.36 *12,740*	0.34 *1,700*	0.23 *270*	0.30 *39,540*
Japanese Larch	0.16 *3,140*	0.25 *48,875*	0.29 *32,190*	0.24 *7,500*	0.27 *930*	0.26 *92,635*
Norway Spruce	0.20 *3,268*	0.24 *14,981*	0.28 *9,360*	0.31 *2,920*	0.29 *500*	0.25 *31,029*
Sitka Spruce	0.24 *1,640*	0.21 *24,538*	0.24 *22,419*	0.29 *10,590*	0.34 *5,980*	0.24 *65,167*
Douglas Fir	0.20 *1,980*	0.28 *15,215*	0.26 *37,180*	0.31 *26,522*	0.28 *1,985*	0.28 *82,882*
Total	0.22 *41,176*	0.27 *261,034*	0.29 *153,959*	0.30 *53,590*	0.31 *10,145*	0.28 *519,904*

Note.—Figures in italics are the actual number of trees used to obtain each average. *The main crop top-height is the estimated height of the 100 largest-girthed trees per acre, omitting any trees to be removed in the current thinning.

The range of volumes was found to vary from almost nil to just over one hoppus foot per pole, but Table 1 suggests that 0.28 hoppus feet over bark, is a reasonable estimate of the *average* "smallwood" volume per tree for all species and height classes for which data were available. A calculation of standard errors was made and these show that the true mean is likely to lie between 0.26 and 0.30 hoppus feet over bark. "Top height" in this article is used to denote the average height of the 100 largest-girthed trees per acre.

From this same investigation the average number of trees removed per acre at each thinning in Forestry Commission woods was obtained, and the results are given in Table 2.

AVERAGE NUMBER OF TREES REMOVED PER ACRE AT EACH THINNING

Table 2.

	Top-height Class					
	20 feet	30 feet	40 feet	50 feet	60 feet and over	Average for all Height Classes 20 to 60 ft.
Scots Pine	357 (100-1,120)	356 (60-1,180)	311 (20-760)	95 (60-200)	30 (10-40)	337 (10-1,180)
Corsican Pine	359 (160-620)	408 (60-830)	336 (120-680)	162 (80-280)	55 (20-80)	338 (20-830)
European Larch	295 (120-590)	280 (60-860)	255 (60-700)	189 (80-470)	68 (40-120)	262 (40-860)
Japanese Larch	262 (140-460)	335 (20-700)	235 (20-680)	170 (20-400)	133 (60-230)	267 (20-680)
Norway Spruce	409 (200-680)	361 (40-900)	292 (80-660)	365 (240-500)	250 (220-330)	342 (40-900)
Sitka Spruce	328 (285-380)	315 (60-880)	325 (100-810)	241 (60-620)	193 (60-560)	287 (60-880)
Douglas Fir	248 (120-340)	262 (50-540)	264 (80-640)	204 (20-460)	153 (50-320)	236 (20-640)
Average for all species listed above	338 (100-1,120)	337 (20-1,180)	278 (20-810)	199 (20-620)	150 (10-560)	292 (10-1,180)

Note: Figures in brackets show the extremes recorded.

This table indicates that the average number of poles removed in any one thinning decreases from about 300 to 400 per acre when the top height of the crop is 20 to 30 feet, to about 100 to 150 per acre when the top height reaches 60 feet. The range figures in brackets indicates the great variations that occur in practice within any one species and height class, because of the different local conditions prevailing in the various forests.

Table 3, which has been calculated from the figures given in Tables 1 and 2, shows the average thinning yield per acre of "smallwood" by species and height classes.

AVERAGE VOLUME OF "SMALLWOOD" PER ACRE

Table 3. Volumes in hoppus feet over bark.

	Top-Height Class					
	20 feet	30 feet	40 feet	50 feet	60 feet	Average for all Height classes 20 to 60 feet
Scots Pine	79	107	106	26	—	100
Corsican Pine	90	102	91	52	17	88
European Larch	62	78	92	64	16	79
Japanese Larch	42	84	68	41	36	70
Norway Spruce	82	87	82	113	72	86
Sitka Spruce	79	66	78	70	66	69
Douglas Fir	50	73	69	63	43	66
Average for all species listed above	74	91	81	60	46	82

From this table it will be observed that in most species the volume of "smallwood" per acre removed in one thinning operation is greatest when the top height of the crop is from 30 to 40 feet, the average yield being from 80 to 90 hoppus feet over bark. In these height classes the pines show the greatest production at about 100 hoppus feet over bark per acre. In the pines and larches when the top height of the stand exceeds 40 feet there is a marked drop in the yield of "smallwood", but in the spruces and Douglas fir a considerable yield of "smallwood" is maintained up to a top height of 60 feet or more and in Norway spruce peak production is not reached until the top height of the crop is 50 feet when an average yield of over 110 hoppus feet of smallwood is attained.

The foregoing tables may be of some assistance in estimating the potential production of small-sized coniferous material for use in pulp and board mills, but it must be remembered that the figures given are averages from a considerable number of forests scattered throughout the country, and the output in any particular region or forest may differ considerably from these averages.

The writer wishes to acknowledge the help and advice of Messrs. F. C. Hummel, E. G. Richards and H. L. Edlin in the preparation of this paper.

Summary

A difficulty which faces many woodland owners is the disposal, particularly from early thinnings, of "smallwood", i.e. that part of the tree which is from 3 to 1½ inches in top diameter over bark. From a first thinning this may amount to as much as one third of the total thinning volume. Hitherto, much of this material has been wasted, but there is a growing demand for it for paper pulp and building board, and how far this market can be developed appears to depend very largely on the possibility of framing accurate estimates of the amount of "smallwood" likely to be available over a long term of years.

This article, based on a large number of measurements, shows that the "smallwood" part of the tree has a more or less constant average volume of a quarter of a hoppus foot over bark, and that for the range of data covered by the paper the average volume of smallwood removed per acre in one thinning

operation in young plantations is about 80 hoppus feet over bark. The tables given are averages from a considerable number of forests scattered throughout the country and may be of assistance in estimating the possible yield of "small-wood" from any particular estate or forest.

(*This article was published in the Quarterly Journal of Forestry, October,* 1952, *and is reproduced here on account of its general interest—Editor.*)

LIGHTNING AND FOREST FIRES AT ROSEDALE FOREST

By B. J. ALLISON
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On the 17th May, 1952, a fire occurred on the Cropton beat of Rosedale Forest which was in one respect exceptional in Forestry Commission history and has other points of general interest. It was caused by lightning.

The weather for the previous fortnight had been dry and exceptionally warm for the time of year; on this Saturday at about 3 p.m. a heavy electrical storm swept over the moors from the north-east. At Saltersgate, between Allerston and Rosedale Forests, lighting struck a man ploughing his fields on a tractor and killed him. His two small sons who were riding on the tractor with him were unscathed; the tractor continued running.

At 3.26 p.m. the lightning struck the centre of the planted area on the flat moorland at about 700 feet elevation and set fire to an area of mixed Scots pine and Sitka spruce (P.38), which had reached the thicket stage. The Sitka spruce had in places outgrown the Scots pine nurse, and the long leading shoots of the past two seasons were stretching skywards above the general canopy like spires. The crop in the compartment was somewhat uneven with considerable heather and *Molinia* grass still present in the undergrowth.

The lightning strike in the forest was unaccompanied by rain, and was observed by ex-school ganger R. Bell who, with a fire patrol, was on duty in Banks Nursery on the southern edge of the moor. In the nursery itself, and indeed southwards in the Vale of Pickering, the electrical storm was accompanied by a tropical downpour, so much so that while smoke was curling up from the forest two miles to the north, soil was being washed off the nursery by rain.

The alarm was given both from the nursery and from an observation post at Muffles Head Farm a mile to the east of the fire, where an observer also saw the strike followed immediately by a column of smoke. The general alarm was given to the Fire Brigade and to District Officer E. M. Conder, of the neighbouring Allerston District, by Forester Frank at 3.29 p.m., three minutes after the lightning had struck.

At 4 p.m., when Ganger R. Bell and his men arrived, the fire was burning fiercely in the centre of the compartment, and was then about five acres in extent. There was little wind, and the fire was spreading outwards in all directions almost equally. Simultaneously with Ganger Bell, the Pickering Fire Brigade with one tender arrived. At 4.20 p.m. District Officer Conder reached the fire and immediately called out a lorry load of troops from the Brigade of Guards Training Depot at Pickering, whom he had alerted on his way to the fire.

In the next thirty minutes, tenders from two more Fire Brigades arrived, and also two mobile dam units from Allerston Forest. By this time the fire had increased to twenty acres and had crossed a heather ride into the next compartment to the north, into a P.42 crop of pine and Sitka spruce, where there was much heather. It was being held on the south on a narrow bulldozed track which formed the compartment boundary, about ten feet wide, and here it was held till the finish. The crop across this ride was P.38, similar to the plantation burnt, and it was a remarkable effort to hold it at this ride as the branches were almost meeting over the ride.

There is no water on these moorlands and tenders had to travel about a mile to the reservoir near the forester's house to refill. It was fortunate that a metalled road had been completed in F.Y.51 running right through the forest, this road actually forming the north-western boundary of the compartment.

At 6.15 p.m. a detachment of 43 Guardsmen arrived with their officers and N.C.O.s and the fire, then about 33 acres, was virtually brought under control, although still burning very fiercely. It was finally extinguished at 7.45 p.m. at 35 acres. The full complement of men and machines fighting the fire in its final stages were:

84 men

3 Fire Brigades with tenders

2 Forestry Commission mobile dam units

1 tractor and trailer fitted with water tank.

The main points of interest in the fire were as follows:—

(i) The cause was undoubtedly lightning.

(ii) The fire was held throughout on its most dangerous flank on a ten-foot bulldozed track. A fire-proof break of this width *can* be effective even in thicket-stage plantations if held resolutely.

(iii) The mobile dam unit with one-inch hose and carrying 450 gallons of water, remained in action for 50 minutes. The Fire Brigade Tenders with four-inch hose were in action for only 15-20 minutes before having to go to refill, and even their powerful jets failed to check the fire in the eight to twelve-foot thicket. The heavy hose was difficult to manoeuvre in among the trees.

(iv) The mobile dam units with one-inch hose concentrating on rides and the younger plantations were very effective and enabled the beaters to control the fire.

(v) The importance of setting up a Fire Headquarters at a prominent place was very evident. Until this was done, control was lacking.

(vi) The assistance given by the detachment from the Guards Training Depot was first class.

LIGHTNING AND FOREST FIRES AT LANGDALE FOREST

By J. WEATHERELL

Head Forester, Research Branch

The power of lightning to cause a forest fire has sometimes been doubted, and, though it is known that it does do so sometimes, an actual record of a fire seen to start as the result of lightning is not without value.

On 17th May, 1952, a fire patrol witnessed, at a distance of about three chains, a lightning strike in a seven years old experimental Japanese larch fire belt at Broxa, Langdale Forest, in the North Riding of Yorkshire. He described the event as a vivid blue flash, followed by smoke and flames issuing from the base of one 10 ft. high tree. With rain beginning to fall he had little difficulty in extinguishing the fire.

Examination of the site revealed that the natural vegetation, ling (*Calluna vulgaris*), had been burnt off over a roughly circular area of about four square feet, the tree being slightly off centre within the burnt area. The lower branches of the tree had also been destroyed, whilst higher up there was a slowly ascending spiral of yellow needles bordered by apparently healthy needles. The main stem did not appear to have been damaged; there was, for instance, very little scorching of the stem bark.

A couple of weeks later the tree showed no appreciable change in general appearance, but it did in fact die before the end of the growing season.

The actual cause of death of the larch was not clear. There are three possible explanations, viz.: (*a*) The direct effect of the lightning strike on the stem and crown, (*b*) The effect of the lightning strike on the roots, or (*c*) The burning and scorching effect of the burning vegetation.

Current impressions were that the lightning did not touch either the stem or crown, and that heat from the burning vegetation was responsible for the needle discoloration and ultimate death of the tree.

THETFORD-TYPE STATIC WATER TANKS

By BRIGADIER F. G. DUFTON

East England Conservancy

In large conifer forests in low rainfall districts, where owing to the vegetation of grass, gorse, and heather the fire risk is high, the static water tank is one of the most important items in the Fire Fighting system. At Thetford, for instance, there are some 70 fire tanks of 3,500 gallons or over, serving an area of some 35,000 acres, and the object is to have either static tanks or natural reserves of water spaced at intervals of about a mile, all accessible to fire fighting vehicles.

In the early days of the forest, water had not come into the picture as a fire fighting medium, and during the war years when much of the forest provided storage space for bombs, the Service Authorities erected a number of 3,500 and 5,000 gallon sectional steel or concrete tanks in parts of the forest. After the war these were acquired by the Commission, dismantled, and re-erected so as to cover a greater area of forest, and supplemented by such other sizeable water containers of various patterns as were available.

The maintenance of sectional steel tanks in watertight condition is straightforward, but the initial cost of a 5,000 gallon tank of this type is now £202, and the cost of erection £63. The sectional concrete tanks were sometimes erected on inadequate foundations, often near roads carrying heavy traffic. Subsidence and vibration have resulted in leakage at the joints. The repair of these tanks by the usual process of lining internally with cement plaster and painting with bitumen has proved unsatisfactory. This difficulty, and the need for larger numbers of static tanks at Thetford about four years ago, led to the idea of cheap concrete in-the-ground tanks of about 6,000 gallons capacity, the maintenance cost of which is practically nil.

To reduce the cost of such tanks to the minimum, there must be no steel reinforcement, the least possible timber shuttering must be used, and the design must be so simple that a few forest workers assisted by one or two skilled men can make the tank in a few days. The Thetford tank, described below, complies with these factors.

The site having been chosen on level ground accessible to vehicles using a fire-route, pegs are driven in at the corners of a square of side 18 feet. The earth is excavated to a depth of about 6 feet 6 inches in the middle, the sides sloping evenly (not in steps) at an angle of 45 degrees. The flat bottom of the tank will then measure about 8 feet square. It is inadvisable to excavate a sump, as this has proved a source of extra expense in construction and a point of potential leakage. The earth spoil is spread, leaving the side of the tank nearest the road, and a two-foot space round the other sides clear of obstruction. As excavation proceeds, a wooden surround, consisting of 7 inch by 1 inch boarding, is erected on edge round the tank, roughly levelled with a spirit level, and lightly nailed to 2 inch square stakes driven, three per side, against the outer face of the boarding.

A 5/3½ concrete mixer (i.e. a machine taking a charge of 5 cubic feet of dry materials, giving 3½ cubic feet of wet mixed concrete) is placed in the middle of the "open" side with a short length of corrugated iron or wood to act as a chute, so that the mixer can be emptied into the excavated hole. 5 cubic yards of ¾-inch stone is tipped to one side of the mixer, and 5 cubic yards of washed sand on the other. 24 bags of ordinary cement are stacked nearby and covered with a tarpaulin. 250 gallons of water in a suitable tank completes the requirements of materials and plant.

The excavation of the whole and assembly of plant usually takes five men two days.

The next operation is to line the hole with concrete in one day as a continuous operation. This requires 6 men, at least one of whom should have experience in concrete mixing. Continuous batches of 1 : 2 : 4 concrete (½ bag cement, 1 bag sand, 2 bags ballast) are delivered to the bottom of the tank where two men wearing gumboots apply the concrete 4 inches thick with shovels first to the bottom, and then to one of the sides, working up from the bottom. To obtain an even four-inch thickness to the sides, a pair of 3 inch × 2 inch timbers approx. 7 feet long are placed temporarily against the earth slope, six feet apart, on their two-inch faces, from floor to ground surface. These timbers are packed up at each end on a small "bed" consisting of a trowelful of fresh concrete, so that the upper edges of the timbers are 4 inches from the sloping earth face. As soon as the concrete is laid by shovel, the surface is faired off flush with the top edge of the timbers. When the work on this side is complete, the timbers are removed for use on the next side, and the space where they rested is filled in with concrete. The surface of the concrete is left rough till all four sides and bottom are done, when a finishing coat of ½ inch mortar made from one part of cement to two parts of sand is applied all over and finished with a plasterer's steel skimmer. When finishing the kerbs, 6-inch lengths of old piping, ½ inch internal diameter (through which the horizontal straining eyebolts will pass) are inserted in the concrete at each corner and at 3 ft. intervals round the tank, about 4 inches from the top surface. After about a week, the boarding is removed, and a wire netting cover made. This is wired up into an 18 ft. square "apron" on the ground. No. 8 gauge wires are placed across the tank at 3 ft. intervals in both directions, and fitted to the straining eyebolts which are inserted in the tubes in the kerbs, and lightly tensioned. The cover is then placed on top of the wires and laced down, a hinged flap being made to take the suction hose of the firepump. The tank is then filled. After a further fortnight the wires are strained till the cover is flat.

The cost of such a tank, which depends to some extent on the location, is approximately as follows:—

		£	s.	d.
Materials:	5 cu. yds. ¾ inch stone delivered @ 16/5d.	4	2	1
	5 ,, ,, No. 1 washed sand delivered @ 13/-	3	5	0
	24 cwt. cement @ £4 10s. 7d. ton	5	8	9
	20 No. 9″ × ⅜″ galvanized straining eyebolts for sides @ 9d.		15	0
	4 No. 12″ × ⅜″ galvanized straining eyebolts for corners @ 1/-		4	0
	2/3 roll wire netting, 19 gauge @ £1 19s. 0d. roll	1	6	0
	1/3 cwt. 8 gauge wire @ £2 10s. 0d. cwt.		16	8
	24 No. 6″ lengths pipe, ½″ int. diam.		12	0
Labour:	Excavation (depends on soil): 5 men 2 days	10	13	4
	Concreting: 6 men 1 day (incl. mixer driver)	6	8	0
	Making and fixing cover: 2 men 1 day	2	2	8
Provision of Plant:	5/3½ concrete mixer for 2 days, less driver say,....	1	0	0
	3-ton lorry for 2 days, less driver, say	4	0	0
	250 gall. water tank		—	
		£40	13	6

OBSERVATIONS ON WINDBLOW IN YOUNG PLANTATIONS AT ALLERSTON

By D. ROBERTSON
Foreman, Research Branch

The widespread damage, particularly in the north-east of Scotland, caused by the gale at the beginning of 1953 brings windblow into line with fire as one of the forester's biggest headaches. It makes one speculate as to what can be done to ensure more stability in future forest crops and also whether anything can be done to mitigate such damage in crops already planted which are reaching the thinning stage.

For record purposes, and in the hope that some salient features with regard to windblow might arise, I had the task of charting areas of windblow in some of the experiments in the Wykeham Experimental area of Allerston Forest in Yorkshire. From these charts and from general observations certain points emerge which may be of interest.

In these relatively young plantations, up to thirty years old, the worst damage was suffered by heavy crowned species such as *Pinus contorta* and Corsican pine. Scots pine suffered to a lesser extent and Japanese larch, within the experimental area, suffered not at all. It may be well to consider this question of crown density in the establishment of plantations on the more exposed site.

The apparent wind-resisting capacity of Japanese larch is interesting. In one particular case it was noticed that a larch was still standing in rather a large gap where all surrounding pine had been bowled over. The obvious reason for this, of course, is the deciduous nature of the tree, but it may also be that the larch stem is more resilient than that of the pine. This leads one to consider the possibilities of using Japanese larch as shelter belts around and within plantations, where the larch can be grown. Even inferior larch would be worth while if it proved an effective means of reducing damage by wind. The same would apply to hardwoods on suitable sites.

In general it was found that unthinned plantations and also those well-thinned plantations where the trees had had ample room for some time, withstood the gale. From this it may be deduced that the timing of thinning is of first importance. Delayed thinnings force the crowns to the tops of stems. Very often they become misshapen and one-sided, which all adds up to an ill-balanced tree—an easy prey for a gale! Early and frequent light crown thinnings are indicated to get the trees more slowly acclimatised to conditions of wider spacing. The crowns have more freedom of movement which in turn should lead to a better root development and stronger stem. It is when a delayed thinning is carried out in the winter, when the danger of gales is greatest, that the worst damage may be expected. In this connection, it may be policy, in certain cases, to leave a marginal belt of a stand unthinned during the winter and attend to it in the spring. In other words, confine thinning operations to the interior of the plantation during the winter months. In any event, the handling of margins on exposed sites should be given careful consideration. It may be that thinning of marginal trees at an earlier age than the rest of the stand would induce stability of the "edges", giving wind protection to the trees within. Alternatively, at time of establishment, the marginal trees could be allotted wider spacing.

In conclusion, it may be said that, on these moorlands, the degree of cultivation had a bearing on stability. The deeper and more complete the cultivation the better. Single furrow ploughing showed a tendency to confine the root systems to the ground between the plough furrows. The horizontal spread, at right angles to the plough furrow, was restricted, so that trees were more liable to throw by a wind blowing across the direction of ploughing.

RABBIT CLEARANCE IN KING'S FOREST 1947 TO 1951

By J. J. SMITH
Head Forester, East England

On my take-over at King's Forest, March 1947, my biggest problem was the destruction of some 80,000 rabbits in unbrashed plantations consisting of approximately 6,000 acres ranging from P.36 to P.41.

The army had been in occupation from 1941 to 1946, all fencing had disappeared and the damage to the plantations from tanks, but more so rabbits, was considerable over the whole area. Over some 2,000 acres the crop was 100% damaged, so the problem had to be tackled, first of all fencing, clearing the area of rabbits and replanting and beating up the lesser damaged areas.

My first job was to fence the area off in approximately 500 acre blocks, but owing to the difficulty in getting the rabbits out of the unbrashed plantations the areas had to be reduced to 200 or 300 acre blocks.

At first 5 warreners were employed but this was just hopeless, so to clear some 800 acres for P.48 planting the number of warreners was increased to 9, and by September 1948 to 12. I must add here that although my warrening strength was 12 men, half of these had had very little, if any, experience of the work, but it was strength I wanted to walk the rabbits out into the nets with dogs, of which there was about 12 in number.

My first method of attack was long nets (about 20 in number) walking and driving the rabbits into them. This was very successful for a time and our bag on many days ranged from 400 to 500 rabbits and by September 1947 we had caught 10,326 rabbits, so we plodded on and by September 1948 another 27,386 had been accounted for. However, the position still seemed hopeless for there appeared to be as many rabbits as ever, and by now the job of getting them into the nets was almost hopeless, we could get them nearly into the nets and then they would double back to be hunted all up again.

So now one more headache to know what to do next. However, shooting was the next form of approach and shoots were organised. "Mr. Bunny" seeing no nets, came out across the rides to be met by a hail of shot; this proved we were on the right track once again and up went our daily bag. I must mention here that two days' shooting resulted in 1,276 rabbits and 26 hares being shot and by September 1949 another 25,671 had been added.

Our shooting method had now proved that we were on the turning point. I was now able to reduce my warreners to 10 and by September 1950, another 11,056 had been caught and by September 1951, another 2,640 were accounted for, and now my warreners were reduced to 7 and the job practically completed apart from some small areas not then enclosed in the main block.

I should mention that during the whole time we were using traps and snares and the final mopping up in each block was done by the use of ferrets and destroying the burrows and I must add that the area was completely cleared; no damage whatsoever was done to the young plantations after replanting.

The total number of rabbits caught by September 1951 was 77,079.

I had many anxious and worrying times during this period but I shall always remember the good days spent on the shoots with colleagues from adjoining beats.

VOLE DAMAGE TO TREES AT TEN FEET FROM GROUND LEVEL

By J. H. THOMSON
Forester, Research Branch

Damage done by voles at a height of ten feet from ground level on *Chamaecyparis pisifera* (Sawara cypress) was recently observed in Benmore Forest Garden. Several trees were found dead as a result of bark gnawing, which may have occurred in the winter of 1947-48. Those have now been cut out but a few trees were left, as a matter of interest.

The damage was not detected until Autumn 1950, when some of the fast growing *Abies grandis* (with which the plot was beaten up in 1939) were cut to help the surviving cypresses. The damage was at first thought to be due to squirrels, but closer examination showed that this was not the case. The branches, which are not in whorls in this species, are very close together, right to ground level, and it must have been comparatively easy for the voles to reach the more tender bark near the top of the tree by climbing. The gnawing starts at approximately four feet and becomes increasingly severe further up the stem. The lower branches of all the remaining cypresses have now been removed to approximately five feet, to prevent further attack.

Voles appear to have a great liking for this species, and damage has always been severe in this particular plot. Five hundred plants were planted in 1930. In 1931 severe damage was reported and the stems were treated with "Trepan", which was only partially successful as a deterrent. In 1934, only forty out of the original five hundred plants were alive, and few of those had escaped vole damage.

Robinia pseudacacia ("acacia") is another species which is particularly attractive to voles. A plot of this was planted adjacent to a plot of *Betula lutea* (yellow birch) in the Spring of 1950. Both plots were completely eaten by voles, but no damage was done to the birch until the acacia had been completely destroyed.

DENDROCTONUS MICANS, A CONTINENTAL PEST OF SITKA SPRUCE

By G. E. GODWIN
Divisional Officer, North Wales

Most foresters and forest officers have, at some time or other, felt a slight misgiving at the thought of the large areas of pure Sitka spruce they have been instrumental in planting. There are two schools of thought on the subject. The first, claiming justification by results to date, considers that there is no cause for alarm; on reasonable sites Sitka has been most successful, and on most of these sites it has really been the only species worth planting, the only possible species with which to mix it being one or other of the pines. Efforts to plant hardwoods on these typical Sitka sites have usually been disappointing. Why should we waste time and money trying to plant, say, birch or alder, which will hang fire for years after the surrounding Sitka has grown vigorously and closed canopy? If the traditional belief that all crops benefit by an admixture of hardwoods is well-founded—and there are magnificent plantations and natural coniferous forests that have never seen a hardwood—let us introduce them in the second rotation, when forest conditions have been built up.

The opposite school of thought argues that monoculture is against nature, that natural coniferous forests, if they do not contain some hardwoods (e.g. birch in the Scandinavian pine-spruce forests), at least contain several species of conifer, and that we should be trying to create balanced communities and not just large plantations. This school points out that in creating large areas of a single exotic, whose long-term performance on afforestation areas is not known, we are taking a grave risk. The fact that no major threat has yet appeared, after only thirty years or so, is no guarantee that none will appear. Already concern is being caused by attacks of *Neomyzaphis* and by unexplained dying in groups.

In between these two schools of thought is a third, not committed by scientific knowledge, intuition, or the gift of prophecy to either view, but prepared to judge by results, and in the meantime to keep a sharp eye open for anything which might threaten our existing plantations or cause us to review our practice. The appearance of any threat to Sitka spruce in European countries with conditions comparable to our own is obviously of very great concern.

On recent visits to Denmark, the writer has been made aware of one such threat, which during the last five years has caused increasing concern. This is the bark beetle *Dendroctonus* (*Hylesinus*) *micans* Kugel, which is not found in this country, but occurs over most of northern and central Europe, and which in recent years has shown a decided preference for Sitka as against its more normal host, Norway spruce. It can be a primary pest, and it is a killer, Sitka rarely surviving for more than two years after being attacked, and perfectly healthy trees sometimes succumbing in a matter of months. As it chiefly attacks trees in the pole stage, the effect of an accidental introduction into this country can be imagined.

The following is a brief description and summary of the present status of *D. micans* in Denmark. The manifold increase observed since 1947 led to an investigation in 1949, on which these notes are based. The position has worsened since then.

Description of Beetle. The largest European bark beetle, length 7 to 8 mm. (between ¼ and ⅓ inch), shining black with numerous short yellow hairs. Head visible when viewed from above; wing covers longer than head and thorax together.

Distribution. Norway, Sweden, Denmark, Germany, Holland, Belgium, Luxembourg, Switzerland, Austria, Hungary, Jugoslavia, Czechoslovakia, Poland, Finland, Russia. Absent so far from Britain, Western France and Mediterranean countries.

Species Attacked. Usual host Norway spruce (in Jugoslavia *Picea omorika*), occasionally Scots pine and other conifers; widespread planting of exotics has shown that it decidedly prefers Sitka spruce to any other species, but also attacks *Picea alba*, *P. orientalis*, *P. pungens*, *P. jezoensis*, *Pinus contorta* and mountain pine.

History in Denmark. Thought to have arrived via Sweden and Germany. Known as occasional pest of Norway spruce since 1861. Of no economic importance till middle 1940's, and particularly after 1947. Enquiry in 1949 showed widespread attacks, mainly on Sitka and Norway spruce on poor heathland and blown sand in Jutland.

Species and Age Classes Attacked. By far the most serious attacks are on Sitka, with Norway spruce second. Norway spruce occupies a vastly greater area than Sitka in Jutland, but the fact that the greatest number and the most serious attacks are on Sitka shows that *D. micans* seeks out the Sitka. Attacks are chiefly on crops 31-40 years old, a little later in the case of Norway, but attacks have occurred on trees under 20 and over 60 years. There is an obvious connection with thickness of bark and therefore diameter; Sitka, with faster growth, would be attacked earlier. It so happens that many of the earlier Sitka plantations in Jutland reached a suitable size during the 1940's, and this is one obvious reason for the present increase.

Soil and Quality Classes Affected. The heaviest attacks are in stands grow-on poor, sandy soils, but cases occur on good soils, and fast growing Sitka are readily attacked.

Relation of Dendroctonus micans to Fomes annosus and Drought

It appears that *D. micans* often, but by no means exclusively, attacks stands and trees affected by *Fomes annosus*. Most of the stands attacked are reported as affected to a greater or lesser extent by *Fomes*, but some stands attacked are stated to be free from *Fomes*. There is therefore some conflict of opinion; in some cases only trees affected by *Fomes* are stated to have been attacked, in other cases many trees affected by *Fomes* were not attacked, in others the incidence of *Fomes* was very slight. As *Fomes* is very common on the poorer soils, and as some attacks are reported in stands free from *Fomes*, it seems clear that *D. micans*, besides readily attacking trees affected by *Fomes*, also attacks trees not affected, and in some cases at any rate can be a primary pest. (The writer, in the summer of 1952, saw a 50 year old stand of excellent Sitka, where a few months previously all trees showing signs of attack had been removed in a heavy thinning. Nevertheless, a number of the remaining trees were already showing signs of attack.) As a matter of interest, opinion in Schleswig (Germany) seems to be that *D. micans* and *Fomes* are closely connected; not so in Holland, where *D. micans* is said to be a primary pest, and in Finland too there is no definite association.

As regards drought, there was a widespread belief that the prolonged dry summer of 1947 had something to do with it. This belief lacks any proof, but it seems to be a fact that other bark beetles increased markedly in Europe after 1947.

Other Factors

1. *Damage to bark*. Some reports blamed damage to bark as a contributory factor, e.g. through felling and extraction, pruning, scorching, callusing, peeling, bark in forks, etc.

2. *Thinning and light*. Other reports connected *D. micans* with recent thinning and increased light intensity, or with trees on the edges of stands. In a series of State sample plots, C and D grade thinnings were heavily attacked, lighter grades not at all.

Economic Importance

Out of a sample of 43 cases of attack in 1949, 13 were assessed as having caused no economic loss as yet, 10 as a small loss only, and 20 considerable loss in that heavy thinning or even clear felling had been necessary. Increased danger from windblow following heavy thinning was a cause of anxiety in some cases. One district intended to give up planting Sitka altogether.

It should be mentioned that in some cases attacks had reached an apparent maximum, or were diminishing. The removal of a number of trees is no very great matter, but attacks are often on groups of trees or on the biggest trees. Sitka is usually killed in two years; Norway spruce survives longer.

Attacks on very young stands are so far rare, and even if *D. micans* is to be classed as a permanent major pest, it may still be possible to grow Sitka to an economic size on a short rotation.

Protective and Remedial Measures

Generally speaking, none has been evolved. As *D. micans* breeds in both healthy and unhealthy trees, ordinary silvicultural measures are not of much use. In the United States, *D. micans* does not occur, but there are 24 other species of *Dendroctonus* attacking various conifers, and large sums are spent annually in trying to prevent the spread of the more serious ones, principally by felling infected trees and barking or spraying them. No method is known of killing the beetles on standing trees without also killing the trees. Trapping is useless, as the beetle prefers living trees to cut material.

In Denmark, unsuccessful attacks have been recorded, where the tree shows a copious flow of resin, but no beetles or larvae are found.

This, then, is a summary of what is happening in Denmark. What are the prospects of *D. micans* finding its way to this country, and what will happen if it does? As regards the possibility of *D. micans* appearing in Britain, there is, of course, that excellent *cordon sanitaire*, the English Channel and the North Sea, which other major Continental pests of various descriptions have found to be too much for them. It is reassuring that *D. micans* did not apparently occur in Western France in 1949, but there may be good reasons, such as the lack of suitable stands of Sitka on poor soils. In any case it is widespread in Holland, Belgium and Denmark, too near for comfort, and presumably only a few beetles or larvae of suitably assorted sexes would be required to start a population. Climatic conditions in what we regard as typical British Sitka country, notably a relatively high rainfall, are very different from those obtaining in Denmark, where the rainfall is of the order of 24 to 28 inches per annum. Our Sitka soils, too, are usually more or less peaty, whereas the heaths in Jutland are mainly dry sands with a hard pan. But the list of countries where *D. micans* occurs shows that it is tolerant of some climatic variation; the writer's knowledge is confined to Denmark, and he knows nothing of the conditions or scale of attack in the wetter or more mountainous countries. In any case, the East Anglian climate and soils are to some extent comparable with those in Denmark, and East Anglia and the south-east are the parts of Britain nearest to the source of danger.

If *D. micans* does make its appearance, what is likely to happen? Will it sweep the country and ravage our Sitka plantations? Is this the sign the anti-monoculture school has been waiting for? If it is, would our Sitka be much better off if it had been mixed with hardwoods or with other conifers? Or, if it does make its appearance, will it create temporary havoc in the eastern counties and then settle down to become a respectable resident pest?

The writer does not know, but having seen *D. micans* at work less than a day's journey (or less than two hours' normal passenger flying time) away, he would very much like to know. If he were the owner of Sitka spruce near the eastern seaboard, he would be building a series of Martello or Micans towers, or at least organising a very close watch on any sign of Sitka dying—especially if he came across a shining black bark beetle about 7 or 8 mm. long, with numerous short yellow hairs . . . .

Grateful acknowledgments are due to B. Beier Petersen, of the Royal Veterinary, Agricultural and Forestry College, Copenhagen, for permission to make use of the results of his investigations on the subject.

FOMES ANNOSUS IN EAST ANGLIAN PINE SAMPLE PLOTS

By J. G. WASS
Forester, Research Branch

An article has recently been written by Rishbeth (3) on the damage caused by *Fomes annosus* in East Anglian pine forests. In the summer of 1949 I saw considerable damage caused by this fungus; the conclusions in this paper are based on these observations and on Forestry Commission Sample Plot data.

These sample plots, as will be seen from the list given below, are distributed over a wide area of Norfolk and Suffolk.

Forest Area	*County*	*Number of Plots* Scots Pine	*Number of Plots* Corsican Pine
Rendlesham	Suffolk	4	4
Brandon	Suffolk	7	8
Thetford	Norfolk	4	2
Cranwich	Norfolk	4	4
Swaffham	Norfolk	4	4

(Fifteen new plots included in the above list, have been omitted from Tables 4 and 5).

All the plots on which the observations were made are on glacial drift, mainly sand with flints, of varying depth and overlying chalk, except in the Rendlesham area where the glacial drift overlies Norwich Crag. Most of the crops, excluding the old stands, were furrow-planted on old agricultural land. The majority of these plots are in series for comparison and Yield Table purposes, the silvicultural treatment, i.e., thinning grades, being different between plots within the series (2). The thinning grades used are:—

A	grade	—	Removal of dead trees only
B	,,	—	Light low thinning
C	,,	—	Moderate low thinning
C/D	,,	—	Moderate to heavy low thinning
D	,,	—	Heavy low thinning
D++	,,	—	Very heavy low thinning
L.C.	,,	—	Light crown thinning

The grade of thinning generally applied to pine crops by Eastern Conservancy foresters approximates to the Research C/D or moderate to heavy low thinning grade. Apart from the 15 new plots—which have received but one thinning in 1949—all the plots have been thinned repeatedly, some as many as six times.

The severity of *Fomes annosus* infection appears to depend on four factors:

1. Availability of stumps
2. Depth of soil over chalk
3. Type of land planted
4. Species—pure or mixed crops

1. Availability of Stumps

In the first instance the abundance of *Fomes annosus* is determined by the amount of food available, and it is therefore common for years after a felling has taken place, because the tree stumps form a medium on which the fungus is able to live and "build up" before attacking neighbouring trees.

Rishbeth (3) believes that *Fomes annosus* colonises the cut surface of the stumps by means of wind-borne spores, grows in the stump and spreads laterally along the roots, eventually infecting roots of living trees in contact with them. He notes that *Fomes annosus* occurs more frequently in large stumps than small ones of the same age, and that this is possibly because the competition with rival fungi occupying the stump is less intense in the larger volume of wood. Observations in our Sample Plots seem to support this, because it was found that the number of dead trees depended more on the size of stumps than on their number.

Table 1 shows that the L.C. thinning grades have a death percentage as high, and in many cases higher than the D. grades. In this connection I have noted that suppressed trees retained as an under-crop in an L.C. grade never appear to be infected, but at the moment I see no reason for this. The D++ thinning grades, with one exception, are all on the deeper soils and this has helped to counter-balance the effect of the greater number of large stumps that are left by this type of thinning. The one exception (E.154, Table 1), has suffered damage accordingly. Besides the grades mentioned above, there are two plots of "line thinning" established and thinned in 1943; in one plot (E.163) every alternate two rows have been removed and in the other (E.164) every alternate three; adjacent (E.162) is a D grade plot for comparison purposes. The two line thinning plots are seriously infected, but the D grade plot, where there are fewer large stumps, is only slightly infected.

In plantations where new plots were established and were given a first thinning in 1946 or 1949, no sign of *Fomes annosus* was found inside the plantations, but infected trees occurred on the edges of the compartments where extraction racks had been cut some years previously.

This points to two things:—

(*a*) That it takes a few years for the fungus to invade the stumps and pass thence to the roots of living trees.

(*b*) That owing to the absence of dead stumps *Fomes annosus* rarely attacks trees in unthinned plantations.

The A grade plots are unthinned except for the removal of dead trees and, in all instances but one, these plots are free from infection irrespective of the site; in all cases the A grade plot is in the centre of the series, all the other plots being infected; in the case of plot E.140, the plots on either side have been abandoned as sample plots owing to the depredations of the fungus. In the only infected A grade plot (E.139) the fungus has spread from the adjoining D grade plot (E.138) into one corner of the A grade plot where it has killed 13% of the trees in the plot including seven dominants (See Table 1.)

2. Depth of Soil over Chalk

Where the plots have suffered badly from *Fomes*, in each case the soil overlaying the chalk is shallow, varying in depth, but never more than 24 inches. Where the infection is slight or absent in thinned plantations the soil is invariably deeper. The reasons for this are probably twofold; firstly, as Rishbeth has pointed out, trees on alkaline soils are more liable to infection, and secondly, as I found when digging soil pits in the plots, the roots of pines do not penetrate the chalk more than a few inches and even then they are sickly. It is probable that roots tend to spread wider laterally where vertical penetration is impeded. This might increase the possibility of contacts with infected stump roots and thus help to explain the greater degree of infection on shallow soils.

3. Type of Land Planted

Land types are thought to influence the development of the fungus (3) and (4) e.g., old woodland sites are notorious for harbouring the disease, but from the plots observed it is impossible to assess the difference. It is understood from records that all but the old plots were planted on old agricultural land, but I was unable to discover whether the land was arable or pasture. The old plots are remarkably free from infection, no sign of *Fomes annosus* being found anywhere.

The three old Scots pine plots (E.130, 172 and 131) are of natural regeneration, obviously on old woodland sites, but there is no record of the disease having been found in these plots. The two old Corsican pine plots (E.129, 179) were planted early this century and these also are free. In each case the condition of the land prior to planting is unknown, but all are on deep soils.

As at least three of these stands were originally intended for wind-breaks, it may be assumed they were left unthinned, or at least underthinned in the early stages, and this has no doubt contributed to their freedom from infection. My observations point to the fact that where land has been clear of stumps at the time of planting, e.g. old agricultural land, the infection has undoubtedly arisen at the commencement of the thinning or rack cutting and not before.

4. Species—Pure or Mixed Crops

Only two plots are underplanted, but observations were also made in a wood with a beech undercrop, which lay adjacent to the pure sample plots. In each instance the underplanted woods, especially where the beech was well established, were in a healthier state than the adjoining pure crops, deaths being few and isolated. The two sample plots that are underplanted have other factors that may be unfavourable to the fungus, i.e. a deep soil and vigorous crops.

Another interesting point is that one crop was regenerated naturally and none of the plots established in this way is infected, nor have I seen any natural Scots pine seedlings, which occur profusely in plots devastated by the fungus, that have been killed by *Fomes*. Whether these seedlings are to some extent resistant to the disease I cannot say. Perhaps they are merely too young to be infected.

If it can be established that mixed woods are less vulnerable to attack than pure crops, it would obviously be an advantage to establish mixed crops. *Fomes annosus* is a fungus that kills trees in groups and spreads outwards to others. Where this occurs I suggest that it might be advisable to fell all dead and sickly trees in and around the infected area and to replant the gap so formed with beech. This might help ultimately to restrict the spread of the disease and could also be considered to improve the woods from the aesthetical and ecological standpoints. As the badly infected plantations occur on calcareous sites it should not be difficult to establish beech. The underplanting of line-thinned Corsican pine carried out elsewhere in Thetford Chase looks extremely well, and the many good mature beech stands in the Thetford and East Harling districts give a good indication of what can be expected.

The other plan to consider is the cessation of thinning operations on the more unfavourable sites and restricted thinning and underplanting on sites that are more favourable. Although this may sound revolutionary let us consider the implications.

Firstly the evidence of our Sample Plots suggests that by not thinning the forester can keep *Fomes annosus* out of his woods, even on the most unfavourable sites (Plots E.133, E.136 and E.142). Secondly, the permanent Sample Plot Records of the Forestry Commission show that for the first forty years of the life of a stand the total volume of timber produced (though not necessarily the volume usefully harvested) will be much the same whether thinning operations are carried out or not (2). In other words, if a stand is thinned the remaining trees will put on increment rapidly and the standing volume plus the volume removed in thinning will be about the same as the standing volume of an un-

Table 1

DEATH PERCENTAGE DUE TO *FOMES ANNOSUS* IN EAST ANGLIAN PINE SAMPLE PLOTS

Location and Plot Nos.	Species	Death percentage and soil depth in inches in Thinning Grades: Light A	Light B	Moderate C	Moderate D/D	Heavy D	Very heavy D++	Low crown	Remarks
Young Crops P.1920-26 Rendlesham									
E.153, 152	S.P.					2% *40"*	0.8% *40"*		
E.151, 150, 149	C.P.				5% *50"*	2% *54"*	Nil *56"*		E.149 beech underplanted. Crop very vigorous
Brandon E.142, 143, 141	S.P.	Nil *18"*				20% *18"*		50% *18"*	E.143 and 141 abandoned owing to damage by *Fomes annosus*
E.139, 138, 154, 140	C.P.	0.8% *18"*				16% *14"*	13% *20"*	10% *20"*	*Fomes* has invaded from E.138 and killed a few trees in one corner of E.139
E.156, 155	S.P.					6% *28"*	7% *29"*		
Thetford E.162, 163	C.P.					0.3% *19"*	3% *17"*		For comparison: E.163 line thinned every alternate two rows
E.164	C.P.						2% *19"*		For comparison: E.164 line thinned every alternate three rows
Swaffham E.133, 134, 158, 132	S.P.	Nil *26"*				4% *33"*	6% *38"*	5% *25"*	E.158 Crop very vigorous
E.136, 137, 157, 135	C.P.	Nil *18"*				3% *36"*	0.6% *28"*	17% *30"*	*Fomes annosus* has invaded E.135 from adjoining rack stumps
Old Crops P.1894-1906 Brandon E.129, 179	C.P.					Nil *52"*		Nil *45"*	
E.130, 172, 131	S.P.		Nil *36"*	Nil *43"*	Nil *38"*				All S.P. natural regeneration. E.172 is, in addition, beech underplanted

Note.—The plot numbers and information relating to each plot are read in order from left to right across the table. Soil depth for the respective plots is shown in Italics below each death percentage.

PINE SAMPLE PLOTS IN EAST ANGLIA

Table 2

Plot No.	Date of Establishment	Date of First Thinning
128—Abandoned, blown	April — 1939	April — 1939
129, 130	April — 1939	April — 1939
131	April — 1939	June — 1945
132	May — 1939	May — 1939
133	May — 1939	February — 1943
134, 135	May — 1939	May — 1939
136	May — 1939	February — 1943
137, 138	May — 1939	May — 1939
139	May — 1939	February — 1943
140, 141 (141 Abandoned 1945, (*Fomes*)).	May — 1939	May — 1939
142	May — 1939	February — 1943
143, Abandoned 1945 (*Fomes*)	May — 1939	May — 1939
149, 150, 151, 152, 153, 157, 158	April — 1942	April — 1942
154, 155, 156	March— 1942	March — 1942
162, 163, 164	May — 1943	May — 1943
172	June — 1945	June — 1945
179, (Was previously 128, and this plot was established in same stand after 128 had been abandoned as blown)	November—1947	August — 1949

Note.—Plots Nos. 131, 133, 136, 139, 142 are all "A" grades and thinnings have removed dead trees only.

thinned crop of the same area, growing on a similar site. In the latter case the increment per tree will be less, but the greater number of trees will compensate for that; the difference in overall increment per acre is very small.

This seems to indicate that thinning—or lack of it—decides not the quantity but the type of produce one is able to get from the forest. If only pit props are required, then the "no thinning policy" could be carried out. Where the demand is for saw timber the position is different, and here it is necessary to give a few observations.

All trees in the Forestry Commission Sample Plots are numbered, girthed and given a classification, the latter depending on the general form of the tree. From this information, the story of the development of the crop, or of individual trees, can be obtained.

It has been shown (1) that a sub-dominant tree rarely becomes a dominant even if the type of thinning favours it by giving it room for development, for almost invariably it is cut out in a subsequent thinning. This being so it is hardly worth the trouble of thinning to help it.

An unthinned plantation is somewhat akin to virgin forest in that all classes of trees are found therein. Tracing back the life history of dominant trees in our unthinned plots in East Anglia (E.133, E.136, E.139, and E.142) it was noticed that they were, and in many cases still are, the elite stems. If the dominant trees were at all deformed then such deformation is of recent origin and many of these malformed trees appear to be "moving down" in the canopy to become co-dominants and sub-dominants, so that the misshapen tree is gradually over-topped by well-shaped trees of equal vigour and can therefore do less damage to neighbouring trees than is sometimes feared.

I have observed that if in unthinned woods the leading shoot of a dominant tree is broken by wind or damaged by insects, the tree not only suffers an immediate loss in height, but also that the side shoot which subsequently takes over the lead often puts on little growth during the first few seasons, and that by this time the tree may have fallen into the co-dominant class. The same appears to apply to forked trees. Thus in unthinned plantations stems that keep growing straight usually win in the race for survival.

In other words, it seems that we can take less credit for the quality of a final crop in a thinned plantation than we sometimes like to think; do not let us assume that all pine woods should be left unthinned, this is not the case; but I certainly think that in the pine plantations of East Anglia where *Fomes annosus* creates a special problem, special measures may be required to meet it.

Incidentally, some of the best mature Scots pine I have seen in this country —Brick Kiln Enclosure in the New Forest—was only lightly thinned before being taken over as a Sample Plot in 1929 at the age of 64 years, and it has since been thinned as a B grade. This crop is over 100 feet tall and has produced, including thinning, 9,871 cubic feet of timber per acre, (over bark volume); the stem form is good and there are no blown trees.

It is of course perfectly true that some well-shaped dominants may be suppressed by badly-shaped ones if the latter are more vigorous to start with. Where stem form is generally good, as it is in East Anglia, this matters little, but where it is bad and every tree counts, thinning may be essential if a satisfactory final crop is to be achieved.

A definite answer to the question whether, by not thinning, damage by *Fomes annosus* can be avoided without serious loss in the quality and quantity of timber produced and without incurring other disadvantages, can only be provided if whole compartments are left unthinned, but kept under close observation for a whole rotation for comparison with adjoining compartments treated according to present day practice. This would be a big step, but as the problem appears to be sufficiently important to warrant a large-scale experiment, I believe it to be one in the right direction.

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FOREST BRIDGES

By Colonel R. H. PACKWOOD
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The Forestry Commission maintains some 300 bridges in Scotland, more than 100 of which were built within the last five years by its own staff. Others were "inherited" along with roads taken over with acquired lands. Rising costs, shortages of materials, and scarcity of labour combine to make the upkeep of these bridges a problem of increasing magnitude. In an endeavour to cut down the costs of both construction and future maintenance of new bridges the

Commission has tried out several types of bridges, some of which are described in this paper.

The first need is that new structures in general use should be strong enough to carry the present and anticipated future maximum loadings, which in practice is being taken to mean the equivalent of a transporter loaded with a T.D. 18, aggregating nearly 30 tons, with a maximum axle load of 15 tons.

Other requirements are that bridges should be of the simplest character, easily erected with a minimum of design, supervision and skilled labour; and durable, involving the minimum of maintenance. Portability of component parts is another desirable feature.

In 1947, when any kind of bridging material was difficult to procure, the Commission was fortunate enough to secure a stock of military bridging equipment, including a quantity of the Bailey type which had proved of such inestimable value for war purposes. The outstanding merits of this type of bridge were that its components were easy to transport, and simple to assemble; and that long spans could be launched with a minimum of skilled labour and supervision. Prefabricated trussed spans of this type, assembled on site from "man-handle-able" panels, provided the quickest and safest means of spanning large gaps. Intermediate piers and temporary staging were eliminated, and in a few hours a structure of known carrying capacity could be in service without the bother of calculations or designs. For spans of 50 feet or greater, i.e. outside the range of simple beams, trussed spans of this type were, at that time, the only practicable answer.

A war-time requirement the Bailey had to fulfil was that every component must be light and portable. To meet this condition, the trusses were formed of panels of limited length, resulting in numerous joints. To save weight, bridge members were composed of high-quality steels of slender section, fabricated into intricate shapes. For peace-time uses, however, these numerous joints and intricate shapes create problems of maintenance which do not arise in war-time. Inaccessible surfaces and joints add to the difficulties of removing rust and of repainting. Neglect of repainting leads to corrosion, with consequent loss of effective area of steel, which in time can reduce the safety factor to undesirably low limits.

Where the climate is conducive to early corrosion and where conditions are unfavourable for outdoor painting, the cost of flame-cleaning and re-painting 60 ft. single-single Bailey spans in remote localities has amounted to over £200, and in one instance to nearly £4 per lineal foot of bridge. It is not possible to forecast, as yet, the average "life" of successive repaintings, but indications are that it is not likely to be more than five years, and may be as low as three. Assuming that it averages four years, the annual cost of cleaning and painting may be £1 per foot of span. To this must be added the expense of re-decking at intervals not yet determined but which may be from 10 to 15 years. This would add another 4/- to 5/- per foot to the annual maintenance charges.

These figures emphasise the need for avoiding the use of truss bridges except for long spans. For short spans, simple beams and slabs as referred to later are better both in first cost and maintenance. A reserve stock of Bailey bridging held in readiness for emergency use is invaluable, as one of the special merits of the Bailey bridge is the rapidity with which it can be put in position. To eke out supplies of components, and to reduce the consumption of steel and the cost of maintenance, double-trusses are being avoided wherever possible by building intermediate piers. By this means, the longest span need seldom exceed 60 feet, for which trusses may be single-single.

Beam Spans

For bridges of 20 to 50 ft. clear opening, beam spans composed of rolled steel joists have furnished the best answer. They are easier to clean and repaint than fabricated trusses, and there has been no particular difficulty about transportation or erection. The Commission has a stock of heavy joists 24 in. × 9 in. × 100 lb. per foot, in units which can conveniently be joined with plates and bolts to make lengths up to over 50 feet. It is of interest to note that because of the present price of timber decking, it is cheaper and better to use four of these joists per span, at 2 ft. 8 in. centres, decked with 3 inch timber, than to use three joists at 4 ft. centres decked with 4 inch timber, even though three joists are strong enough for the loading. The point is, of course, that one extra joist, good for perhaps 40 or 50 years, will save one inch thickness of timber every time the decking is renewed, which may be on three or four occasions during the life of the steel. An alternative to timber is a concrete deck of the type referred to later which, besides being more durable, is impermeable and therefore affords better protection for the underlying steel. This method, however, calls for steel reinforcement and for skilled labour to bend and place it, as well as carpenters to fix timber formwork. Under present conditions, timber decking is the simplest and most practicable medium. In Scotland, good quality local softwoods, e.g. larch or creosoted Scots pine, are considered most suitable for deck-planks, relative cost being the deciding factor as to which to use. Either should give ten years service.

Tramrail Bridges

For spans of 20 feet down to 5 or 6 feet, used tramrails have proved very satisfactory. The accompanying plans (*Figs* 1 and 2), show how they are used. These rails were originally 6¾ in. by 7 in., weighing 103.7 lb. per yard, and were bought at prices varying from £12 to £14 per ton, or less than half the cost of new structural steel. A span of 18 ft. clear waterway, or 20 ft. overall length, requires 17 rails (including 2 for kerbs) weighing about 6 cwt. each, or a total weight of 5 tons of rails, purchased at £60 to £70, i.e., at £4 per lineal foot of bridge. The rails are embedded in a slab of concrete 8½ to 9 inches thick, the surface of which finishes about 2 inches above the top of the rails. The relatively close spacing of the rails permits concrete to be placed without formwork other than narrow strips of used sheet iron resting on the upper surfaces of their seats. The approximate quantity of deck concrete for a span 20 ft. long would be about 5 cubic yards, costing about £25. To this must be added the outlay on piers or abutments. The total cost of these bridges has worked out from £6 to £10 per foot of span, depending on the type of piers or abutments. The outstanding advantages are (1) minimum demand for materials of a kind which are in short supply; (2) minimum demand for timber for constructional purposes, and none at all for permanent use; (3) little skilled labour or technical supervision required; (4) no paintings, renewals or other maintenance charges; (5) capital and annual costs are substantially less than any other form of bridging, at present-day rates; (6) not likely to be harmed if occasionally overtopped by floods, provided, of course, that piers and abutments are in keeping with the superstructure.

Referring to the accompanying plan, the overall length of span is given as 20 feet, or 18 feet in the clear. This limiting span is determined by deflection, which under full load can be about 1½ inches, or more than would be permitted in first class practice. For occasional forestry loads, however, deflection of that amount is considered admissible.

Used rails may be considerably weakened by loss of effective area through wear and corrosion, and they may also have become crystalline in structure,

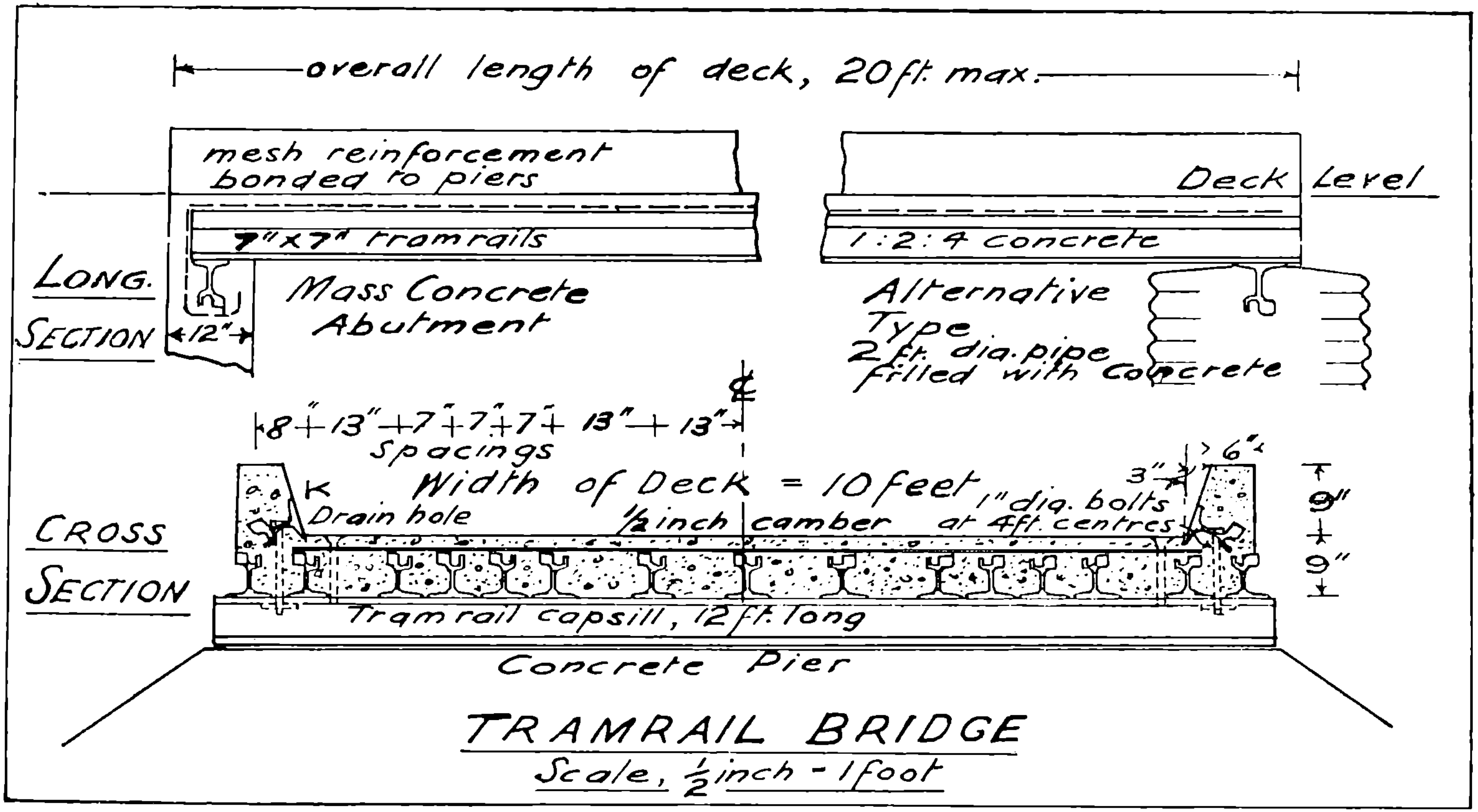

Fig 1. Tramrail Bridge. Details of Construction.

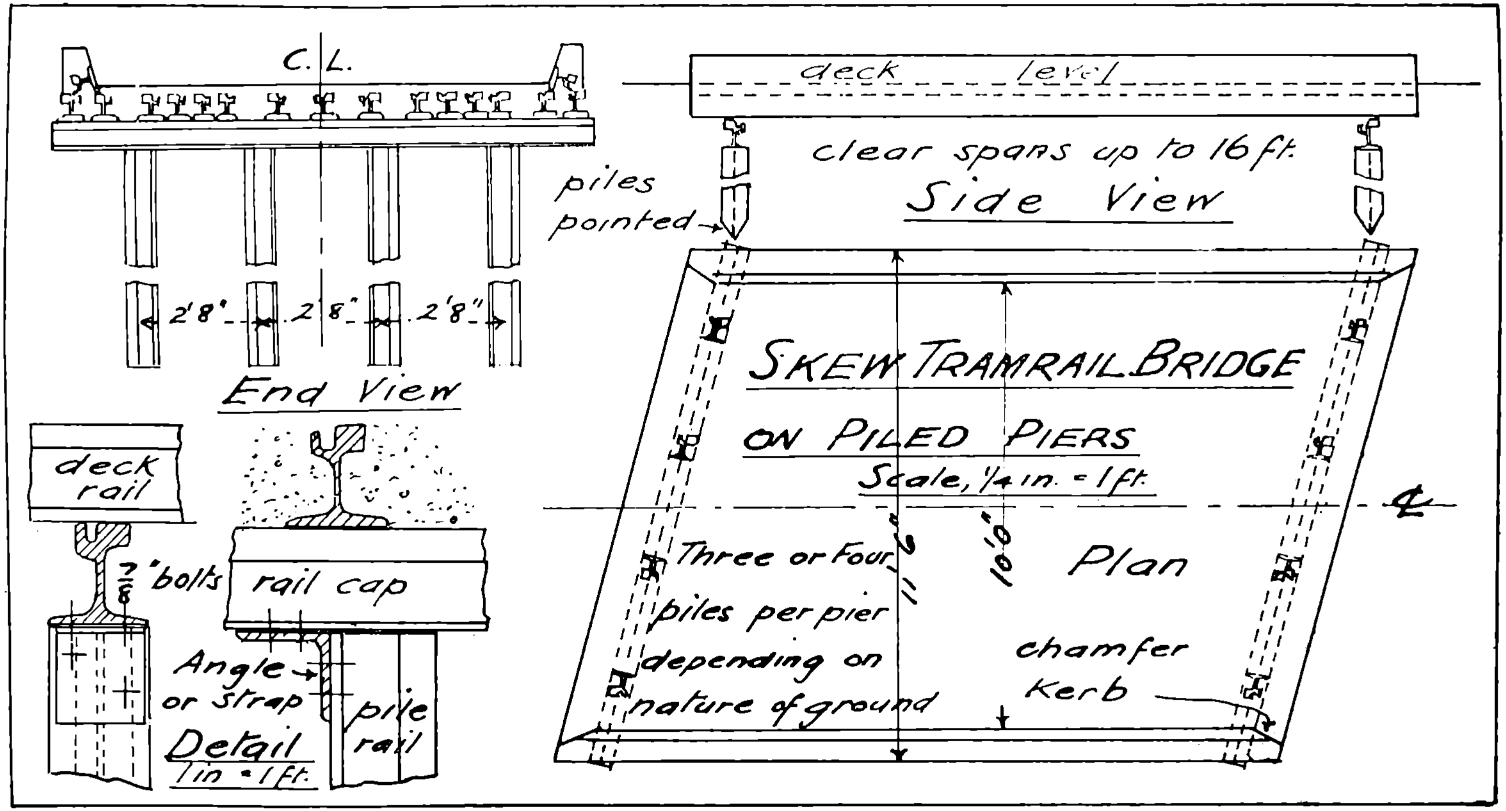

Fig 2. Skew Tramrail Bridge. Details of Construction.

this latter defect causing a tendency to fracture in cold weather. Furthermore, the individual rails in a deck system may become subject to extra loading if vehicles wander off-centre, or if wheel loads are unevenly spaced; and each rail has, of course, to bear its own due share of the "dead load" of the deck structure. For these reasons, calculations of strength and deflection cannot be very precise. A new tramrail of the lighter type, 96 lb. per yard, will safely carry 6 tons evenly distributed on an 18 ft. span, or 3 tons concentrated in the centre. For worn rails, the safe load may be only 50 per cent of those amounts. On this basis, eight or ten of the fifteen bearer rails in the single-lane deck as shown in the drawing will take care of twelve or fifteen ton axle loads.

Regarding the deck, it is considered that handrails are unnecessary for most forest bridges, but substantial kerbs are an asset. Handrails are liable to be damaged by long overhanging loads, especially if vehicles get out of control in frosty weather, and therefore a relatively deep, strong kerb, as shown in the drawing, is a better insurance against accident.

Photograph 8 shows a bridge 45 feet long on a skew of 45 degrees, in three equal spans. Tramrails embedded in concrete form the deck slab, and in addition, short lengths of tramrail have been used as piles for the piers and abutments. These pile rails, 15 feet long, were pointed and driven through firm gravel and boulders to a penetration of about 10 feet, using a builders' small piling frame and a light drop-hammer actuated by a Fordson winch. The field cost of this bridge, i.e., excluding superior direction and supervision, worked out at about £8 per lineal foot.

The use of tramrails has been extended to cattle-grids, for which they have proved very suitable. Because of their favourable shape and heavy weight they make a much more stable and comfortable running surface than any other material that has come under the notice of the writer. Apart from the saving in cost, the feature which most commends itself is the absence of noise and rattle. The layout of the grid follows, in principle, that recommended for general adoption by the Ministry of Transport, modified for use by the Commission in Scotland, and embodying tram rails as the bearers.

Future Types of Beam Bridges

When the present stocks of military rolled steel joists are used up, future spans of 20 ft. to 50 ft. will include two types of bridges both well suited for forestry purposes. From 10 to 30 ft. simple slabs of concrete of constant depth, reinforced with straight (uncranked) steel rods, will be adopted where conditions suit. Thus, a 20 ft. span will be a simple slab 13 to 15 inches deep, reinforced with straight longitudinal steel rods of one inch diameter at 6 inches centre, with transverse rods ¾ inch diameter at 12 inch centres. Except for a slight camber the depth of the slab will be uniform, i.e., there will be no girders. Though these will not be so easily erected or so straightforward as the tramrail type, they will be more suited to forest conditions than the conventional type of reinforced concrete which employs moulded beams and deck. The latter requires more elaborate formwork and reinforcing steel, as well as concrete of higher quality, all of which calls for more supervision and skilled labour. Concrete of medium strength, using local gravels, can quite safely be used for the simple-slab type of structure. Probably the most important point to watch is that the cement be fresh.

For spans of 30 to 50 feet the so-called "composite bridge" of rolled steel joists and concrete deck may prove the most suitable under certain conditions. In this type, a concrete deck is cast on the top flanges of the joists, to which are welded or rivetted devices which enable part of the compressive stresses to be borne by the concrete, instead of entirely by the steel. This effects a considerable

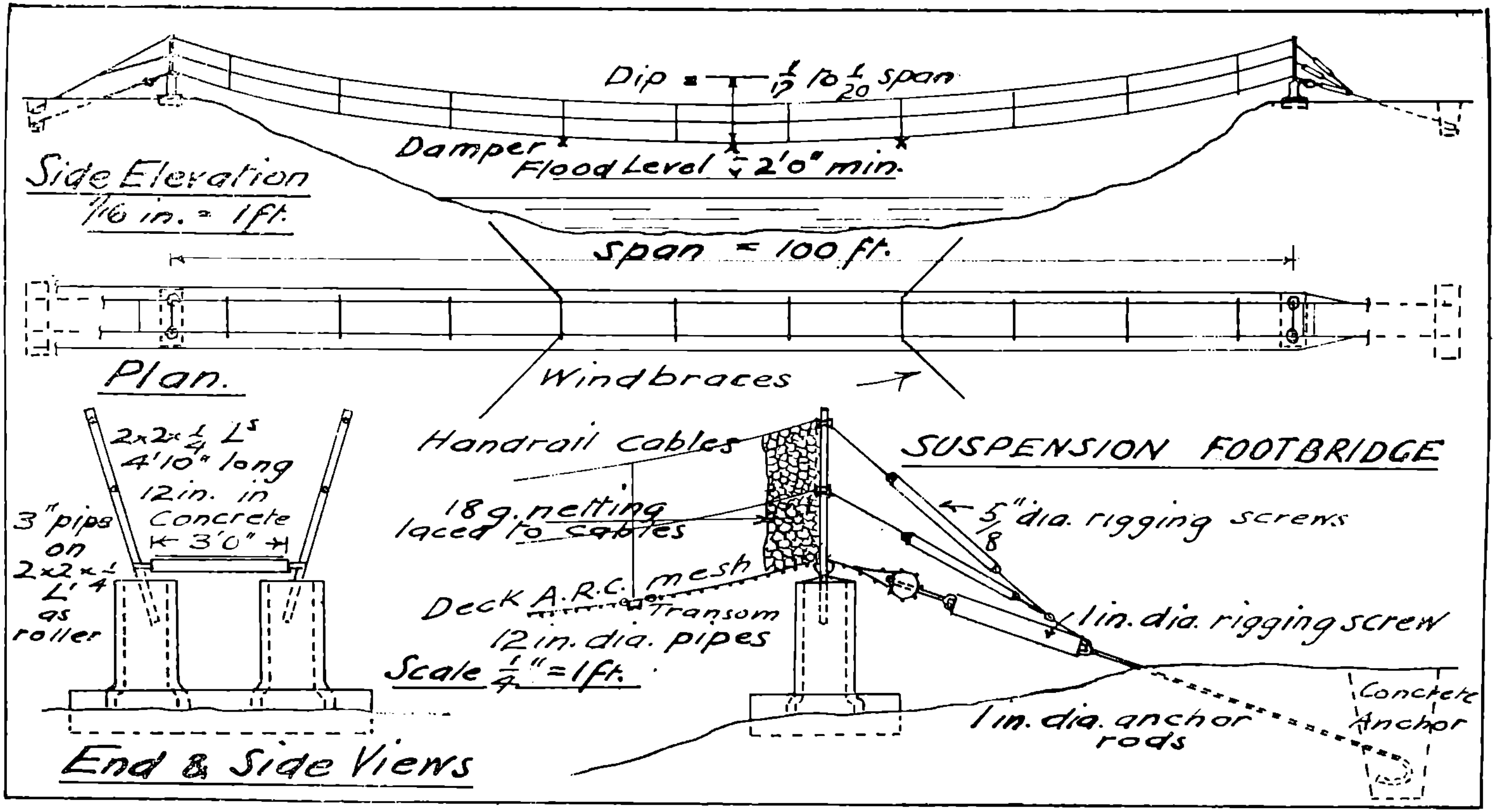

Fig 3. Suspension Footbridge. Details of Construction.

saving in steel. Disadvantages of the composite bridge are the extra work and cost involved in adapting the joists, and the relatively high-class work called for in the deck-slab. Nevertheless, it seems at the moment to be the best available alternative, and designs have been prepared in readiness for its adoption.

A comparatively recent development in reinforced concrete practice is the so-called "prestressed concrete" which is finding favour for structures, including bridges, both large and small. Large bridges are built in situ, using special equipment to apply the prestress. Small structures may be built up in situ from prefabricated components. But the writer sees no scope at present for prestressed concrete in the relatively small and usually isolated bridges on the Commission's forest roads.

Suspension Footbridge

The special function of this type of bridge is to provide pedestrian access at sites where the cost of a vehicular bridge is not warranted; the object is, usually, to reduce walking time. A type of military bridge developed during the second world war for pedestrian and light-vehicle traffic, generally for short-term use in difficult country, has been adapted for forestry purposes; the design provides for a simple, light, cheap and quickly-erected structure, easily maintained in safe condition if given occasional inspection and attention. (See *Fig.* 3).

The ideal site is one where the height of the river banks is sufficient to ensure adequate clearance above flood level when the span is stretched to the designed dip (sag), thereby avoiding the necessity for high artificial supports.

In essence, the bridge consists of a length of wire mesh, stiffened with cross-timbers at about 10 ft. intervals, supported on piers of simple construction which keep the mesh clear of the ground, and tied to anchorages, preferably of concrete. The mesh is three inches square, made of No. 3 gauge steel wire (one-quarter inch diameter).

This netting forms the deck and its longitudinal wires act as the suspension cables, and therein lies the reason for the low cost and light weight of the structure. "Handrails" on each side consist of two wires of extra-flexible balloon cable of about one-fifth inch diameter with a breaking strain of 2 tons; these wires are so adjusted as to be nearly parallel with the deck, and they support the 18 gauge sheep netting which forms the sides. Care must be taken to see that these "handrail" wires and mesh take no part in carrying the load of the bridge, which can be the case if they are stretched too tightly. Adjustment of the tension of both deck and side wires is effected by means of turnbuckles (rigging screws). An important point about the steel mesh is that the welding of the transverse to the longitudinal wires must be "deep penetration". Ordinary reinforcing mesh is usually only lightly welded at the crossings of the wires, and may not be strong enough for the normal type of field joint used at the junctions of sheets of mesh.

The piers shown in Photograph 6 consist of 12 in. diameter culvert pipes 8 feet high, reinforced inside with a cylinder of wire-mesh and filled with concrete of local gravel. Alternatively, brick, mass concrete or timber may be used as piers, and in exceptional cases, where the river banks are high above water level, it would be possible to dispense with piers altogether and to use only a sill. The tendency of the bridge to undulate is damped down by two lengths of heavy tramrail weighing about 1¼ cwt. each, fastened at about the third points of the span. From the ends of these rails, wires which serve as wind-braces are secured to pickets on the river banks.

The first two of these bridges was erected over the Glenbrittle River on the Island of Skye, by forestry labour led by a Headquarters' Clerk-of-Works. The material had to be transported from a depot on the east of Scotland, involving a round trip of 260 miles. The larger of these bridges has a clear span of 100 feet, flanked by side-spans of 30 feet each, total 160 feet. The wire mesh weighs 12.2 lb. per square yard, and the weight of the whole length is about 6½ cwt. The cost worked out at about £200, or about 25/- per foot.

When these bridges were being constructed, the river happened to be low, which enabled the mesh to be placed in half lengths from each side of the river, and jointed in mid-stream. Had this not been practicable, the whole length could have been pulled across from one riverbank by means of a Trewhella jack or by block and tackle.

There are no points about the design worth special mention, except that the dip or sag should be about one-seventeenth to one-twentieth of the span, or in the case of 100 ft. span, 5 to 6 feet. Horizontal tension at mid-span can, of course, be reduced by increasing the dip, but this tends to create rather steep grades near the piers. The safe load on a span of 100 feet with a dip of 6 feet is about 20 men, evenly spaced.

Wire mesh does not provide an ideal footpath for high-heeled shoes, but this demerit could be overcome by affixing a central strip of ruberoid or bituminous damp-course, say 18 inches wide. The mesh was expected to prove unattractive to animals, including rabbits and deer, but it may be mentioned that the forester's dog now makes the passage, though somewhat reluctant to begin with.

A matter which affects the life of the bridge is that the wire mesh should not touch the ground. The ends should be turned around a pipe or length of round timber, through which pass solid tie-rods which transmit the pull to the anchorages. As previously stated the latter should preferably be of concrete, but for quick temporary erection each anchorage may consist of a round or square log, buried sufficiently deep to develop the required resistance. Tie rods are placed in narrow trenches which are subsequently backfilled. In choosing the size of rod, a margin is allowed above the actual strength requirement, to cover loss by corrosion: though if the rods are treated with bitumen or red lead, such loss can be small.

Timber Bridges

If trees of suitable species and size are available there is much to commend the idea of improvising small bridges from locally-grown timber. In their simplest and cheapest form, these bridges may consist of round logs as stringers resting on ground sills, both types of timber being lightly adzed at crossings to ensure a reasonable bearing surface. Stringers should be secured to ground sills with drift-bolts consisting of 18-inch to 24-inch lengths of plain round steel, ¾-inch diameter, driven into ⅝-inch diameter bored holes. Heads and nuts are unnecessary. The upper surfaces of the logs should be lightly adzed to a plane surface to receive 3-inch-thick sawn deck planks, which latter should be secured to the stringers with deck spikes 5 inches long.

Apart from the question of durability, there are considerations which restrict the use of wooden bridges to a limited field. Principal amongst these is the continual increase in the weight of the loads to be carried. During the early stages of the life of the forest, heavy plant such as tractors for ploughing and excavators for road extensions, usually, for convenience, carried on transporters, are the heaviest items, and loads of this type limit the longest timber span to about 16 feet. There is also a marked tendency towards the general adoption of longer and heavier commercial lorries, frequently loaded well up to their nominal capacity. Differences in gauges of these loads, together with a certain amount of freedom to wander off-centre, can cause uneven distribution of the load and hence possible overstressing of individual stringers. Taking these and other factors into account (such as wide differences in the strength of various timbers) there is ample cause to use a high factor of safety.

As a practical example, a 16-foot span would require not less than six stringers of 15 to 16 inches diameter to cope with loading of the nature referred to above. At best, 20 feet could be regarded as the longest practicable span of the simple stringer type. At sites where a longer bridge is necessary, rather than resort to multiple spans of timber (which tend to obstruct the waterway), it is better to use rolled steel joints in longer lengths.

Nevertheless, the writer believes that when mature trees of suitable dimensions become more readily available there will be increasing scope for bridges constructed from locally-grown timber, especially in remote areas.

The total length of bridges constructed by the Forestry Commission in Scotland during the last five years now amounts to nearly a mile, distributed along 600 miles of road much of it in remote localities. They are being added to yearly, and obviously any type which is adopted should be carefully considered not only from the standpoint of practicability and cost, but of long-term maintenance as well.

THE INTEGRATION OF FOREST OFFICERS' DUTIES IN COMMISSION FORESTS AND PRIVATE WOODLANDS

By J. P. NEWTON
District Officer, South-West England

As my district was one of the three in the far South West of England which were used as a pilot experiment for the combination of Private Woodland and Commission Forest work at District Officer level, I thought it would be of interest to give a brief history of the scheme as clearly as I can remember the early details.

In the early part of Forest Year 52, it became obvious that Private Woodlands District Officers could not manage to inspect all the woods involved in the large number of felling licence applications which they were then receiving.

Two things were done to help carry the load, Two Foresters were put on private woodlands work to take some of it, and the Conservator instructed that hedgerow licence applications for woods within easy reach of State Forest District Officers' homes were to be sent to them for the necessary inspection and subsequent report. Very soon it became apparent that there was a considerable overlap in time and travelling, as the Private Woodlands District Officer was still covering the same large area on his other work. About March 1952, the Conservator, Mr. A. H. Popert, called a District Officers meeting in Bristol, and at this he put forward his "Combined Operation" scheme for discussion and criticism.

Briefly, the scheme was to give the District Officers complete charge within their districts. They were to remain responsible for the management of the Commission's own forests, they were to undertake all licence inspections, all Private Woodlands Advisory Work, all matters to do with Dedication, Approved

Woods and Small Woods. They were to keep a watch for possible cases of illegal felling within their districts, and they were to undertake the first stages of acquisition for the Commission of bare and derelict land. This meant that they would make the first approach to an owner of such land, find out whether he were willing to sell or lease at a price acceptable to the Commission, and if so to forward a report to the Conservancy Office.

The chief advantages of the scheme were that:—

Travelling time and mileage within the Conservancy as a whole would be reduced; each District Officer would build up a complete knowledge of his own district; the Private Woodland Officer who also administered Commission forests would have an added value to woodland owners as he would be more intimately aware of local conditions; also he would be more immediately available to such owners if they had problems they wished to discuss.

The discussion with the District Officers at this meeting suggested that there might be snags. First there might be conflicting loyalties in a District Officer to Commission Forest or to Private Woodlands work. If this happened more time might be given to one side of the job than to the other, which might suffer thereby. It was also suggested that woodland owners might object that their own District Officer would be less available to them.

With these possible snags in mind the Conservator put forward his scheme to the Director of Forestry for England, Mr. O. J. Sangar, and after due consideration it was decided to start a pilot experiment in the three districts west of the river Exe. At this stage full responsibility for initiating possible acquisitions had not been given to these District Officers.

After the pilot experiment had been going for a few months from May 1952 the Director came down to see how it was working, and called a meeting of the District Officers concerned in the Launceston Office. The chief thing that emerged from this meeting was that District Officers did not yet know their districts very well. They knew a bit about the managed woodlands but practically nothing about land ownership of the many unproductive areas of farm land and woodland. They could not yet be said to have a complete knowledge of their districts, especially as it was from these unproductive lands that future acquisitions must come. It was therefore important that a descriptive record be built up of all land suitable for forest use. There was some discussion of the best form for this record to take, how it should be compiled and kept, and it was partly as a result of this discussion that the Land Use Books and Maps were brought into being.

About a year after the pilot experiment had started it was decided to extend the system to the whole South-West Conservancy. There was one slight variation, in that four of the districts were put under dual control. In each of these two pairs of districts a senior District Officer was in complete control of both districts, but the junior Officer did all or nearly all of the work in one of them. At the same time, in two of the other districts, the largest ones, newly joined officers under training were sent to assist with inspections, etc., under the control of experienced officers. The two private woodlands Foresters were retained for a time to help with inspections. They covered part of several districts as required, but later, with the opening of further new units, they returned to take charge of Commission areas. The plan from that time was for District Officers who needed help in carrying out inspections to enlist their own Foresters for this work.

It was suggested that devolution be taken a step further and that the two Divisional Officers in the Conservancy should each take half of the Conservancy and each in his own Division control both private woodlands and Commission

Forest work. It was decided not to do this for several reasons, one of the chief being that under the existing system the private owners still had one technical officer who dealt only with Private Woods. It was thought necessary that this should continue to be so.

The effects of this scheme of integrated duties within the districts may now be reviewed.

First, all the good points of the scheme as it was originally envisaged have been borne out in practice. Second, the snags which were expected have not materialised. There has not been any conflict between Private Woodlands and Commission Forest duties, and neither Divisional Officer has had cause to complain that his work was not getting sufficient attention. Also on the whole, private owners seem to have been quite satisfied with the new arrangement, and in several cases they have been interested to hear that methods of work and silvicultural ideas, which the inspecting officer is urging them to adopt, have been applied with success at nearby Commission forests. If they want to see the systems in action the District Officer can invite them to come and see the example in a Commission Forest. This is also a great help to the District Officer as he can speak from practical experience very often, and not only on theory. The only criticism levelled by private owners has been that Commission Officers for any one area seem to change very frequently, and so they are not assured of continuity of advice. This criticism was made, however, shortly after the change took place. Now it would seem likely that District Officers, once the number and size of districts has been stabilised, will remain in one area for longer than before, as there will be no need to move them to give them experience of both kinds of work.

Certain other aspects of the scheme call for comment. First, the District Officer cannot always visit Commission forests so frequently as before, and more reliance must be placed on the Forester in charge. Second, that a Forester is available to him, in appropriate instances, to assist with inspections and advice on estates near his forest.

Third, the District Officer must be rather more punctilious in his dealings with private owners than with other Commission staff. The Conservator and his office staff will realise that if their letters are not immediately answered by the District Officer he is probably snowed under with work, and they will not take it as a personal affront when there is a delay of several days, but the private owner looks for an immediate answer to his letter, and he must have it.

Fourth, there is a limit to the number of Districts into which a Conservancy should be divided. If the Districts become too small and have in them too few Commission Forests, there is a danger that they may become too parochial silviculturally. There will not be enough diversity of forest types to give either the officer sufficient experience or the private owner sufficiently experienced advice. It is important also, that the District Officer shall be familiar with land on the fringes, as well as in the centre, of his district.

With regard to the future of this scheme there are one or two points which must be borne in mind. The volume of private woodlands work is increasing all the time, every dedicated estate brings a certain quota of work which must be done each year, felling licence areas subject to replanting conditions come up for inspection, more and more contacts are made which may lead to forestry work of one kind or another, and in any case if forestry work is advisable, these contacts must be re-made from time to time to try to persuade owners to act.

At the same time new Commission Forests will be created and these will also add to the District Officer's commitments, and such forests in his District may not be conveniently situated for him to obtain much local help on private woodlands work. The first essential therefore is for the District Office to have an intelligent clerk. He can take much of the load of office work from the officer, and he can certainly ensure that owners are never left wondering when their letters are even to be acknowledged. Having a clerk the District Officer will be able to go out for a longer time into the field, but there is likely to come a time when he even needs more help there than he can get from his own Foresters. He may then need to employ a private woodlands Forester. In many ways it would be wise to give this job to a senior man, preferably senior to the other foresters in the district, for then he could give help not only with private woodlands work but with Commission Forest work as well. In this connection he may be invaluable to help train young Foresters newly appointed to their own units.

With regard to the future training of District Officers, it must be remembered that it is not fair either to the Officer or to the owners to put a man in charge of private woodlands work until he has thoroughly got the feel of the neighbourhood through experience in the Commission forests there. This really means that he must serve an apprenticeship under a senior officer, but that does not mean that he must go about a great deal with that senior officer as a mere observer. He must be given definite jobs to do, to begin with, mainly in Commission forests, but later, when he has more knowledge, he may help with private woodlands work as well.

To sum up therefore, in the integrated district the officer gets to know his area really well, the silvicultural possibilities of the local soil and climatic conditions, the possibilities of acquisition in various areas especially those near existing units, the forestry consultants and contractors, and the private owners with their various problems of estate management. As it has worked so far there do not appear to be any real drawbacks and a good many advantages.

THE BALANCE SHEET AND SUPPORTING SCHEDULES

By G. T. SAMPSON

Senior Professional Accountant, Headquarters

The following paper was delivered at the Chief Clerks Conference at Northerwood House, March 30th—April 1st, 1953.

By way of introduction to the subject of "The Balance Sheet and its Supporting Schedules", it would be as well to clear the arena, and decide what we mean by "Balance Sheet". The phrase is so very loosely applied nowadays, that one person's idea of a Balance Sheet is never the same as that of the next person. I suppose we are all familiar with the benevolent old gentleman who rises at a meeting in the village hall to present the Annual "Balance Sheet" of the village Bowling Club. His audience sit back and nod wisely, or make rude remarks, as he reels off what the Club has spent and what it has received, leaving the magnificent sum of £x safely in the Post Office Account. Amid cheers or boos, as the case may be, the so-called Balance Sheet is adopted. That is not the kind of Balance Sheet we are discussing today. In fact, what the benevolent old gentleman refers to is not a Balance Sheet at all. The purist would call it a 'receipts and payments' account.

The Conservancy Balance Sheet is a vastly different thing, and is designed to give a bird's eye view of the ultimate result of the countless number of transactions which have occurred and have been recorded during the specific period up to the date of the Balance Sheet. Each recorded transaction of the Conservancy has been codified, classified and analysed and put through the grinding machine of the system of Accounts, until there emerges the distillation—so to speak—which is presented to the reader in Balance Sheet form.

Our Conservancy Balance Sheet has been designed along the lines of best modern practice. This practice has been hammered out through the ages, and a Balance Sheet is of such importance that legislation has laid down the *minimum* amount of information which must be given. The best known legislation is probably the series of Companies Acts which have appeared from time to time, and which fall to examiners in setting examination papers like manna from heaven. It would be quite legitimate to ask what bearing all this has on a Conservancy or on the Commission.

I think the answer is in stewardship and a picture of that stewardship in a quickly assimilated manner. The law realised that, where a few individuals were responsible for utilising the funds belonging to other people, then the interests of the latter must be safeguarded. One of the tools designed to do this was the Balance Sheet, because it gave a comprehensive but compact summary of what had happened to other people's money. From this point of view alone, it is apparent how important the Conservancy Balance Sheet becomes, since we are dealing with the funds of millions of people. It might be said that the treasurer of the village bowling club, referred to previously, has given a perfectly good account of his stewardship. He certainly has clearly stated where the money came from, on what goods and services it has been spent, and how much remains, after the year's activities. This may or may not be sufficient for the few people who constitute the club, but the all-important questions remain completely unanswered by the statement presented to them. What assets have we? Have we increased them or decreased them, and if so, by how much? Do we owe money to outsiders, and how much? If these are just a few of the questions which arise in a tiny affair like our Bowling Club, with its one simple and constant object, then a vast and growing organisation like the Commission requires something more than an elementary recital of payments and receipts. Management at the top—and I carefully refrain from describing its constitution —is by its nature remote from the sphere of operations. If they are presented with a properly drawn up Balance Sheet, it enables them to see the results and meanings of the transactions of a given period and their impact on what has gone before. We have therefore the complete picture from birth to the Balance Sheet date. To see *how* the results have come about, the whole Statement of Accounts is at one's disposal, whereby explanation is offered in greater detail. The details of other items, not covered by the accounts, are of course contained in the Schedules supporting the Balance Sheet. These Schedules merely remove detail from the Balance Sheet and so preserve its compactness.

There, in outline only, is the Balance Sheet to which we refer when talking about the Conservancy Balance Sheet.

Let us look a little closer into the various items which appear on the face of this Balance Sheet.

First of all the *Assets Side*. Assets may be classified as either fixed or current. There is no generally accepted hard and fast rule that because an asset has such and such name, it must invariably be a fixed asset. What is a fixed asset to one concern may be a current asset in another. There is however, a broad principle to guide us in this matter. The Fixed Asset is that which has been acquired for purposes of retention over a long period, and which the business must have if it is to function as a business. No dealing is done in the ordinary course of trade by the buying or selling of such assets. Any sales which might occur are because of a surplus to requirements, or more often, because of obsolescence. Purchases likewise are replacement of obsolescent items or for expansion of scope of activities.

The current asset, on the other hand, is one in which the undertaking is actually dealing as part of its ordinary trading transactions day in and day out. No sort of permanence attaches to these current assets—they are like the waves of the sea, always there but always different ones.

If the Forestry Commission were only to come into being on some foreseen date, how simple it would be. The acquisition of an asset would then be recorded at cost as and when it took place. However, the cold fact remains, that over the past thirty or so years, we have accumulated a vast quantity of assets and we must arrive at a figure of cost, or closely estimated cost, for those assets. It is better to stick to the cost basis (or to estimated cost), as any other method would result in many inequalities and anomalies. The compilation of these lists of past-acquired assets will, of course, be a fairly long-term process, and meanwhile the cost of presently-acquired ones will automatically be recorded in the various asset accounts. As the figures for past-acquired assets are brought into the books, the capital account of Conservancies, i.e. Headquarters Current Account, will be correspondingly increased.

Although this listing and pricing of assets—using a somewhat casual term—appears to be a formidable order, a good deal of the necessary information will already be found in Conservancy offices. It requires patient excavation and collation, and an ever-watchful eye to see that the ultimate goal is not swamped or obliterated by masses of detail.

The basis of putting a price on Fixed Assets is, as mentioned, cost or estimated cost. Items like Freehold Land, Acquisition Expenses, Vehicles and Machines, Sundry Plant and Machinery should not present much difficulty, as there will be some record of their purchase cost. A fair amount of digging back into past records will no doubt be required, and some of this work is already under way in the work on Area Records. Assets created mainly by own labour and own materials—such as Roads, Sheds, and Lookout Towers—will most probably be the subject of close estimations in cost, carried out by the officers concerned in conjunction with whatever past records or information are available. A steady, constant build-up is required. I have no means of giving an estimate of how long all this will take, but the longest journey is started with the first step, and it is amazing how much ground can be covered by steady plodding.

The Schedule of Fixed Assets gives the make-up of the figure for each item in the Balance Sheet. Each item has two lines, the "A" line being the year's transactions added to or deducted from the balance brought forward from the previous Balance Sheet. The "B" line shows from inception, the total purchases, transfers inwards, new construction and other additions, and the deductions for total Sales, Transfers Outwards, Depreciation and other credits. From the two lines, therefore, we can see firstly the impact and result of the one year's transactions, and secondly (Line B) how all the assets right from the first were built up or dispensed with.

In Current Assets, possibly the most important and spectacular item is "Commission Forests". I will not expand on the method of arriving at the initial cost of these, but suffice to say that the annual cost of Silvicultural Operations is added to the initial cost of Commission Forests. The annual cost of Silvicultural Operations is, of course, disclosed in a separate account. This accumulated cost, together with any standing timber purchased, gives the cost price of Commission Forests. The cost of timber supplied from Commission Forests for sale, conversion or own consumption is credited to Commission Forests Account.

In the case of Nurseries, a Schedule summarises the additions to the valuation at the beginning of the year, and the deductions in the form of sales of plants and transfers outwards. It is anticipated that a more accurate appraisal of the cost of growing nursery plants will be possible. In theory, the principle is that all Nursery expenditure will be cancelled by the charges made for sales of plants and for issues of plants. In practice, of course, this balance will never be obtained, as there will always be quantities of growing plants on hand, from year to year. These growing plants, and unexhausted manurial values, constitute our Nursery valuation—one of the few departures from the principle of stating assets at cost.

Before leaving the subject of Current Assets, I would like to touch upon the subject of "Stores". Allocation to operation is made by means of the Direct Overhead Account, and at the moment is on a somewhat arbitrary basis. The guiding rule is that the main purpose of the Stores item decides where it is to be charged when issued for use. It must be remembered that because an item, say expenditure on a spade, has been charged to Planting, the spade itself is not written off. It has been issued from stock of stores, and the cost of it charged to Planting, but the article itself still remains "on charge" to the Forester.

It may well be that the purchasing procedure and stores issue procedure require considerable overhaul, but there are other more important matters which take precedence at the moment.

The remaining item—Sundry Debit Balances—requires very little explanation. You can see the kind of things which go to make it up, and I can only repeat the time-honoured warning about making the word "Sundry" one's servant and not one's master.

The *Liabilities Side* of the Balance Sheet can be divided into three main groups:

(1) Main Fund—i.e. H.Q. Current Account.

(2) Outside Parties' Fund—i.e. Current Liabilities.

(3) Revenue Fund—i.e. Balance of Consolidated Profit and Loss A/c.

A glance at the other side of the Balance Sheet shows how these three funds have been invested in Fixed and Current Assets.

The Headquarters' Current Account forms in effect the Capital Account of the Conservancy. Advances to the Conservancy, payments made on behalf of the Conservancy constitute the flow of capital from Headquarters. Any items incurred *by* the Conservancy *on behalf* of Headquarters are of course deducted, and the net balance appears in the Conservancy Balance Sheet as Headquarters Current Account.

The corresponding item in the Headquarters Balance Sheet is the Forestry Fund. The Headquarters Balance Sheet will contain the results of many more activities than does the Conservancy one. Research, Education, Publications, mentioning a few, are all activities carried on by Headquarters. Any expenditure incurred by Conservancies on these activities will automatically be transferred to Headquarters through the medium of the Headquarters Current Account.

The cost of Services to Private Woodland Owners is at present transferred to Headquarters, and the total cost of these services will presumably appear in Headquarters Balance Sheet as an appropriation of part of the Forestry Fund. I sometimes wonder whether the name "Services to Private Woodland Owners" is not a little misleading. There are really two kinds of services the Commission performs. One is the service offered by the Commission to private woodlands by way of advice and supplying of labour and materials. For this service the Commission is entitled to charge the recipient and in fact does so. The unpaid portion of this service appears in Sundry Debtors or perhaps Recoverable Charges. The other service is the administration of licensing for felling, and the paying of the various planting and maintenance subsidies, all of which are regulated by Statute. As our Balance Sheet is referring to the latter item, a certain amount of confusion could arise where the difference between the two types of service is not appreciated. Incidentally, it will be interesting to observe in the future how the total amount of the various grants compares with the cost of administration of those grants.

The liabilities to outside parties, under the heading of Current Liabilities, require but little comment here. The method by which the figures are ascertained belongs to the descriptions of the basic records. In addition to the normal trade creditors, the Current Liabilities may contain provisions for unpaid work in progress. For instance on Housing contracts there may very easily be a large amount of work carried out by the builders for which no demand for payment has been received up to the Balance Sheet date. In order to get a true picture of the affairs, provision will have to be made for this.

The "Items in Suspense" heading is a temporary one, and is used only for those credit balances at the Balance Sheet date which are held in abeyance until it is known what to do with them.

The third group on the Liabilities side of the Balance Sheet is the Revenue Fund, that is the net balance of surpluses and deficits. At present, we have contented ourselves with merely marshalling the various surpluses and deficits on the face of the Balance Sheet. No attempt has been made to show how these surpluses or deficits will be dealt with. All this will be a matter for "high level policy" and our immediate duty will be to discover the facts and display them clearly and compactly on the Balance Sheet. Many matters have to be taken into consideration, not the least of which is the matter of interest due to the Treasury on Forestry Fund advances and value of property acquired under Forestry (Transfer of Woods) Orders.

Apart from all these "high level matters", there is one point of domestic interest to Conservancies. At what point should Directorate Overheads and Headquarters Overheads be brought in? Ought Conservancies to be loaded with a proportion of these overheads? I think you will agree that to load the Conservancy Accounts in this manner would be unnecessary. Apart from considerations of the clerical labour involved, the Conservancies have no control over the proportion of these overheads to be borne. It seems fair and reasonable that the Conservancy Consolidated Profit and Loss Account should show the unadulterated results of its own activities, and the Directorate and Headquarters Overheads should be added as the Accounts proceed up the chain.

As our forests grow older, the sales of timber will increase. The account entitled "Preparation and Sale of Timber, Minor Produce and Minerals" will become the main account and the other accounts such as Estate Lettables, Estate retained by Minister, Farms, if any, will become of less importance when compared with Preparation and Sale Account. Silvicultural Operations and Nurseries Accounts will remain very important, for they, among other things, will regulate or decide the cost of produce which we are selling. It is confidently hoped that we shall be well and truly in "big business" when the emphasis on Establishment of Forests changes to Extraction from Forests.

Now, I have ranged over the Assets side and across to the Liabilities side. The Balance Sheet is an interesting document and when properly compiled gives the picture right from the inception of a business. In this sense it is an historical record, but because it gives the disposition of Conservancy or Commission resources, it can provide a springboard for taking off into future policy.

The truth of a Balance Sheet is obviously dependent on the truth of every entry in the books of account. It is not at all a bad plan to cultivate the art of appreciating the effect of a transaction on the "Balance Sheet".

NATURAL HISTORY NOTES FROM THE HIGHLANDS

By K. A. H. CASSELS
District Officer, North Scotland

"The wonder of the world, the beauty and the power, the shapes of things, their colours, lights and shades; these I saw. Look ye also while life lasts."

To those interested in natural history, work with the Forestry Commission offers much of interest and endless opportunities for seeing the unusual and appreciating the beautiful. Here are a few experiences which will still hold their niches in my memory when my knees have grown too stiff to take me to the hill.

An acquisition survey in the Trossachs was the occasion of two such. The month was late October and the weather (surprisingly) had been fine for some days. The grey rocks stood out boldly against the golden birches and russet bracken and no ripples troubled the surface of Loch Katrine. I was walking through hillocky ground in scattered birch, when, coming over the crest of a knoll, I saw a golden eagle sitting on a rock not twenty yards below me. Unfortunately I had no time to dodge back out of sight before he saw me and, spreading his great wings, flapped hurriedly away, giving me a magnificent view as he did so. I have seen eagles both before and since as black specks in the sky, inanimate silhouettes drained of all colour, but never have I seen an eagle so close that every shade and gloss and sheen of gold and brown was visible against the hillside below me. As the wings opened, I saw that the greater part of the tail feathers were white, indicating that the bird was young, still in juvenile plumage, and this, perhaps, accounted for his presence here, rather outside the eagle's usual range. Young eagles, as with many other birds, tend to wander when no longer dependent on their parents—an arrangement apparently designed to increase the range of the species. The light tail feathers of the juvenile plumage have given rise to not a few reports of the rarer white-tailed or sea eagle.

I saw my friend again later in the day, back in more usual perspective as a small black speck high in the sky. He was being mobbed by a pair of ravens and, while I watched, a party of hoodies joined in. This was too much and the eagle swung away over the hills towards Crianlarich. It was interesting to see the two species of Corvidae side by side and it brought out strongly the difference of size and voice and emphasized the complete mastery of flying technique of the larger bird. The difference brought to mind the clumsy gambols and shrill yelps of puppies as against the strength, agility and control of the mature dog.

On another day shortly after, I was working my way along the Loch Ard Forest deer fence when a rustling in a clump of dead bracken attracted my attention. At this point the fence bent at an angle towards me so that the animal causing the sound was almost cornered. I approached quietly, therefore, in the hope of getting a good view, nor was I disappointed. I had just stretched out my stick to stir the bracken gently when there was a noise like a soda siphon and a three parts grown wild cat shot out of the other side into the angle of the fence. Here she cowered for an instant and then, half jumping, half climbing, she scaled it and disappeared in the bracken beyond. I suppose she was not in sight for more than ten or fifteen seconds and yet I have a clear picture in my mind of the broad skull and flattened ears, of grey and black tiger markings and —hall-mark of authenticity— the short bushy tail of the true wild cat.

I have not yet had the good fortune to see a wild badger, though I know of several earths, but my most recent meeting with a fox occurred under rather surprising circumstances. Having occasion to visit Ceannacroc Forest, I set out from Inverness and shortly, beyond Urquhart Castle, I rounded a corner to find a full-grown fox sitting calmly in the middle of the road eating a run-over rabbit—and this at eleven o'clock in the morning!

On another occasion I had to inspect the source of a water supply in a forest not far from Inverness. Walking up inside the forest fence I noticed some curious erratic movements in the long grass in front of me just beyond some pine branches, débris of a recent storm. On reaching the spot I found a beautiful cock capercaillie with one foot in a rabbit-snare. I freed him and took him in my hands and as I looked at his scarlet eyebrows, at the irridescent sheen on his neck and the delicate lacings on his feathers, I found myself, like Sir Bedivere with the sword Excalibur "valuing the giddy pleasure of the eyes". I let him go and, for all I know, he still nips an odd bud or two from the Commission's pines!

Perhaps the high spot so far in my natural history experience is seeing and identifying a hen harrier from a road in Easter Ross, which shall be nameless as I understand the birds bred not far away. Driving along, this large pale buff bird caught my eye as it followed approximately the line of a small burn. Dragging my attention back to the road just in time to prevent an unpremeditated descent into the ditch, I stopped quickly and got out my binoculars. The bird was certainly a hen harrier, though too far away for many details of plumage to be visible, but the flight was quite unique. Most bird books make reference to "methodically quartering the ground" when speaking of the flight of harriers. A more misleading statement—to me at least—I cannot imagine, unless a white butterfly fluttering to and fro above a cabbage patch is "methodically quartering the ground". The flight of the harrier was like nothing so much as the aimless and erratic wanderings of a butterfly, largely, I think, because the bird holds its wings much higher above the body than most (at an angle of almost 45 degrees), very much as a butterfly does at certain stages of its flight. Thus the body swings somewhat in the manner of something suspended from a parachute before it has reached equilibrium. A similar effect may sometimes be seen in spring in the courtship flights of pigeons when the birds glide with wings steeply raised.

These are some among many pleasant memories of days spent in the wood or on the hill—of watching deer, both red and roe, in the Old Caledonian Forest beside Loch Beinn a' Mheadhoin where (apart from the loch itself, of course, which has been much raised by the Hydro-Electric Board) it is possible to look around and say "These woods haven't changed in a thousand years"—of the enormous otter that crossed the road in front of me below the Gribun Rocks in Mull—of the pair of Canada geese which I saw at the mouth of the Aros (still, so far as I know, the only record for the Isle of Mull)—of the two barnacle geese, which I found on the saltings between Inverness and Nairn, so tired with their flight from far Spitzbergen that they would only walk away when I got to within fifteen yards—of the wild goats on Ben Lomond and the grey Atlantic seals who will come to listen to you if you sing to them—albeit only from curiosity!

Indeed, many pleasant memories—but I wonder if I shall ever see a pine marten?

REPORT OF THE LYNFORD SCHOOL BIRD CLUB, 1953

The year's work of the Club may be summarised under the following heads:

1. The Official Nest-box Experiment.
2. The Club's Nest-box Experiment.
3. Observation and Recording of Species, Migrants and Natural Nests.
4. Participation in the British Trust for Ornithology Bird Ringing Scheme.

Weather

Although the early weather in late February was mild it turned cold in March, but in spite of this, nest building did not seem to be interrupted as had been the case in the previous year. Throughout the season the weather continued mild with frequent periods of rain.

A comparison with last year's dates for the start of the nesting period at both Cranwich and Mousehall is made below:—

Coal Tit — Mousehall: 5 days later than 1952, lasting 6 days longer.

,, ,, — Cranwich: 5 days later than 1952, lasting same time

Great Tit — Mousehall: Approximately same time as last year.

There were insufficient data to fix breeding dates for Great Tit at Cranwich or for Blue Tit; but, in general, the breeding season was about a week later.

Official Experimental Areas

The boxes at Mousehall remained in the same position as the previous year, but at Cranwich the boxes in the Scots pine extension were re-sited.

Scots Pine Block, Cranwich

As in previous years a higher occupation figure was obtained from the Scots than from the Corsican pine.

Species. Boxes were occupied by six species—Coal, Great, Blue and Willow Tits, also Tree Creeper and Wren in the following proportions:—

	Coal	*Great*	*Blue*	*Willow*	*Tree Creeper*	*Wren*
Mousehall	47%	35%	12%	3%	—	3%
Cranwich	62%	14%	14%	—	7%	3%

The Willow Tit, Tree Creeper and Wren were additional species to the previous year.

Clutch Sizes

(i) *First Broods*

		Smallest	Largest	Average
Mousehall	Coal	10	11	10.5
	Great	9	11	10
	Blue	9	10	9.3
Cranwich	Coal	8	11	10
	Great	6	13	9
	Blue	8	12	10

(ii) *Second Broods*

Mousehall	1 Great Tit
Cranwich	4 Coal Tit
	2 Great Tit
	1 Blue Tit

Comparison of Breeding Seasons—Mousehall and Cranwich

The dates are those on which the first egg was laid.

	Area	*Extent of Season*	*Beginning*	*Ending*	*Number of Clutches*
Coal Tit					
	Mousehall	21 days	15th April	6th May	12
	Cranwich	13 days	18th April	5th May	14
Great Tit					
	Mousehall	20 days	21st April	11th May	8
	Cranwich	13 days	2nd May	14th May	2
Blue Tit					
	Mousehall	14 days	26th April	9th May	3
	Cranwich	7 days	26th April	2nd May	3

Coal Tits started breeding 3 days later at Cranwich as compared with Mousehall, and Great Tits were 11 days later.

Coal Tits were again the most numerous breeding species. The number of Great Tits at Cranwich showed a marked decrease on the 1952 figure, for which there seemed no obvious reason. It was encouraging, however, to find the Willow Tit again breeding at Mousehall after an absence of two seasons, and also the Wren and Tree Creeper at Cranwich.

Reduced Occupation

In both areas there was a still further reduction in the occupation figures which may in part be due to the disturbing effect on breeding population, caused by the weasel attacks of the previous season.

Mousehall dropped from 24.6% to 17.3%.

Cranwich dropped from 19.5% to 14%.

Desertions and Deaths

At Mousehall Coal Tits reared the most successful broods, there being only one case of desertion. One incomplete Great Tit clutch was deserted, and nestling mortality affected 3 broods. Out of the three Blue Tit's nests, one was deserted with eggs, and another with young. The Willow Tit successfully reared 3 young from a clutch of 9.

At Cranwich there were no desertions and nestling mortality was on a very small scale.

Club's Nest-box Experiment

The three areas A, B, and C were retained with only minor alterations in the siting of the boxes. Areas B, and C, had occupation figures of 45% whilst area "A" had an occupation figure of 30%.

		Percentage by Species			
	Overall Occupation	*Coal Tit*	*Great Tit*	*Blue Tit*	*Other Species*
1950	69%	5%	62%	31%	2%
1951	61%	22%	59%	14%	5%
1952	43%	18%	60%	13%	9%
1953	40%	24%	55%	18%	3%

As in previous years the Great Tit was predominant in all areas, but as can be seen from the above table, the overall occupation continued to drop, for which there seemed no apparent reason.

Deaths and desertions in the school areas were small.

Clutch Sizes

	Smallest	*Largest*	*Average*
Coal Tit	6	12	9.3
Great Tit	3	9	7.4
Blue Tit	5	10	8.25

In Area C a Great Tit incubated, for 6 weeks, nine eggs which turned out to be infertile. The nest eventually was deserted.

Other Species

A Tree Creeper nested in the same box on Area C as the previous year, but unfortunately out of the 6 eggs laid 3 were taken and the young which eventually did hatch out soon died.

Observation of Species and Natural Nests

The following first dates of migrant species were recorded by members throughout the season around Lynford Hall.

18th March,	Ringed Plover (Roudham)	19th April,	Blackcap
31st March,	Stone Curlew	19th April,	Reed Bunting
3rd April,	Chiff Chaff	19th April,	Tree Pipit
4th April,	House Martin	24th April,	Sedge Warbler
9th April,	Swallow	4th May,	Swift
10th April,	Whitethroat	5th May,	Garden Warbler
11th April,	Wheatear	5th May,	Lesser Whitethroat
12th April,	Willow Warbler	6th May,	Grasshopper Warbler
13th April,	Sand Martin	8th May,	Nightjar
15th April,	Cuckoo	10th May,	Turtle Dove
15th April,	Common Curlew	18th May,	Spotted Flycatcher
18th April,	Nightingale	20th May,	Whinchat
19th April,	Yellow Wagtail	10th June,	Red-backed Shrike

A young Kingfisher was found under the office window on 28th August, 1952, and was liberated down by the lake.

The pen Mute Swan died on 14th September, 1952, after successfully bringing up 8 young. A duck Golden-eye was observed on Longwater on 13th November, 1952. Two Whooper Swans and one Bewick Swan were seen on a local mere on 14th December, 1952. A pair of Garganey was observed on 12th April, 1953. The Golden-eye, Bewick Swan and Garganey are all new species on the School list, bringing the total to 119.

A Black-backed Gull was seen on fallow ground near Didlington Nursery during February. A dead Brambling was picked up in the Carriage Drive. Crossbills were observed on two or three occasions at Lynford Cross and Croxton.

A pair of Mute Swan returned to the lake in the Spring and reared 3 young from a clutch of 7 eggs. Two Tawny Owls' nests were found, one at Methwold on the ground in a Corsican pine plantation, and one on the water tower in the Hall grounds.

Natural Nests

Official B.T.O. nest record cards were complied for the following nests found by members.

Blackbird	8	Nightjar	4
Song Thrush	4	Little Grebe	2
Missel Thrush	1	Mute Swan	2
Hedge Sparrow	2	Coot	3
Wren	1	Mallard	6
Robin	2	Woodcock	2
Long-tailed Tit	1	Chiff-chaff	1
Pied Wagtail	2	Swallow	2
Tawny Owl	2	Moorhen	3
Whitethroat	1		
			49

In addition cards were compiled for occupied nest boxes as follows:—

Coal Tit	39
Great Tit	36
Blue Tit	15
Willow Tit	1
Tree Creeper	3
Wren	2
	96

Bird Ringing Scheme

The following species were ringed:—

Song Thrush	5	Coal Tit	44	Swallow	9
Blackbird	4	Tree Pipit	5	Hedge Sparrow	3
Nightjar	2	Yellow Bunting	3	Tawny Owl	2
Great Tit	47	Redstart	4		
Blue Tit	14	Whitethroat	6		

The number of rings used—148—shows a marked increase on last year's figure.

RAIDS ON NEST BOXES BY WEASELS

By D. A. SHERRELL

Forester, Education Branch

An interesting case of a predator adapting itself to a new source of food occurred in the severe and unexpected raids by weasels on nesting boxes put up for experimental purposes in the pine plantations of Thetford Chase. A full report on these boxes was given in Journal No. 22, pages 104-112, under the title "Breckland Bird Studies".

The nest boxes in question, 350 in number, are set out in two areas some six miles apart, one of which carries a crop of pure Scots pine, the other pure Corsican pine. The boxes are attached to the trees at an average height of 4½ feet from the ground; in all cases the stems of the pine are clear of branches to a height of at least 6 feet and in some cases to a height of 20 feet having been brashed and pruned in the course of silvicultural operations.

The boxes were first put up in 1948 and until the breeding season of 1952 there was no evidence of weasel attack. Such deaths as occurred were caused either by starvation, disease or through the activity of sparrowhawks; none of these causes of casualties can be compared with the severity of the weasel attack.

The sequence of events in this attack by weasels was as follows: On the 2nd May, four nests in boxes in the Scots pine area were found to have been completely destroyed, the remnants of egg shells being mixed in with the nesting material. During the ensuing week similar destruction occurred in 11 nests in the Scots pine area and 19 nests in the Corsican pine area; in many cases in addition to broken eggs the remains of the incubating parent were found.

Suspicion was first directed against the red squirrel, which occurs in some numbers in both areas. To combat attacks from this source the entrance holes in the side of the boxes were modified by the addition of a drilled wood block which was placed over the pop-holes, thus forming a longer tunnel and placing the nest contents out of the reach of a squirrel. It was not until a weasel was actually discovered destroying eggs and young in one of the modified boxes that the identity of the attacker was established.

Damage continued, in a spasmodic fashion, until the last week in June, but it is probably of importance to note that the most concentrated attacks, in both areas, occurred during the first fortnight in May. Details of the damage done are given below:

Corsican Pine Area: Out of 39 occupied boxes, 24 nests were attacked. Of the 311 eggs laid in the occupied boxes, 182 eggs were destroyed. A destruction of 58 per cent.

Scots Pine Area: There were 37 occupied boxes, of which 16 nests were attacked. In the 37 nests there were 357 eggs, and of these 146 were destroyed. The percentage destroyed was slightly less at 41 per cent.

The numbers of young birds destroyed could not be ascertained, but several broods, some fully fledged, were certainly wiped out.

In assessing the attack the following salient points must be borne in mind:

(1) Such attacks had not previously occurred in these areas.

(2) Although weasels occur normally in these areas, there is no evidence to show that there was an abnormally high population at the time of the attacks.

There is an abundance of natural food, particularly rabbits, in the immediate vicinity of both areas.

(4) The attacks reached there climax simultaneously in areas six miles apart.
(5) Similar attacks did not occur in other nest box areas, some of which are also in pure conifers, situated approximately mid-way between the two affected localities.
(6) The damage was uniformly distributed through both areas, with the exception of one block in the Corsican pine area.

In attempting to provide a reason for these attacks, one might suggest tentatively that weasels feeding young at this time would find in the eggs and nestlings either an easier source of food or some additional required nutrient; again it might be suggested that it had taken the resident weasel population a period of five nesting seasons to discover an easy source of food. These occurrences present an interesting problem of animal behaviour.

NATURAL VEGETATION OF OAKWOODS IN ALICE HOLT FOREST

By I. G. HALL
Foreman, Research Branch

A knowledge of the natural vegetation of any forest is an essential prerequisite to a fuller understanding of the forest environment. Moreover, this knowledge is also of value, apart from its intrinsic interest, when one forest is compared with another. Generally it is the commoner plants which are most significant, so that there is no need to be an expert botanist. A day's, or even half a day's visit to representative sites can yield valuable information. For example, the floristic details of Alice Holt Forest, given below, were collected in a day.

Before describing the natural vegetation of Alice Holt Forest some brief details on topography, soil and rainfall, may be useful. The altitude ranges from about 250 feet to 400 feet above sea level. Rainfall averages 32 inches a year. The underlying soil parent material is Gault clay which, over much of the forest, is overlain by plateau gravel of varying thickness. Depending on the presence or absence of the plateau gravels and their exact nature, three main soil types can be distinguished:—

(1) *Clay soils:* these are brown earths of good base status, but with imperfect drainage.
(2) *Gravelly drift soils:* these too are brown earths, but are sometimes locally degraded; they are also rather acid and poorly drained.
(3) *Sandy drift soils:* podzols occur on this soil type, which is of poor nutrient status and generally has good profile drainage.

Forest Cover

Oak has been an important tree in the forest at least as far back as the early Middle Ages and quite probably long before. At the present day it is still important, but conifers have also been increasingly planted since the latter part of the 19th century. Most of the present oaks were planted, and are between 80 and 130 years: they vary between 50 and 90 feet in height; in the lists of natural vegetation which follow, most of the species are typical of the oak woods.

Natural Vegetation on Clay Soils

Woody species, which are commoner on this soil type than on any other, include ash, field maple, hawthorn (*Crataegus monogyna*), blackthorn (*Prunus spinosa*), dogwood (*Cornus sanguinea*) and wild rose (*Rosa canina*). Conversely, yew and rowan are very rare if not absent. The most abundant woody species, however, is blackberry (*Rubus fruticosus* agg.); honeysuckle (*Lonicera periclymenum*) is also very frequent.

Dog's mercury (*Mercurialis perennis*), bugle (*Ajuga reptans*) and enchanter's nightshade (*Circaea lutetiana*) are perhaps the most typical non-woody species. Others include male fern (*Dryopteris filix-mas*), herb robert (*Geranium robertianum*) and, on felled areas, plume thistle (*Cirsium palustre*) and angelica (*Angelica sylvestris*): common grass species are tufted hair grass (*Deschampsia caespitosa*), and fiorin (*Agrostis stolonifera*).

Of the mosses, *Fissidens taxifolius* is a very constant and reliable indicator of clay soils. Others, more common on this soil type than elsewhere, are *Eurhynchium praelongum* and, somewhat less constantly, *E. striatum*.

Natural Vegetation on Gravelly Drift Soils

Common woody species include yew, holly, goat willows (*Salix caprea*), hazel, honeysuckle and, especially, blackberry. The most significant floral difference between this soil type and the clay lies in the presence, locally, of such species as common heather (*Calluna vulgaris*) and bilberry (*Vaccinium myrtillus*). There is also a notable decrease in ash and, especially, dogwood (*Cornus sanguinea*).

Of the herbs, dog's mercury and enchanter's nightshade are significant absentees. Bracken (*Pteridium aquilinum*) is by far the most abundant non-woody plant, dominating large areas under oak. Other typical species are wood sage (*Teucrium scorodonia*), wood spurge (*Euphorbia amygdaloides*), wood sorrel (*Oxalis acetosella*), broad buckler fern (*Dryopteris austriaca*), brown bent (*Agrostis tenuis*), and wood poa (*Poa nemoralis*). Yorkshire fog (*Holcus lanatus*) is often abundant, particularly on felled areas.

Typical bryophytes are those associated with moderately acid soils, and include *Dicranella heteromalla*, *Dicranum scoparium*, *Polytrichum formosum*, and *Hypnum cupressiforme*. On degraded brown earths, such as sometines occur under old oak, *Leucobryum glaucum* is locally abundant.

Sandy Drift Soils

The number of woody species is appreciably less than on the other soil types. Bilberry is typical and, where shade is not too dense, is sometimes dominant. Common heather is also locally frequent on ride sides or in very young plantations; birch, yew, and rowan are quite common. Blackberry is again frequent, though probably not to quite the same extent as on the heavier soils. The poorer soil is reflected also in the fewer species of non-woody plants. Bracken (*Pteridium aquilinum*) is the most abundant species, and is sometimes dominant or co-dominant. Others are broad buckler fern (*Dryopteris austriaca*), heath bedstraw (*Galium hercynicum*, creeping soft grass (*Holcus mollis*), purple moor grass (*Molinia caerulea*), and wavy hair grass (*Deschampsia flexuosa*).

The mosses are similar to those on gravelly drift soils, but are more abundant. They include *Dicranella heteromalla*, *Leucobryum glaucum*, *Dicranum scoparium*, *Plagiothecium denticulatum*, *Pleurozium* (*Hypnum*) *schreberi*, *Polytrichum spp.* (chiefly *P. formosum*) *Mnium hornum*, and *Tetraphis pellucida*.

Summarizing, the distinctive feature of the natural vegetation of the old oak woods, on all soils, is the prevalence of blackberry and to a lesser extent, honeysuckle. To these may be added bracken, which, except on clay soils, is also generally present.

The following list gives only the more common species of the forest. The plus sign shows the soil type on which the species is commonest. A few have been shown as being equally common on two soil types.

A. Woody Species

	Clay	*Gravel*	*Sand*
Acer campestre (field maple)	+		
Betula spp. (birch)			+
Castanea sativa (Spanish chestnut)		+	
Fraxinus excelsior (ash)	+		
Ilex aquifolium (holly)		+	+
Salix spp. (goat willows)		+	
Sorbus aucuparia (rowan)			+
Taxus baccata (yew)		+	+
Calluna vulgaris (heather)			+
Crataegus monogyna (hawthorn)	+		
Cornus sanguinea (dogwood)	+		
Corylus avellana (hazel)	+	+	
Hedera helix (ivy)		+	
Lonicera periclymenum (honeysuckle)	+	+	
Rubus fruticosus (blackberry)	+	+	
Rosa canina (wild rose)	+		
Ruscus aculeatus (Butcher's broom)	+		
Vaccinium myrtillus (bilberry)			+

B. Herbs

	Clay	*Gravel*	*Sand*
Angelica sylvestris (angelica)	+		
Ajuga reptans (bugle)	+		
Cirsium palustre (marsh thistle)	+		
Chamaenerion augustifolium (rosebay willow herb)		+	
Digitalis purpurea (foxglove)		+	
Euphorbia amygdaloides (wood spurge)		+	
Epilobium montanum (broadleaved willow herb)		+	
Fragaria vesca (wild strawberry)	+	+	
Galium hercynicum (heath bedstraw)			+
Geranium robertianum (herb robert)	+		
Hypericum perforatum (perforate St. John Wort)		+	
Mercurialis perennis (dog's mercury)	+		
Oxalis acetosella (wood sorrel)		+	
Primula vulgaris (primrose)		+	
Potentilla reptans (potentilla)	+	+	
Stellaria holostea (wood stitch wort)		+	
Scilla non-scripta (bluebell)		+	
Teucrium scorodonia (wood sage)		+	
Urtica dioica (nettle)	+		
Veronica chamaedrys (germander speedwell)		+	
V. officinalis (common speedwell)		+	

C. Grasses

	Clay	*Gravel*	*Sand*
Arrhenatherum elatius (false oat)	+		
Agrostis tenuis (brown bent)		+	+
A. stolonifera (fiorin)	+		

	Clay	Gravel	Sand
Brachypodium sylvaticum (slender false-brome)	+		
Deschampsia flexuosa (wavy hair grass)			+
D. caespitosa (tufted hair grass)	+	+	
Dactylis glomerata (cocksfoot)	+		
Holcus lanatus (Yorkshire fog)		+	
H. mollis (creeping soft grass)		+	+
Molinia caerulea (purple moor grass)			+
Poa nemoralis (wood poa)		+	
P. trivialis (rough stalked meadow grass)		+	
Juncus spp.	+		

D. Ferns

	Clay	Gravel	Sand
Dryopteris austriaca (broad buckler fern)		+	+
D. filix-mas (male fern)	+		
Pteridium aquilinum (bracken)		+	+

E. Bryophytes

	Clay	Gravel	Sand
Atrichum (Catharinea) undulatum		+	
Brachythecium rutabulum		+	+
Dicranella heteromalla		+	+
Dicranum scoparium			+
Eurhynchium praelongum	+		
E. striatum	+	+	
Fissidens taxifolius	+		
Hypnum cupressiforme		+	+
Leucobryum glaucum			+
Mnium hornum		+	+
Plagiothecium denticulatum			+
Pleurozium schreberi			+
Polytrichum formosum		+	+
Pseudoscleropodium purum		+	
Thuidium tamarascinum	+	+	
Tetraphis pellucida			+
Lophocolea spp. (Hepatics)		+	

THE MARSH PENNYWORT, HYDROCOTYLE VULGARIS, AS A WEED IN NEWBOROUGH NURSERY

By W. A. LINDSAY-SMITH *District Officer, North Wales*
and D. RANWELL *Department of Botany, University College, Bangor*

In the spring and summer of 1951, pre-emergent weedkiller trials with white spirit and vaporising oil were carried out at Newborough Forest nursery, on Anglesey.

It was noticed in these experiments, that only one weed was completely resistant to the spray and survived all applications of the oils throughout the growing season. Moreover, the forester reported that in the later applications the oils were collected by the large surface area of its orbicular peltate leaves, thus increasing the concentrations of the oil locally and causing damage to tree seedlings.

The weed was identified as *Hydrocotyle vulgaris* L., Marsh pennywort or "white rot", and it raised some interest as it was not a common plant in our forest nurseries. Accordingly, more information on the plant was sought. At this time Mr. Derek Ranwell of the Botany Dept. of the University College of North Wales was studying the flora of Newborough Warren sand dunes, and has kindly provided a brief note on *Hydrocotyle vulgaris* in its relation to the sand dunes at Newborough. Before coming to Mr. Ranwell's note, a brief outline of the history of Newborough Forest may be of interest.

Newborough Forest

Newborough Forest, covering 2,115 acres, is situated in the extreme southern corner of the Island of Anglesey on part of Newborough Warren, which is the most extensive stretch of sand dune on the island, covering about six square miles. The forest is bisected by a north-east to south-west ridge of schistose rocks, with jasper, ending in Llanddwyn island.

The origin of the dunes is quite recent. Historical records show the encroachment of sand in Elizabeth's reign. There is no shelter from prevailing winds, the ground rising gently from sea level to about 120 feet. Rainfall is about 30 to 35 inches, and exposure severe from the south-west.

Blown sand covers the major portion of the forest. Most of the fixed ground in the north has been planted since 1947. The south consists of sand dunes and occasional winter lakes (slacks).

Newborough Nursery

The nursery at Cwningaer was started in 1948. Soil analysis Figures in 1947 were as follows:—CaO, 0.14; P_2O_5, 4.8; K_2O, 0.006; organic carbon, 1.2. The pH was 6.2. Previous to 1947 there had been no cultivation. The fields were permanent leys of fair quality. The farmer ploughed them in 1947 with the exception of a very wet and boggy piece in section 22. He grew a fair crop of potatoes on part of the area (section 20), and a good crop of oats on the other part (section 22). In 1948 we ploughed to a depth of 9 to 12 inches, and included the wet, uncultivated part. Deep cut-off drains made ploughing of the wet area possible. The whole area was bare fallowed.

Section 22 is the area heavily infected with *H. vulgaris*. This section was lined out in 1949 and at the time looked very dry. However, in the winter of 1949 wet patches were noticed, and these were drained by deep run-offs. In 1950 the area was under seedbeds. The weed was not abundant or troublesome in 1949 or 1950.

Notes on Hydrocotyle Vulgaris

Historical

First recorded for Anglesey by Davies (1813), *Hydrocotyle vulgaris* is known to have been established as a frequent species in *Salix repens* marsh on Newborough Warren at least 40 or 50 years ago (Wortham, 1910).

Present Distribution

Rare or absent in the immature seawardmost slacks, the species becomes established in second line immature slacks over most of the area occupied by *Salix repens* marsh both on the west and east side of the rock ridge. In fixed dune slacks (e.g. the Clwt Gwlyb area) and in the middle regions of semi-mature slacks it becomes locally abundant and may show a cover value of 14 per cent. and a percentage abundance up to the same figure. *Hydrocotyle vulgaris* does not establish on the dunes, though in spite of its prostrate habit it is not among the first species to disappear where sand accretion is active, as at the tension line between *Salix* marsh and the base of dune leeward slopes.

It is a plant predominantly of wet areas in fixed dune regions at Newborough.

Associate species

Hydrocotyle is a common constituent of marsh and fen floras in general, and its commonest associates on dune *Salix repens* marsh, taken from four west coast North Wales dune systems, are as follows:—

Flowering plants

Salix repens *dominant*
Agrostis stolonifera *sub-dominant*
Carex flacca
Bellis perennis
Carex goodenowii
Juncus articulatus
Lotus corniculatus
Holcus lanatus
Plantago coronopus
Potentilla anserina
Prunella vulgaris

Mosses

Acrocladium cuspidatum *very abundant*
Hypnum species
Brachythecium species

Factors Affecting Distribution

Water. Much of the ground occupied by *Hydrocotyle* at Newborough is regularly flooded each year during the four months December—March inclusively. But in areas normally beyond the range of winter flooding, as in some of the Forest Nursery seedbeds, it can still thrive. The summer water table in the ground it colonises falls to not much more than three feet below the surface in the drier parts, and in the lower-lying wetter regions it is well above three feet below the surface all the year round.

Soil. Clapham, Tutin and Warburg (1952) state that the species is usually found on acid soils. On the Warren it can occur on soils having a pH up to 8.2 (glass electrode), though it establishes in areas where the soil reaction is nearer the neutral mark. Free carbonate up to 3 per cent. by weight and organic matter from 1 to 4 per cent. by weight are typical figures for the soils on which it establishes itself.

Accretion. As has been pointed out, *Hydrocotyle* can withstand a certain amount of sand accretion, but where it is of the order of one to two inches per year it is still a rare species, while it begins to establish itself in areas where the annual accretion is below one inch.

Competition. The behaviour of *Hydrocotyle* in relation to competition is not known, but since it establishes in closed vegetation and is a constituent of marsh and fen floras where the vegetation is often dense, its ability to develop elongated petioles holding the leaves a good 9 inches above the ground no doubt helps it to compete successfully in these communities.

Spread. No information is available about its ability to spread by seed, but its remarkable powers of vegetative spread by means of the pale coloured rhizomes have earned for it the apt but uncomplimentary local name of "white rot".

Control in the Forestry Nursery

The relatively open seedling beds of the Forestry Nursery where the water table remains fairly high throughout the year are ideal sites for the spread of *Hydrocotyle*, and the practice of hand weeding actually promotes spread by breaking up the rhizomes into small pieces which readily regenerate.

As with ground elder and couch grass, cultivating and harrowing are probably the most economical and effective means of control.

References

Clapham, Tutin and Warburg (1952): *Flora of the British Isles.*

Davies, H. (1813): *Welsh Botanology*

Wortham (Ca. 1910): Unpublished thesis.

Note. Hydrocotyle vulgaris is a member of the natural order Umbelliferae, most species of which show great resistance to the mineral oil sprays used in forest nurseries.—*Editor.*

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(1) Grants for Woodland Owners.

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(3) The Forestry Commission in Scotland.

(4) Forestry in Wales.

(5) (Also in Welsh: Coedwigaeth yng Nghymru).

(6) Heath and Forest Fires: Instructions for Fire-fighting.

(7) Hints on Controlling Grey Squirrels.

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