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CONTENTS

	Page
EDITORIAL	v
A Forestry Visit to Russia. LLOYD O. OWEN	1
Bison in Poland. POLISH CULTURAL INSTITUTE	4
The Care and Use of Cross-cut Saws. H. W. P. HUTSON, J. W. L. ZEHETMAYR, and C. P. KIRKLAND	7
The Mid-Wales Survey. G. B. RYLE	21
Planting Forests in Wales. E. HAYDN PUGHE	24
The Chilterns Project. J. L. DAVIDSON	27
History of Ratagan Forest. R. O. DRUMMOND	32
Historial Notes on the Forests of Alice Holt and Woolmer. W. H. DIXON	58
Four Cornish Forests. H. L. EDLIN	71
The Crarae Forest Garden. M. V. EDWARDS	79
A Working Plan for Policy Woodlands. H. CRUICKSHANK	81
Lake Vyrnwy Forest, Montgomeryshire. G. D. HOLMES	84
Reay Forest, Sutherland. LANGSHAW ROWLAND	87
Notes on the British Association Meeting at Sheffield—September, 1956. I. J. W. SALTER	92
Three New Nature Reserves. NATURE CONSERVANCY	96
Sunbiggin Tarn and Moor. D. F. FOURT	100
A Visit to Coniston Old Man. D. F. FOURT	103
The Collection of Cones from Tall Trees. D. T. SEAL	105
Ledmore Nursery. CONSERVANCY STAFF, EAST SCOTLAND	108
Notes on Farm Implements used in Forest Practice. H. F. PARLETT	111
Sowing Trials of Graded Acorns at Willingham Nursery in 1953. D. F. MARSHALL	114
Work on Limestone Soils at Dalton Forest, Westmorland—1951–55. J. V. CROSLAND	115
Afforestation of Ironstone Workings in Northamptonshire. G. BACKHOUSE and M. NIMMO	125
Planting the Hardlee Flow. E. J. B. HARDCASTLE and F. MCNICOL	130
Tine Ploughing at Speymouth. F. J. DONALD	132
Japanese Larch on an Area of Rank Weed Growth. R. B. HART	134
The Economic Approach to Weeding in the Establishment of Tree Crops. B. R. HAMMOND	135
A Note on Some Mixed Conifer Plantations in Mid-Wales. G. J. FRANCIS	137

Some Notes on the Management of Natural Ash Crops. B. R. HAMMOND 140
Cultivation of Willows for Basket Making. K. G. STOTT . . 142
Eucalyptus at Whittingehame Estate, East Lothian. G. M. L. LOCKE 143
Araucarias at Monreith Estate, Wigtownshire. G. M. L. LOCKE 144
Notes on Some North American Trees. D. L. SHAW 145
Prevent Forest Fires. DENNIS HEALEY 147
Fire on the Hills. DR. C. H. GIMINGHAM 148
Introducing Pyrology. WARWICK DEAL . . 150
A Handy Trailer for Fire Fighting. J. W. ENGLAND . . . 155
Notes on Fire Protection at Lyminge Forest, Kent. S. WATKINS . . 156
The Control of Deer in Commission Forests, with Particular Reference to England. J. S. R. CHARD and J. B. STOCKS 157
The Roe Deer. H. A. FOOKS 163
Fighting the Pine Beauty Moth with the Todd Insecticidal Fog Applicator. R. C. KIRKLAND 165
Needle Diseases of Conifers. T. R. PEACE 169
Forest Engineering Economics. E. R. HUGGARD 173
British Forestry Development in the Early Twentieth Century. D. L. SHAW 177
A Note on Forester Training. H. CRUICKSHANK . 180
Education for Administration. L. G. BARTER . 182
Should We Go Back? T. S. HARVIE . 183
Discounts and Decimals. H. S. FROST 185
A Fish Hatchery. D. J. FOURT 185
Greenfinches and Lawson Cypress. JAMES MACDONALD 189
British Timbers. E. G. RICHARDS 189
The Brandon Depot, Thetford Chase. G. BACKHOUSE and M. NIMMO 194
The Ari Sawmill at Strachur. R. LINES 198
The Chipboard Factory at Annan. J. A. B. MACDONALD . . . 199
The Preparation of Wood Wool at Mortimer Forest. KLAUS WAHLE . 201
What Can There be in a Ladder? *from the* DENNY LOG . . . 201
The Use of Wood in Musical Instruments. J. MOGFORD . 205
Charcoal Burning in Sussex. D. L. PARNALL 206
Conifer Barks as a Source of Tannins for the Leather Industry. J. R. AARON 209
PHOTOGRAPHS *Central Inset*
STAFF LIST . 214

EDITORIAL

Royal Visit Celebrates Our Millionth Acre Planted

On 8th May, 1956, Her Majesty the Queen visited Eggesford Forest in Devon to unveil a monument commemorating the planting, by the Commission, of its millionth acre of trees. Eggesford was chosen because it was there that, away back in 1919, the Commission's first trees were planted by Lord Clinton (then a Forestry Commissioner, and Chairman from 1927 to 1930); Mr. H. Murray (Assistant Commissioner: later Sir Hugh Murray); Divisional Officer C. O. Hanson; and Forester Tom Brown. But the more recent ceremony was naturally intended to show royal appreciation of our work all over Great Britain, and Commissioners and members of the staff from England, Scotland and Wales were all present.

The Queen, who was accompanied by His Royal Highness the Duke of Edinburgh, was received by our Chairman, Lord Radnor, and Lady Radnor; Sir Arthur Gosling, Director General; Mr. Heathcoat Amory, Minister of Agriculture; and Mr. James Stuart, Secretary of State for Scotland. After the unveiling of the memorial stone, Her Majesty and the Duke of Edinburgh planted oak trees, and subsequently spoke to a number of Forest Workers and their wives. Photographs of the visit will be found in our centre pages, as photos 1 and 2.

Honours

In the New Year Honours for 1956, Mr. Tom Farmer, who is now Chief Clerk at Dumfries, received the award of the M.B.E. Mr. Farmer was stationed for some time in London, where he acted as Secretary to the Committee on Hedgerow and Farm Timber, and prior to that he was at Glasgow. Head Forester Jones, who has had charge of Delamere, an old Crown Forest in Cheshire, for thirty years, received the B.E.M.

In the Birthday Honours list, issued in June, Mr. E. Wynne Jones, Deputy Surveyor of the New Forest since 1949, received the O.B.E. Mr. Wynne Jones had previously served as Acquisition Officer for England and Wales and as Conservator in charge of private woodlands work at the Office of Director, England. Mr. J. L. Shaw, a District Officer in North Wales, who has been concerned with the development of Gwydyr Forest and subsequently with private woodlands work, was awarded the M.B.E.

As we go to press, we learn with pleasure of the award of the C.B. to Sir Henry Beresford Peirse, Bt., our Deputy Director General, who was formerly Director of Forestry for Scotland. At the same time Mr. James Butcher, a Senior Executive Officer in the Finance Branch at Headquarters, receives the M.B.E. in appreciation of his thirty-seven years of service to the Commission.

The Commissioners

During the year there has been one change in the constitution of the Forestry Commission. Mr. John McNaughton, C.B.E., resigned on his appointment to the Crofters Commission in January; but he continues his connection with forestry as a member of the National Committee for Scotland. Major John Stirling has been appointed a Knight of the Thistle.

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, Bt., J.P.
Mr. Lloyd O. Owen, J.P.
Major Sir John Stirling of Fairburn, K.T., M.B.E.
Mr. W. H. Vaughan, O.B.E., J.P.
Mr. Stanley C. Longhurst, J.P.
Mr. A. P. F. Hamilton, C.I.E., O.B.E., M.C.
Major D. C. Bowser, O.B.E.
Mr. H. A. Turner, *Secretary*

We record with regret the death of a former Commissioner, Sir John Stirling Maxwell, K.T., of Pollok and Corrour. He was appointed in 1919 as one of the first Commissioners, and served as Chairman from 1930 to 1932. Sir John, who died, aged 89, on 30th May, 1956, will long be remembered for his pioneer work in planting the peaty moors of Corrour, and his life-long enthusiasm for the cause of Forestry.

Promotions and Transfers

Mr. Andrew Watt, a Conservator stationed at Headquarters, has been appointed to the post of Director of Forestry for Scotland, in succession to Mr. A. H. H. Ross, who is to retire in March, 1957. Mr. Watt has previously served as Conservator in charge of West Scotland, and at the Scottish Directorate Office in Edinburgh. For the past few years he has also been Chairman of the Forestry Commission Branch of the Institution of Professional Civil Servants.

In April, Mr. A. D. Palmer, who had been Deputy Establishment Officer in London since 1950, was transferred to Edinburgh as Chief Clerk to the Scottish Directorate. His duties in London have been taken over by Mr. M. L. David.

The following District Officers were promoted to the Divisional Officer grade during the year, and have taken up duties at the stations indicated; Mr. I. V. Dent, York; Mr. J. Chrystal, Inverness; Mr. R. J. G. Horne, Aberdeen; Mr. R. A. Innes, Inverness; and Mr. J. W. L. Zehetmayr, Work Study Section, Forest of Ae, near Dumfries.

Mr. M. J. Penistan, who has returned to Britain after his Nuffield Foundation Scholarship tour of Australia, New Zealand, South Africa, and several countries in Europe, is now stationed at Bristol.

Other moves during the course of the year included that of Mr. E. C. Harper, Higher Executive Officer, from Alice Holt to Finance Branch at Headquarters; his place as Chief Clerk at the Research Station is now held by

Mr. R. Rendle, who was formerly in the English Directorate Office. Mr. R. Coote, who also was previously in the office of Director, England, is now Chief Clerk in the South-West England Conservancy at Bristol.

Retirements

Mr. James Fraser, O.B.E., who for twenty-five years had charge of the North Scotland Conservancy, retired in February after thirty-six years' service with the Commission. "Jimmie" Fraser, as he is universally known, acquired a unique knowledge of every corner of his vast charge, which included seventy-two forests scattered between John o' Groats and the islands of Skye and Mull. He is an authority on old Highland lore, and his unfailing fund of humour will long be remembered by his colleagues.

The South West England Conservancy lost two senior officers during the year. Mr. A. H. Popert, who had been with the Commission since its inception in 1919, and had served in most parts of England and Wales, retired in January after ten years' work as Conservator at Bristol. Divisional Officer D. F. Stileman, who was engaged on private woodlands work, has left us after twenty-seven years' service.

Brigadier S. A. K. Batten has retired from the post of Directorate Engineer for England, and is succeeded by Colonel R. N. Packwood.

In April, Mr. F. C. Handford, O.B.E., retired from the post of Chief Clerk in the Scottish Directorate Office at Edinburgh, after serving the Commission for thirty-six years. Although his duties touched on every aspect of our work, one of Mr. Handford's favourite interests was the development of the National Forest Parks, and he was Secretary of the Committee which organises those in Scotland.

Obituary

We regret to record the death of Mr. Walter Matthews, Chief Clerk at the Bristol Office since 1951, who lost his life as the result of a road accident in August.

Visits by French and Russian Foresters

The growing appreciation of our work among overseas foresters is shown by the visits of two official overseas delegations. In May, a party from the French Direction Générale des Eaux et Forêts, headed by M. F. du Vignaux, Directeur Général, toured forests in South-East England, and West and South Scotland. Later, in June, a delegation from Russia, led by Mr. J. S. Shinov, Head of the Forestry Division of the Ministry of Agriculture of the Russian Federation, visited Alice Holt, the New Forest, West Scotland and Kielder.

In August, a party from the Commission paid a return visit to Russia under the leadership of Mr. Arthur Lloyd Owen, a Forestry Commissioner, whose account of the tour will be found further on in this issue. The other members of our delegation were: Sir Henry Beresford-Peirse, Deputy Director General; Mr. James Macdonald, Director of Research and Education; Mr. J. R. Thom, Conservator in the Scottish Directorate; Mr. J. Q. Williamson, Conservator of Forests for South Wales; and Dr. F. C. Hummel of the Research Branch.

Conference and Study Tours of the International Union of Forest Research Organisations

The Twelfth Congress of the International Union of Forest Research Organisations was held at the Imperial Forestry Institute, Oxford, from 7th to 14th July, under the presidency of Professor Aldo Pavari, of the Stazione Esperimentale di Selvicoltura, Florence. Mr. B. V. Mills, a Higher Executive Officer at Headquarters, acted as Secretary of the Congress. The Commission's delegation, which included several officers of the Research Branch, was led by Mr. James Macdonald, who was nominated, during the course of the meeting, to succeed to the presidency early in 1957. Mr. Macdonald was also responsible for the organisation of the seven study tours that followed the Congress, during which parties of delegates visited a selected region of Great Britain to study the progress of research work both in Commission forests and on private estates. A number of our staff presented original papers to the Congress, which meets every three years in order to co-ordinate research, in various specialised fields, among its member institutes.

The Seventh Commonwealth Forestry Conference, Australia and New Zealand, 1957

As we close for press, preparations are well advanced for this important conference which is to take place from 26th August to 10th October, 1957. The Commission delegation will be led by Sir Arthur Gosling, Director General, other members being Mr. James Macdonald, Director of Research and Education; Mr. George Ryle, Director of Forestry for Wales; and Mr. Charles Begley, a District Officer in the Research Branch, who is also the Secretary of the Standing Committee on British Commonwealth Forestry. One of the main topics for discussion will be the use of exotic trees in the various countries of the Commonwealth, and a bulletin on this subject, so important in Britain, is being prepared by the Research Branch.

The Scottish Forest Tree Seed Association

The Commission has been closely associated with the formation of this new body, which has as its object the improvement of the quality of all kinds of forest trees by encouraging the use of seed and plants of known and approved origins. Mr. J. D. Matthews, the Research Branch Geneticist, has surveyed the main sources of seed in Scotland, and has classified them according to quality. The Chairman of the Association is the Earl Cawdor, who is also a member of the National Committee for Scotland; the management committee includes Messrs. J. R. Thom and D. I. Seal, of the Scottish Directorate; while Mr. H. Brown, also of the Edinburgh Office, acts as Secretary.

The Editor's Bookshelf

Two District Officers, Messrs. H. L. Edlin and M. Nimmo, have been concerned, the former as author and the latter mainly as illustrator, in two books on trees published during 1956, namely *Treasury of Trees* (Countrygoer Books, 75/-) and *Tree Injuries* (Thames & Hudson, 21/-). Mr. Edlin has also written *Trees, Woods, and Man* in the New Naturalist Series (Collins, 30/-), and translated two books by the German author, Dr. Alfred Schwankl, namely *What Wood is That?* (Thames & Hudson, 25/-) and *Guide to Bark* (Thames & Hudson, 12/6).

In view of the growing importance of utilisation in our operations, we should like to draw attention to the publications of the Forest Products

Research Laboratory, Princes Risborough, Bucks. A full list can be obtained free of charge from that address. In addition to bulletins, reports, etc., sold as priced publications through H.M. Stationery Office, the Laboratory also produces free Leaflets which can only be obtained by direct application to Princes Risborough. The titles available in the Leaflet series include:

No. 6. *Dry Rot in Buildings; Recognition, Prevention and Cure.*

No. 8. *The Common Furniture Beetle.*

No. 11. *The Hot and Cold Open Tank Process of Impregnating Timber.*

No. 49. *Grading of Sawn British Softwoods.*

Among the priced publications, the Laboratory's *Handbook of Home-Grown Timbers* (H.M.S.O. 2s. 6d., or 2s. 8d. post free) is a useful account of the properties and uses of the materials that we grow.

Those interested in the raising of poplar may care to know that a pamphlet entitled *Home Grown Poplar for Matches and Baskets* is available free of charge from Messrs. Bryant & May, Ltd., Fairfield Works, Bow, London, E.3. The British Wood Preserving Association, of 6 Southampton Place, London, W.C.1, has recently published a free pamphlet entitled *The Use of Creosote Oil for Wood Preservation*, which gives a concise outline of the several processes available.

Westonbirt Arboretum

In June the Commissioners appointed a Committee, representative of both horticultural and forestry interests, to advise them on the management, care, and maintenance of the famous Westonbirt Arboretum. This unique collection of trees and shrubs was founded in 1820 by the ancestors of Sir George Holford, who developed it further; more recently it was tended by the late Lord Morley, from whose estate it has recently been acquired by the Commission. It is situated some four miles south-west of Tetbury in Gloucestershire, beside the main road to Chipping Sodbury, and contains outstanding examples of the rarer conifers, maples, and rhododendrons. The Committee is to consider ways of making the collection more accessible to the public.

Developments at Alice Holt

Work has just been started on the building of a modern wing at the Alice Holt Research Station. This is to be set up at the rear of the old mansion house, on ground formerly occupied by outbuildings. It will include modern laboratories and a refrigerated seed store, and should be ready for occupation by the close of 1958.

The Work Study Section

(*Contributed by J. W. L. Zehetmayr*)

As recorded in the Annual Report for 1954-55 the Commission has for some while been considering setting up a work study section, and a start has now been made in the Forest of Ae. The object of work study is to improve methods of working and increase productivity in the widest sense. The procedure followed is to time-study operations with a stop watch, during which the exact method used by the worker is recorded as well as the time taken. From consideration of the observations made, possible improvements in methods may be deduced. Variation in the effectiveness of workers is observed, poor results

may be due to the use of wrong methods, which may in turn be due to lack of training. Finally, delays and difficulties which cause variation in the time taken for a given job are spotted and consideration can be given to their elimination. From the results of time study and with the best known method in operation, the next step is to evolve equitable piece rates which take into consideration the relative difficulty and amount of work involved in each job. It should be mentioned here that study does not stop at the workers, the methods of checking and supervision are also examined, together with the system by which the management controls the work.

The principles set out above may be applied to any industry, and have been progressively more widely used in British industry since about 1930. In forestry, however, countries with an important forest industry have, not unnaturally, progressed beyond anything attempted so far in Britain. Sweden, after pioneer work in the 1920's, set up work study organisations for forestry to cover the whole country between 1937-50.

To return to the Forestry Commission section; a start was made by employing a firm of professional Work Study Consultants, Production Engineering Ltd., to work on a specific project—the production of chipwood from marking to despatch from the forest, at Ae and nearby forests—during which operation the first Commission team would also be trained. So after an initial course in London, Divisional Officer J. W. L. Zehetmayr and District Officer R. E. Crowther found themselves in a Glasgow steel works and a Dundee jute mill respectively for "work study experience". After this they returned, with relief, to Ae to join Mr. M. N. B. Parker, the production engineer sent by the consultants, who had meanwhile been finding his feet in the forest, a very necessary start to any work study job in a new industry. Later Senior Executive Officer J. Wharam and Forester C. P. Kirkland arrived and they also took the London course. It is hoped to add an engineer to the team so that all branches of the staff are represented and can contribute their various skills to the team.

So far marking, felling, extraction, sawing, loading and junior supervision have been studied, felling being much the most important and complicated from the time-study angle, for as we all know, no two trees are alike. The problem of measuring the work accomplished is very much greater than in industry, where the raw material and product are usually standardised in shape, weight and form. How, for instance, does one assess the branchiness of a tree which is a main factor in determining the amount of snedding required? How should one set about collecting all the working time spent by a pair of fellers on an individual tree, when they are working by batches, first axe brashing, then sawing, then pulling down, snedding and peeling, and finally carrying out to lane, as many as sixty trees in a batch so that the work on each tree is often spread over two days. As a result a good deal of time so far has been spent on working out a technique of study for each job.

On the method study side, improved tools are under trial; Swedish peelers, axes with shorter handles (instead of the dangerous custom of cutting the end off), spring loaded tongs, are a few now in use. The amount of heavy lifting during extraction and sawing has been reduced with a new type of horse-drawn sulky and the use of triangular supports. Thus the tree butts are now put on to the sawbench by pushing down on the tip, with the pole over a roller, set about the point of balance of the tree on a level with the sawing table.

On the subject of piece rates, progress is much slower, since a great deal of data must be collected before the existing rates can be altered with confidence. The major change that can be foreseen is an alteration in the basis of payment,

the object being to pay for work done, which is not necessarily the same as the amount produced. Thus for hand loading it is clearly fairer *to the workers* to pay by the weight lifted: the foot cube and the Hoppus foot per ton are the forester's and District Officer's worry.

The result of these changes in methods, tools, and method of payment should be to increase productivity, both increasing the workers' earnings and also reducing the cost of operations to the Commission. This will be the test of the success of the new section over the years.

Our Photographs

This year's collection of photographs has been selected to illustrate features mentioned in various articles and also the versatility of the Commission's work in many parts of the country.

The photographs of Her Majesty the Queen were taken by Mr. Tony Anderson, who has charge of the Photographic Section at Alice Holt. Mr. Arthur Lloyd Owen, one of the Forestry Commissioners, kindly contributed the pictures taken during the visit to Russia. Roger Lines, a District Officer in the Research Branch, climbed to 1,900 feet to get the picture of the European larch at the top of the Loch Ericht plantations, while the view of shelterbelts in Shetland was taken by Head Forester James Farquhar, also of the Research Branch, in the course of a visit to study tree planting prospects in those islands.

Photographs from the official collection include those of the limestone crags at Dalton Forest, taken by Miss Kathleen Wood, and those of the Ledmore lining-out machine, taken by Mr. Eric Marquis. Other pictures from this collection show the use of a safety line for tree climbing, the tan bark exhibit, and the manufacture of wood wool.

District Officer E. J. B. Hardcastle contributed the pictures of the Hardlee Flow in South Scotland, and Assistant Forester J. W. England those of the trailer equipped for fire-fighting at Rheola Forest in South Wales. Mr. Jack Aaron, a Research Branch District Officer, provided the picture of spruce bark harvested for tanning in Austria. Mr. Victor Blankenburgs, a surveyor at Kielder Forest, is responsible for the photographs of the deer and of the bogged tractor, and Mr. Klaus Wahle, a forest worker at Mortimer Forest, took the views of the cross-cutting of logs for wood wool, and the Kingslaw barking machine. The picture of the bison was kindly provided by the Polish Cultural Institute.

Mr. K. G. Stott, who is the Willows Officer at the Long Ashton Research Station near Bristol, kindly provided the general view of willows growing in Somerset. The pictures of planting and harvesting willows were kindly made available by Dr. H. G. H. Kearns.

The photos of the Ledmore lining-out plough are by Mr. J. M. Hood, of Hawick; those of the Cornish forests by Mr. G. W. F. Ellis, of Bodmin; and those of charcoal burning by Mr. G. C. Anckorn, of Halstead, Kent.

Contributions to the Journal

The main purpose of this Journal, which has just reached the milestone of twenty-five issues spread over thirty-five years, is to spread among our staff a knowledge of the most efficient methods for carrying out their daily work. Those who practise forestry are inevitably spread thinly over the land, making personal contacts infrequent: and it is most important that knowledge of a

good way of doing a job should be made available, as soon as possible, to others faced with a similar task elsewhere. The Editorial Committee is anxious to see all such good ideas put into the shape of a Journal article. Please do not hesitate because you have doubts about your ability to express yourself on paper—if any touching up is needed, it will be the Editor's job to see to it.

All contributions should be set out on foolscap, using one side of the paper only, and it is a great help if they are typewritten in double spacing. They should be sent through the usual channels (normally the Conservancy Office) to: Mr. H. L. Edlin, Editor of the Forestry Commission Journal, 25 Savile Row, London, W.1. A note of the writer's name and initials, his official position, and his address for correspondence should be included. Diagrams or sketches are acceptable, and should preferably be drawn in Indian ink on white paper; if you are not sure of your skill as an artist, do your best and—if the article calls for illustration—we will make a fair copy. Photographs of staff or technical interest are also welcome, and should be submitted as black-and-white prints, preferably on glossy paper.

We shall be glad to receive your contribution at any time of the year, for a steady flow of material eases the task of editing; but the last date for receipt of articles for the 1957 number will be 31st December.

JOURNAL OF THE FORESTRY COMMISSION, No. 25, 1956

A FORESTRY VISIT TO RUSSIA

By LLOYD O. OWEN

Forestry Commissioner

The Russian foresters who visited Great Britain in June arranged a reciprocal visit and seven of us flew out of London airport on the 28th July.

We seemed to pass through the curtain at Helsinki when we boarded a twenty-four-seater Russian plane with no safety belts or restrictions on smoking, and in eleven days we flew to Leningrad—Moscow—Kiev—Kharkov—right down to the Caucasus and back. The pace was fast, we calculated that we travelled 6,000 miles, slept in six different beds with one night sitting up in a plane and ate unaccustomed meals at unusual hours.

We were welcomed everywhere with complete hospitality and became proficient at receiving bouquets of flowers from young maidens at airports.

The language problem was the only real difficulty and it was most fortunate that we took with us an excellent interpreter, Peter Norman, while Mr. Shinov greeted us at Moscow airport with Ina, a Russian interpretess. Dr. Hummel made valiant efforts to reinforce our interpreters and Mr. Macdonald carried on long conversations with Russian botanists through the medium of Latin. I recall a direct conversation with only three Russians—a deputy minister who had visited the Royal Show at Nottingham—a security officer and a clerk in an Intourist Hotel. One often rose from a long meal knowing more of one's neighbour's digestive capacity than of his mental process—or they of ours.

A visitor is therefore largely dependent on impressions and what his eyes can register.

Forest Data

Some extracts from the tour notes will give an idea of the immensity of forestry in the U.S.S.R.:—"$\frac{1}{2}$ of the country's territory"—"above $\frac{1}{4}$ of the world's woodlands"—"above $\frac{1}{2}$ of all our forests are mature and over-mature ones"—"annual cut is about 350 million cubic metres; annual increment is about 800 million cubic metres".

93.4 per cent of the woodlands are situated in the Russian Federation (Russia) and the other fourteen republics share the remaining 6.6 per cent, which accounts for the statement: "Forests are spread most unevenly on the territory of the country".

The forests are classified in three groups:

Group 1: 6.1 *per cent*

Green belt zones adjacent to all towns, factories, etc. Felling is restricted to "improvement cutting, sanitation and renewal cuttings and selective cutting of over-matured trees".

Group 2: 8.7 *per cent*

Forests in "little-wooded/forest steppe regions and densely populated areas". Felling must not exceed the annual increment.

Group 3: 85.2 per cent

All other forests—mainly in northern Europe, Siberia and the Far East. "These regions supply the national economy with timber and all types of cuttings are allowed".

Timber industries are being moved to Group 3 areas and it seems that the local demands can be satisfied from the restricted fellings of Groups 1 and 2.

Moscow

The drive from the airport into Moscow gives a visitor an indication of tree-lined avenues of the future. Everywhere we went—even in the Caucasus with its wealth of natural timber—ornamental trees are being planted at the roadside. Three rows alongside main roads with single rows in the villages seemed to be the universal pattern; but the verge, whatever its width, was planted—there is plenty of land.

We visited the Kremlin and the museum within its walls, housing the priceless gifts given to the Tsars, the Ministry of Agriculture with its platform lift in perpetual motion, and the State University recently built on a 500-acre site to house 16,000 students with an excellent natural history museum on the 24th floor. One evening we went to the permanent Agricultural Exhibition where each Republic has its own pavilion with an enormous hall full of tractors and agricultural machinery. Forest plots demonstrating thinning technique and the story of soil preservation stand alongside a complete collection of forest machinery, which looked large and rather cumbersome to our eyes. It was nearly dark by the time we reached the Forestry pavilion and we were very tired—suddenly all the flower beds were lit up and the fountains played.

The experimental plots at the Moscow Academy of Agriculture had been layed down in 1865 to study soil moisture, acclimatisation and seed yield—as a contrast for those accustomed to Lammas growth, we heard of a growing period of only twenty-three days in a year.

We also visited the Pushkin All-Union Research Institute—some distance out of Moscow—where we were greeted with Caucasian wine, fruit and Cognac. A good walk through the forest was most welcome despite a heavy thunderstorm. At the Dendrarium certain species had suffered from frost, which did not seem surprising with a temperature of —45°C. last winter! At dusk we were motoring round the catchment area of the Moscow water supply and heard the "same old story" of shelter belts to preserve soil moisture. The belts—rather than blocks—had been established in 1939, with inter-row planting at 4 ft. spacing of shrubs, larch, shrubs, spruce, shrubs, pines, shrubs, birch, and then repeated.

I leave to others an assessment of Russian research work but it was clear that it spanned the political changes. Great emphasis seemed to be placed on soil preservation in all its aspects—light density, moisture and wind. The short growing season with a winter freeze down to 3 ft. provides problems of which we are fortunately immune.

Kiev

Mr. Lukyanets, whom some will remember over here, met us at Kiev where we visited his research station. The high-light was a walk through the forest at dusk with the conversation turning to the prevalence of wolves, and it was a relief to see an armed forest guard keeping his watch at the end of the ride. In the Forester's wooden house we experienced the Ukrainian custom of

ladening your guest with the uneaten food from the table and we departed with our pockets and indeed motor cars stuffed full of the fruits of the earth.

Kharkov

At Kharkov we were in the Steppe region—flat and featureless but now being broken up by rectangular shelter belts, thirty metres wide with an unplanted protection zone of nine metres. It is claimed that by 1953 the shelter belts amounted to over half a million acres. Hardwoods with oak predominant were planted inter-row with shade-bearing bushes in the belts we examined. The belts are spaced 300 metres to 500 metres apart and now stand about 20 ft. in height. The State belts following the rivers are said to be several hundred miles in length and the collective farm field belts link into them. The windows of the Russian 'planes afforded excellent visibility and from the air the rectangular patterns of the shelter belts appeared complete. It is claimed that the shelter (moisture preservation) has already raised agricultural production by 7 per cent over-all and they hope to get good timber out of the belts eventually.

Caucasus

It was getting warm when the plane landed at Rostov for servicing and hot by the time it had hopped over the Caucasian range—a bad half-hour for poor travellers—and landed in the sub-tropical zone south of Sochi, a health resort on the Black Sea. We stayed in a miners' sanatorium built like a palace with extravagant headroom and colonnade balconies. One awoke to the sound of cheerful music over the loud speakers and watched the other residents turn out to do P.T. round the fountain under the eye of a doctor.

The most interesting silvicultural day of the tour lay ahead as we motored down the winding road along the beautiful coast of the Black Sea in small cars with fast drivers, skidding each hair-pin bend.

Tobacco grew in the fields as the road turned inland and entered a valley with natural hardwoods on either side. Gradually as the valley became a gorge and the road climbed, silver firs began to replace the hardwoods. At 3,000 ft. a natural landslide had formed the beautiful Lake Ritsa with spruce now predominant on its steep slopes and higher again Scots pine stood with snow still lying in the gulleys. Jeeps were required to reach the Alpine meadows above the tree line where stock was grazed on a *hafod* system with herdsmen living in slab huts.

At 4,500 ft. there was a magnificent stand of primeval conifers which had stood unmolested until the recent construction of the road up which we had travelled. Natural regeneration was limited and it was presumed that the *hafod* system had its silvicultural drawbacks even in the Caucasus!

The next morning was spent at the dendrarium in Sochi, founded sixty years ago and containing "1,700 species, varieties and kinds" from all over the world.

The journey back to the airport was interrupted to visit the Khosta yew and box grove. 1,000 year-old yews standing in canopy up to 90 ft. cast a dense gloom under which only box could survive, some of which were 30 ft. high.

"Aida" at the Bolshoi Theatre concluded the tour and as Mr. Shinov who had accompanied us throughout the tour bid us goodbye he stressed that the next British Party should visit the coniferous forests of the North.

Conclusion

Basically it seemed that the Russian foresters were confronted with many problems similar to our own—the census not yet completed—the attempt to grow more remunerative timber—the lack of roads—the desire to become self-sufficient by increasing the output of cork and nuts.

Politically a visitor gets the impression that the world began in October, 1917, so it was of particular interest to hear that their forest tradition is much older.

Finally it must be recorded that despite the great distance we travelled and the large area of forest we inspected we did not see a derelict or neglected stand.

Photographs taken during the visit will be found in the centre pages, as photos 3 *and* 4.

BISON IN POLAND

Contributed by the Polish Cultural Institute, which recently presented a pair of European bison to the Commission; these bison are now at the London Zoo

The European bison (*Bison bonasus* L.) is a typical animal of the ancient forests and steppes of our continent, very numerous in the not far distant past and ousted from its haunts by the advance of civilisation.

Up to the First World War, i.e., up to 1914, besides a small group in the Caucasus it existed in the free state only in Eastern Poland, in the Bialowieza forest, where there were about 700 specimens, and in a reserve in Upper Silesia, in the forests of the Prince von Pless, where there were seventy animals.

The 1914-1919 war completely destroyed the Bialowieza bison. The last specimen was killed by a poacher in 1920. There were preserved only the bison sent to the zoological gardens of other European countries from Bialowieza. In Pszczyn there remained only three examples, of which two were Plebejer and Platen bulls, and one was a Plakette female.

From 1929 the Polish state undertook the work of restoring bison, in view of the scientific importance of the preservation of the animal. At this period purchases of bison from foreign zoological gardens began. It was only possible to acquire three examples of bison of Bialowieza descent of completely pure blood. These were Borus, Biskaja and Bizerta. From these three a new Bialowieza line was bred, which amounted in 1938 to fourteen animals. In that year the restored herd of bison at Pszczyn, numbering sixteen specimens, deriving from the surviving Plakette female and the Plebejer bull, passed into the ownership of the state.

In this state of affairs, with thirty head of bison, Poland was one of the leading countries breeding pure bison. At this time the bison were kept in three reserves in Bialowieza, Pszczyn and Niepolomice.

The Second World War of 1939-1945 again decimated the Polish stock of bison. After the ending of hostilities in 1945 there remained in the Bialowieza Reserve only seventeen of these animals, and as many in the Pszczyn Reserve in Silesia.

Work on the preservation of this dwindling species has continued since then in Poland. From the preserved thirty-four animals up to the time of writing (15/10/56), despite quite numerous losses occasioned by the inroads of sickness in 1953-4, the size of the bison community has risen to 130, of which ninety-two remain in the country, thirty-eight having been in that period exported to zoological gardens or the major European breeding countries.

The present number of bison in Poland amounts to about 40 per cent of the world population of this animal. Of the above-mentioned ninety-two specimens, eighty-seven are kept in five breeding centres, and five are kept in zoological gardens on show.

Breeding Grounds

The breeding centres for bison are located as follows: in Bialowieza, Bialystok province; in Pszczyn, Katowice province; in Niepolomice, Cracow province; in Smardzewice (near Tomaszów Mazowiecki, Kielce province), and the centre at Borkie in Mazuria which is in the course of extension.

In the location of the centres account is taken of the forest pasture environment essential for rational husbandry and peculiar to this animal, which guarantees the best living conditions. Rearing is carried on in a semi-wild state on a total area of about 1,300 acres.

In our work we proceed from the assumption that the bison is not a typical forest animal. Its recent existence in the depths of forests was, as already indicated, the result of the advances of civilisation, under the pressure of which the bison sought shelter in the forests.

The true and best conditions for bison are provided by an environment of good grazing grounds, with patches of leafy forest. Such conditions, affording the animals in closed reserves the maximal quantity of their natural basic foods, are those which we try to create for the bison in the breeding centres.

We limit human aid in these conditions to the essential remedying of albumen deficiencies with concentrated fodder in the summer period. In winter if necessary we keep the animals on an almost complete regime of hand feeding.

In the choice of place for reserves, which are situated most often in leafy forests, attention is always paid to ensuring that all enclosures should provide good grazing clearings. Also desirable is the presence of natural branch food in these enclosures (ash, maple, elm, oak, aspen, willow, hornbeam). This latter kind of food should provide 20 per cent of the daily green fodder.

Since, however, this growth is very quickly destroyed by the bison within their enclosure, the possession of plantations of these types of trees is essential —particularly of such quick growing trees as the willow, outside the reserve, in order to ensure the systematic bringing in of this tree fodder, which is on account of the tannin it contains an important supplement to the basic diet of these animals.

On the basis of our experiences up to the present in the reserves, we have come to the conclusion that there should be allowed per animal—irrespective of age—twelve to fifteen acres total surface, of which two to four acres should be grazing ground in forest clearings. These clearings should be kept continuously in proper condition by suitable cultivation and application of compost or minerals to ensure their proper regeneration.

The Breeding Stock

Bison on our conditions of rearing attain their full development at between thirty-six and forty-eight months, and the heifers usually calve at the age of four years.

On principal we endeavour to segregate according to age and sex. Calves remain with the cows up to eight months, or somewhat longer according to their development. The females usually calve every year, while in the free state they more usually calve every two years.

The bulls remain with the females selected for them only in the rutting season. Young animals up to eighteen months stay in joint enclosures set apart for them. In the future they will stay in joint pastures in the forest. After that period begins the division according to sex, to avoid too early and uncontrolled calving and its consequence in the way of the hampering of the development of the too-early calf.

To limit the possibility of choice of outside individuals, there is controlled inbreeding in the third, or, exceptionally, second degree.

Recently there has been an exchange of stud bulls from Russia and Sweden. In the course of next year they will be sent as breeding animals to selected herds.

Safeguarding the Herds

The breeding of bison in a semi-wild state in breeding centres situated in the depths of our forests, depends above all on almost complete isolation of these herds from man and his environment. These animals hardly encounter people after they reach maturity. The introduction of visitors and tourists into these Reserves is on principle forbidden. In isolated cases the Ministry permits Polish and foreign scientists to visit the breeding centres.

The aim of this, besides the preservation of absolute tranquility for the bison, is their isolation from contact with environments that might introduce epidemics or infections into our herds of bison.

Also with this aim in view we have established an isolation belt round each of our centres. This belt, depending on the local conditions, has a radius of half to one mile from the enclosure of the reserve. In the belt, all forestry works conducted by the State Forestry Establishments, are entrusted to the supervision of the direction of the centre concerned.

Forestry workers in this area are provided with special clothing and footwear, handed to them each time they enter the area. As a means of disinfection for footwear, wheels of vehicles and horses' hooves, a 2 per cent solution of caustic soda is employed. These same arrangements apply to superintendents, and to all visitors and vehicles on the territory of the reserve.

These rather troublesome and costly precautions were imposed after the epidemic of cattle disease which ravaged the centres in 1953-4.

A photograph of bison in a Polish reserve appears on the centre pages, as photo 6.

THE CARE AND USE OF CROSS-CUT SAWS

By Major-General H. W. P. HUTSON, *Chief Engineer*
and Messrs. J. W. L. ZEHETMAYR, *Divisional Officer*,
and C. P. KIRKLAND, *Forester*, of the Work Studies Section

Next to the axe, the cross-cut saw is the most widely used of the forester's tools, serving both for tree felling and the cutting of logs into lengths suited to transport and subsequent conversion. The correct maintenance of saws is a technical task which involves several distinct stages, each of which must be tackled in turn in order to restore the teeth to their original first-class condition. But no other tool shows such rewards, in ease of working and increased output, for proper and skilled attention to its upkeep.

Types. Several patterns of cross-cut saw are made (see Fig. 1) and each is supplied in several lengths, the two-man saws ranging from 3½ ft. to 8 ft. and the one-man saws from 2½ ft. to 5 ft. The most popular saw for felling pitwood poles is a 4 ft. or 4 ft. 6 in.

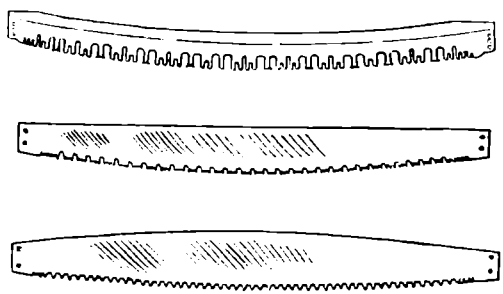


Fig. 1. Three types of felling saw:
Top: Hollow back, lance tooth.
Centre: Straight back, Great American tooth.
Bottom: Salmon-bellied cross cut, peg tooth.

Choice of a Saw. This will depend upon the size of the trees to be cut and also upon individual preference. Of the two-man saws the straight back saw is usually preferred for the heavier timber because the blade is stiffer and is less likely to be damaged if the saw gets pinched. But for small timber the narrow hollow-back type is liked since the narrow blade allows a wedge to be driven in behind the saw whilst the cut is still shallow. Good quality saw blades are ground with a slight taper in thickness from the thicker toothed edge to the thinner back ("thin to back"). The object is to keep as much of the blade as possible from rubbing the cut. This makes for freer movement of the saw. Handle holders on two-man saws should not be rivetted to the saw blade as this would make it impossible to withdraw the saw from a wedged cut.

Saw Teeth. There are many different tooth patterns. (See Fig. 2).) Tenon Tooth and Peg Tooth are the indigenous British types. During World War I there began to be a change over to the Great American Tooth which gives better sawdust clearance. Saws with raking teeth have come into general use in this country only recently. The Lance-tooth, if properly set and sharpened, is probably superior to any other for timber felling by hand cross-cut saws. This type of saw is that mainly referred to in the following pages.

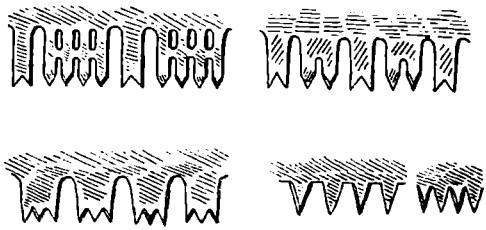


Fig. 2. Five types of saw tooth: *Top left:* Lance tooth, perforated, with rakers, four teeth per group. *Top right:* Lance tooth, with rakers, two teeth per group. *Bottom left:* Great American tooth. *Bottom right:* Peg teeth with large gullet, and (extreme right) small gullet.

Functions of the Teeth. There are two kinds of teeth—cutting teeth and rakers. The former are in effect, a double series of sharp and pointed double-edged knives which cut the fibres of the wood. They are so filed and set that one tooth cuts on one side and the next on the other. The rakers act with a chiselling action and, being slightly shorter than the cutting teeth, cut out a thin shaving of wood. This thin shaving rolls up in the gullet between the raker tooth and the cutter tooth next to it and is thus carried out of the cut, when it falls to the ground. On the return stroke of the saw, the opposite point of the raker comes into action in the same way. It is for this reason that a cross-cut saw should be long enough for at least one half to protrude from the sides of the timber which is being cut. If this is not the case the saw will not properly free itself of the accumulated shavings at the end of its stroke. For the same reason long strokes are much more effective than short ones.

Care of Saws. Unless a saw is kept in good working condition much of the sawyer's efforts will be wasted. For the best results a saw ought to be sharpened every few days of regular use. It should not be allowed to get worn and dull before receiving attention. The kind of "sawdust" made is a good guide to the condition of a saw. If long stringy curls of sawdust are coming from the cut you know that the cutting teeth are severing the wood fibres on both sides and the rakers are chiselling out the wood so severed. Fine, granular sawdust, on the other hand, is a sign of dull teeth, or incorrect sharpening and poor adjustment.

Saw Maintenance Tools. The saw is a precision instrument. Special tools are needed for correct sharpening.

The *saw clamp* can be a home-made device of very simple design. (Figs. 3, 4, 5 and 6.) Its essential features are that it shall hold the saw firmly and perfectly straight with the teeth pointing upward. It is very desirable to have the clamp hinged to its supporting base so that the saw can be tilted away from the filer at an angle of about 30 degrees. This makes it possible to file the cutter teeth without bending over and to watch the filing operation more easily. The result is more uniformity in the bevel on the teeth. The pattern of vice in Fig. 5, introduced in several forests by Head Forester Calder of Carron Valley, is very satisfactory.

A saw clamp can be improvised in the woods by driving in two (or three) stout posts. Slits are then sawn in the tops of the posts to take the back of the saw (Fig. 3).

Special Saw Files (Fig. 7) are made for almost all patterns of teeth. They should be fitted with proper handles.

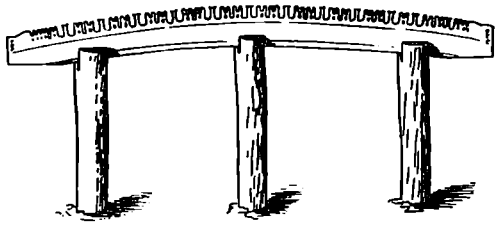


Fig. 3. Simple saw-clamp, using round timber.

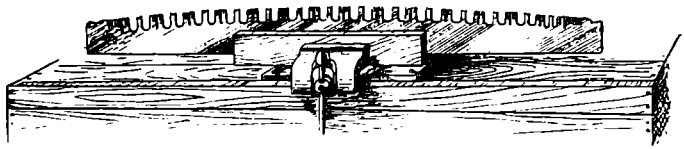


Fig. 4. Saw-clamp made by modifying a vice.

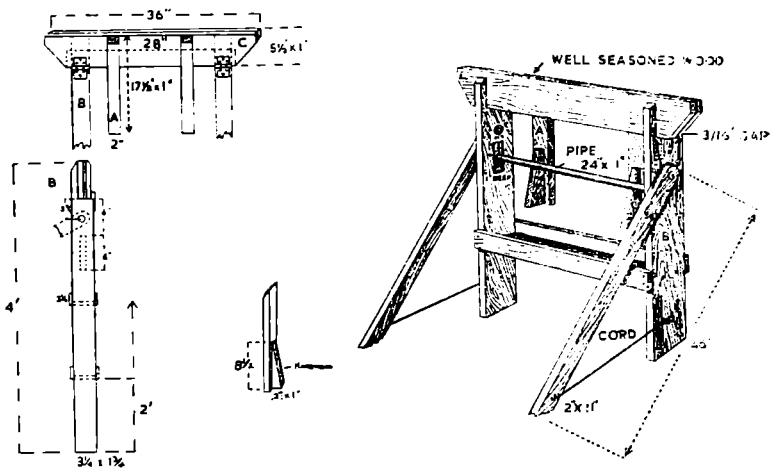


Fig. 5. Saw-clamp designed by Forester Calder.

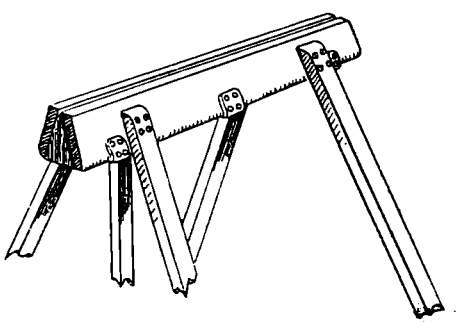


Fig. 6. Sloping pattern of saw-clamp.

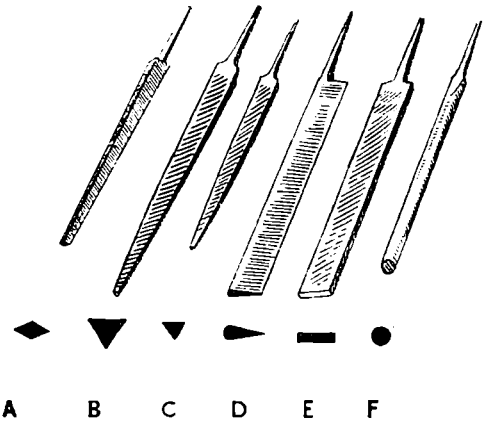


Fig. 7. Six types of files for saw sharpening. *Left to right:*

a. Feather edge, 8 in. second cut
b. Taper, 9 in. second cut.
c. Taper, 5 in. smooth.
d. Knife cross-cut, 8 in. second cut.
e. Mill saw file, 8 in. second cut.
f. Round, constant diameter, gulletting file, double cut (usually 10 in. long).

In filing, push the file forward smoothly and carefully, with an even speed and under even pressure. Use long strokes and raise the file from the tooth at the end of each. Take care always that the file bites upon the saw: never allow it to slide. Do not try to file on the back stroke. Tap the file frequently on the bench so as to loosen particles of metal that may be sticking to the cutting surface. Occasionally clean it with a steel bristle brush (file card).

Stones are sold in different degrees of coarseness (Fig. 8). A hard fine-grain whetstone is used in saw-sharpening after stropping and after filing the bevels on the teeth.

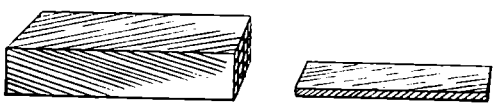


Fig. 8. Two types of sharpening stone suitable for saws.

SAW MAINTENANCE PROCEDURE

A saw, properly sharpened and set, should stand up to several days' work, especially on soft woods, before it needs attention again. Daily maintenance should not therefore be encouraged. It will be better to let a capable man do a complete doctoring once a week, or as soon as a saw needs it, than risk the harm likely to be done by day-to-day filing by workmen who have not been instructed in saw maintenance.

It is essential that:

(1) The filer understands the way the saw works.
(2) The correct files for the particular tooth type are used.
(3) The proper accessory tools are available and are used.
(4) The saw blade is firmly held in the clamp.
(5) The lighting is good.
(6) The filer take his time over sharpening.

For the full "doctoring" of a Lance-tooth saw, which should be necessary very approximately every month or so, the sequence of operation is:

(*a*) Cleaning blade, to free from rust and resin.
(*b*) Stripping (also known as jointing).
(*c*) Adjusting rakers.
(*d*) Filing the gullets.
(*e*) Setting.
(*f*) Filing the rakers.
(*g*) Filing the cutting teeth.
(*h*) Checking, and, if necessary, adjusting the set.

Cleaning. The better the quality of a new blade, the more polished is the finish. Accumulation of rust and resin increases friction and the amount of set necessary. Cleaning may be done with a petrol- or paraffin-and-oil mixture. Some thin oil on the blade at the end of the day will help to keep the blade bright.

Stripping. (Fig. 9.) The purpose of this operation is to bring all the cutting tooth points to the same height, keeping the original curved tooth-line. It is done preferably with an old worn file—an unhandled eight-inch mill file worn rather smooth—held in a stripping block or jointing tool.

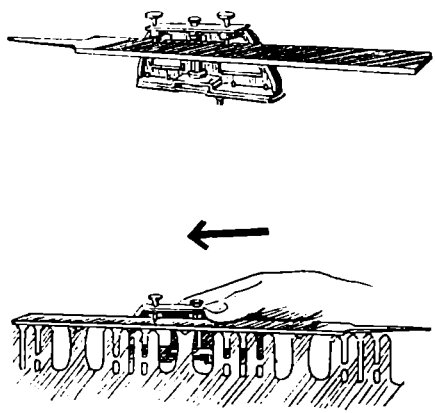


Fig. 9. Stripping block or jointing tool. Upper figure shows how file is held; lower figure how it is used; the arrow shows direction of motion.

The saw is first clamped so that the teeth stand upright. Then the tool holding the file is drawn along the entire length of the saw blade over the tooth points. The pressure should be very gentle so as to avoid excessive cutting, but it should be greater at the two ends since a saw generally wears most in the middle. The stripping is repeated until all the tooth points are marked by the file. When this happens to even the lowest tooth, all the points are at the same height. Broken teeth, however, should be ignored. Any burrs which may form should be removed by a few light strokes of the stone drawn along the side of the teeth, so that the set indicator will give the correct readings when applied to the teeth points.

Adjusting the Rakers. The next step is to bring all the raker teeth to a proper height. They should be slightly shorter than the cutter teeth or they will chisel

into the kerf too deeply and tear up wood which has not been severed by the cutters, leaving a ragged edge on the strings of sawdust removed. Too long rakers make the saw jump and also make it pull harder and cut more slowly. On the other hand, rakers which are too short do not chisel deeply enough to remove all that has been dealt with by the cutters. Experience will teach the filer how to fit his rakers to suit local cutting conditions but, in general, rakers should be 1/100 to 1/64 inch (.2 to .4 mm.) shorter than the cutters for use in hardwoods and frozen softwoods, and 1/64 to 1/32 inch shorter than the cutters when used in unfrozen softwoods (.4 to .8 mm.).

The combination raker gauge and stripping tool (Fig. 10) can be used for filing the rakers. The tool is fitted and adjusted to give the proper reduction in length of the rakers, and then the points of the latter which protrude are filed down flush with the filing plate.

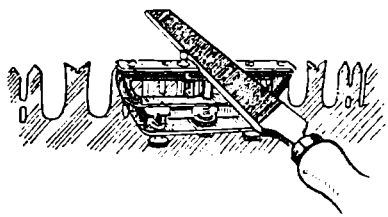


Fig. 10. Using the combination raker gauge and stripping tool.

Filing the Gullets. As a general rule a tooth should be kept in its original shape. Hence, as wear and stripping reduces the tooth height, so the tooth gullet must be lowered. This is done by filing at right angles to the blade with a round gulleting file. If the sawdust does not drop out of the gullets automatically, the gullets must be deepened. (Fig. 11.)

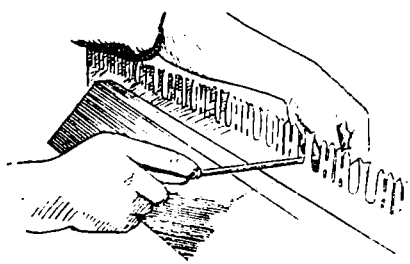


Fig. 11. Filing the gullet.

A clean and even gullet is important for the satisfactory removal of sawdust and for this reason any jagged edge which might occur during the filing should be removed. In addition such an edge may start a crack in the saw.

Setting. This is the operation by which the teeth are adjusted so that clearance is given to the body of the saw in its passage through the timber. Without this clearance the timber would bind on the saw. The clearance or set given to the saw must be equal on each side, otherwise the saw will "pull" to the side which has most. Setting is just as important as sharpening.

Setting is usually done before filing the cutting edges. There should, however, be an inspection of the evenness of the setting as a last precaution.

Setting should not take up more than about 2/3 of the tooth height, the less the better. The whole tooth should not be set as this may lead to cracks developing in the gullet. With setting by hammer and anvil only the top $\frac{1}{4}$ inch of the tooth is set.

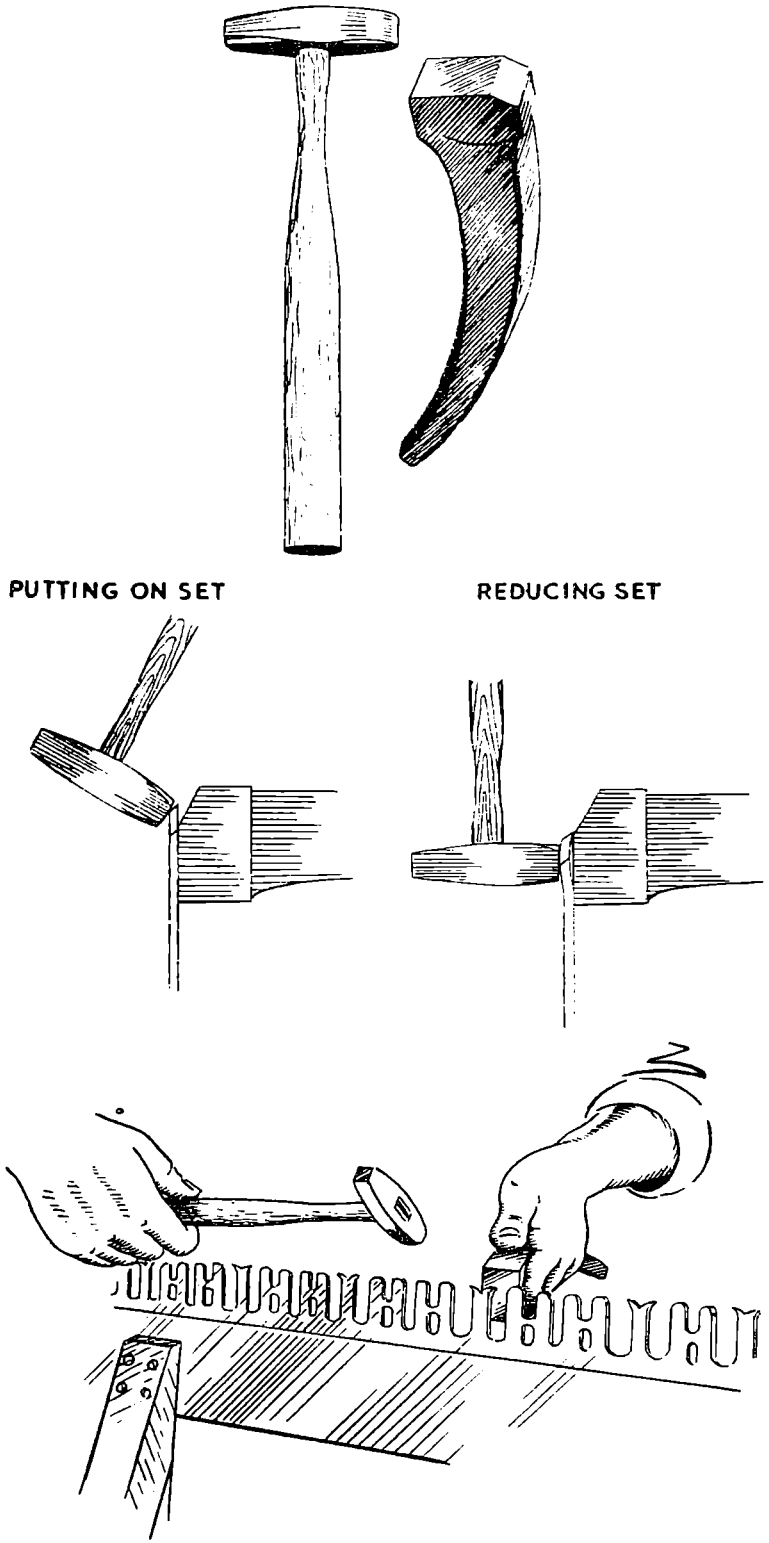


Fig. 12. Saw-setting with hammer and anvil. *Top:* The anvil and the hammer. *Centre:* How "set" is put on or reduced. *Bottom:* General view of the operation.

The amount of set depends upon the saw itself, upon the type of wood to be sawn and upon the user. It is always best to work with as small a set as possible. The set should be larger for soft woods than for hard woods. The average is about 1/64 inch (.4 mm.) for soft woods, and about 1/125 inch for hard woods (.2 mm.). Setting is usually done with a hammer and anvil, or with a saw set key (Figs. 12, 13); with the former method there is no danger of breaking a tooth.

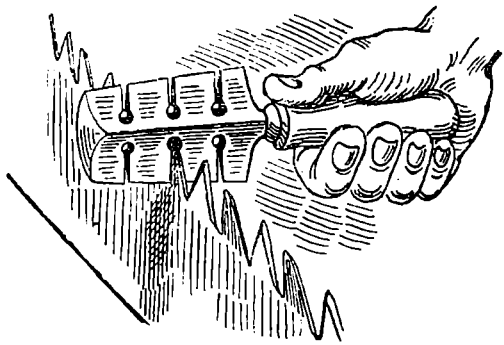


Fig. 13. Spring setting of peg teeth using the hand saw-set.

The *set indicator*, if placed along the saw so that the point of the tooth lies in the centre of the moving arm, will show what set is on the tooth. Teeth must then be bent the requisite amount. Indicators usually read in tenths of a millimetre. All teeth must have the same set.

In the absence of the above tool, a set gauge made from a piece of steel may be used. The required set must first be filed on the face of the gauge. Gauging the set is done by sliding the gauge along the sides of the teeth, when the user should be able to see or hear which teeth are incorrectly set. (Fig. 14.)

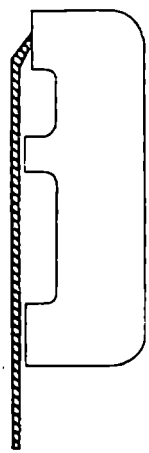


Fig. 14. Using a simple set-gauge (cross-sectional view).

Filing the Rakers. Start by filing down in the middle of the teeth with the edge of a file. Then file straight across the wings of the rakers until each comes to a sharp edge, which should be at right angles to the saw. A flat or triangular

single cut file should be used. Keep the file horizontal and take care not to reduce the raker points below the height indicated by the jointing. After filing, each side of the V should have an angle of about 45 degrees from the vertical. Do not touch the gullet side of the rakers with the file. (See Fig. 15.) As a final touch, only to be recommended for the skilled sharpener, rakers may be swaged with a hammer.

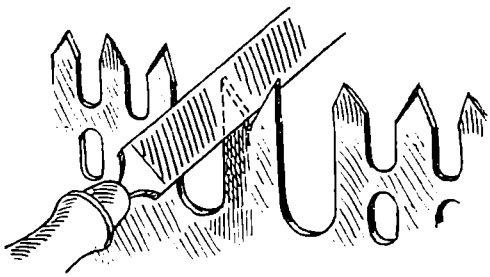


Fig. 15. Filing the rakers.

Filing the Cutting Teeth. The cutting teeth are then filed and sharpened by bevelling the points so that each is, in effect, a two-edged knife. (See Fig. 16.) The heavier and the harder the wood to be sawn, the less the bevels and the more rounded the points should be to prevent weakening the teeth so much that they may break or bend.

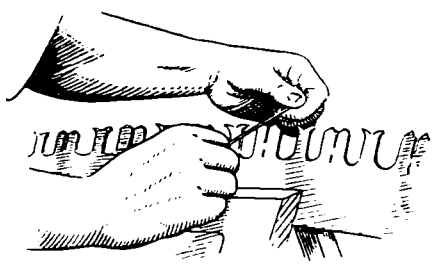


Fig. 16. Filing the cutting teeth.

The saw should be held firmly in the clamp and should make an angle of 30-45 degrees with the operator. The file can then be held almost horizontally. The filing strokes should go from the bottom of the tooth up towards the point.

First file the left-hand side of every other tooth, beginning at the left-hand end of the saw, and making all the file strokes with the file held in the same direction relative to the saw. File each tooth only so much that about half of the flat which the jointing produced is removed.

After this filing, the tooth side or edge should be knife sharp for up to one-third of the tooth height. Be careful that no burrs appear in the tooth gullets.

Next continue with the right-hand side of the same teeth, beginning with the right-hand end of the saw. File exactly as before until the flat on the tooth top is just removed. The last few strokes must be done extremely carefully since the slightest heavy touch may spoil the work.

Burrs formed on the opposite side of the tooth by the filing operation may be carefully removed with a whetstone run lightly along the saw against the face of the bevels just filed.

It is always difficult when changing over from filing the left-hand side to the right-hand side to keep the file at the same angle. When filing the left-hand side of the teeth the file handle should be held in the right hand and the file point in the left; when filing the right hand of the teeth the file handle should be held in the left hand and the point in the right hand.

A good way of maintaining the correct filing angle, for those unaccustomed to filing, is to set up a system of parallel lines which will serve as a guide for the file. (Fig. 17.)

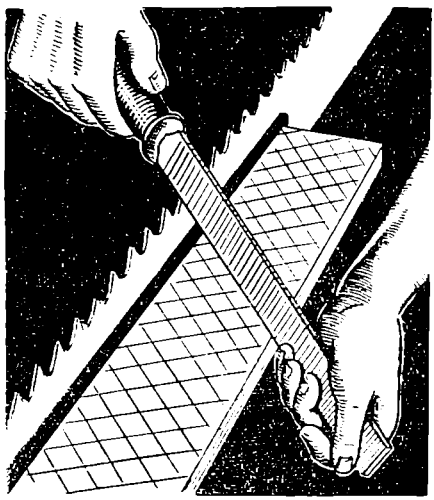


Fig. 17. Using parallel "saw lines" as a guide to filing angle for cutting teeth.

After filing all the teeth on the one side of the saw, the latter is turned round and the teeth on the other side filed in a similar manner.

Topping of Teeth. The American Lance-tooth saw can be made to cut easier and better by filing an extra bevel on the teeth where the two bevels meet. This thins out the teeth towards the point. Use a narrow, fine-cut file and work with light strokes. The bevel should end about 1/32 inch from the tooth point. (See Fig. 18.)

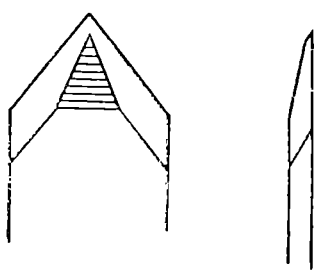


Fig. 18. Topping an American Lance-tooth.

With other saw types a slight topping of the teeth is done to give an increased effect and a longer life to the sharpness of the tooth.

This is particularly recommended for hard timber. The topping is done as follows:

After filing the forward side of the tooth in the ordinary way, a few strokes with the file are given to the rear side, care being taken not to remove the flat at the junction of the two sides. This is a good guide for filing the top. The top of the tooth is now filed from the rear at an angle of about 45 degrees to the tooth line. The filing is stopped as soon as the flat disappears. The top face should never be longer than 1.5 mm.

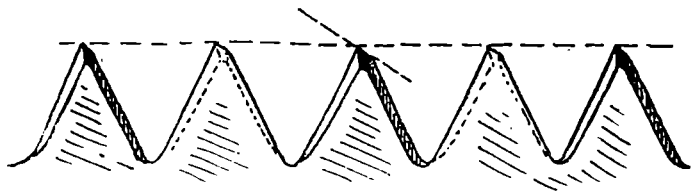


Fig. 19. Topping ordinary teeth.

Honing. After filing, all burrs should be removed from the sides of the teeth. This should be done with a fine pocket stone which should be lightly drawn over the row of teeth, touching only the parts of the teeth which have been set. This stoning also adjusts the set. (See Fig. 20.)

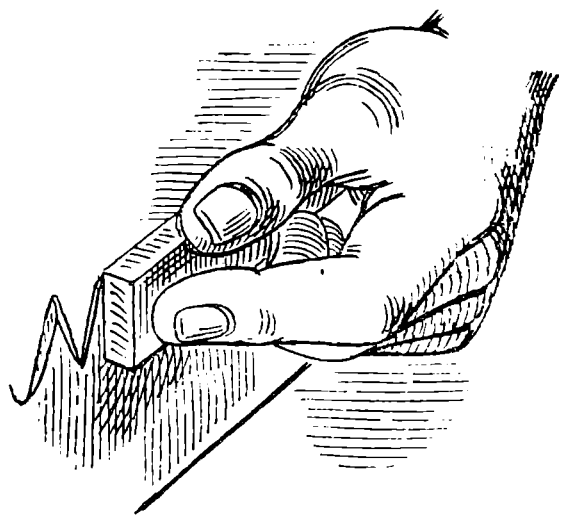


Fig. 20. Honing.

Neglected Saws. Constant sharpening of the teeth of a saw, without at the same time keeping the gullets deep enough, has resulted in many saws reaching a stage when it is no longer an economic proposition to try and repair them by hand. Such saws need to be sent away for re-cutting.

Handles. The wing-nutted bolt-on type is preferred, as the old fashioned loop handle with threads inside the grip has the disadvantage that it allows no

clearance for the hands when a felling cut is being made close to the ground, or where there are large spurs. (See Fig. 21.)

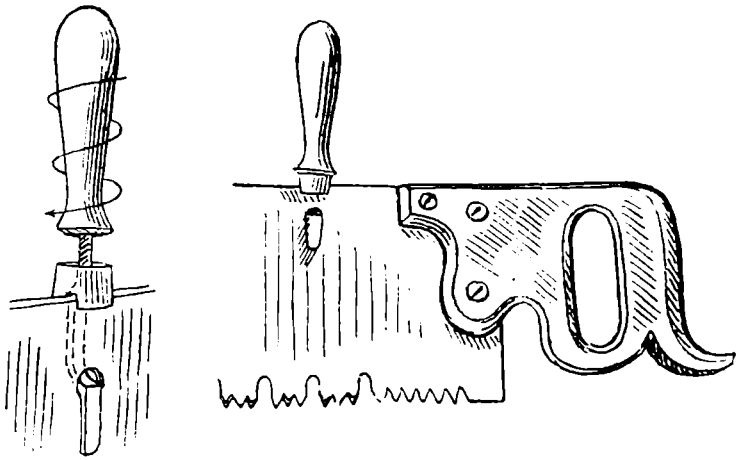


Fig. 21. Loop handles.

The bolt-on type handle can be set at right angles to the saw (see Fig. 22), but the end of the handle then projects below the saw. Moreover, control over the saw seems less with the handle in this position. (See Fig. 22.)

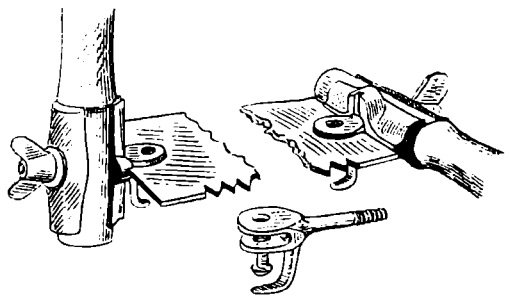


Fig. 22. Wing-nut bolt-on handles in two positions.

USE OF THE CROSS-CUT SAW

Cross-cutting. (Fig. 23.) Start with a few sharp and short strokes. Keep the hands away from the sides of the saw and above all, do not put a hand on the log, near the saw cut, at any time. The blade is quite likely to jump out and inflict a very bad injury.

After the cut is started saw with long easy strokes. The saw has teeth through its length and it does its best work when all of them are used. When two men are sawing, do not push the saw into the log. This causes buckling and a crooked cut which makes the saw much harder to pull. In two-man sawing each man should pull only.

If the saw begins to pinch, stop and put a wedge in the cut behind it. In small-sized stuff it is usually better to raise the log and block it up from underneath when cross-cutting. When sawing resinous woods such as pine and spruce, sprinkle the saw blade occasionally with paraffin.

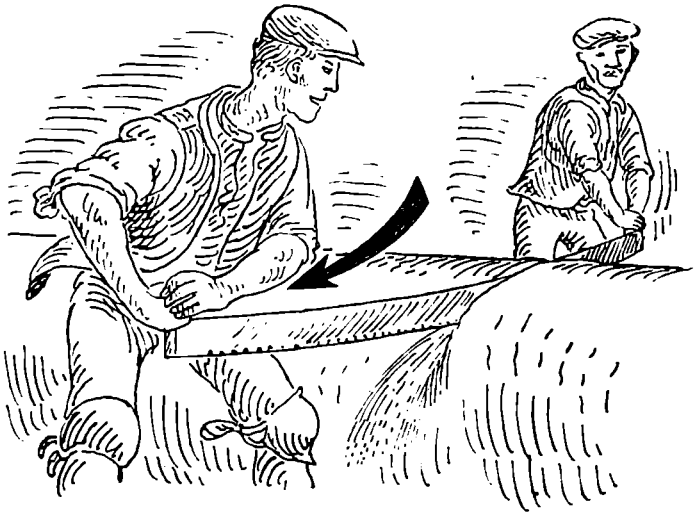


Fig. 23. Starting a cross-cut.

Felling. The use of the saw in felling is much the same as in cross-cutting. It is important to keep the blade running straight and level with no sag in the middle until it is well started in the tree. (Fig. 24.)

If there is such a sag, it will cause a "U"-shaped cut through which it will be much harder to pull the saw. The best way to prevent this is to grip the saw blade with one hand, alongside the handle, and to be careful to pull straight away from the cut on a level with it. When the cut is well started, the long steady fast-cutting strokes of the expert saw crew can be started. It is not necessary to *pull* the saw deeper into the cut. The belly in the blade will take care of that. Just pull the saw straight out and then let your hands ride the handle back as your partner pulls it his way. Don't push or the saw blade will buckle. And don't expect your partner to pull your arms back as well as the saw.

Fig. 24. Felling with the cross-cut saw.

When not in use saws are best hung vertically so that there is no chance of their acquiring a permanent bend.

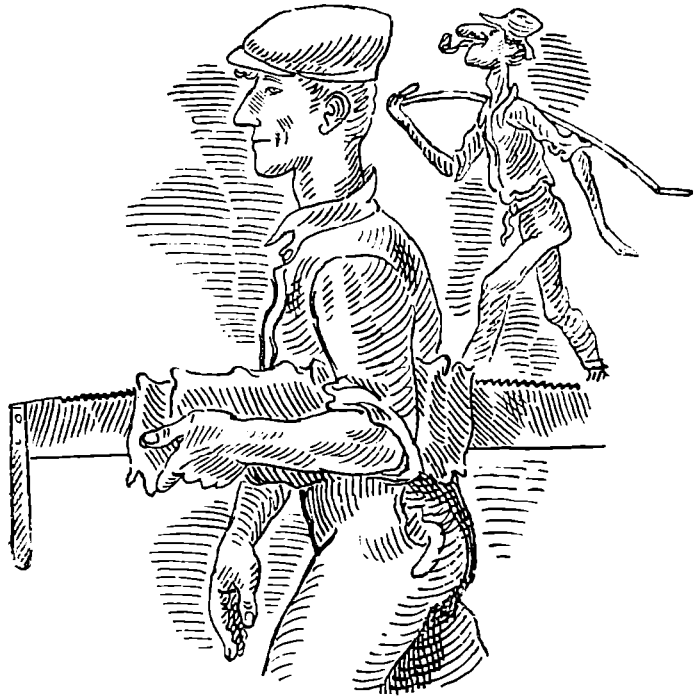


Fig. 25. Two ways of carrying a saw.

SAFETY PRECAUTIONS

In carrying the saw, it is best to remove one of the handles and put the blade across the shoulder with the teeth away from the neck. When turning with the saw in this position be very sure that no one is standing near you. Saw tooth punctures make very bad wounds. (Fig. 25.)

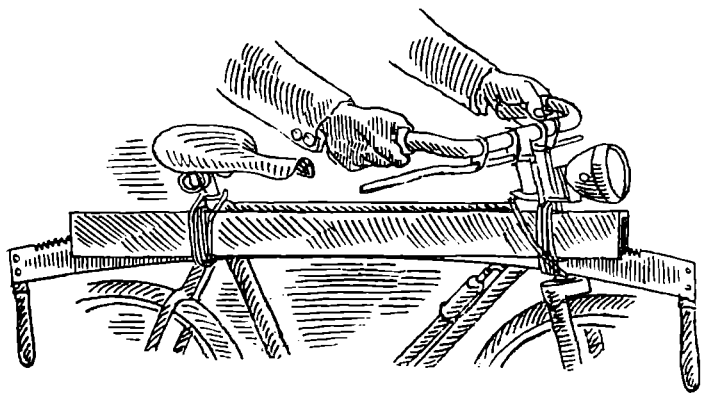


Fig. 26. How to carry a saw on a bicycle.

For long distance carrying, a short length of fire hose, slit through its length and tied over the saw teeth, will protect the edge of the saw, and the user.

Never let an unguarded saw rattle around in the bottom of a lorry where it can be stepped on. There is no quicker way to ruin the filing job. It is cheaper and easier in the long run to make a carrying rack or tool box.

If a saw is taken on a bicycle, a rigid guard is safest. (Fig. 26.)

Finally, remember that the worst accidents occur when least expected. *Always* treat your saw with respect, since it has not merely one chisel-sharp blade, but a whole battery of them. Never let it drop or fall casually aside, for it can spring back with force enough to cause a really nasty wound.

THE MID-WALES SURVEY

By G. B. RYLE
Director of Forestry for Wales

Hill farming is a touch-and-go business and but for fairly lavish assistance meted out to the hill farmer in the form of grants of various kinds (there appear to be some fifteen different subsidies for which upland farms may be eligible) it is perhaps more "go" than "touch". Rural depopulation has been proceeding apace in upland Wales for very many years and though the problem is possibly little different in Wales to what it is in comparable uplands of England and Scotland it undoubtedly has a more direct bearing on the rural economy of the Principality because the hill farms constitute such a big proportion of its total agricultural land.

In 1954 the Welsh Agricultural Land Sub-Commission was commanded to make a survey of an area of nearly 300,000 acres in Cardiganshire, Montgomeryshire and Radnorshire, chosen because it illustrated the rural depopulation problem in a very acute manner.

The selected territory contained 1,404 individual farms, though during the previous half century 782 other farms had gone out of existence. Of these 1,404 farms, 929 were occupied by owners or tenants over fifty years of age and there were only 1,147 children. The total population of the territory was 10,686 (or one person per twenty-eight acres) of whom 4,808 lived on the farms and the remainder resided in Tregaron and Rhayader (about 1,000 each) or in scattered hamlets. It is estimated that the district carried 363,547 sheep and lambs (1.3 per acre after deducting the areas of forest lands and reservoirs) and 26,469 cattle and calves.

The Sub-Commission considered that 795 of the 1,404 farms had a doubtful or poor future and that whatever steps might be taken to improve the agricultural productivity of the district it must be anticipated "that the numbers employed in agriculture will continue to fall for some years yet. It follows that if rural depopulation is to be checked or reversed the remedy must lie in the promotion of rural activities other than agriculture".

The district is supplied by 555 miles of road (i.e., one mile per 540 acres) but of this 208 miles are of "Class III" while no less than 208 miles are "Unclassified" and quite largely impassable for regular motor transport. As

the product of a penny rate ranges from a mere £737 in Cardiganshire to £806 in Radnorshire (the rateable value of the latter being largely swollen by a big English water undertaking) it will be appreciated that the chances of any major road improvement schemes being put in hand by normal means is remote in the extreme.

At the time of writing the Report in 1955 the Forestry Commission held 26,714 acres at Tarenig, Hafren, Myherin, Ystwyth and Coed Sarnau in North Conservancy and at Towy in South Conservancy. About half (13,321 acres) had been planted and there were 6,093 acres still to plant, the remainder being agricultural or other unplantable land.

The Sub-Commission's opinion that the only solution to the depopulation problem was to be found by the development of rural industries "other than agriculture" is strongly amplified by forecasts of substantial forestry development, and the maps which appear as appendices to the Report indicate some 100,000 acres which are considered to be "uneconomic for agricultural development" or to be of "uncertain agricultural future" wherein it is anticipated that "considerable areas will be offered for sale and acquired by the Government for afforestation".

Much stress is made in the Report on the need for a closer co-operation between agricultural and forestry interests and on the material advantages which would accrue from a happy marriage between the two interests. It is interesting therefore to consider what material dowry forestry could bring to the union. Marriage is an equal partnership but already the stalwart critics of the Report, while not condemning forestry, have assumed for their purpose that the bride shall be a kitchen maid, there to serve the master but not to interfere in his "old ways of life" and above all not to disturb the sheep. Forest shelter belts would be grand, forest roads could link farm to farm and thence to civilisation, casual forest labour could help on the farms at harvest time and forest fences would form good boundaries to ease the shepherding problems.

Basically even these severest critics have got the right idea but they have completely misinterpreted the depth or the perspective of the problem picture: they have forgotten that the problem is one of serious and continuing rural degeneration and not just one of sheep.

Let us assume that of the 100,000 acres which the Report describes as having a dubious agricultural future 60,000 acres will in due course become available for forests. How would that affect the district? How could it, together with the 19,000 acres already in hand, be most happily married to the 40,000 acres which would remain under food production within this main forest mosaic and to the 150,000 or so acres in the more prosperous parts of the district?

In the first place there would need to be a steady increase in population. 60,000 acres primarily devoted to hill sheep probably gives employment to about 100 men who would be displaced. But 60,000 acres of forest will ultimately provide steady employment to about 1,000 men. This is a figure upon which it is difficult to obtain reliable evidence but European and British experience points to it being fairly near the mark. The rate at which forestry can provide for this increase of 900 men will naturally depend upon the rate of afforestation, but as it is already evident that there is an absolute shortage of able bodied potential woodmen in the district (such has been the result of the past steady depopulation) and as it is certain that there is an absolute shortage of habitable dwellings in the district, so it is evident that the provision of

accommodation must run hand in hand with any useful growth of forest work. There will thus be a need to introduce building tradesmen into the area concurrently with the introduction of woodmen. The full road net-work of the newly formed forests will not need to be constructed until nearer the date of first thinning, when produce will have to be extracted on heavy vehicles. But such is the sparseness of existing usable roads that the main backbone of the ultimate road system will need to be constructed *ab initio*. Without this, not only would it be uneconomic to get men and materials to the afforestation areas but the fire risk, without adequate quick access and the invaluable breaks which well designed roadways create, would be intolerable.

Thus in remote terrain, such as much of this land comprises, the *initial* stage of forest formation will require a larger investment of capital than is normally required in more highly populated and developed lands where the labour force can usually be small at the beginning and where it can grow gradually until the ultimate productive stage of the forest's development is reached.

The need for housing right at the outset will naturally bring with it social benefits which will impinge themselves directly upon the whole of the community. Nowhere is there any desire that woodmen should be segregated from the rest of the community in isolated forest villages: thus housing will take the form of extensions to existing villages or to the few small market towns. There will be new life instilled into the local shops, schools, places of worship and social centres. Maybe improved 'bus services will follow: there would be greater call for contact with the larger towns of Newtown and Aberystwyth which lie outside the area.

Early formation of the main road arteries into the forest blocks must quite obviously benefit the isolated farmsteads which they will pass: they must even diverge here and there to create such access. Co-ordinated planning which will be so essential for the proper economic development of this type of countryside will require that direct forestry expenditure and disbursements out of certain other pockets will have to be pooled for the good of these areas as a whole: isolationist planning by separate departments of the Government or Local Government machine could only fail to bring about that revivification which is so badly needed.

The benefits of shelter created by forests are hardly yet accepted by the average hill farmer in Wales. The work of W. A. Cadman (F.C. Forest Record No. 22, *Shelterbelts for Welsh Hill Farms*) has in fact been better received in other parts of Britain, but, nevertheless, an appreciation is beginning to awaken. While the development of forestry as a key industry in mid-Wales cannot be *primarily* concerned with shelterbelting either on a major or on a minor scale, the Forestry Commission will be able to do a lot to help the farmer. The unilateral shelter benefits even of our large forest blocks are recognised by some of our neighbours and we are now acquiring many comparatively small parcels which, in course of years, will have a marked influence on the local climate, especially in the western portion of the territory. The formation of properly designed shelterbelts by farmers themselves under Hill Farming schemes (for which 50 per cent grants are available from the Ministry of Agriculture, Fisheries and Food) has not yet become popularised. There is scope here for a joint campaign by the local officers of the Ministry of Agriculture, the Forestry Commission and the Co-operative Woodland Societies.

Mid-Wales carries a large number of small marginal farms where the level of subsistence is extremely low and whereon in fact there is not full-time work

for the occupiers. The development of large forests will provide an abundance of part-time employment for the more industrious of such farmers and their sons. There is much to be said in favour of the owner-occupied "forest worker's holding", especially as these properties are ineligible for assistance under Hill Farming schemes. On the other hand it may be anticipated that many of these smaller farms will also be available for acquisition by the Forestry Commission so that the rough lands will be planted and the in-bye will be formed into normal forest holdings.

The **Mid-Wales Investigation Report** (Cmd 9631) covered an exceptionally degraded block of countryside, but the area was selected purely as an example. Its recommendation may be taken to apply in greater or lesser degree to a very much larger stretch of the uplands of Wales. Even among the intensely industrialised valleys of South Wales scores of hill farms have gone to ruin. In parts of Brecknock and Carmarthenshire conditions are equally as bad as in the Investigation area. Northwards into Snowdonia a similar story can be told.

But while sheep farming, suitably aided, remains a lucrative business for a few in a lowly populated countryside, any change of land-use, even if it results in bringing a new virility to the community, is bound to have opponents. There can undoubtedly be a perfect marriage of farm and forest in hill country, but only if it be appreciated that *both partners must have land on a large scale* and that there must be quite a radical departure from that "old way of life" which has in fact become a creeping paralysis.

PLANTING FORESTS IN WALES

By E. HAYDN PUGHE

Ganger, North Wales

After over twenty-five years of being at the receiving end of jibes and insults by almost every class and creed, there are evident signs that the timber planting industry is beginning to get due notice. I myself cannot give a definite answer why, the truth is that there are several movements in Wales drawing nearer to the idea of silviculture. It must be admitted that when this industry was in its infanthood from fifteen to twenty years ago, that the average man could not realise that anything was happening in rural Wales. To-day, there are thousands realising, when they see the big lorries under their loads of shapely timber that something has indeed happened.

It can be put down as characteristic of human nature that, when we have condemned anything for a long time, it is difficult to praise it all of a sudden, we have to subdue our admiration for a while before letting it go, and we have reason to believe that this is happening to-day. We might as well realise at once that we are living in a revolutionary age, we have witnessed two world wars in the last forty years. Gone is the generation that would not change its job or occupation. Transport by now is such a convenient factor that we do not think twice about having to work ten or even twenty miles from home, and for that reason, we are not compelled to stick to any job because it is the only job close to hand.

We in Wales are in dire need of a new heavy industry. Shortage of men is a general complaint in the slate quarries of North Wales. If this exodus from

the quarries continues it cannot be foreseen what will happen to them. It is evident, however, that many quarrymen are fleeing from their occupation to avoid the risk of silicosis, and quite naturally they look for an open air job. If the "Forestry", as it is called in many places, is close at hand, it can be an ideal and interesting job for a man who emerged from the bowels of the earth to find a healthier work. That is one reason why we want this new industry in rural districts, because, by transporting workers to factories in built-up areas or towns, we depopulate the rural area and dislodge the man from his environment. Without a doubt, this is a duty and responsibility that should weigh heavily on us all. We hear the cry about the depopulated areas often enough from individuals and movements. But who of them has a plan or a cure to this acute problem? But, of course, some would not care to hear this. But "Who hath ears to hear, let him hear". Here we have salvation for the rural areas in one word, and that is afforestation.

We of rural districts in Wales should take to afforestation like ducks to water for the simple reason that handling and carving different types of wood was indeed a part of the culture of the place, and can be said to be inborn in most of our forefathers who lived in the rural districts. In the old time when their lot was much harder than what we know it to be to-day most families were almost self-supporting. Many a husbandman kept his family clad in clogs all the year round, their soles would be neat and skilfully done from alder wood. They would also eat from wooden vessels, and up to this day all the containers and tools for buttermaking are done of wood. May the reader remember that carving these articles under the big old chimney in the evenings was their main recreation.

Even when a young man wanted to give his young lady a present, to get engaged to her, it would be useless to try and get anything at a jeweller's shop, or even get a ring. If the young man could not carve wood himself, he would know somebody who would carve a love spoon for him to take to his sweetheart. If he would want to get engaged, he would have to get a double love spoon, i.e., something resembling Siamese twins in spoons. (Some of these spoons can be found even now, and also replicas by rural carvers of to-day.)

Since they depended so much on wood, it was only natural that they took a keen interest in different sorts of woods, and had a keen eye to find the proper piece of wood for their requirement. It was a part of the culture of the rural districts, and that makes it all the more surprising to hear the authorities of the Forestry Commission declare that we in Wales do not take enough interest in afforestation. If this is a fact, it is a great disadvantage to Wales, and a disadvantage to the Commission also. It cannot be said that anybody is so blind that he will not admit that the Welshman is the best man in Wales to grow trees in Wales, and, of course, the same thing applies everywhere else. Who can grow trees in Scotland like a Scotsman?

Probably the Welshman is not the ardent fellow his neighbour over Offa's Dyke is, but when the Welshman is convinced that a new thing is a good thing he cannot be beaten. The Forestry Commission is anxious to get more Welshmen as Foresters, and I am of the opinion that the young Welshman will answer the call in the near future.

In the meantime, the Commission may do well to look to those units that have kept pure Welsh, as many in the valleys of Merionethshire have done. Maybe these are only rare exceptions, but now and then a Welshman on the supervisory staff is transferred to a unit that is one hundred per cent English-speaking. Probably an English speaking supervisor is appointed to the Welsh-

speaking unit. This may cause difficulties in both the English and Welsh-speaking units.

We are given to understand that the Commission is very much alive to the acute problem of the depopulation of the rural districts, and has every sympathy with those who try to stem it. Inasmuch, we can expect considerable help in this direction, and it seems indeed that the best answer to the problem so far, is the Forestry Commission's smallholding. We have here a chance for new families to take root in the rural districts to accompany the remains of the old stock that hand on their patrimony. It is indeed difficult to find a better solution to the problem than this.

We also know that the Commission is building whole villages in districts where a great acreage is planted, and where there are no houses available for the workers demanded in the area. Some people are bemoaning that these new establishments do not take after the Welsh village, but seem to take the pattern of English villages. Hardly can we blame the Commission for this. I for one would think it is the prime duty of those who watch and keep guard over the welfare of Wales to take care of the do's and don'ts relating to the Welshness of the new village rather than sit on the fence to find faults.

This is what the position looks like at present. The Commission is growing timber in Wales. We have every reason to believe that the Commission is anxious that we Welshmen do take the foremost part in this industry in Wales. On the other hand there is a class of people jealously watching the Welsh culture who cast a suspicious eye on every move that is contrary to their ideas. After looking at the position from every angle, I cannot whatever find any proof that the Forestry Commission is doing anything that is detrimental to the Welsh way of living.

All that is wanted, and what is mostly lacking, is mutual understanding and co-operation. The Commission admits many mistakes in the past, and it does not guarantee that it will not do even more in the future, but it will claim that it is always ready to listen, and take heed of suggestions regarding to the relation between the Welsh customs and timber planting.

We mentioned in the first paragraph that the Forestry Commission had been subject to many jibes and insults. Where did these come from? One is tempted to ask, and did the Commission deserve such treatment? One can say without hesitation that most of the upbraiding came from the farming fraternity and whether it was right or wrong it can safely be said that most of it was the result of lack of understanding, and co-operation between silviculture and agriculture. This is a great pity too, for agriculture could have gained more often than not from a better understanding.

If we travel along and across Wales, many a poor old slope can be seen, too poor really for sheep grazing under its heavy crop of bracken. This would be the ideal place to grow trees; larch trees, for instance, would relish it. If the Commission could get more of this type of land, there would be much less of the better sheep grazing land planted with trees. The farmer would be repaid twofold also in shelter for his stock which he would soon gain from these scattered plantations.

Now and then we hear another complaint also, "That our forests and plantations are much too uniform, and monotonous". If there is a cause for a complaint here, it can be attributed to the fact that whole farms, and sometimes estates, have been planted. We should certainly have more variety in the colour of the landscape as a whole if the above suggestion was adopted.

Mutual understanding and co-operation have already been mentioned. Is it possible to carry these farther? I have in mind whilst writing these lines, a piece of land that has been bought by the Forestry Commission, and will be planted in due course. It rises to about fourteen hundred feet above sea level. Much of it can be said to be fairly good sheep grazing land. Bordering with this land but nearer sea level is an old *ffridd* (sheep walk) covered with a thick crop of bracken, with a road skirting it. It can be safely said that sheep would thrive much better on the land belonging to the Commission and without doubt, the old *ffridd* is useless except to grow trees.

Could more be done in this direction? That is to change parts of land, if it is obvious that both parties were to gain from such transactions. If this could be done on a larger scale it would certainly do much to alleviate the ill-feeling that has prevailed between two industries that have so much in common.

We Welshmen of every party might as well realise that we must grow timber in Wales. It does not matter a bit whether our Parliament will be at Saint Stephens or nearer Saint Fagans, we must have timber and the sooner we plant it, the sooner it will be of some use to us.

After all is said, what can be more stately and permanent than trees? What better heritage could a father leave for his children on a farm than an abundance of growing trees, be they hardwoods or conifers?

We of the Welsh nation are apt to take examples from the Bible to press a point home. What of the story of Abraham when, getting on in years, he decided to leave something after him that would be permanent? "And Abraham planted a grove of trees in Beer-Sheba".

THE CHILTERNS PROJECT—1951/1956

By J. L. DAVIDSON

District Officer, East England

In several respects the woodlands of the Chiltern Hills present features of outstanding interest to foresters. They form one of the most heavily wooded parts of the country and have a long tradition of management in association with which there has grown up one of the leading furniture manufacturing centres of Great Britain. An unusually high proportion of the woodland area has survived war felling as high forest in the eighty to 150 year age class. The importance of the contribution these woods can make to the national forest estate was recognised at an early date by the Forestry Commission and in 1951 the main part of the area was made the subject of special study combined with a scheme for improved management by the launching of a scheme under the title of the Chilterns Project. At the time the Commission's Private Woodland work was very much less intensive than now, and although this work elsewhere has reached a stage equal to that envisaged for the Chilterns, so that it is scarcely possible to consider the Project as distinct from similar work in other parts of the district, it remains an area with special considerations. A review of progress made since the launching of the scheme five years ago may be of interest.

The area chosen was that part of the Chiltern Hills between the Thames in the south and the Wendover/Amersham road in the north, bounded on the

west by the main chalk escarpment, and on the east separated from the still well wooded but largely suburbanised parts by the line Amersham/Beaconsfield/Bourne End. It is a stretch of low chalk hills with mixed farming in the valleys, the lower slopes, and on the broad plateaux of the tops. Woodlands mainly occupy the tops of the narrower ridges and the steeper upper slopes of the valleys, where they form the characteristic hangings. The chalk is well covered with clay-with-flints on the tops of the hills, in the valleys, and on gentle slopes, but where the gradient is steep this cover is shallow or replaced by a few inches of chalky soil. Where not covered by woodland these steeper slopes produce only poor grazing barely able to compete with the invasion of shrubby species typical of chalk lands. The whole area taken into special consideration is 150,000 acres of which 27,000 acres are classified as woodland, described in 1951 as follows:

High Forest, broadleaved ..	20,000 acres
„ „ conifer and mixed	2,300 „
Coppice and Coppice with Standards	600 „
Scrub and Devastated ..	2,200 „
Bare, mainly war felling	1,900 „

The importance of the broadleaved contribution will be noted. Almost the whole is beech though there are a few stands of oak and ash, and many of the beech woods contain a small proportion of ash, oak, and cherry. Of the beech it is estimated that 80 per cent is aged 100 years or more, 15 per cent from fifty to 100 (mainly seventy to 100), and only 5 per cent is under fifty (mainly recent planting).

The purpose of the Project idea was the investigation of the management and silviculture of the area leading to a campaign to stop the deterioration of the woods which was recognised as taking place, and the restoration of those woods which had already suffered to a condition of full productivity. Since almost the whole of the woodland area was (and still is) privately owned the closest co-operation of owners was sought, a programme of research on natural regeneration of beech started at the Commission's Watlington Forest, and a District Office opened at Princes Risborough to serve as the focal point for the collection and distribution of information.

During the past five years every wood has been visited and reported upon, the owners or agents contacted and the management discussed. The record of ownerships of woodland which has been compiled on a set of six-inch Ordnance Survey sheets shows the present position to be:

Estates with over 500 acres of woodland	14 with	11,900 acres
„ „ 150/500 acres of woodland ..	32 „	8,900 „
„ „ under 150 acres of woodland ..	163 „	4,500 „
Forestry Commission holdings		1,700 „

(It should be noted that the above figures as with others quoted in this article do not include the many small woods of under five acres on any one estate.)

In 1951 the Commission held only about 300 acres at Watlington Forest. Though small, this and other more recently acquired areas have played an important role for research and demonstration purposes.

With a few notable exceptions the management of the woods was unimaginative and founded on a form of selection system which had come to be

regarded as traditional to the area, if indeed there was any policy at all. The general attitude was well expressed by several estate owners who would display old estate maps pointing out that the woods had survived a policy of selection felling with natural regeneration for generations and provided a regular annual outturn of timber which was a main source of income for the estates. Scant attention was paid to the warnings of a number of experienced foresters who, for the past thirty years and more, had pointed out the obvious lack of regeneration, and very little attention was given to proper conditions for the growth of the older age-classes. It was not appreciated that, although conditions a century ago, when many of the woods probably contained a reasonably balanced mixture of age classes and there was an adequate market for small as well as mature timber, may have provided grounds for continuous operation of a selection system, subsequent important changes in the markets had forced owners to change their felling policy and with that the whole structure of the woods. Nearly all the woods can now, for all practical purposes, be regarded as even-aged, and a continuance of the selective felling which was practised so widely could only lead to further deterioration of the woods.

With the decline of the bodgers who fashioned furniture parts from the small girthed timber, and the growth of modern mills demanding larger logs, thinnings became neglected. One result of this is seen in the large areas of dense beech woodland with trees of small girth which, from their age and site, should have been reaching the larger girths of mature trees such as the local furniture trade requires. Whether, with treatment at this late stage, they will improve appreciably remains to be seen, but measurements made in Watlington Forest give hope of at least partial success.

While thinning was neglected, selective felling of the more mature trees continued without a break. Many owners, especially on the larger woodland estates, rely on an annual income from their woods which they are entitled to expect, but because of the low prices which have prevailed for a very long time, up to a few years ago they found that this income could be gained only by felling trees of good quality. The result has been an ever increasing proportion of poor quality trees in the oldest age-class.

The third factor in the deterioration of the woods has been the almost total lack of regeneration. Though a larger part of the Chiltern woods than is perhaps generally realised was probably planted a century or more ago, and some planting has been done since, the traditional method has been to rely on natural regeneration. In few woods are there any appreciable quantities of trees under seventy years of age, and much of what little natural regeneration there is has so suffered from lack of attention that it is useless. On the other hand there are large stands resulting from natural regeneration of only a little over seventy years ago. Several reasons have been advanced to explain this failure. Though rabbits were abundant till recently, and must have destroyed vast numbers of seedlings, it seems probable that a main contributory cause has been the increased density of many stands resulting from the neglect of thinning, with its associated deterioration of the upper soil conditions, relatively poorer production of seed from the narrow crowns, and the reduced vigour of seedlings to withstand attacks from insects in the relatively darker and drier conditions under a heavy canopy. It is noticeable that in the few woods with trees of really mixed ages, as would be normal in a selection forest and as may have been common in the Chilterns at one time, the woods present a very much more open appearance than the average Chilterns woods of to-day. It is also noticed that where the soil is frequently disturbed, as where the public have free access to woods, regeneration is frequently plentiful. Further research on the

problems connected with natural regeneration of beech is in progress in the Commission's Watlington Forest.

During the past five years there has been increasing attention given by woodland owners to these matters. Through persuasion and demonstration, especially during felling licence inspections, the need for adequate thinning has become well recognised and the greater part of the timber from the Chiltern woods to-day comes from thinnings. It is encouraging that the Commission's officers are frequently consulted on the marking of the thinnings and although there is the thought of smoothing the passage of the subsequent felling licence, there is a very genuine desire among most owners to treat the woods on proper silvicultural principles. Since the war there has been little real difficulty in finding a reasonable market for the smaller timber and this has, of course, been a great help. Though it is difficult to separate genuine thinnings from selective final fellings which are often carried out at the same time, an analysis of the record of felling licences issued indicates a rate of thinning of about 400 acres a year in the older beech woods. There has, in addition, been almost 1,000 acres of thinning done in the five years in the younger stands of conifer and broadleaved species and in the middle age class of conifers.

Selective final felling of mature trees has continued, but emphasis has been placed on the removal of a much higher number of the poorer quality trees and there is a slow movement away from the purely selective felling of former years towards seeding fellings under a group system of natural regeneration, or more recently the shelterwood compartment system. Whatever the system, all felling licences are backed by restocking conditions. Since natural regeneration is generally the aim, except in very understocked woods where clearing and replanting is necessary, owners have been encouraged to retain sufficient of the best of their trees for seed production. Though the tendency to fell the best and leave the poorer trees has been very largely reversed, it was not without some difficulty at first during consideration of felling licences; but the position is generally accepted now and it is rarely necessary to criticise the marking of fellings.

It has been mentioned that natural regeneration remains the basic policy in most of the woods. Though it has not been successful in maintaining the woods in the past half century, experiments in scarifying the ground during the fall of mast in 1950 were most encouraging. Though on a small scale the results have been well publicised with the result that in the first good fall of mast since then, which has taken place this (1956) autumn, at least 600 acres have been given fairly intensive treatment. Combined with the almost total absence of rabbits there is hope of satisfactory regeneration of considerable areas. At the same time there is general willingness to accept the responsibility of planting within a reasonable time should natural regeneration fail.

The areas planted during the past five years have been:

Dedicated and Approved Woodlands estates..	505 acres
Other estates (mostly with grant aid)	300 „
Forestry Commission	451 „
	1,256 „

Most of the planting has been done in the past three years and although the rate is adequate to achieve the restocking of the bare and derelict woodland within a reasonable time it is very very far from adequate when consideration

is given to the very large areas of mature and near mature woodland much of which is poor in quality and productivity. It seems unlikely that a big increase in the rate of planting can be expected in the near future because of labour shortages, especially for maintenance of young plantations, but if improved technique in promoting natural regeneration is successful much of the difficulty may be overcome. Most plantations have been made with mixtures of conifer and beech. The economic and cultural advantages of the conifer are well recognised, but there is room for much greater attention to the use of alternative species on some of the poorer sites and in mixture with the beech in the older woods when they are regenerated. Such mixtures might prevent the poor soil conditions which are noticeable in many of the pure beech woods on the more acid sites.

The increased interest in planned management is reflected in the progress made with Approved Plans. The table below shows details of the present position with the 1951 position in parenthesis:

Under Approved Management—			
Dedicated ..	13 (2) estates with	5,400 (1,200)	acres
Approved Woodlands ..	16 (0) „ „	6,100 (0)	„
Preparing plan for approval	5 „ „	1,800	„
Forestry Commission Areas		1,700 (300)	„
		15,000	
Other Estates—			
Suitable for Dedication:			
Over 250 acres	10 estates with	5,800	acres
150/250 acres	8 „ „	1,300	
Under 150 acres	32 „ „	2,500	„
		9,600	„
Miscellaneous—			
Under negotiation for Forestry Commission acquisition		500	acres
"Small Woods" ..	125 estates with	1,800	„
		26,900	

More than half of the estates which have not yet agreed to prepare a plan for approval are not opposed to the idea in principle, but are holding back on the grounds that they cannot undertake any scheme until they manage to find the necessary labour. This is a very real difficulty in the district. It is hoped that the recently formed co-operative society will be able to help particularly the smaller estates. Among the estates where there is no suggestion of preparing a plan at present are a number of timber merchants owning extensive blocks but mainly of mature and near mature timber not requiring much management until a decision is taken to fell and the restocking question arises.

Not all the plans are as satisfactory as might have been hoped, but they give some assurance of protection against further deterioration and the restoration of the derelict areas and bare land. The more even-aged character

of the woods is recognised in most plans by the employment of group or shelterwood compartment regeneration systems in the older woods and clear felling followed by planting in the poorly stocked and derelict areas. A few still cling to the system of selective fellings. The more uniform-aged systems are being encouraged not only because of the condition of the woods but because they enable the owner to concentrate his regeneration efforts on smaller and well defined areas instead of over large areas where the control (made much tighter by restocking conditions attached to felling licences or dedication) is less easy and has, in the past, been too often lost.

Though the Commission's activities were viewed with some suspicion at first, despite the support given by the Royal Forestry Society and a few leading woodland owners, relations have now improved very greatly and there are only two or three estates of any importance where its officers are not welcomed. The current problem is not one of seeking the co-operation of owners so much as keeping up with the numerous requests for advice and assistance. The recent reorganisation of duties to include both Private Woodland and State Forest work has been of very great help. It makes possible not only easier arrangements for demonstrating points to owners in the Commission's woods but allows the District Officer to speak with much greater authority on day-to-day matters of costs and methods. This is an important point with most owners and has been a very great help in gaining their confidence. The smaller area of the District is also making possible a more intimate knowledge of the woods, which is more essential now that the initial contacts have been made during the past five years. The District Office is, in fact, becoming the focal point for the interchange of information on matters of all kinds relating to woodland work, as was envisaged in the scheme.

HISTORY OF RATAGAN FOREST

By R. O. DRUMMOND
Divisional Officer

This account of Ratagan Forest in the North Conservancy of Scotland was written by Mr. Drummond when he was District Officer in charge of this area in 1951. *It has been included, though in abbreviated form, as an example of the way in which such Forest Histories may be set out, and also as an interesting record of Commission activities in the Western Highlands.*

I. Situation

Ratagan Forest takes its name from the sheep farm which was acquired to form it. The forest is divided into two sections, separated by the watershed running parallel to the south shore of Loch Duich; this watershed also forms the county boundary between Ross-shire (on the north-west) and Inverness-shire (on the south-east).

Ratagan section lies in Ross-shire in the parish of Glenshiel, and Moyle section lies in Inverness-shire in the parish of Glenelg.

The forest as a whole lies between the south shore of Loch Duich, near the head of that sea-loch, and Glenmore. It was acquired by feu from Colonel Baillie of Dochfour in 1921.

Kyle of Lochalsh is the nearest railway station, twenty-two miles by road from Ratagan House. A steep and twisting road leads over the top of the watershed (Mam Ratagain) to the Moyle section and thence to Glenelg on the Sound of Sleat.

II. Area and Utilisation

The total area acquired was 2,481 acres, of which 1,693 acres have been compartmented. Of the compartmented area, 1,563.5 acres are under plantations, and the rest comprises blanks, mainly lying along the high exposed top edges of compartments. Forest Workers Holdings, including grazing outruns, cover a further 174 acres of the uncompartmented area, and the remaining uncompartmented area is unplanted and unplantable, lying on the exposed ridge watershed between the two sections.

There were no acquired plantations.

A nursery was started at Ratagan in 1923 of about two to three acres in extent. In 1927 the area was increased to four acres by the addition of an acre of nursery at Moyle. In 1931 the Ratagan nursery was increased by a further two acres. In 1934 Moyle nursery was abandoned and planted up, and the Ratagan nursery was steadily reduced until only one acre remained in 1936. Seed beds were sown annually until 1933, and thereafter the nursery was used for lining out only. This small nursery continued until 1947, when it was finally closed down and sown to grass and let for grazing, as had been done with the rest.

III. Physiography

Ratagan section lies on the moderate to steep slopes along the southern shore of Loch Duich, with a north-easterly aspect, rising from sea level to a height of about 1,200 feet on the watershed, in a horizontal distance of some 4,500 feet.

In the Ratagan section there are two main streams cutting down through the plantations, the Allt Ratagain and the Allt na h-Inghinn. These are deeply cut and steep sided, with precipitous walls and waterfalls on their upper reaches. The slope is also cut into deeply by many smaller burns.

Moyle section lies on the south-westerly face of the slopes down from the watershed to the Glenmore river. Here there are two main streams, Allt Choire Thorrlaich and the Allt Lionagah. These streams are not so deeply cut as on Ratagan, but have broken rocky beds and steep sides in their upper reaches.

The Moyle section is more gently sloping than Ratagan, rising from about 200 feet along the Glenmore valley bottom to 1,200 feet on the watershed, in a horizontal distance of some 8,000 feet.

Exposure is not a serious factor in either section, except at the top limits of planting generally, and at the north-west edge of Ratagan, in particular, where the effects of exposure are noticeable but not serious.

IV. Geology and Soils

The geological formation is mainly granite, with schist coming in at the southern corner of the forest. This is much decomposed near the surface in parts.

Soils are generally reddish-brown, loose and gritty. The soil is very shallow on the steeper upper slopes of Ratagan, but is generally of good depth on the Moyle side.

Peat has formed and accumulated to a depth of up to three feet on the flats above Ratagan House, and at the southern end (and in patches throughout) on the Moyle section.

On ridges and knolls on the Ratagan side, a shallow, tough peat layer has developed, four to six inches in depth.

V. Vegetation

At the time of acquisition, the vegetation was mainly *Nardus*, *Festuca*, *Molinia* and *Scirpus* on the higher slopes, with *Anthoxanthum* and fine mountain grasses becoming more common on the lower slopes.

Juncus, bog myrtle and *Eriophorum*, with some bog asphodel, *Sphagnum* and lichen occurred in the wetter and peaty places.

Heather was mainly confined to patches on the higher slopes. Bracken was commonly found, particularly on the lower slopes. There was no timber on the area, and only a very little birch scrub, which was mainly confined to the sides of streams.

At the present time, the vegetation has been almost completely suppressed over the bulk of the area where spruces and Douglas fir were planted, and have become established. In checked areas so planted, there is usually a weakened *Calluna vulgaris* growth, with abundant *Sphagnum*, *Hylocomium* and occasional *Polytrichum* and liverwort.

Bracken is still common in the Moyle section on rides, under larch and where canopy is still not closed.

Under larches there is still a plentiful ground vegetation of grasses (*Holcus* spp. *Aira caespitosa*), *Oxalis acetosella*, *Digitalis* and *Primula* and mosses (*Thuidium*, *Mnium*, *Plagiothecium*, *Hylocomium* being common, *Polytrichum*, *Dicranum*, *Catherinea undulata* and liverworts local).

VI. Meteorology

The average annual rainfall is about 75 inches and is evenly distributed through the year, with May usually the driest month. Snow rarely lies for long or to a great depth, and then only on the high land between the two sections, generally above the top limits of planting.

Both late and early frosts are seldom of an intensity to cause any damage. The only recorded instance of frost damage was from a severe late frost in May, 1935. A little damage from the same cause occurred in 1945.

Prevailing winds are from the south-west and often reach gale force. But the forest is nowhere directly exposed and little damage is anticipated or has occurred except by freak storms, and on the upper limits of Moyle planting. Such small blows as have occurred are usually confined to small wet patches with poor drainage and fast growth.

VII. Risks

The danger from fire is not very serious as the area is, on the whole, wet. The main sources of danger are from fires on the roadside or in the forest, started by hikers or roadmen, and, to a less extent, muirburning by neighbours. Fortunately, most of the roadside plantations on Ratagan side have now grown beyond the most dangerous stage.

The only fire which occurred in this forest was in March, 1929, when some

fifty acres of P.23 and P.24 were destroyed by a fire starting on the roadside. This was replanted in P.30.

Roe deer are still plentiful and do some damage annually. Rabbits are plentiful outside the forest, but are kept well in check and do little or no damage to the plantations. Voles gave great trouble in 1935, but not since then.

Both sections of the forest harbour sheep, where grazing and shelter under larch is attractive. Fence maintenance and periodic drives before lambing help to keep them out, but there is always a small population. They do little or no damage now.

Red deer, which were plentiful in the early years, are now uncommon and do little or no damage. There have been no insect attacks of any importance.

As regards fungi, damage to European larch through die-back and *Dasyscypha calycina* has been and still is serious, though the climax of the attack appears to have passed.

About two acres of Douglas fir are dying from an attack of *Phaecryptopus gaumanii* first noted in 1950 spring. No other fungal attacks of any importance have been observed.

VIII. Roads

Apart from the County road from Ratagan over Mam Ratagain to Glenelg, and the forest road from that into Moyle Forest Workers Holdings, there were no roads in the forest until 1946. There were, however, a number of useful inspection footpaths.

In 1946, a start was made, mainly by hand work, on putting in roads to the areas where thinning was becoming necessary. This work continued by hand and with increasing use of bulldozers and a dumper until 1949-50, when a full programme laying out a road system and feeder tracks which would tap all areas likely to become ready for thinning up to the end of 1954, was drawn up. By 1951, good progress had been made, and it is hoped that the end of 1952 will see the completion of the above programme.

Thinnings were in arrears for lack of roads at the end of the war, and are still delayed for this reason, but the position is now satisfactory as the new roads should enable us to catch up.

IX. Labour

Labour has been adequate generally for the Ratagan section, from local residents and Forest Workers Holdings.

At Moyle, also, the position has always been fairly satisfactory, by using a bothy at that forest to accommodate the extra five to eight men not available from local residents and Forest Workers Holdings.

There are three Forest Holdings in Ratagan section, and two Forest Holdings at Moyle.

Eight new houses are in process of erection at Ratagan, and some labour may be available for Moyle from the six new houses now in course of erection at Glenelg. The hostel at Moyle will then be closed down, and labour transported to Moyle to the extent necessary.

X. Silviculture

(i) Preparation of Ground

(*a*) Fencing

The first enclosure for P.23 was made for that year's work only, but in the following year the whole of Ratagan section was fenced in. The fence was all rabbit and stock proof, but was made deer proof only on those sections where red deer were most likely to get in.

At Moyle, the procedure was similar, a start on fencing being made in 1928 and final enclosure being completed in 1932, the fencing just keeping about a year ahead of the planting until then, to enable rabbits and other vermin to be brought under control just in time.

(*b*) Weeding and Scrub Cutting

There was little scrub to clear, but such as there was was cut out and burnt a year ahead of planting. Bracken growth was heavy on most of the areas planted up, and this was cut over, often twice in the year, or sometimes for two years, before planting. Heather growth was patchy and mainly confined to the higher ground, and there is no record of this having been burnt or cut prior to planting.

(*c*) Drainage and Turfing

Very little drainage was done in the first year or two, but became progressively more intensive as the need for it became apparent, and the method of turf planting became established practice. Thus, in the first year or two, an average of some two-and-a-half chains of drains per acre were cut, but this increased to some twenty-five chains per acre in 1930 and subsequent years. The increase was also partly due to the fact that the best naturally drained slopes were taken up for planting first.

(ii) Choice of Species

Appendix III shows the areas of each species originally claimed as planted, and the areas of each species as they exist in 1951. Apart from changes due to adjustments of areas, and replanting of a burnt area of some fifty acres, the changes in proportions of the species planted are slight. This tends to confirm the opinion that the original choice of species was usually sound. Roughly, the percentages of species planted and still existing are:

> Sitka spruce, 48%; Norway spruce 19%; European larch, 9%; Japanese larch, 9%; Hybrid larch, 5%; Pinus contorta, Scots pine and mountain pine together, 5%; *Thuja*, *Tsuga*, *Abies grandis* and *Abies nobilis*, 2.5%; Douglas fir, 2.5%.

The only serious criticism of choice of species is that European larch has been planted too extensively on doubtful areas. Serious losses from canker and die-back have occurred and are still occurring (though the climax of the attacks seem now to be past) and the crop which remains will always be very open. Attempts to underplant have been made on a medium to small scale, using beech, *Abies nobilis* and *Abies grandis*, and spruces, but these have largely failed due to concentration of roe deer on such patches. The proper policy now is probably to wait until the remaining trees reach an exploitable size, and then to decide whether to accept them as the crop, or to fell, fence and replant.

A lesser criticism possible is that Douglas fir generally is of poor quality, and Sitka spruce would probably have produced as great or greater volume

and of better quality; and, finally, that, from the areas still in check, it appears that many very doubtful patches were planted up which it would probably have been better to leave unplanted, and that on the Ratagan side planting was originally carried too high up the hill.

Changes of species by beating up have not occurred to any great extent. In general, it is true to say that excessive beating up was done up to about 1932. For as many as three years after planting (in each area planted up to about 1932) very extensive beating up was done, using the same species as originally planted. From about 1932, the increasing use of spruces and *Pinus contorta* indicates that it was about that time that such changes of species as did occur, occurred.

In conclusion, however, it is true to say that, with the exception of European larch, the choice of species used was very sound.

(iii) **Planting**

(*a*) **Spacing**

There is nothing special to note on this. The spacings used were those usual at the time when the planting was done.

(*b*) **Type of Plants Used and Source of Supply**

Information about the source of supply is rather sketchy, but it is generally true to say that most plants came either from the home nursery or from South Laggan and Inchnacardoch. So far as information goes, most of the Sitka spruce seed came from Queen Charlotte Island, and much of the European larch was of continental origin. There are, unfortunately, no records to show the source of Douglas fir seed used.

As regards type and age of plants used, it is generally true to say that, since 1934, plants used were of the normal age and size, as they were in the first year or two of planting. Between 1925 and 1933, however, there was much use of big plants, e.g.:

P.25	Sitka spruce	2+1+2 and 2+1+1
	Japanese larch	2+1+2
P.26	Sitka spruce	2+2
	European larch	2+2
P.27	European larch	3+1
	Norway spruce	3+2+1
	Sitka spruce	3+2
P.28	Japanese larch	3+1
P.29	Sitka spruce	2+2
	Hybrid larch	2+2 and 2+1+1
P.30	Sitka spruce	3+3 and 2+1+2
	Norway spruce	3+2+3
P.31	Sitka spruce	2+2+2
	Norway spruce	2+2+2
	Japanese larch	2+1+1
	European larch	2+1+1
	Pinus contorta	2+1+1
	Abies nobilis	3+3
P.32	Sitka spruce	2+1+1
	Norway spruce	3+1+2

(*c*) **Methods of Planting**

In P.23 and 24, direct notching with the "Schlich" planting spade only was used.

In P.25 to P.28, mainly notch planting, with a little pit planting, was done, and a very small amount of turf planting was started in P.28.

In P.29, turf planting was on an appreciable scale in the wetter areas, for planting spruce, the rest being notch planted.

From 1930 to 1932 more and more turf planting was done, so that, by 1932, at least half the planting was on turves, and from then on turf planting became general, except on the very best ground where notch planting continued to be used until about 1936.

(*d*) **Annual Rate of Planting**

The main bulk of the planting was completed by P.33, and thereafter it was small areas of wetter and tougher ground that were being planted. The average rate of planting from P.23 to P.33 was about 140 acres per annum, and from P.34 to P.48, in eight planting years, further areas were planted at the rate of about twenty acres per annum.

(*e*) **Manuring**

The use of slag at Ratagan is first mentioned in connection with the beating up operations in 1933, but it appears not to have been used at the time of original planting until 1934—the last year of the main planting programme.

Slag (and later ground mineral phosphate) appears to have been regularly used in all beating up operations from that date. From 1934, also, a "consolidation" programme was started, and at this time slagging of existing "checked" plants in backward areas was done.

(*f*) **Success of Establishment**

An assessment made in 1932 showed that 296 acres were established and 1,103 acres not established at that time.

By 1935, 807 acres were established, and 634 not established.
„ 1938, 1,116 „ „ „ „ 330 „
„ 1947, 1,429 „ „ „ „ 76 „ „

Progress towards establishment has, therefore, been very satisfactory.

(iv) **Ploughing**

No ploughing was done on Ratagan Forest.

(v) **Beating Up**

As already noted, in all the main planting, very extensive and probably excessive beating up was done for three years after the original planting. From the third year after planting, beating up was continued on a reduced scale, and in all these works the original species was generally used in beating up.

In 1934, a definite consolidation programme was introduced, which comprised a full cleaning of existing drains, and the making of many additional drains, particularly in the areas planted in the first few years (where the original draining was very inadequate), and in all checked areas, which were mainly in inadequately drained wet hollows and on wet ridges and slopes with tough peat covering.

In this consolidation operation (which lasted from 1934 to 1943), Sitka spruce was the main species used, being planted invariably on turves and slagged. Scots pine and *Pinus contorta* were also used, to a much less extent, while Oregon (and some Grey) alder was also extensively used up to 1936. Most of the alder have since died out or remain as stunted bushes.

All the plants used in beating up were slagged or given ground mineral phosphate, the first use of which is noted in 1933; and at the same time, existing checked plants, whose recovery seemed possible, were also manured.

The results of the consolidation work and extra draining have been very satisfactory, except on a few tough peat ridges and knolls, where progress towards establishment still continues in most cases, but is very slow. It seems probable that better results in such places would have been achieved if more Scots pine and *Pinus contorta* had been used and less Sitka spruce.

In 1931, beech was used to interplant through the larch areas of almost all areas planted to that date, and in P.30, about two acres of larch was similarly interplanted with *Abies nobilis*. Roe deer, which found cover in the established spruce areas, played havoc with the interplantings and only occasional plants have survived, which are of little importance in the crop now.

In general, big plants were used in all beating up operations. The plants used in interplanting were generally 2+2 or 2+2+1 beech and *Abies nobilis*.

(vi) **Weeding**

The main weed species throughout was bracken and luxuriant growth of grasses. In addition to cutting of bracken for one or two years prior to planting, cutting of bracken and grass was continued for several years after planting. In some cases almost the whole planted area had to be weeded for about three years after planting, and weeding continued, in the worst cases, on an annually reduced scale for as long as ten years after planting.

In only a few areas, where growth of bracken was exceptionally heavy, was bracken cut more than once in a season.

While it now seems that weeding was done on too big a scale and continued for an unnecessarily long time in some cases, there is little doubt that the quick and even establishment of the crop can be largely attributed to the extensive and thorough weeding regime adopted at this forest.

(vii) **Mixture of Species**

So far as records go—and examination of the existing crop bears out this statement—practically no intimate mixtures were originally planted at Ratagan Forest, with the possible exception of small areas on hard knolls and even then, mainly at the upper planting limits, where some Scots pine and mountain pine were introduced among the Norway spruce and Sitka spruce. Even this is doubtful, as the mixture in these places may have been made at the time of subsequent beating up.

In general, species were planted in pure blocks, the species most suitable for the changing soil conditions and exposure having been selected and planted. The heavy beating up in the first two or three years after planting was usually confined to using the same species as had been originally planted.

Such intimate mixtures as do occur are almost all the result of the "consolidation" beating up which was carried out over the long period 1934-1943 (the introduced species being mainly Sitka spruce and alder (mainly Oregon but

some Grey), with a fair amount of Scots pine and *Pinus contorta* and some small quantities of mountain pine, *Thuja*, *Tsuga* and *Abies*), and also the introduction of *Abies nobilis* and beech by interplanting through the poor larch areas, mainly European larch.

Of all these, the areas which carry intimate mixtures of any extent and importance today are confined to the following:

(*a*) Douglas fir and Sitka spruce: (*b*) Norway spruce and Sitka spruce: (*c*) Sitka spruce and Scots pine or mountain pine or *Pinus contorta*.

In addition, beech and some alder still persist in many of the larch areas, but generally only a few beech remain to the acre, and these broadleaved species are very stunted and twisted. It is doubtful whether more than a very few will persist to the end of the rotation, and the only effect they are likely to have is as soil improvers. They are unlikely to be of any value for timber.

(*a*) *and* (*b*) **Mixtures: Sitka spruce with Douglas fir or Norway spruce**

In the case of these mixtures, the main crop will continue to be the originally planted species, i.e., Douglas fir or Norway spruce, and the introduced species (Sitka spruce) which is generally more vigorous and of better form than Douglas fir will only form a small part of the final crop. It will generally be favoured in Douglas fir, but in Norway spruce it will be treated equally with the Norway spruce, keeping whichever species will be more valuable and will fit in best with the general crop up to the end of the rotation.

The interaction of one species with another is not clear, and the main value of the introduced Sitka spruce is to give a useful crop on areas too poor for the original species.

(*c*) **Mixtures: Sitka spruce with pine**

Here the original choice, Sitka spruce, was beaten up with a pine, and this mixture occurs mainly on the harder knolls and at the top of the planted area. The pines have, in some cases, suppressed the Sitka spruce, which never came out of check, but generally the pine has and is acting as a nurse, and the spruce is coming out of check. Each area will be treated on its merits in deciding whether to retain some or all of the pine permanently or for only part of the rotation.

(viii) **Rate of Growth, Form, etc.**

A tabular statement is given as Appendix IV which describes the growth and condition of the main species, in areas selected as showing the best growth for that species.

The following comments have more general application to each species:

Hybrid larch

Growth and form are both very good.

European larch

This species appears to be unhappy. Attacks of canker and die-back have left most crops rather open, with many trees looking sickly, crooked and showing poor growth. There are now signs that the crops as a whole are recovering and growth appears slightly more vigorous.

Japanese larch

Growth is good, but the form is variable. There are many rough-headed and bent stems and, in some cases, the greater part of the crop is composed of

this type of tree. But generally such trees occur as wolves in a crop of good form, so that thinnings should enable a crop of good form to emerge after about three more thinning cycles.

Douglas fir

Growth is good, but the crop is of the course-branched type of tree, with stems not quite straight and much tapered. Volume yields will probably be good, but quality poor.

Sitka spruce

Growth is very good, and form also is good. Almost all faulty stems are removable in the first two thinnings. There are, of course, backward areas on poor sites, but even these show promise.

Norway spruce

Growth is satisfactory, with the exception of backward patches which are more frequent than in Sitka spruce. Form is fairly good, but there is in most areas a tendency towards swollen bases of branches, and often much fluting at the base of the tree, with signs of spiral grain in many stems.

Scots pine and Pinus contorta

The small areas of these species are usually on exposed sites with poor soil. Bearing this in mind, growth is satisfactory and form fairly good, except for the tendency in Scots pine towards swollen bases of branches giving a rough stem.

Abies nobilis and Abies grandis

Growth is fair to good for both species, with *Abies grandis* the better. Form is poor for *Abies nobilis*, with stems often slightly crooked, branch bases swollen and taper quick. The form of *Abies grandis* is usually good.

Mountain pine

Growth is fair and form hopeless.

Tsuga and Thuja

Growth and form are both fair, but there have been severe losses in the *Thuja*.

Broadleaved Species

Beech, used for underplanting, persists as slow-growing misshapen bushes. Patches of sycamore are growing well, but are of poor form Very little alder persists, and then only as stunted bushes, except along the burn sides.

(ix) **Past Treatment of Established Plantations**

The first opening-up of established plantations took place in 1935, when the removal of wolf trees was started over some two acres of Japanese larch in P.23.

In 1937 a small acreage of brashing was started in Douglas fir, European larch and Japanese larch in P.23—twenty-six acres. The method of brashing has always been the same and comprised the removal of side branches to a height of six to seven feet of a varying proportion of stems, but always choosing the best stems for brashing. In the early days, only the very poor stems were left unbrashed. Later, as a measure of economy, only the best were brashed. Thus, to begin with, all stems left after first thinning had been brashed, and many brashed stems were removed; whereas, in later years, almost none of the brashed stems were removed in first thinnings, and some unbrashed stems remain even after two thinnings.

The area brashed increased annually, being some sixty acres by 1940, and 200 acres in 1945; and then dropping to about ninety acres in 1950, at which figure it is likely to remain for some years.

Cleaning was generally done along with the brashing, and this remains the practice, the areas increasing and decreasing corresponding to the brashing, though less in area.

Thinnings, which were started on a small scale about 1938 in Douglas fir and larches (two to three acres), increased in these species in the areas first planted to some twenty acres in 1940, then stayed steady at thirty to forty acres per annum up to 1943, still in the same species. Very little preparation of produce or extraction was done up to this time, and this was mainly for fencing material. In 1944, the thinning programme increased to 100 acres and remained at about that figure or rather less until 1950. It was in this year that first thinnings in Sitka spruce were started. Extraction increased, and pitwood production started in 1944, since when about 10,000 cubic feet of pitwood and fencing material were produced annually until 1950. For the period 1950 to 1954, the thinning programme is expected to be in the neighbourhood of some 150 to 200 acres per annum.

As regards intensity of thinning, the only thinnings done were rather light' but, as the areas of larches and Douglas fir to be thinned were small, second and third thinnings were done after two to three year intervals, and the thinnings were adequate to keep the crop open and healthy.

The thinnings in Sitka spruce in 1944 and up to 1949 were also light and, due to the war years and increasing areas, subsequent thinnings were delayed. In 1949, the intensity of thinnings was increased and appears to be satisfactory, provided a return can be made in three years to do a further opening, or within five years at most.

Due to the very great numbers of stems to be removed in the somewhat delayed thinnings in some Douglas fir and Sitka spruce areas, it has been found better to leave much of the smaller, uneconomic and dead or suppressed poles standing at the time of the first thinning, to decrease the amount of lop and top on the ground, to make horse extraction easier, and also to protect the trees to be left. This practice appears to be sound and is to be continued. Such stems are generally removed at the time of second thinning as a measure of "forest hygiene".

The main products from these forests so far have been fencing material (from the larch) and pitwood from the rest of the larch, the Douglas fir and Sitka spruce, and from the small quantity of Norway spruce so far thinned.

Much of the earlier thinnings, except in the most accessible areas, were left lying due to extraction difficulties. The heavy thinning programme carried out in 1949 brought this problem very much to the fore, and in that year the first heavy road-making programme was undertaken. The road system, started in 1946 on a small scale, began to bear fruit in 1949 to 1950, and the roads alone brought many areas within the range of economic extraction. A caterpillar and sulky; a wheeled tractor fitted with 300 yards of hauling cable and a winch, and a light outhaul cable, for dragging timber; wooden chutes; together with a very early and not very successful overhead cable extraction system; all these methods have been and are being tried, to supplement the normal horse-drag and lorry extraction. It seems that these and other methods will all have their uses in the varying conditions of slope, and soil conditions, on is forest.

Appendix V comprises a statement of data obtained from 1/20th acre thinning plots.

(xi) **Research**

There are no Research Branch areas on Ratagan Forest, but there are five permanent sample plots which have been reported upon as follows:

"In March, 1949, five permanent sample plots were established in Ratagan Forest.

"These plots cover the growth of five species from different P. years and on various sites. Details are as follows:

Plot No.	*Site*	*Species*	*Age* (1949)	*Q.C.*
195	Cpt. 23	Hybrid larch	22	—
197	Cpt. 40(B)	European larch	17	I
198	Cpt. 5	Sitka spruce	19	III
199	Cpt. 6	Pinus contorta	16	—
200	Cpt. 19	Norway spruce	23	I

"With variables of age and location particularly elevation, the plots are not strictly comparable. The data, however, show that the Hybrid larch with a top height of 50½ feet have at present outstripped the others in height growth, for the next best, the Norway spruce of Quality Class I, are 7 feet shorter.

"At their establishment thinning, plots 195, 198 and 200 respectively, produced 622, 620 and 538 cubic feet per acre (quarter-girth under-bark measure), and they are again due for treatment in 1952.

"The *Pinus contorta* was the slowest growing species of all, for its average height at sixteen years was 24 feet and canopy was not yet complete".

(xii) **Conclusions in the Light of Experience Gained**

As far as the planting and establishment of the forest are concerned, the main conclusions to be drawn are that the selection of species for planting and the methods of planting and subsequent tending adopted were on the whole sound. In regard to choice of species, for original planting, only European larch appears to have been used on too great a scale, and in unsuitable sites, to any considerable extent.

Sitka spruce and Norway spruce were generally correctly selected for the sites, but in some cases more pine should have been used, generally as a nurse, but in a few of the worst cases, in place of the spruce, especially on the most difficult hard knolls at higher elevations.

The necessity for full draining and turfing in the wet peat areas became apparent very early, and extensive additional draining and mounding were done as soon as the need did become apparent, together with the use of phosphatic manures, as soon as the need and advantages of this became known, about 1934.

The futility of attempting to interplant larch with any species without adequate opening up, particularly where roe deer have become established in neighbouring thickets, has been proved beyond doubt. The fine crops of Hybrid larch obtained on Ratagan indicate that this species should be used to the greatest possible extent on suitable ground in similarly situated forests, to the exclusion of European larch, except on the very best ground. Japanese

larch should similarly be used in preference to European larch. Pines should always be used in mixture with Sitka spruce on the poorest sites and on knolls, as a nurse.

The quality of Douglas fir is generally rather poor, tending to have coarse branches, slightly crooked stems, and a quick taper. The sites selected for planting this species seem suitable, and the poor quality is, therefore, probably due to using plants from seed of unsuitable origin. Had the seed been from trees of suitable type, the crop would probably have been quite satisfactory. Alternatively, the excellent growth and form of Sitka spruce introduced in beating up Douglas fir areas shows that this would have been a satisfactory alternative.

The conclusion to be drawn here is the necessity of ascertaining the quality of Douglas fir seed sources, if this species is to be used; and of further experiments to see if this, and not site factors, is the reason for the poor quality of Douglas fir found so often on sites apparently suitable for the growth of this species.

APPENDIX I

SELECTED NOTES FROM INSPECTION REPORTS

(i) Inspection in June 1926 by J. A. MacAlpine

It is noted that planting to date was by Schlich spade, the plants being "notched" in after screefing. The types of soil and vegetation were noted as falling into four main types:

Type	*Soil*	*Vegetation*	*Species Planted*
1.	Shallow peat varying from 1 inch to 4 inch in depth over a heavy dark loam intermixed with small rock particles	*Juncus*, *Erica*, *Calluna*, *Carex*, *Myrica*, with some *Scirpus*, patches of *Polytrichum* and bracken where the peat disappears	J.L. E.L. S.S.
2.	Deep reddish loam—on a section of the area previously cropped with European larch	Bracken, *Molinia*, *Aira* and other grasses	J.L. E.L.
3.	Fairly deep peat (6 inches to 12 inches) mixed with small rock particles and a visible amount of mineral matter	*Myrica*, *Scirpus*, *Northecium* with *Erica* and *Calluna*	S.S. N.S.
4.	Loose gravelly soil on banks of streams composed chiefly of partly disintegrated rock, but with sufficient finer particles to form a good forest soil	Chiefly *Erica*, with *Calluna* and bracken	D.F.

Comments on choice of species and present conditions of growth at the time of inspection can be summed up as follows:

Generally speaking, the soil conditions seemed quite suitable for the species chosen. Possibly mountain pine would have been a better selection than Norway spruce in some places. More intensive planting methods would have been advantageous and the use of mattock planting was suggested.

Sitka spruce

Noted as doing well and very satisfactory.

Norway spruce

Some of the worst soil conditions were found in this area, and here satisfactory growth of any species was not to be expected. It was noted that growth was good in the better sections, and that the addition of a few surface drains might yet give a fair crop all over.

Douglas fir

About two acres were beaten up with Norway spruce, and now the area was fully stocked and all plants looked extremely healthy. About two-thirds of the Douglas fir were believed to be of Fraser River origin and their height growth was not so great as the rest of Oregon origin.

Japanese larch

Excellent growth and very few casualties noted.

European larch

Parts of the area had made a good start, but voles had caused considerable damage. Elsewhere, plants did not recover from the check of planting, and Sitka spruce was therefore introduced in 1926 beating up. Very heavy vole damage occurred, about 90 per cent of the spruce being cut back, though many sent up fresh shoots. It was noted that, where Sitka spruce had been planted in 1925 in parts immediately alongside the 1926 beating up Sitka, the beating up plants had been attacked by voles but the 1925 plants were untouched by voles.

(ii) **Inspection by F. Scott, Divisional Officer—April, 1928**

*P.*23 *Norway spruce*

Still backward. Any further beating up to be done on turves.

*P.*23 *Japanese larch*

1927 beat-up plants were of poor quality. More filling up should be done in 1929 if good quality plants available.

*P.*25 *Norway spruce*

Recovery in colour good and plants will soon be free of ground vegetation, which is less rank here.

*P.*25 *Sitka spruce*

Slow improvement noted in worst areas, but elsewhere crop is now established and growing well.

*P.*26 *Japanese larch and Hybrid larch*

Full stocking and good growth noted, and it was now thought that the very intensive beating up given was scarcely necessary.

*P.*26 *Norway spruce*

Colour good but growth poor, especially in less fertile areas. Mass weeding will have to be continued for some time over most of the area.

(iii) **Inspection by Sir John Stirling Maxwell, Assistant Commissioner—October, 1928**

P.24 A poor area with *Scirpus, Calluna, Erica tetralix* vegetation planted with mountain pine showed fair recovery. Part of this area to be experimentally

planted with Sitka spruce on turves from turf drains, giving basic slag to half the section so planted. Douglas fir growth noted as good, and Sitka spruce variable, depending on site factors, but generally satisfactory. European larch noted as of a better type than usual.

P.25 Recovery of both spruces patchy but promising.

P.26 Norway spruces and larches are forming an encouraging crop, but most of the European larch was considered to be of a poor type.

(iv) **Inspection by Commissioners—April, 1935**

Present: Sir Alexander Rodger, Major Strang Steel and Mr. H. C. Beresford Peirse, District Officer

A general inspection of P.29, 30, 31 and 32 on Moyle showed excellent growth, which Major Strang Steel stated was, especially in regard to spruce, the best stocked and most promising block he had seen in the north. The intensive initial draining and subsequent deepening of a proportion of the original drains was favourably noted and stressed as being an important deterrent to future windblow.

(v) **Inspection by the Chairman, Sir Roy L. Robinson—August, 1943**

Extraction problems were discussed in connection with thinnings in European larch, Japanese larch and Hybrid larch in P.26 taking place as required. The necessity for proper drainage and water control on all roads and tracks in such places was emphasised, and the suitability of such sites for wire rope extraction was pointed out by the Chairman, who explained the method. Equipment for this was being arranged by the Assistant Divisional Officer.

The necessity for carrying out thinning in larch, whether extraction was possible everywhere or not, was emphasised by the Chairman. In the worst European larch areas, the Chairman advised heavy thinning and underplanting with such species as *Tsuga*, Norway spruce and Douglas fir.

The exceptionally good stocking, growth and form of Hybrid larch as compared to European larch was pointed out by the Chairman.

In connection with the suggested underplanting, and with a small area so treated with *Tsuga* as the underplanted species, the possibility of heavy roe damage (seen in the underplanted area) was discussed. It was pointed out by District Officer that control of roe deer was almost impossible until neighbouring spruce areas (which harboured these deer) had reached the brashing stage. Very slow growth of Norway spruce P.26, planted on heather, was noted, and the Chairman stated that the choice of species was wrong, and should not be repeated in such places, even though drainage did assist the spruce. The moral was pointed by observation of a bracken and heather knoll planted with spruce and Scots pine where the Scots pine was showing excellent growth.

Later a visit was paid to Moyle. The excellent and comparatively even growth and full stocking on this section was noted, with only European larch again showing less promise than the other species.

A small area in P.33 showing good growth of *Pinus contorta* and poor growth of Sitka spruce on a poor heather knoll was visited, and a plot in P.26 where the mountain pine planted then was planted through later (P.37?) with Norway spruce and Sitka spruce. The spruces looked promising on the better type of peat, and the Chairman advised the cutting back of branches of the mountain pine where these were interfering with the growth of promising spruces.

(vi) Chairman's General Note on Certain Forests in the Western Highlands, following Inspections at Achnashellach, Ratagan, Inverinate, Slattadale, North and South Strome in 1943

Afforestation has now been proceeding long enough to show up clearly the main successes and the main failures in these and similar areas, and it is the purpose of this note to draw some conclusions and to speculate on the future lines of advance.

The natural conditions in relation to tree growth are of course not identical in all the forests but broadly speaking they are very similar. The climate is maritime, very wet, and exposure to westerly winds considerable except at relatively low elevations. Spring frosts can be a nuisance locally. The soils are broadly either "creep", and are then associated with a good surface vegetation or the remnants of indigenous broadleaved species; or morainic, associated with heather and heather associations characteristic of the wet mild climate. This broad generalisation omits "flush" types and inter-moraine peat developments.

The growth of selected species on the first broad type is very rapid. The chief problem is to select from the spruces, larches, Douglas fir, etc., that which will give the optimum result, and there is already enough evidence on the ground to avoid gross errors in the future.

The second broad type, namely the moraines, constitutes the major problem in afforestation. Morainic deposits are often more extensive than would appear at first sight. In the valleys and on the lower slopes they are easily detected by their characteristic rounded shape, but they also occur extensively higher up the hills in less characteristic form. They are sandy in composition and on most, I suspect, the soil has been leached and a pan formed. Our experiments show that, except in exposed places, it is possible to raise certain species (Japanese and Hybrid larches, Sitka spruce, *Pinus contorta*) moderately well, provided the surface is deeply trenched and basic slag is applied.

Practically everywhere the planted morainic areas show up as backward or unstocked. Spruce (generally Norway) was planted in the earlier P. years and was quite obviously the wrong choice. Extensive deep drainage has got the plants slowly on the move in some cases, but future development also is bound to be slow.

The first important point to note is that the morainic soils require special attention and the second that they can be detected with certainty before planting. The gross errors of the past can therefore be avoided if only by refraining from planting. That course, however, would be a confession of impotence to which I am not prepared to subscribe.

How then are we to proceed? There are two courses open: first, the mechanical method of developing our ploughing technique to overcome the special topographical difficulties and second to adapt our silvicultural methods to the special conditions. Both courses must be explored. I have asked that the experimental ploughing shall be pushed at Achnashellach next Spring. Here I am concerned only with the silvicultural method, which, incidentally, should help also on ploughed ground.

I think it is almost certain that these moraines were originally covered with Scots pine which reached pleasing dimensions on the lower parts and presumably tailed off into scrub at higher elevations.

There is evidence that the indigenous pine when planted will behave in much the same way though probably the first crop will be poorer and the limit

of scrub pine will be lower than with the old indigenous forest. If, therefore, we had planted Scots pine originally on many of the morainic deposits the lower parts of the forests at least would have presented a continuous as opposed to the present moth-eaten appearance. On the other hand, on the upper moraines, the Scots pine would have been blasted and as a pure crop would have been hopeless.

In the experimental treatment of moraines more attention has been paid to *Pinus contorta* and mountain pine than to Scots pine and more attention still to the larches (Hybrid and Japanese) and spruces than to the pines. In my opinion the pines are a better pioneer crop than the larches or the spruces because they are deeper-rooting and thus activate a greater volume of soil. How far this is essential in such a wet climate remains to be seen. I have seen Sitka spruce growing really well up to thirty years on almost bare igneous rock at Thirlmere (Lake District). Nevertheless, depth of activated soil is obviously of importance and I view with some suspicion the shallow-rooting habits of the spruces and larches in pure plantations.

Coming now to the characteristics of the individual species. My present view is that as regards the pines, Scots pine should be planted pure on those sites which are reasonably sheltered and in mixture with Sitka spruce on those sites where it will develop sufficiently well to get the spruce away. Mountain pine I would relegate to the worst and peatiest morainic sites, again in mixture with Sitka spruce. I am still uncertain of the part *Pinus contorta* should play. It suffers severely from deer damage which is a great drawback. Silviculturally, it is in some ways unsatisfactory, it casts very little shade compared with Scots or mountain pine, and is, therefore, slow in suppressing surface vegetation. It is very apt to be top heavy and to grow crooked. On the other hand, it appears to be deep-rooting and to stand exposure better than Scots pine. I know there is a difference of opinion on the status of this species, and I think it important to review the data which are available. My own inclination at this stage is to rely much more on the indigenous Scots pine than on a tree of which we have relatively speaking very small experience.

As regards the larches we can obviously write off European larch at any rate in pure crops. I was impressed with the growth and form of hybrid larch on good sites but on the experiments on moraines there did not appear to be much in it between hybrid and Japanese larch up to eight years or so. I did not see any older experiments.

To summarise my views as to possible future advances in the treatment of morainic soils:

(1) An important point to be kept in view is the deepening of the active soil. This can best be started by ploughing and where that is impossible by deep rooting species which should also form a part of the crop on ploughed ground.

(2) We require to know far more about the rooting systems of all species which come into consideration. This calls for systematic investigation not only of Experimental areas but also of older stands. For example, we should learn a lot by investigating the root systems of Scots pine and European larch on the areas being felled near Achanalt. The loan of a caterpillar from the Newfoundland Unit would enable stumps to be uprooted easily.

(3) We require to know more about the silviculture of the indigenous Scots pine on the West Coast—how much exposure will it stand,

how fast does it grow, and so on—I have the feeling that with soil preparation it will not only grow quicker but will also stand a good deal more exposure than we have hitherto thought.

"R.L.R."

(vii) **Inspection by the Chairman, Lord Robinson—September, 1947**

The road work on Moyle was seen, and the Chairman emphasised the need to use mechanical equipment as fully as possible in such places which lent themselves to this, and especially where there was, as here, a labour shortage.

Small patches of Japanese larch in P.30, being thinned, were inspected and the Chairman observed that such small patches were a nuisance and should be avoided, as they needed more frequent attention than the crop as a whole, and extraction from such small scattered plots was difficult.

In P.30 some poor European larch was seen, and it was decided that this should be well thinned out as it was too early to decide whether it would form a useful crop or not. In P.31, Japanese larch of poor form was inspected. The Conservator considered it might be advisable to thin out heavily and put in groups of Norway spruce and Sitka spruce.

The Chairman said he would prefer to see two more routine thinnings carried out before making the decision. If the crop was still poor after this, the next thinning thereafter should be heavy, and the crop underplanted with Douglas fir or Norway spruce. He did not favour the use of Scots pine as an underplant. The Conservator canvassed the more extensive use of *Abies grandis* for such work. The Chairman said he had a theory that, if larches in general were green-pruned at an early stage, many diseases which later spoilt the tree would be avoided, as such attacks usually started low down on the tree in recent wounds there.

A discussion on the choice of species for planting on hard knolls led to the Chairman commenting that the previous winter had proved *Pinus contorta* was too frost-tender and that he would like to see more Scots pine used in such places. The Conservator suggested a trial of *Pinus banksiana*. He did not altogether agree that *Pinus contorta* could be condemned, but the use of *Pinus contorta* with Sitka spruce had given trouble because of the rapid growth of *Pinus contorta*, and for this reason, he was suggesting *Pinus banksiana*, a slower growing non-exacting pine, as a solution for the difficulty.

(viii) **Inspection by Mr. A. Watt, Conservator (Scottish Directorate)—February, 1949**

Ratagan Section

Thinnings in progress and recently carried out were inspected in P.26, C.12; P.29, C.8; P.24, C.26, the species being Sitka spruce.

Discussions mainly concerned the period of time which could be expected to elapse between thinnings, the intensity of thinning to be done and possibility of using length of crown or the proportion of length of crown to total height, as a guide in this matter. Also, on the stage at which first thinnings become necessary in a Sitka spruce crop.

The general consensus of opinion was that, while shorter thinning cycles might be advantageous, the limitations imposed by labour and increasing areas becoming ready for thinning, made it probable that a five-year thinning

cycle would prove reasonably satisfactory, and possible to achieve. In view of this, thinnings should probably be heavier than they were being done. The small suppressed trees had been left standing, as the Forester considered that it was more economical to do so, and it avoided littering the ground. They did not interfere with good extraction so much when left standing, and helped to prevent damage to good stems in dragging operations. Although it left the appearance of the crop denser and more ragged, this had no adverse effect on the crop.

In one area where thinning had been delayed, the crowns had been reduced to one-quarter to one-fifth of the total height, and it was estimated that 15 to 20 feet or about half of the crown had died by congestion and suppression one season. As height growth was continuing, the crowns appeared to be recovering satisfactorily after thinning.

Thinning in Hybrid larch P.26 was inspected. It was agreed that a five-year thinning cycle would now seem adequate here also, but a few more trees should be removed if the area had to be left for five years.

Areas of P.24, 25 and 26, originally planted with Norway spruce, but beaten up with Sitka spruce on turf, after draining and slagging in 1937, were inspected. Both Sitka spruce and Norway spruce were now making steady growth except in the very worst patches.

Moyle Section

Thinnings in European larch and Japanese larch were inspected and particularly small areas in P.30, 31 and 32, where underplanting in gaps with Noway spruce and Sitka spruce had been attempted. These appeared to be doing well, and it seemed clear that the ground was more suited to these species than to larch. While it was uncertain whether European larch and Japanese larch would eventually make a reasonable crop or not, it seemed probable that it would have been better to treat more of it in this way earlier, as in the case of these small plots, i.e., in 1937 and 1938.

Brashing in an area of Sitka spruce P.30 was inspected, in which brashing of trees at about 12 feet apart had been done. It was hoped that this would enable horses to work, and, if so, it would be continued as a measure of economy.

Extraction problems were considered and the use of ropeways or metal chutes seemed advisable to bring material to a basic road system which required development.

(ix) Inspection by Sir Henry Beresford-Peirse, Director (Scotland)—August, 1949

Thinnings in P.26 and 27, mainly Sitka spruce and some Norway spruce, were inspected. The thinning generally was approved, but caution was necessary in the case of Norway spruce at the edge of backward patches of that species.

Erosion in a main drain was noted, and plugging with branches, pegging these down as necessary, was decided upon in an effort to stop erosion.

Methods of extraction and means of reaching the thinning programme target set in the Plan of Operations were discussed. The need to save our labour

by getting sales standing, or at roadside, to the maximum possible extent was stressed by the Director. The making of a shelter and provision of a small saw bench for conversion of larch to fencing posts, etc., for sale in the Skye market was approved as a means of providing wet weather work. The heavy thinning done in poor European larch now apparently recovering from die-back was approved, and the Director stated that no replant should be undertaken until deaths ceased, so that a replant or underplant could be done over the whole area in one operation.

APPENDIX II

SUPERVISION—RATAGAN FOREST

Divisional Officers:

Mr. F. Scott, 1921-31; Mr. J. Fraser, 1931-39; Mr. D. S. Spraggan, 1939-42; Mr. A. Watt, 1942-45; Mr. J. Fraser, 1945-46; Mr. J. A. Dickson (S.F.O.), 1951—to date.

Conservator:

Mr. J. Fraser, 1946—to date.

District Officers:

Mr. L. A. Newton, 1921-25; Mr. J. W. Mackay, 1926-27; Mr. J. Meldrum, 1927-31; Mr. H. C. Beresford Peirse, 1932-35; Mr. D. S. Spraggan, 1935-39; Mr. A. M. Fraser, 1939-46; Mr. A. L. Orr-Ewing, 1946-47; Mr. D. S. Spraggan, 1947-49; Mr. R. O. Drummond, 1949—to date.

Foresters:

Mr. J. A. MacAlpine, 1921-29; Mr. W. Murray, 1929-46 (Gd. I), 1946-49 (Head); Mr. A. Mackay, 1949—to date.

APPENDIX III

P. Year	Area originally claimed (O) and existing now (N) by Species																										Total Areas	
	E.L.		J.L.		H.L.		D.F.		N.S.		S.S.		S.P.		M.P.		P.C.		Th.		Ts.		A.N.		A.G.		Br. Leaf		Orig.	Now
	O	N	O	N	O	N	O	N	O	N	O	N	O	N	O	N	O	N	O	N	O	N	O	N	O	N	O	N		
23	—	—	60	32	—	—	13	5	31	8	—	6	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	104	51
24	26	9	4	2	—	—	16	7	5	2	63	68	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	114	88
25	6	4	5	—	—	—	—	1	86	73	28	30	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	125	108
26	9	10	—	1	8	9	4	4	61	49	24	23	—	—	6	2	—	2	—	—	—	—	—	—	—	—	—	—	112	100
27	33	33	—	—	8	12	7	8	36	30	63	58	—	—	3	3	—	—	—	—	—	—	—	—	—	—	—	—	150	144
28	—	—	8	11	4	8	—	—	1	—	40	37	12	9	4	—	—	—	—	—	—	—	—	—	—	—	—	—	69	65
29	8	6	4	5	6	8	1	2	23	22	91	81	—	—	7	2	—	—	3	1	—	—	—	—	—	—	—	—	143	127
30	26	30	28	40	—	2	—	—	85	70	87.5	100	9	4	4	1	—	—	—	—	—	—	—	—	—	—	—	—	239.5	247
31	27	25	30	54	—	—	—	—	28	32	69	75	9	2	—	—	15	—	2	1	2	2	8	10	—	—	1	2	191	203
32	21	21	17	4.5	—	—	—	—	7	7	106	106.5	1	1	—	—	2	2	—	—	—	—	—	—	2	2	4	—	160	144
33	11	11	6	6	—	—	—	—	7	7	83	85	5	1	—	—	7	9	—	—	—	—	—	—	—	—	—	—	119	119
34	—	—	—	—	—	—	—	—	—	—	28	28	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	28	28
35	—	—	—	—	—	—	—	—	—	—	17	18	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	17	18
36	—	—	—	—	—	—	—	—	—	—	5.5	5.5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	5.5	5.5
39	—	—	—	—	—	—	—	—	—	—	17	17	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	17	17
40	—	—	—	—	—	—	—	—	—	—	17	16.5	—	—	—	—	2	2	—	—	1	1	—	—	—	—	—	—	20	19.5
41	—	—	—	—	—	—	—	—	—	—	26	26	—	—	—	—	4	5	—	—	—	—	—	—	—	—	—	—	30	31
42	—	—	—	—	—	—	—	—	—	—	16	17	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	17	17
43	—	—	—	—	—	—	—	—	2	—	29.5	31.5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	31.5	31.5
Totals O	167		162		26		41		372		810.5		37		24		30		5		3		8		2		5		1,692.5	
Totals N		149		155.5		39		27		300		829		17		8		20		2		3		10		2		2		1,563.5

Difference of 129 acres less claimed now is due mainly to write-off of 113 acres in 1934 due to resurvey. Upper boundary having been claimed too high.
The big drop in years 1923 to 1925 was due to a fire, the area being replanted in 1930 and 1931.
A.N. = Abies nobilis. A.G. = Abies grandis.

A. RATAGAN BLOCK

APPEN

Compartment	Spec.	P. Year	Age	Geology	Soil	Aspect	Slope	Altitude
								(ft.)
17	H.L.	26	25	Red granitite	Shallow brown earth. Depth 2 to 10 in. Slight podsolisation. Drainage free.	N.	Medium	300
17	E.L.	26	25	Red granitite	Shallow brown earth. Depth 2 to 10 in. Slight podsolisation. Drainage free.	N.	Medium	300
11	J.L.	25	26	Red granitite	Brown earth. Depth 4 to 16 in. Mainly shallow. Drainage free.	N.W.	Medium	500
26	D.F.	24	27	Red granitite	Deep brown earth. (Average depth about 12 in.). Colluvium with red granitite fragments. Drainage moderately free.	N.W.	Gentle	100
19	S.S.	26	25	Red granitite	Weakly defined podsol, with a 3 in. humus layer. Drainage free. Average soil depth at 9 in.	N.W.	Gentle	350
22	S.S.	27	24	"	"	"	"	"
19	N.S.	26	25	Red granitite	As for C.19 S.S. above.	N.W.	Gentle	350

B. MOYLE BLOCK

Compartment	Spec.	P. Year	Age	Geology	Soil	Aspect	Slope	Altitude
								(ft.)
31	S.S.	29	22	Glacial conglomerate largely Mica Schist and Gneiss fragments in sandy gravel over Schist.	Deep sandy brown earth. 2 in. humus layer. Drainage moderately free.	S.	Gentle	150
38	N.S.	29	22	Glacial conglomer. Largely schistose. Loose and sandy. Over Red Granitite.	Deep brown earth. Sandy. 2 in. humus. Drainage moderately free.	S.E.	Gentle	100
38	J.L.	29	22	As for C.38 N.S. above.	As for C.38 N.S. above.	S.E.	Gentle	100
41	A.N.	31	20	Alluvium. Largely Granitite and mica schist.	Deep brown earth. Sandy. Freely drained.	Open to the South	None	100
40	A.G.	32	19	Glacial conglomer. Largely mica schist. Loose and sandy, deep. Over Red Granitite.	Deep brown earth. (Slight discontinuous podsolisation). Sandy. Freely drained.	S.W.	Gentle	200
53	S.P.	33	18	These species are showing satisfactory growth at 1,000 feet elevation, in exposed positions				
51	P.C.	33	18	Top height is as yet under 25 feet and quarter girth at breast height is under 3 inches.				

*Measurements of last "5" years' growth were taken during second

DIX IV

Exposure	Ground Vegetation	Best Growth		Average Growth		Form	Mean Annual Height Increment	Mean Current Height Increment during last 5 years*
		Tot. Ht.	Q.G. B.H.	Tot. Ht.	Q.G. B.H.			
Sheltered	Grass spp. a Digitalis o Pteridium aquilinum o Polypodium spp. o Hylocomium a Hypnum a	(ft.) 60	(in.) 10¼	(ft.) 53	(in.) 6¼	Good	(ft.) 2.12	(ft.) 2.11
Sheltered	Pteridium aquilinum a Grass spp. a Digitalis purp. f Polypodium spp. o Hylocomium, Hypnum } spp. a	56	8¾	50	6	Moderate	2.00	1.26
Sheltered	Grass spp. a Digitalis purp. o Hard Fern o Hylocomium, Hypnum } spp. a Other Moss spp. a Oxalis acet. o	63	11½	56	6¾	Moderate	2.15	1.70
Sheltered	Polypodium spp. o Hylocomium splend., Hypnum schreb., Hylocomium trig. } a Other Moss spp. f	66	13½	58	8	Moderate	2.14	2.25
Mod. sheltered	Nil. (In rides— Grass spp. a Bracken f Moss spp. f)	—	—	60	7¾	Good	2.40	2.27
,,	,,	67	11½	—	—	—	—	—
Mod. sheltered	Nil.	60	10¼	52	5½	Poor	2.08	1.70

Exposure	Ground Vegetation	Best Growth		Average Growth		Form	Mean Annual Height Increment	Current Annual Height Increment during last 5 years*
		Tot. Ht.	Q.G. B.H.	Tot. Ht.	Q.G. B.H.			
Mod. sheltered	Nil. (In rides— Grass spp. frequent Juncus comm. o Moss spp. f)	(ft.) —	(in.) —	(ft.) 45	(in.) 5½	Moderate	(ft.) 2.13	(ft.) 2.10
Mod. sheltered	Little ground vegetation Grass sp. o Moss spp. f	37	5½	—	—	Moderate	1.68	1.75
Mod. sheltered	Grass spp. a Bracken f Digitalis o Potentilla erecta o Moss spp. f	42	5¾	—	—	Moderate	1.90	1.93
Mod. sheltered	Nil.	—	—	20	4¾	Poor	From an estimated total ht. 1.25	1.25 Average vol. per stem = 3.13 cu. ft. (h)
Mod. sheltered	Nil.	38	5¾	—	—	Moderate to good	2.00	2.25

with a southerly aspect.

Both Pinus contorta and Scots pine are in shallow podsols with occasional peaty hollows.

week in August, 1951. They are, therefore, tending to be underestimates.

APPENDIX V

DATA ON THINNING YIELDS AT RATAGAN

(*a*) From Thinning Yield Forms, 1/20th acre Plots

Compartment No. ..	23	21	21
Species	H.L.	N.S.	S.S.
P. Year and Age ..	P.27-22 years	P.26-24 years	P.27-23 years
Number of Thinning ..	3rd	2nd	2nd
Years since last thinned ..	5	3	4
Elevation	500	400	300
Aspect	N.E.	N.E.	N.E.
Date	October, 1949	March, 1950	March, 1950
Before Thinning:			
Number of Stems per acre	740	1,100	1,193
Av. B.H.Q.G. inches	5¼	4¼	4¾
Upper Ht. Ft. ..	50	30	49
After Thinning:			
Number of Stems per acre	470	960	960
Av. B.H.Q.G. inches	5½	4½	5
Thinnings:			
Number of Stems per acre	270	140	233
Av. Total Ht. Ft. ..	46	27	39
Vol. Pitwood Cu. Ft. Q.G.	751	98	335

(*b*) *From Marking Figures for Sale Lots*

			Marked per Acre		*Average of Thinned Stems*		
Species	*P. Year*	*Age*	*No. of Stems*	*Volume hop. ft.*	*Length (ft.) to 2½" dia.*	*Q.G.O.B. inches*	*Vol. to 2½" dia.*
S.S.	27	24	221	355	23	3½	1.8
S.S.	28	23	448	1,149	26	4¼	2.4
S.S.	29/30	21/22	380	689	24	4	1.8
N.S.	26	25	113	167	21	3½	1.5
E.L.	27	24	115	245	30	4	2.1

(*c*) Also refer to Research Branch Sample Plot form No. 9

Plots sited in Ratagan Forest Nos.:	S.195	Species H.L.
	S.197	„ E.L.
	S.198	„ S.S.
	S.199	„ P.C.
	S.200	„ N.S.

NOTES BY MR. J. FRASER, CONSERVATOR, NORTH SCOTLAND, ON MR. DRUMMOND'S RATAGAN FOREST HISTORY

Name

The name "Ratagan" means "small fortified enclosure" (see Watson's *Place Names of Ross and Cromarty*, page 172). The name "Bealach Ratagain" (the pass of the small fortified enclosure) is probably a great deal older than the name of the farm. There are other local explanations of the name "Ratagan", but the authority quoted is reliable.

Acquired Plantations

Drummond records correctly that there are no acquired plantations of any importance. A record of a few older trees planted on the land should be made.

In the Allt Ratagain below the waterfall, there are about thirty trees, Norway spruce, aged probably sixty years. At acquisition, there were more trees, but the Commission felled and used for fencing of early plantations some of the acquired trees. The timber was used to make split stobs.

In Compartment 26 there were the remnants of a larch plantation felled about 1905 by Morgans of Crieff. Poor trees in the plantation were left, and some of those were standing when I first saw the place in 1931. There are still a number of those larches scattered through the planted larch. A few scattered larches through the planted larches of P.26 in the valley of the Allt na h' Inghinn are possibly naturally regenerated trees. There are remains of stumps of wide spaced larches in P.27.

There is reported to have been a small European larch plantation in C.4, now P.30, which was cut in P.20 before acquisition by the Commission.

Road

The old twisted road over Mam Ratagain is part of the old military track giving access to the barracks at Glenelg. The mason work on the bridges is worth examination. (See *The Road from the Isles*, Pochin Mould, 1950, and *Wade in Scotland*, Salmond, 1938.) The track and the pass existed long before they were improved for use of foreign garrisons.

Geology and Soils

A 6-inch sketch map showing the geological information is forwarded along with the plan. A green crayon line shows the outline of the plantations. The map is useful as some measure of the use which we can make of geological information. The area is probably one of the most fertile properties which we have acquired, but a planting prescription based on maps alone might be far off the mark. Differences of slope, elevation and minute configuration of the surface exercise very marked effects on the soil and on the soil fertility, on the one rock type. Again, in the south-east corner of P.23, the soil overlying rocks with a poor character for fertility shows a fast growing Japanese larch crop.

Choice of Species

Our biggest mistake in choice of species was in the use of Norway spruce for the high elevation planting of P.23 and P.24. The mistake was one of the time and was not confined to the North Conservancy, but the lesson was learned; perhaps even too well. In earlier years also, in spite of many lessons in the

matter of planting European larch, we failed to appreciate the importance of natural drainage. We failed also to appreciate the effect which the dead herbage from a heavy grass crop may make on the water retained in a soil when that dead herbage is left on the soil surface. We failed also in providing sufficient surface drains to counteract the effect. The "unhappiness" of the European larch, the swinging and the twisted form must be partly attributed to those drainage faults.

Oregon Alder

The amount used was small. Ratagan was one of the few places where the species was given some reasonable chance on mineral soil. In most places we expected too much from all the three alders, and in most places the trees developed stag-headed crowns very early. This was specially true on peat covered soils. In P.27 Oregon alder seemed to have done a useful service in filling up gaps in Douglas fir and grew well up to the winter of 1946-47. The frost of that winter killed many, but there were a few survivors.

Conclusions

Ratagan experience, along with the experience of other west coast forests, allows the view that Douglas fir should be grown in those forests only on soil which has a good natural drainage in the sub-soil. Scott's later views on the importance of using strong stocky plants once or twice transplanted deserves the greatest respect, and he learned from his misfortunes.

Mr. James Macdonald, Director of Research, during a visit to the forest, made the observation that there should be no undue hurry in clear felling of small failure patches of either European larch or Japanese larch. He made the point that any mature survivors would probably be a hardy stock worth considering for future seed collection. The observation might be considered along with the plans which must be made within the next twenty years for the formation of permanently uneven-aged woods within the forest.

HISTORICAL NOTES ON THE FORESTS OF ALICE HOLT AND WOOLMER

Contributed by W. H. Dixon, formerly a Foreman at Alice Holt, now with the Nyasaland Department of Forestry.

The old crown forests of Woolmer and Alice Holt are situated in the County of Hampshire. Alice Holt lies about four miles south of Farnham, in Surrey, and is separated from Woolmer by a belt of agricultural land and heathland.

Now, in 1956, Alice Holt has a woodland area of 2,075 acres, divided into the following Inclosures: Straits 236 acres, Goose Green 222 acres, Lodge 411 acres, Holt Pound 269 acres, Glenbervie 367 acres, Willows Green 198 acres, Abbotts Wood 242 acres, and there is also a new acquisition known as Bourne Wood, of 130 acres.

Woolmer has close on 2,000 acres divided into Brimstone Inclosure, Forked Pond Inclosure, Lynchborough Park and Wood, and Weavers Down. The forest has been leased to the War Department since the turn of the century, and was finally transferred to that department in 1955.

Alice Holt and Woolmer are names of great antiquity. The latter is written in the old Saxon Charters as WULFMAERES GEMARE, later in A.D. 907 it is spelt UULFAMERE, and WLUEMERE, and in A.D. 1200 as WOLVEMERE. During the last century it was known as Wolmer. From these early spellings, it is apparent that Woolmer was one of the last strongholds of the wolf in England. The word "mere" in this instance denotes an "outlying part" as distinct from the northern mere, meaning a lake.

The name Alice Holt has been greatly changed from the Saxon ALCIESHOLD, AISHOLD, ASHESHOLD, AXESHOLD, AXIHOLT. In A.D. 1169 it was written ALFSHOLT, and in 1242 as ALFIESHOLT. There have been many theories as to the original meaning, probably the correct one is "the Holt (or wood) of the Ashes". The form Alice Holt first appears in the Bishop of Winchester's Pipe Roll for 1373.

The area lies over the Older Beds of the Upper Greensand, Gault Clay, and Lower Greensand of the Cretaceous System, Woolmer and Bourne Woods lying mostly on the Greensand, and Alice Holt on the Gault Clay, giving two characteristic tree crops in the Scots pine plantations of Woolmer, and the oak woods of the Holt.

Pre-History

Alice Holt forest probably originated in the Atlantic Period (5500 B.C.-2600 B.C.) with pedunculate oak emerging as the main tree. From the many fragments and chippings of Mesolithic and Neolithic flints which have been picked up in the forest area it is certain that man has dwelt in the forest precincts from Lower Palaeolithic times.

Some of the earliest discoveries at Woolmer were of the Bronze Age. Bracelets, rings, swords, spearheads, and bronze torques were found, and are now in the British Museum. Scattered throughout the forest are numerous earthworks and tumuli. At the time of the invasion of Britain by the Romans, the country now known as Hampshire was covered by almost impenetrable forest. Alice Holt and Woolmer most probably formed part of the great forest of Anderida, which stretched in a great unbroken wave over the North Downs, and southwards into the valleys between the Downs.

The Gault clay of the forest, and the oak woods upon them, were used by the Romans for the making of pottery. South of the present forest office at Forest Lodge in Goose Green Inclosure are to be found the remains of Romano-British pottery kilns. Over a large area of this Inclosure, and lying very close to the surface of leaves, are to be found thousands of fragments of pottery. In many places they are over three feet deep. The actual sites of the kilns are easily identified by the blackness and friability of the soil compared to the surrounding clay.

During the last war a kiln site was excavated, and a range of Roman household articles including jugs, drinking cups, plates and bowls were found. On some of the pottery fragments the easily identified mark of fingerprints were found. From the vastness of the workings it is thought that perhaps this was the "Black Country" of Roman Britain, at least for the southern half of the country.

The range of the pottery covers the years A.D. 50-A.D. 400, that is almost the length of the Roman occupation, and falls into the following eras:

Claudian	A.D. 43-69
Flavian	A.D. 69-96
Late First Century	A.D. 96-117

Hadrianic	A.D. 117-138
Antonine and Late Second Century	A.D. 138-200
Third Century	A.D. 200-300
Fourth Century	A.D. 300-400

In 1741, Woolmer pond, which was then about 66 acres in extent, was drained, and hundreds of coins and medallions of the reign of Marcus Aurelius and his Empress Faustina were found. Later, in 1744, more coins were found, and these represented all the Emperors from Claudius (A.D. 43) to Commodus (A.D. 192).

In 1867, the then Lord Selborne found coins of Lucius Verus, and a sepulchral urn containing bones, and some iron axe heads. Later, bronze saw blades and an urn containing about 100 coins of Gallienius were discovered, and at Woolmer pond again, in 1873, a large collection of coins were unearthed. These totalled about 30,000, and were mostly of the last sixty years of the third century. This hoard is thought to have been the army chest of the Emperor Allectus. In A.D. 296-7, Constantius Chlorus had landed in Hampshire, and had advanced north and defeated the armies of Allectus, who had marched south from London. Historians are of the opinion that this battle was fought in the Woolmer area.

Apart from the archaeological finds, there is little historical information of any accuracy of the forest area of those days, but it is reasonable to suppose that there were still vast forest areas when the Romans departed after four centuries of occupation. During this time the Britons had adopted Roman methods of agriculture. The various Teutonic invaders, Saxons, Angles, Jutes and Frisians depended mostly on their herds and flocks, which fed on the herbage and mast of the woodlands.

The Woolmer-Alice Holt forest during the Anglo-Saxon period lay between the most settled parts of Hampshire and Surrey, and contained but few villages. At that period in history the land was known as "folk land", the forests and woods being state owned. As husbandry became to be of more importance under later Saxon rule, more of the woodland was felled and cleared of trees, and fenced around to keep the wild animals off the cultivated land. The animals were thus gradually driven into the more inaccessible parts of the forests. As time passed and more and more land was cultivated, the woodlands became vast sanctuaries for the deer and wild life, and gradually too, the more powerful and influential of the local men began to usurp the rights of the common man over these game areas.

The Forests in Norman Times

After the Norman conquest there were still large parts of the Saxon forests left, forests and fens alike became Crown property, although in their Domesday Book, the Normans dismissed tracts of woodland as *Hoc Est Vascata*—"this is waste!" The timber in the forests of those days would be worth a large sum of money at today's prices, but in the eleventh century it was valued only for the number of deer and swine which the woodlands could support.

Centuries ago, the Kings of England made their own hunting grounds, (the first forest laws being passed by INE, King of Wessex in A.D. 693). A commission was sent out under the Great Seal of England, and they viewed, perambulated, and bounded the desired tract of land, wooded or otherwise, and after this record had been returned into the Chancery, an order was then sent to the Sheriff of the county to proclaim that without the King's special licence

none should hunt or otherwise chase any manner of wild beast within the said limits or bounds. This made the area a "chase", but it did not become a forest until certain forest officers had been appointed, and it became subject to the forest laws, and came within the jurisdiction of the special courts of the "Justice in Eyre".

Alice Holt and Woolmer are both relics of the original royal chase forests, the only others in Hampshire being New Forest and Bere Forest. Great importance was attached to sport, there being no fewer than four gradations which, under royal licence, could be enjoyed by nobles, knights, and other landowners. These were:

1. The hunting rights of the forest.
2. The privilege of "free chase".
3. The privilege of "free park".
4. The privilege of a "free warren".

The wild beasts of the forest were listed as Hart, Hind, Hare, Boar, Wolf, Buck, Fox, Martin, Cat, Roe, and the "connie". The fowls of the forest were "Pheasant and Partridge and none other".

There was one rare animal that infested the woods of Hampshire, even as late as the thirteenth century and that was the wild cat. In 1720, Robert of Warnford, and Will Kerenet were allowed to kill them in Woolmer and Alice Holt Forests.

Three of the lakes which have now almost vanished from Woolmer were called after wild creatures, viz., Hogmer Pond, Cranmer Pond, and Wolmer Pond. Black game which had been abundant at Woolmer became extinct during the time of Gilbert White, the naturalist and curate of Selborne near the forest, who spent a lot of his time there. They were re-introduced afterwards by Sir Charles Taylor, who was Ranger of the Forest. They were imported from Cumberland and flourished for a time, the last one was killed about 1750.

Roe deer abounded at Alice Holt, whilst at Woolmer the deer were Red and Fallow. At the beginning of the eighteenth century there was a head of about 500 Red deer, and Queen Anne whilst on a journey to Portsmouth was prevailed upon to break her journey through the forest and rest on a bank (afterwards called Queen's Bank) and see the whole head of deer driven past her. In 1830, the Duke of Cumberland sent huntsmen and "six yeoman prickers" in scarlet jackets, together with staghounds to Woolmer, and conveyed the remaining deer to Windsor.

Alice Holt woods must have presented a different picture when it was grazed by herds of deer, cattle and swine. The oak woods of today carry a very heavy growth of ground and underwood vegetation.

General Howe who was a grantee of Alice Holt in the late seventeenth century turned out some wild German boars and sows into the forest, and for a time, a wild buffalo, but it so terrorised the neighbourhood, "that the country rose upon them and destroyed them".

At the present time there are still roe deer in Alice Holt and a pair of roe deer were seen at Woolmer by the writer, late in 1953, after an absence of many years.

For administering the forest laws, the woodlands of the State were divided into two areas, those north of the Trent, and those south of the Trent, and justices for these two parts appointed. They were known as "Justices in Eyre", and

travelled about from place to place holding forest courts. There were three forest courts:

1. Court of Attachment, or Woodmote.
2. Court of Swainmote.
3. Court of Chief Justice in Eyre.

The first two were composed of officials of the forest, the court of Woodmote was held every forty days, each forest official attending. This court was to look into all offences committed in the forest, and to tabulate them for presentation to the Swainmote court.

The Court of Swainmote was supposed to be held three times a year, the first court fifteen days before mid-summer for the purpose of clearing the forest of all animals, the second fifteen days before Michaelmas when the herbage money for cattle was received, and the third was held forty days after Michaelmas on the feast of St. Martin. At that time the forest was again cleared, and no animals except deer were admitted from the 11th of November until the 23rd April; this period was known as the "winter haining". Also at this court, the presentations of the Court of Attachment were received and enrolled, the smaller offences tried and those of more importance presented to the Justice in Eyre, to whom the rolls of this court were certified at the next sessions of Eyre, and those rolls which were expected to contain an account of every offence committed, of every deer killed, and of every tree felled in the forest, the value of the tree, the amount of the fine imposed, and the money for pasturage and pannage of cattle and swine. The Court of Justice Seat was to be held at each forest once in every three years.

The forest courts of Woolmer and Alice Holt were held at Ward-le-ham, now known as Worldham, which was the administrative centre for the forest and which had a royal residence as late as the sixteenth century at what is now Lodes Farm, Kingsley. King John, when hunting in the forest, stopped at King John's Hill at Worldham. Gilbert White describes letters he saw addressed to the "Bailiff of Wolmar and Asles Hold, Robert de Venner", and sent by King John in 1206. Before the end of the fourteenth century Worldham was held by Thomas Chaucer, a son of Geoffrey Chaucer, the poet.

A Survey in A.D. 1171

The earliest known survey of the forest is that made in 1171, and reads as follows:

"THE PERAMBULATION OF THE FORREST OF ALIS HOLT AND WOLMER IN THE TYME OF KINGE HENRYE THE SECOND A.D. 1171"

"This is the perambulation of the forrest of Alis Holt bounds in Wolmer in Suth (County of Southampton) made in the year of Kinge Henrye, the sonne of thempriss (the son of the Empress Matilda, daughter of Henry I) the XVIII, of that Kinge and instance of Ethelband the Bauld, archbishop of Canterbury, Henrye, bishoppe of Winchester, Robert Mawdyt, Robte. Anglin, Nicholl Lindshot, and others that oftetime complained of the charge and governance of the said forrest. And this perambulacon was made by Gerrard Chamberlain, Allin Montagewe, Justices, and by XII Jurers chossen in the same Shire in the hundred of Aulton (Alton), and by Robt. Vannz, chief forrester, by the wardeners, rewardeners, and other ministers of the same forrest and by the next neighbours.

"And this perambulacon beginneth at a place of extendment wch is Amisford, and so fowrthe into Gretinham, and so fowrthe into Aldeweke, and so

fowrthe westwarde throught little Strode into the toppe of the Hill above Grimsgrove and from the toppe of that Hill downwards into the nether side of the hill towards the marler of Whatley and so always by the hill into thashe of sowthe hailes and so stretchinge towardes the north into Wyke and so fowrthe by the hilles syde to Estward-le-ham, and throughout the garden of Robt. Vannz and after that to Sannidalles into thest side of the courte goinge Downwardes to Stonyrigge and so farre fowrthe as Benforde Stretchinge into thoke of Mawdit Wood and by a little Ryver goinge down from Doggettes into hole Due, and fowrthe as the highwaie leadethe throughout Okhanger into Black-Mere, and so into the lec. Except the serjantcy of Okhanger that Oweth his Ourne franchise by charter of Kinge Edward and so goinge Downewarde from the lec by the Roo water into Kippinge howsse and so fowrthe into the longe pathe into Rakeswell and so by the longe meare into Rake and so fowrthe by a pathe called the fennepathe into Dorneforde and so by that fenne water into Bradbridge and so into Wasford and so into Monkenmyle of Al Kenfold by and by the bounds of Suth and Surr into Kinwardes Kate and so alwaies by the aforesaid bounde into Ro Dicke and by the bounde into Dagmer and into the bounde called Hemyngeswaie that is in the Ryver called Waits and so goinge upwardes by the foresaid place of extendment except the landes and tenements of Waltercominge that be of the fil of therall of Glos that liethe betwene the said Ryver of the Kings Wood goinge upwardes into Hewardeswell and so to the linch raill wch landes bene free by Olde conquest.

"In witness whereof
"Willm Windsore".

The King usually appointed a Lord Warden, ranger lieutenant, or master forester to be in charge of the forest. A notorious outlaw infested the Alice Holt area, his name was Adam de Gurdon, and he was a member of an old Norman family and a follower of Simon de Montfort. His exploits as a brigand and swordsman became known over a wide area, and he was finally challenged to a duel by Prince Edward; this took place at Long Sutton, near Alton. Edward won, but generously pardoned his adversary, de Gurdon becoming one of Edward's henchmen, and was created Warden of Wlfmere and Asles Hold, and settled at Selborne. He was succeeded as warden by John de Venuz in 1304.

The forests had long been a matter of dispute between the King and the people. Attempts were made again and again to add further tracts of land to those already held by the Sovereign. Edward I showed great reluctance in confirming the Forest Charters. The forests were under a special law, administered in their own courts, with quite an army of officials. The officials were the King's men who looked after his lands, and looked to him only, and strengthened his hand in case of need; all fines and levies collected by them went into the royal purse, and so there was a great advantage to the Sovereign to keep the Crown rights in the forests unimpaired.

The flesh of deer slain at Woolmer was to be sent to a spittle house (almshouse) "if not sweet enough or fit enough to be eaten by the better sort of people". All mastiffs in or near the forest were by law to have three claws of the fore-feet cut off. This was so that they could not chase the deer. A few lords were exempt from the forest laws; there was an inquiry at Winchester in 1269 before Roger de Clifford "by oath of the verderers of Alryeshott and Wulwemere, and of Robert de Chiltelay, and eleven others, regarders and agisters, approved and lawful men of the same forests, whether William de Kernet, Lord of Colmere, ought to be quit as he and his ancestors up to the present have stood quit of the expeditation of their dogs, by reason of their lands, which are within the bounds of the said forest, or not". The verdict was given in their favour.

Forest Officers

The officers of the forest and their duties were as follows:

VERDERERS or judges of the Swainmote court and directors of all other officers of the forest. There were usually four to each forest.

REGARDERS who were to go through the forest and make their "regard" every third year, to inquire into all offences and survey "asserts", "wastes and purprostures", usually twelve to each forest.

FORESTERS. Their duty was to "walk the forest both early and late, watching both the vert and venison, attaching and presenting all Trespass against them within their own Bailiwick". They were usually appointed under letters patent but some were "foresters in fee", holding the office for themselves and their heirs on payment of a fee to the King. The office was liable to great abuse. Foresters were often appointed in excess numbers, and lived by extortion and illicit exactions, which from time to time necessitated special legislation.

AGISTORS. Whose office was to receive and account for the agistment or profit arising from the herbage or pannage of the King's woods and lands. There were four to each forest.

WOODWARDS were subordinate to the foresters. They had to walk the woods with billhooks or hatchets, and might not carry bows or arrows. They took the following oath: "You shall truly execute the office of woodward of Alice Holt Woods as long as you should be woodward there, you shall not conceal any offence either in Vert or Venison that shall be committed or done within your charge, but you shall truly present the same without any favour, affection or reward, and if you see or know any Malefactors, or find any Deer killed or hurt you shall forthwith do the Verderer to understant there of, and you shall present the same at the next Court of the Forest, be it Swainmote, or Court of Attachment, so Help me God".

The crown lands were administered worst during the latter half of the seventeenth century, when great abuse was prevalent, the custodians farming them out to their own advantage. The gradual enclosure of the forests went on through the Middle Ages, and many "grants of assert", or power to enclose were made to those who held land round the forest. Thus the Abbey of Waverley, near Farnham, held an estate at Dockenfield (now part of the forest known as Abbotts Wood), and at Binsted. The Abbot obtained a licence to "enclose forty acres that is within the Metes of the Forest of Woolmer". In the reign of Charles, another sixty acres were enclosed near Binsted.

The office of Keeper, or Lieutenant, of Woolmer and Alice Holt was granted on lease for lives, or terms of years. Many were women, in 1699 there was a Mrs. Howe, in 1777 a Lady Hillsborough. Other lieutenants were Duke Humphrey and Richard, Duke of York.

In the thirty-third year of the reign of Henry VIII, an act was passed establishing a court called the "Court of General Surveyors of the Kings Lands", but five years later this was dissolved, and a new "Court of Augmentations" was created.

The power invested in the Chief Justices, in Eyre was often abused, and they were found guilty of irregularly disposing of timber in the forest to their own advantage. The Court of Exchequer was formed, but the system of management still being defective, a Surveyor General was appointed. This office existed for a very long period, and later passed to the Commissioners of Woods and Forests, before finally coming to the Forestry Commission in 1924.

A Survey in 1635

A further survey was taken of Alice Holt and Woolmer in 1635: "Survey taken the tenth day of June, in the 11th year of the reign of our Sovereign Charles, by the Grace of God, King of England, Scotland, France and Ireland, Defender of the Faith.

"We, the said officers of his Majesty's Woods, within the Forest of Alice Holt and Woolmer, who hereonto set our Hands and Seal by virtue of Warrant to us directed from the Worshipful Charles Harboard, Esq. his Majesty's Surveyor General, do hereby accordingly to the Purpot of the said Warrant certify concerning Extents, Metes, Bounds, and Quality of the said Forest and concerning the several Officers and names of the present Officers and Ministers and their Deputies, and concerning the Lodges, Parks, Enclosures, Profits and Allowances, and certain of them appertaining and concerning the Coppices, Woods, Underwoods, and fit places to be enclosed for supply of Timber Trees and other contents of the aforesaid Warrant in Form hereafter expressed".

PERAMBULATION

"First, as touching the Bounds and Extents of the said Forest beginning at Amersford and so to Isington Hatch, and so to Aldwicke, and so as the footpath leadeth to the top of the Hill above Grymshame alias Grimsrove and so as the old footpath leadeth to the old marlpit, which is in Crockensland, and so as the footpath leadeth by the side of the said Hill to the wood or lynch above Sturtle-Mead, and so to the broad Hatch at Puer Hill alias River Hill and then as the footpath leadeth by the side of the Hill into Shakestrete, and so directly to the Pleystow of Whatleigh, and so by the Hedge on the East side of the said Shake-strete as it goeth along to the Foot of the old Marlpit at Whatleigh and so to the top of Amerspot, and so above the top of Randoles Cryme to Modies Putt, and so to the Ash of Southees, and so bending a little towards the North to Wolstansnall and descending directly to Cottes—where something did stand—and so to Weeke, and so by the middle of the Gate of John of Lynch now in the tenure of Robt. Cheyney, and so ascending by the middle of the garden of John of Lynch to Cruchaswell, and so descending to the East corner of the garden of Nicholas Churches, and so to Gonds-Well alias Goodwell Springs, and so through the middle of the field called Le Houke, and through the middle of Puckwell's Croft, and so by the middle of Beere-croft, and so to Farnhull, and so descending a little to Stone-Ridge into Binswood, and so by the Ditch of Worldham Park to Danstys Marsh, and so to Manditt's Hatch, and so by a little brook descending to Doggetts and so by the same little Brook into Hole Lane, and so through the middle of Okehanger near the Eastern Hedge to the Great Way which leadeth to Echgate, and so to Boreherne, and so by a little Brook to Echlake aforesaid, and so by the great way leading to Blackmore, and so by the way that goeth to Thelegridge, and going down by the Red Water to the House of Cupping and so to Longford, and thence into the Bottom of Longmore to Buckerswell alias Rackswell, and so to the Highway which leadeth from Woolmere to Midhurst, and from thence in the New Path alias Fen Path to Old Thorne, and so by the same New Path to Quernford, and so going by the water downwards to Brad-Bridge and so to Lindford Bridge, and so descending by the same water to Broxhead Bridge, and so by the same water to Huntingford Bridge, and so by the same water to Munken Hill in Dockenfield, and so by the same water to a little Brook which descendeth from Cope-Hatch, and so descending by the same Brook between the land of Bele in the County of Surrey, and the land of Dockenfield in Southton, to Botherlease Pull, and so by the Bounds of the said Counties to Kenards Bat and so by the two said Counties to Udes Hatch, so ascending a little stream to Rowditch, and so by the Bounds

of the said two counties to Benyngs Were, which is in the River of Wey, and then going up the Bank to Amersford aforesaid, the Bound first mentioned".

The officers of Alice Holt and Woolmer at the time of the above survey were:

Robt. Tirwhit, Esq.	Lieutenant of the Forest aforesaid. What Fees or Profit belong to him we know not.
Wm. Murray, Esq.	Ranger of the said Forest, but what Fees belong to him or other Profits we know not.
Henry Hooke, Esq. John Fielder, Esq.	Verderers, what Fees belong to them we know not.
Arthur Squib, Esq.	Steward, but what Fees belong to him we know not.
Gabriel Lapp, Esq.	Woodward, for marking, 4d. per tree. Upon sale of wood or trees, 12d. in the Pound, and the bark of trees barked.
Allen Beldham, Esq.	Deputy Woodward there.
Thos. Hobson, Esq.	Forrester of the North Walk of Alice Holt. For wages in money, three pounds and ten pennies per annum. The Profits of the Great Park being a Barren Heath for the most part, beside the feeding of the Deer, together with the use of the Great Lodge, and a little Lodge for the use of the Under-Keeper, we value to be worth per annum, eight pounds. Fees of Deer killed, Windfall trees, Dead trees, Browse, and Firewood.
John Fish, Esq.	Forrester of the South Walk, for wages, three pounds and ten pennies per annum, the Profits of the Goose Green Park with the Lodge therein, beside the feeding of the King's Deer therein, we value to be worth ten pounds. Fees of Deer killed, Windfall Trees, Browse, and Firewood.
Wm. Knight, Esq.	Forrester of the West Walk, for wages three pounds and ten pennies, the Profits of the Old Close with Lodge therein, besides the feeding of the King's Deer therein, we value to be worth ten pounds per annum. Fees for Deer killed, Windfall Trees, Dead Trees, Browse and Firewood.
John Fish, Esq.	Forrester of Bordon Lodge in Woolmere, for wages three pounds and ten pennies per annum. Fees for Deer killed, and the profits of the Lodge and Enclosures, there unto being about ten acres worth about forty shillings per annum. Cutting of Heath, and digging of Peat and Turf.
John Adams, Esq.	Forrester of Lynchborough Walk, for wages three pounds and ten pennies per annum. Fees for Deer killed, the Profits of the Lodge with the enclosures to the same, being worth three pounds. Cutting of Heath, digging of Turf and Peat.

It will be noted that in the latter two cases at Woolmer, there is no mention of trees, Woolmer at that time being an open windswept heathland.

Alice Holt was divided into three Bailiwicks, or Walks. They were North, South and West, Woolmer was divided into Bordon and Lynchborough Walks, a description of which follows:

NORTH BAILIWICK

Stony Lake to Sturcle Mead Green	Containing in length 6 Furlongs, and in breadth 4 Furlongs. A thin wood of Oak, some dottards, all of full growth and decaying, some Beeches, Ash, Maple, and Thorn, worth by estimation £573. From the River of Thames 18 miles, which is nearer than any Port, or part of the Sea.
Great Park	Containing by estimation 400 acres, some Trees of Oak good building and cleaving timber, some Ship Timber, and some Dottards, all of good growth, some decaying, worth by estimation £73 or thereabouts. From the said River of Thames, 18 miles.
Thistly Green to Cottons Lane	A thin wood of Oak containing by estimation in length 6 Furlongs by 3 in breadth, good building and cleaving timbers, some Dottards, a little Beech, Ash, all of good growth and decaying, worth by estimation £1,143. From the River of Thames 18 miles.
Cotton to Recklesham Hatch	A thin sheer wood of Oak, by estimation 5 Furlongs by 4 Furlongs, good Building and Cleaving Timber, some Ships Timbers, some Dottards, some Beech and Ash, and most of full growth, by estimation £984.
Park Post to Locke Reade	A thin sheer wood, containing by estimation 2 Furlongs square, Good Building and Cleaving Timber, some Ship Timber, some Dottards of full growth and decaying, and a few Beeches worth by estimation £404.
Rowditch to Homeshill with Gors Point	A thin wood of Oak containing in length $\frac{3}{4}$ mile, by 4 furlongs in breadth. Good Building and Cleaving Timbers, some Ship Timber, some Dottards, some Beech, all of good growth and decaying, worth by estimation £345.
Homeshill to Sturts and Udes Hatch	A thin wood containing by estimation a mile in length, in breadth $\frac{3}{8}$ mile, the greater part of Oak, good Building and Cleaving Timber and some Ship Timber, some Dottards, and many Beeches, all of good growth, and some decaying, worth by estimation £916.

SOUTH BAILIWICK

Udes Hatch to the Seven Sisters	A thin wood containing by estimation $\frac{3}{4}$ mile in length, by 3 furlongs in breadth, for the greater part of Oak, good Building and Cleaving Timber, some Ship Timbers, some Dottards, and some Beech, all of good growth, and decaying, worth by estimation £627.
Seven Sisters to Batts Corner	A thin wood, partly of Oak, and partly of Beech, containing in length 6 furlongs, in breadth 6 furlongs, the Oak Trees of good Building and Cleaving Timbers, some Ship Timber, some Dottards, all of full growth and decaying, the whole worth by estimation £641.

Batts Corner to Stony Lake and Sunny Hill	Containing in length 7 furlongs by 4 in breadth, a thin wood of Oak containing good Building and Cleaving Timber, a little Ship timber, some Dottards and some Beech and Ash all of full growth and decaying, worth by estimation £392.
Goose Green	A very thin wood of Oak, by estimation 2 furlongs square, good Building and Cleaving Timber, some Ship Timber, some Dottards, all of full growth and decaying, worth by estimate £184.
Goose Green Park	Containing by estimation 35 acres, wherein some good Oak are good Building and Cleaving Timber, some Dottards, and Ash, and Maple all of full growth and decaying, worth £96 or thereabouts.
Slatgate to Freethend	A wood of Oak, well standed with bushes, in length ½ mile, in breadth 3 furlongs, good Building and Cleaving Timber, some Ship Timber, some Dottards and Beech and Ash, all of full growth, and worth by estimation £539.

In both the Walks aforesaid, we find not above 100 small saplings.

WEST BAILIWICK

Little Strayte	A thin wood of Oak, containing by estimation a furlong in breadth, by 2 furlongs in length, good Building and Cleaving Timber, some Ship Timber, some Dottards, and some Saplings, worth by estimation £367.
Old Close	Containing by estimation 8 acres, some Oak standing scatteringly, good Building and Cleaving Timber, some Dottards and some Saplings, worth by estimation £20 or thereabouts.
The Great Strayte	A wood of Oak containing in length a mile, in breadth 3 furlongs, good Building and Cleaving Timber, and some Ship Timber, some Dottards, well stored with Saplings, Maple and Thorn, worth by estimation £264.

WOOLMERE

Oak Hill	Some scrubbed Oak Trees, standing scattered, worth by estimation £5, of full growth.

The fittest place we can find at Alice Holt to make a coppice (though not very fit as we can conceive) is between Aps Green and Knights Green adjoining to the Abbotts Wood, containing about 10 or 12 acres.

The total of all Trees valued is £9,770.

The Eighteenth Century

Whilst on the subject of Woolmer boundary, there is a story of a boundary dispute told in the Broxhead Parish records, and dated February 27th, 1773. A certain John Morer kept Mr. Fauntleroy's flock of sheep on Broxhead Common and one day the sheep strayed into the forest, upon which the foresters, keepers, and the "hay-ward" drove them to the forest pound at Holywater, where they confined them so long that the sheep "were much impoverished" and upon

complaint being made by Fauntleroy, orders were immediately issued that as many sheep as had apparently suffered from such confinement should be made good by an equal number of deer out of Woolmer Forest, which at that time was fully stocked.

Woolmer of the eighteenth century was roughly seven miles in length, and about two-and-a-half miles in breadth, and extended to the villages of Greatham, Liss, Rogate, Bramshott, Headley, Kingsley, and Selborne. At the present day, only the village of Greatham is adjacent to the forest, bordering it on the western extremity.

In 1663 timber was wanted for the Navy, and suitable timber was found at Alice Holt. The timber had to be conveyed to Hamhaw in Surrey, whence it could be taken to Deptford. The charge for this was laid on the County, and was so heavy that the Justices of Surrey asked to be relieved of part of the charge.

The total number of oak trees in 1783 at Alice Holt was estimated to be 38,919, measuring 15,142 loads, and 6,119 saplings of one or two feet each, besides beech, ash, and elm timber, valued altogether at £45,862, the whole of the forest area being estimated at 15,493 acres.

In 1784, 1,000 oaks were cut, one-fifth of which it was said belonged to the Grantee, Lord Stowel. He laid claim to "lop and top", but the poor of the parishes of Binsted, Frensham, Bentley and Kingsley asserted that it belonged to them and "having assembled in a riotous manner, actually took it away". One man who kept a team of horses took home forty stacks of wood. His Lordship served forty-five of these people with summonses.

Woolmer about this time was described as "not a single tree standing on Woolmer Forest".

The Nineteenth Century

Following the results of the Commission that sat from 1787-1793, many plantations of Scots pine were made in Woolmer forest, which in the early part of the present century were mature woods, often of fine growth. These plantations were made after 1808. The whole of Woolmer was not under plantations, as can be seen by a description of the forest in 1883—"there is little to see in the forest now. A few cattle crop the heather, and perhaps a wild looking inmate of one of the cottages in the forest may be encountered while the chip of the hatchet is heard from one of the plantations. But stillness and loneliness are the prevailing characteristics of the scene".

In 1864 there was a great fire at Woolmer, which killed most of the young plantations. In Longmoor, 540 acres were burned, and in Brimstone Inclosure a further 170 acres were destroyed.

During the eighteenth century, no oak timber had been cut at Alice Holt prior to 1777 for the use of the Navy, probably owing to the fact that the trees up to that time would not be of the necessary size. A fall of 300 loads of oak was then ordered by warrant from the Treasury for the use of the Navy, and delivered at the usual price allowed for oak timber furnished to the dockyards from Royal forests, 38/- per load. It was argued at the time that if the timber had been put up for sale it would have realised nearly £2,500, whereas at the arbitrary price of 38/-, it produced only £1,074 10s. 9d., to which was to be added about £80 for stackwood, again taken away by the people of Frensham, under a pretended right.

An act known as the "Timber Preservation Act" was brought into force in 1808. This was the outcome of a Royal Commission appointed by a special act in 1786 to inquire into the "State and Conditions of the Woods, Forests, and Land Revenues of the Crown", which submitted seventeen reports from 1787-1793. In 1788, John Pit, Esq., Surveyor General of His Majesty's Woods and Forests, visited Alice Holt and Woolmer, and his report was published in 1790, in the third annual report. The report showed 9,136 oak trees fit for naval construction, as against 13,031 in 1608.

At the beginning of the nineteenth century considerable quantities of oak timber were cut for the navy, so that by 1810 little large timber was left. The last lease of the term of the Lieutenant of Alice Holt expired in 1811, and in 1812 there was passed "An Act for the better Cultivation of Navy Timber at Alice Holt". It provided that the deer in the forest should be removed, and power was given to the Crown to enclose out of the waste lands of the forest not more than 1,600 acres, these were enclosed out of some 2,400. The enclosed land was from such parts "as should be found most convenient to be enclosed and to be best adapted for the growth of timber, such enclosures to be freed from all manner of rights, and to be made a nursery or nurseries for timber only, and to be accepted by the Crown as an adequate compensation for all rights of soil, or other rights over the remaining 800 acres of the waste lands of the forest, which last mentioned lands were to become the property of the persons having rights of common over the forest".

An interesting point after the passing of the act was a further proviso—"no rabbits should be kept on any part of the said forest on any account, pretext, or pretence whatsoever".

Thus the commoners were compensated by the surrender of the Crown rights over the remainder of the unenclosed forest. This surrender of rights is not fully understood to this day, as the writer, during his period of service at Alice Holt, frequently met people of the surrounding neighbourhood who insisted that the people have rights to collect fallen and dead wood within the forest.

The 1,600 acres with existing Crown freeholds to the extent of 296 acres, partly occupied by lodges, made the area of the Crown estate of Alice Holt 1,896 acres. Between 1815-1825 the 1,600 acres was replanted with oak upon the clearance of the remains of a matured crop of oak, beech and ash probably planted in the reign of Charles II. As the new crop matured thinnings were made regularly and heavy.

In 1881, a beginning was made to clear away the poorer parts of the 1815-1825 oak crop, and between that date and 1903, about fifty acres of conifer were planted. At this time the woods were under the control of the Commissioners of His Majesty's Woods and Forests, the officer in charge was the Deputy Surveyor of the New Forest, who had a foreman living at Alice Holt in Goose Green Cottage, which is now renovated and serves as the forest office.

Twentieth Century Developments

Sir William Schlich was asked in 1903 to compile a working plan for the forest, and with the help of Mr. W. Perrée, Deputy Conservator of Forests Assam, this was drawn up and presented. After a survey of the woods, they found that 297 acres were occupied by class 1 oak, 1,146 acres by class 2, and 331 acres by class 3 oak, the rest being coppices and new plantings. The total value of timber, cordwood, and bark was estimated to be £95,020. During the years 1847-1904 receipts from Alice Holt woods amounted to £70,446 13s.

11½d. There is no record of quantity of produce. This latter figure, added to the former, gives an amount of £165,000 as total production.

Their plan for the forest was to clear remaining areas of poor oak, and replant with conifer and regulate the fellings over the rest of the area. By 1913, a total of 117 acres of the poor oak had been cut and replanted with conifer, mainly Scots pine with some larch. In 1918, Mr. R. L. Robinson inspected the forest and made certain recommendations for a revision of the Schlich plan. The forest was finally taken over by the Forestry Commission in 1924, and a revised allocation of the working plan was formulated.

The war of 1939-1945 entailed a further change, and the position in 1956 is given below:

CIRCLE	*Total Acres*	*Regeneration*	*Mature or Middle Aged*
Oak ..	600	191	409
Conifer	1,180	653	527
Amenity	147	40	107
Totals ..	1,927	884	1,043

These acreages plus Forest Workers Holdings and nurseries, and the new addition of Bourne Wood total 2,272 acres, of which 2,057 is woodland.

Alice Holt and Woolmer both played their part in the production of timber in World War II. At Alice Holt 140 acres of young conifers were felled, 108 acres were thinned, and 134 acres of hardwoods were clear felled. Total production was:

Mature Conifer	44,000 cu. ft.	Mainly saw timber.
Young Conifer ..	333,000 cu. ft.	„ pit timber.
Mature Hardwood ..	360,000 cu. ft.	„ saw timber.
Coppice Hardwood	10,000 cu. ft.	„ pit timber.

These areas have now all been replanted, poor oak stands are still in evidence at Alice Holt, but most of these are bordering the metalled public roads, and are left for their amenity value. Regular thinnings of the conifer take place, and many thousands of cubic feet are sent to the mines each year. Mature hardwood oak is felled at regular intervals, and there is a steady local demand for firewood and cordwood.

FOUR CORNISH FORESTS

By H. L. EDLIN
Publications Officer

The narrow Cornish peninsula, with its good lands long closely settled, its poor lands barren and fully exposed to fierce westerly gales, may appear to offer little scope for the forester. Yet in some of its deep and narrow valleys, valuable crops of high-yielding trees have, during the past thirty years, been successfully established, while progress is being made in the afforestation of part of the bleaker moorlands. The oldest established woods of the Forestry Commission lie in the region of Bodmin and Bodmin Moor, and for this reason four of them—Bodmin, Glynn, Herodsfoot, and Wilsey Down Forests—

have been selected to illustrate the possibilities of timber production in Britain's most south-westerly county. Recently, two other new forests have been started —one at St. Clement north of Truro, and another at Croft Pascoe on the Lizard Peninsula, while other woodlands have been acquired in and near Stowe Wood, four miles north of Bude, and at scattered points near the Tamar valley. The combined extent of the several Cornish forests is some 7,000 acres, and it is proposed to add to this as suitable land becomes available for afforestation or replanting.

The Natural Setting

Geologically, most of Cornwall is built up of old, hard, resistant sedimentary rocks of the Devonian age, interspersed with masses of volcanic granite. Most of the woodlands of the Bodmin region stand on these Devonian rocks, except for the Halvana portion of Wilsey Down, which is on the granite. Long ages of weathering and erosion have given the Devonian areas the general form of a broad plateau, with an average elevation of about 500 feet above the sea. This plateau, however, is deeply cut by the narrow valleys of numerous winding streams, which run down to the little creeks and bays that diversify the coastline; and it is in such steep-sided glens that most of the woodland lies. On the open plateau, the strong, salt-laden, Atlantic gales make tree growth exceptionally difficult. The granite outcrops rise higher, including much moorland over 800 feet high, and reach 1,375 feet at Brown Willy on Bodmin Moor, the highest point in Cornwall.

The individual rock beds of the Devonian strata, and the soils derived from them, vary considerably in fertility: some, such as the slates or "shillit" have shown themselves very favourable for tree growth, others, such as the Staddon Grit, appear unsatisfactory. On the granite, reasonably good, though peaty, soils are encountered. Rainfall, averaging forty-five inches a year, is everywhere adequate, and most soils are freely-draining. Winters are mild, and young tree crops are rarely held back by frost or snow. Despite these helpful circumstances, the raising of tree crops in Cornwall often presents a challenge to the forester's skill. Within a few hundred yards one may pass from a fertile, sheltered valley slope, where trees grow three or even four feet higher each year, to an exposed, infertile down, where they grow hardly as many *inches*.

The Historical Background

Historians and archaeologists have shown that Cornwall has a longer story of human settlement than any other part of Britain. The men of the New Stone Age, who built stone circles and the curious tombs called "quoits", were succeeded by those of the Bronze Age, who built their tumuli on the hill tops, particularly around Bodmin Moor. These in turn gave way to the Iron Age folk who built the fortified hill top camps or "castles" and became the ancestors of the modern Cornish people. All these early inhabitants practised agriculture; and over the course of the centuries generations of farmers cleared most of the original woodland and enclosed the fertile ground with characteristic "hedges" of boulders, topped with a layer of earth and carrying a growth of sheltering oak, hazel, or hawthorn. But two kinds of ground escaped inclusion in the peculiarly Cornish network of small, squarish fields. One was the open moor and down, too poor for cultivation and serviceable only for rough grazing. The other was the steep valley sides which continued to bear their original oakwoods.

These oakwoods, however, did not escape the influence of man, for as time went on they acquired a value as sources of fuel and timber. Before the days

of coal, firewood was needed for household hearths, and charcoal for industry. In particular, the smelting of the native Cornish ores of tin, copper, silver, lead, and other metals called for a constant supply of charcoal. Timber was wanted for the mining operations, as well as for ship building; and although the local architecture of buildings and field boundaries is predominantly one of stone, beams were needed for roofs and posts for gates. Another important demand was for tan-bark, peeled from the stems of fresh-felled oaks, for tanning local hides—a trade still continued at Launceston and Grampound. By reason of its isolation, these needs had to be met, in the main, from Cornwall's own woodlands, and a simple but effective system was followed. After each portion of a wood was cut, cattle and sheep were excluded and the oaks were allowed to coppice.

For centuries the oak coppices supplied local demands, being cut over at intervals of twenty years or so. In 1947, oakwoods of various kinds occupied 14,000 acres, or nearly half the extent of 31,000 acres then under tree crops in Cornwall.

Today, however, this coppice method of growing oak is quite uneconomic. There is little demand for firewood, charcoal, or tan-bark, and few oak pit-props are now used in the mines. These valley sites cannot grow larger oak timber of the size and quality that commands a good price. Therefore the old oakwoods are being converted, as opportunity offers, to plantations of carefully chosen coniferous trees; or occasionally, on the better ground, to woods of beech. Thus, along the vales, the modern forester's work is largely one of rehabilitation, or the adaptation of old woods to the needs of modern industry. While on the downs and moors the object is to bring into productive use land that is too poor for sustained agriculture.

A good deal of pioneer work in the raising and tending of forest trees was carried out, during the eighteenth and nineteenth centuries, by the owners of the great estates. Examples in the Bodmin district will be found at Pencarrow, Colquite, Glynn, Lanhydrock and Boconnoc. The trees that the landowners planted included several exotic kinds such as the European larch from the Alps, the maritime pine from the Mediterranean, and the silver fir from Central Europe. A good deal of beech, which is native in the south of England, though perhaps not so far west as this, was also grown. Although these privately owned woods stand, as a rule, on the most carefully chosen sheltered and fertile sites, they have provided helpful pointers to the Forestry Commission's work on the poorer and higher ground. Much of their timber, however, had to be sacrificed during the two world wars, and to-day their owners face a big task in restoring them to full productivity. Many have brought their estates into the Dedication or the Approved Woodlands schemes. The Duchy of Cornwall is also actively concerned in the scientific administration of its own extensive woods.

Evidence of widespread woodland in the Cornwall of former times is found in the frequent occurrence of words signifying trees or woods in Cornish place names. Thus "quite" and "goose", local variants of the old Welsh word "*coed*", indicate woods in general; "gelly" and "with" record smaller clumps or groves; while "dar" or "derry" represents oakwood. When the national stocktaking was made of the country's timber resources in 1947, Cornwall was found to have 34,500 acres of woodland (including 3,500 acres that had been felled but not yet replanted). This represented 4 per cent of its land area, which, though well below the average of 6 per cent for Great Britain, was a higher proportion than that found in several eastern counties.

The Forester's Work To-day

However picturesque the old oak coppices may be, they have little prospect of yielding anything of value for the future. Therefore they are being replaced with plantations of trees that will be allowed to grow to their full stature. These trees are grown from seed in local nurseries, and when about three years old and some eighteen inches high, they are transplanted, during autumn, winter, or spring, to the woods; they are set about five feet apart, and 1,750 are needed for each acre of ground. During the next few summers they are weeded, all competing growth such as bracken, brambles, and coppice shoots being cut back. On the moors and downs where there is great need to establish plantations to make use of some of the poorest ground and to provide shelter for farm stock, the work of establishment is somewhat different; there, the grassy, peaty, surface is first ploughed, mainly as a measure of cultivation; this suppresses the weed growth, making subsequent weeding a lighter job.

The thinning stage may be reached within fifteen years in the valleys, or only after as long as thirty years on the moors. Thinnings give the first return of useful produce and money, and, since they are repeated every few years, provide a large share of the total yield. The trees selected for removal are felled and trimmed, and the logs are then hauled or carried to the nearest forest roadway; often the bark is stripped off with a draw knife. Next the logs are cross-cut to the lengths required by the purchaser. At present most of this pole material from the Bodmin area is being cut into pit-props for the South Wales coalfield; but there are also more local demands for fence rails, rustic poles, and timbers of various sorts for Cornish mines and quarries. Some of the thinnings will soon be big enough for sawing up into boxwood, for which there is a big demand in the market gardening districts of the south-west. Thinnings are also suitable for making paper pulp and wallboard, and some of those from Cornwall may eventually be so used.

Gradually, the crop approaches maturity: this is likely to take about eighty years on the moors, but perhaps as few as sixty years in the vales. When the valuable "final crop" is cleared, large logs for the sawmills, suitable for such purposes as building timber, railway sleepers, and packaging work, will be obtained; nearly all such material has at present to be imported to Cornwall, and local supplies will be a useful supplement.

The work of preparing the ground, fencing against rabbits and stock, planting and weeding the trees, thinning, and preparing the produce for market, provides continuous employment for a body of local men. Houses have, therefore, been built for a number of them, and these are sited at strategic points from which a watch can be maintained for forest fires. For the success of the work is always threatened—particularly in the earlier stages of each plantation's growth, by fire. The woods are broken up into sections by fire-breaks or strips of coppice, so that a fire cannot easily spread, and arrangements exist for reporting fires and combating them; but it is far better to have no fires to fight.

The Trees of the Bodmin Woodlands

The old coppices of the valleys consisted almost entirely of the native pedunculate oak, which occasionally makes a fine tree on the deeper soils in sheltered spots, but becomes scrubby and stunted—even when not coppiced—as the windswept ground of the plateau is neared. On the tops, nearly every oak is cut and shaped by the salt-laden winds, and an erect one is rarely seen. Growth is slow, and there is little future for oak as an economic tree. Beech, however, grows fairly well in the valleys, and it is being planted on a considerable

scale to preserve, at least in part, the broadleaved character of the woods. Other hardwoods play only a minor part in both old and new woods; they include birch, alder, and rowan, and the Cornish elm, *Ulmus stricta*, a species noteworthy for its erect stem and light, graceful, habit of branching.

The new planting has been done mainly with conifers, but the kinds chosen show such variety of form and colour, that there is no reason to fear a monotonous landscape. The principal species is the Sitka spruce from British Columbia, a tree of conical form, with bluish-green foliage that often bears a beautiful silvery sheen. It has grown very rapidly in the deep glens, and shown itself tolerant of exposure to salt winds on many moorland sites; but on the dry, gritty soils of the downs it fails to thrive. Next in importance comes the Japanese larch, a deciduous tree with bluish-green foliage and a handsome, red-brown bark; this again is a tree for the glens, where it grows very quickly, and suppresses coppice and weeds; its timber is strong, with a naturally durable heartwood. The Douglas fir, another British Columbian tree, is thoroughly at home in the valleys, where it often grows three feet taller each year and produces a remarkably even crop. The western hemlock, from the same region, shows much promise; it is a very graceful tree with a drooping leading shoot.

But on the exposed downs, with their dry, gritty, infertile soils, and dense heathland vegetation, a completely satisfactory tree has not yet been found. Two trees found very hardy elsewhere, the Scots pine and the Corsican pine, wilt before the salt-laden Atlantic gales, become thin foliaged, and make poor growth. The lodgepole pine—*Pinus contorta*, a newcomer from British Columbia—shows greater promise. Two other pines now finding favour are the maritime pine (*Pinus pinaster*, see photo 9) which was introduced from the south of France and has grown satisfactorily on some private estates, and the Monterey pine (*Pinus radiata*) from California. Both these pines have thriven when used for ornamental planting on the coasts of Cornwall, Devon, and Dorset, and it is hoped that they will do equally well in forest plantations. Although hard to transplant, both grow rapidly when once established. Maritime pine has long leathery needles, huge cones, and a reddish-grey bark; Monterey pine bears bright green needles grouped in threes.

Other trees that have been tried on a small scale, but which have proved ill-suited to the locality except on small well-chosen plots, are the Norway spruce and the European larch. The tallest trees on the private estates are usually silver firs (*Abies alba*), but to-day this fir is hard to raise because of a tiny insect pest called *Adelges nüsslini*, though other related firs prove resistant. Here and there the visitor may find small groups of the Lawson cypress, or the western red cedar, and altogether there is a fair representation of the trees most important in British forestry, though it is evident that only a few are suited to the peculiar climate of Cornwall.

Glynn Forest

The first forest to be established by the Commission in the Bodmin neighbourhood is that known as Glynn, which to-day comprises 2,518 acres. The oldest of its several component blocks is that called Cardinham, in the valley of that name two miles east of Bodmin. Other, younger woods, line the famous Glynn Valley, through which both the high road from Bodmin to Liskeard and the main railway line from Penzance and St. Austell to Plymouth follow the course of the River Fowey. Finally, there are a few outliers beside or near the Lostwithiel-Liskeard road, and around Boconnoc.

The Cardinham portion is approached by a by-road that follows the winding Cardinham Water deep into its glen. Here, where it runs between the

woods marked on the one-inch map as Margate, Collywith, Collabarrett, Lidcutt, Deviock, and Hurtstocks, the previous crop was purely of oak coppice. Between 1922 and 1940 the bulk of this was cleared, and the land replanted with various coniferous trees. The Sitka spruce has proved an outstanding success, showing, on favourable valley sites, some of the fastest growth recorded anywhere in Britain. The largest Sitka, though only thirty years old, has reached a height of 105 feet, and has a girth, at breast height, of nearly seven feet. Over whole plantations, heights around 75 feet are frequent, and the annual increase of timber volume may amount to 300 cubic feet (measured over bark on the hoppus system) per acre; this is equivalent to about ten tons by weight, and at least £15 by value—a high yield from such poor, steeply-sloping land. The scenic effect recalls the tall coniferous forests of the Alps or the Rocky Mountains, and it strikes an unusual, though not unpleasing, note in the landscape. Comparable results have been achieved with Douglas fir and Japanese larch; but the performance of other sorts of conifer have been more variable.

Features of interest at Cardinham include an excellent system of forest roads, used to haul out the steady output of poles and pit-props from thinnings in the thriving woods; which now runs at 40,000 cubic feet a year. There is an ancient "clapper" bridge across the stream, and the ruins of the old Hurtstocks tin mine, which ceased production about the year 1875, may still be seen. Two new houses have been built for the forest staff. A small herd of red deer sometimes frequents these woods.

That portion of the forest which lies along the Glynn Valley includes, on the north, Laneskin, Leball, and Well Woods; and on the south Newbridge, Draw, and Largin Woods. Together these extend more or less continuously over the six miles from Bodmin Road to Doublebois Stations. Here the woods are, for the most part, younger, and in places the work of conversion from oak coppice is still going on. But already the varied hues and forms of Douglas fir, larch, hemlock, lodgepole pine and spruce are combining with the original oak, birch, and alder to maintain, and even enhance, the beauty of this sylvan valley, well known to thousands of travellers by road or rail. On the valley floor there are some remarkable examples of the afforestation of rough river gravels, which have been "stream-washed" for tin ore in days gone by (see photo 8); several sorts of trees, broadleaved and conifer, have proved at home here, so hiding the scars of industry.

The southern outliers of Glynn are, for the most part, newly acquired and only recently planted. They include some sterile downland, at heights around 600 feet, fully exposed to southerly sea-winds; in places this is being ploughed to facilitate the establishment of a tree crop.

The number of people employed at Glynn averages twenty-five.

Bodmin Forest

The five blocks of woodland that make up Bodmin Forest all lie in the lovely vale of the River Camel, north and west of Bodmin town. The nearest and most accessible block is that called Dunmere, which includes Dunmere Park, Pencarrow and East Woods. It borders the main road from Bodmin to Camelford, and drops down towards the mineral railway which runs beside the river to the distant china clay workings of Wenfordbridge. On the edge of the woods are the tree-embowered Dunmere Falls, formed by an artificial weir that acts as a salmon ladder; while on the hill top to the north stand the well-preserved remains of an Iron Age camp called Penhargan Castle. The conversion of the oak coppices here began in 1930, and is still in progress. The trees

planted include Scots and Corsican pines, European and Japanese larches, Douglas fir, and grand silver fir. Broadleaved trees are represented by beech, red oak, and poplar, while amid the oak coppices Cornish elms and a few hornbeams may be found, together with a few maiden oaks of good form. These varied species naturally show different rates of growth and degrees of vigour, but the overall picture is one of great promise. A network of roads has been constructed to make possible the easy extraction of the large quantities of thinnings that will soon be coming from these plantations.

The Helligan block, consisting of Helligan, Shell, and Coldrinnick Woods, lies some two miles farther up the Camel, and about one mile north of Helland village. It comprises oak coppice only recently taken in hand for conversion; but the young Japanese larch are already thriving.

Below Dunmere the Camel winds westwards through a valley of rare beauty, with woodlands on either hand diversified by pastures, and an occasional farmstead and orchard. The railway from Bodmin to Wadebridge and Padstow follows its picturesque course, but there is no main road, and to reach the three westerly blocks of Bodmin Forest it is necessary to take by-roads through Ruthernbridge or Polbrook. The most northerly, called Derry Wood, is a former oak coppice now carrying Japanese larch. Bishops Wood, in the centre, is remarkable for the very rapid growth of Japanese larch, which scales fifty feet after twenty-four years; the Douglas fir is also very vigorous. At Grogley Wood, further south, there is much good Japanese larch and Corsican pine on the lower slopes. Higher up, the crop of Corsican pine and Sitka spruce grown in mixture, is poorer and somewhat patchy, reflecting the sterility of the gritty soil and the exposure found at a 600-foot elevation. For the latest, 1954, plantings, open downland has been ploughed; the trees now being used—admittedly in an experimental fashion—include lodgepole pine, Monterey pine, and Lawson cypress. It is hoped that these will prove hardy under these difficult conditions.

The total extent of Bodmin Forest is 1,491 acres. Eighteen people are employed, and two new houses have been built close to Dunmere.

Herodsfoot Forest

Herodsfoot consists of two large blocks of former oak coppices, and two small outliers, all in the deep valley of the West Looe river and its tributaries. They are centred on the hamlet of Herodsfoot, once an important centre for mining silver and lead; spoil heaps and other traces of workings may still be found in the woods. There is also a small powder factory, still in operation, which survives from the days when charcoal from the oakwoods was a major ingredient in explosives. Looe lies some four miles to the south-east, and Liskeard some four miles to the north-east, of this charming though remote cluster of woodlands. On the one-inch map they bear the names: Trevillis, Canaskey, Trenchay, and Deerpark (in the first large block north of the hamlet); Pendruffle, Tremadart, and Gillhill (in the second block to the south); Polvean and Hall Woods are the outliers.

The process of converting the oak coppices to more profitable plantations has gone on steadily since 1935, and is still in train. The new trees include Douglas fir, Sitka spruce, Japanese larch, western hemlock, red oak and beech. Growth is everywhere promising, but the oldest trees are still in the thicket stage, too small to warrant thinning. A good system of roads has been built, in anticipation of the hauling out of produce. Two new houses have been built for forest workers; they are constructed of Canadian red cedar timber, and roofed with shingles of the same wood; the tree that produces this attractive

and very durable wood, namely *Thuja plicata*, has been planted on a small scale in the Herodsfoot woods. The total area of this forest is 776 acres, and about ten people are regularly employed.

Wilsey Down Forest

Unlike the forests previously discussed, Wilsey Down lies entirely on the high ground of Bodmin Moor, being made up of three separate blocks, totalling nearly 1,200 acres. The oldest of these, which gives its name to the forest as a whole, is on Wilsey Down, and adjoins the main road from Launceston to Camelford for a stretch about one mile long, just east of Hallworthy cross-roads. It stands very high, touching 900 feet near the high road, and falling to 700 feet towards the north, and exposure from all directions is severe. The soil is an infertile grit, and these factors, working together, have proved unfavourable for tree growth. Although, from the roadside, the stands of Sitka spruce, Japanese larch, and lodgepole pine appear flourishing, further in there are many patches of poor growth. These are associated with a characteristic down vegetation of Cornish gorse (*Ulex gallii*), heather, bell heather, cross-leaved heath, blue moor grass, and another moorland grass called *Agrostis setacea*. Research is in progress on the root causes of these failures, in the hope that either by a careful choice of tree, some method of cultivation, or some form of manuring, foresters may, in the future, be enabled to afforest such difficult ground with greater confidence. Planting began here in 1928, but not until 1955 were any portions tall enough to require thinning out; the total areas is 405 acres.

Halvana, the second portion of Wilsey Down to be afforested, forms a conspicuous landmark well seen from the Bodmin-Launceston road between the famous Jamaica Inn at Bolventor, and the cross-roads called Five Lanes close to Altarnun. It is a compact block of some 495 acres, and lies on gently sloping moorland at elevations of 800 to 1,000 feet, between the headwaters of the River Fowey and those of the River Lynher. Brown Willy and Rough Tor, the twin monarchs of Bodmin Moor, stand like sentinels a few miles to the west, and the whole countryside is desolate and exposed. The deep peaty soil overlies a grey granite, and not far away, at Hawkstor, china clay is mined. At Halvana itself there was formerly a copper and tin mine, and the old shafts may still be seen. But to-day the only activity is the tending of the Sitka spruces that have thriven so well on the moist peaty soils, and the harvesting of thinnings from the plantations. These were formed between 1930 and 1940, and were big enough to yield poles and pit-props in 1955.

Davidstow, the third portion of Wilsey Down Forest, stands on another portion of the same high moorland. It is some four miles east of Camelford, close to the by-road linking that town with Altarnun. Covering about 300 acres, it occupies the site of a former aerodrome, the runways being still in evidence. At 950 feet elevation, it is in full exposure to the winds from the Atlantic, only six miles distant, but soil conditions are good and the young trees are thriving. The greater part of the planting was done in the years 1954 to 1955, with Sitka spruce, lodgepole pine, and Japanese larch. There is a forest nursery of ten acres, in which young trees needed for planting at this and other forests are raised from seed; by growing them near at hand it is hoped to get stock inured to the severe local climate, and to avoid losses through delays in transport that sometimes affect the more sensitive kinds.

Despite the poor results at the oldest part of the forest, Wilsey Down provides a valuable pointer to the prospects of timber growing on these wild uplands. Worthwhile production can be achieved, although the impressive rates of growth found in the valleys may always be lacking.

Although forestry is unlikely to become a major activity in Cornwall, this review of the progress made so far suggests that it can bring substantial benefits to the county. One of these will be the provision of locally grown supplies of softwood poles and timber which have had, hitherto, to be imported over long distances at considerable cost. Another will be the creation of shelter on the uplands, which may well increase their capacity for carrying livestock, and so add to the stock-raiser's or dairy farmer's income. Then there is the preservation, and perhaps even the improvement, of the wonderful scenery of the steep-sided valleys and creek shores, which rightly attract to the county a continual stream of appreciative tourists. Finally, there is the provision of useful employment, some of it in outlying inland parishes where other work may be hard to find, and some in the country towns where a constant supply of raw material will help to maintain the sawmilling and woodworking trades.

THE CRARAE FOREST GARDEN

Contributed by M. V. EDWARDS
Divisional Officer, Research Branch

The Crarae Forest Garden is the conception of Sir George Campbell and was started in 1933 on his estate near Minard, on Loch Fyne-side, Argyll. In it the trees are all planted in plots whose size varies from about 100 to 400 plants (or fewer in the case of the rarest species). Their shape is irregular. Planting continued annually, a maximum of twenty-five plots being formed in 1937. Since 1939 only a few plots have been added and the total now reaches 108. So far, about one-third of the total area of thirty-four acres has been planted. In some plots the plants have all died and in certain cases these have been replaced by another species. There remain approximately 100 plots but in some of them casualties are still occurring owing to frost, etc., and some species are only represented by the surviving individual specimen trees. In 1955 the Garden was gifted by Sir George Campbell to the Forestry Commission, and it is now managed by the Research Branch.

The elevation varies from 130 feet at the lowest part to about 230 feet at the highest point so far planted. The underlying geological formation is favourable to tree growth, comprising metamorphosed igneous rocks mapped as "epidiorite, hornblende-schists, etc."

Notes on the More Important Genera

Abies. The European species, *A. pinsapo* and *A. cephalonica*, grow slowly and somewhat irregularly. Western North American firs are well represented, *A. amabilis* and *A. grandis* being especially vigorous and well grown. These two plots are probably growing more luxuriantly than any other plots in the Garden. *A. nobilis*, *A. magnifica* and *A. lasiocarpa*, the last as yet young, are all successful. *A. lowiana* from California is also doing well but the related *A. concolor*, after a good start, is losing its needles and many trees appear to be dying. From the east of North America, *A. balsamea* and *A. fraseri* have both formed good plots.

East Asiatic firs are also well represented but have not proved so successful. *A. spectabilis*, from the eastern Himalayas, has almost entirely succumbed. The west Chinese firs *A. delavayi*, *A. forrestii* and *A. recurvata; A. holophylla* and

nephrolepis from Manchuria; and the Japanese species *A. firma* all grow slowly and rather irregularly; but *A. homolepis* and *A. veitchii* are more vigorous and promising.

Picea. The European species *P. abies* and *P. omorika* are both represented. The Caucasian P. *orientalis*, after a slow start, has grown well. Both *P. omorika* and *P. orientalis* have suffered check in heather areas. Western North American species include *P. sitchensis*, the most vigorous of all the spruces, *P. mariana* (*nigra*), *P. glauca* (*alba*), *P. hurstii* and *P. rubens*, all of which are growing steadily. *P. engelmanni* has not done well. *P. pungens* from Colorado has survived for many years but is gradually dying. Of the Himalayan species, the western *P. smithiana* is almost entirely dead, but the Eastern *P. spinulosa* has grown slowly and irregularly and may form a plot. From Siberia P. *obovata* is doing well but *P. schrenkiana* has suffered severely and its fate is doubtful. West Chinese *P. likiangensis* is growing only very irregularly. Four Japanese species have been planted—*P. jezoensis* has failed; *P. bicolor* is growing slowly: *P. glehnii* promising and *P. koyamai* remarkably good.

Pinus. More species of pines are represented in the Garden than of any other genus but on the whole they are less successful. The high humidity and mild climate of Crarae is naturally less likely to be suitable for pines than for firs and spruces.

Of the European species a few scattered and mis-shapen individuals of *P. pinaster* remain after twenty years' growth. P. *peuke* and *P. montana* are much slower growing but have formed useful plots while *P. laricio*, which is planted on the more exposed upper part of the Garden, has made a start.

The Western North American *P. contorta* is very fast growing and forms a good plot. The related *P. banksiana* is similar but of less good form. P. *ponderosa* and *P. lambertiana* from Western U.S.A. have not been at all successful. *P. radiata* and *P. muricata* from California have behaved similarly. *P. aristata* is slowly dying; *P. montezumae* from Mexico only survived a few years. *P. cembroides* is, however, growing slowly. *P. rigida* has suffered heavy casualties and the survivors are mis-shapen. *P. strobus* is as yet young and planted on an exposed site has suffered badly from wind.

The Himalayan *P. excelsa* is growing slowly but healthily so far. Far Eastern pines are well represented but none are promising. From China *P. bungeana* died early while *P. massoniana*, *P. sinensis* and *P. tabulaeformis* have only survived as scattered trees. The Japanese *P. koraiensis* and *P. thunbergii* have behaved similarly but *P. parviflora* is rather more promising.

Cupressus. *Cupressus sempervirens* has not survived well enough to form a plot but there are a number of individuals, including some of extremely fastigiate form. American cypresses include *C. macrocarpa* which forms a plot although not such a good one as the rather older one on Crarae Estate. *C. arizonica* and *C. lusitanica* var. *benthamii* have also suffered heavy casualties, as has *C. goveniana* which, however, has produced seed several times. *C. torulosa* from Asia has left a few survivors after twenty years and *C. funebris* from China has formed a plot though it suffers severely from blast.

Chamaecyparis. *Chamaecyparis lawsoniana* is growing most vigorously and forms an excellent fast-growing plot.

Tsuga. *Tsuga heterophylla* forms one of the oldest and is also one of the fastest grown and most vigorous plots. A number of other species of *Tsuga* are also represented but are much younger. They include *T. caroliniana* from U.S.A.,

T. dumosa from the Himalayas, *T. diversifolia* and *T. sieboldii* from Japan, all making a satisfactory start.

Cedrus. *Cedrus atlantica* and *C. deodara* were both planted in the early years but have grown much more slowly than any of the surrounding plots. The former species now looks unhealthy.

Other Genera. Three most interesting plots growing alongside each other comprise *Cryptomeria japonica*, *Sequoia gigantea* and *S. sempervirens*. The first-named is the tallest and has been thinned twice. Both *Sequoias* are very promising.

Several plots of *Larix decidua* (*europaea*) of High Alpine provenances have suffered severely from die-back. *L. kurilensis* (*gmelini* var. *olgensis*) failed completely. There is a young plot of *Sciadopytis verticillata* and some survivors of *Taxodium distichum*. There are also trees or plots of a number of broadleaved species including *Eucalyptus urnigera*, and several species of *Acer*.

Failures. In addition to those species recorded above as having failed the following have also failed completely: *Abies religiosa*, *Eucalyptus coccifera*, *E. coriacea*, *E. macarthurii* and *E. viminalis*, *Juniperus virginiana*, *Larix dahurica*, *Pinus ayacahuite*, *P. coulteri*, *P. longifolia*, *P. mitis*, *P. palustris*, *P. pinea* and *Widdringtonia whytei*.

Near the Forest Garden stand several *Eucalyptus* grown by Sir George Campbell from seed sent to him from friends in Australia in 1952. The following species have so far survived: *Eucalyptus gigantea*, *E. fastigiata*, *E. niphophylla*, *E. coccifera*, *E. gunnii* and *E. johnstoni*, together with seedlings grown from established trees of *E. urnigera* at Crarae. There are two large specimens of *E. urnigera* near the house and the belt of trees near the front gate are the progeny of these.

A WORKING PLAN FOR POLICY WOODLANDS

By H. CRUICKSHANK
District Officer, Education Branch

The management of Policy Woodlands is not normally one of the functions of the Forestry Commission, hence a note on the Working Plan of Faskally Policy Woods may be of interest. This plan is based on Professor Mark L. Anderson's recommendations.

Faskally Forest, at present totalling 1,045 acres, includes 185 acres designated as Policy Woods, the remainder being mainly hill land typical of central Perthshire.

The Policy Woods administered by the plan lie in the Tummel-Garry valley of Perthshire from half to three miles north-west of Pitlochry. They are bounded on the north-east by the main road (A9) from Pitlochry to Inverness, and on the south-west by Loch Faskally and the Rivers Tummel and Garry. (O.S. 6-Inch Perthshire sheets XXX S.E. and XXI S.W.)

The area, in the form of an elongated block broken by Faskally House, Gardens and Home Farm, is undulating, sloping generally to the west. Elevations range from 300 to 500 feet above sea level. It is fairly sheltered

but parts are exposed to north-westerly winds from the Tummel valley. The average rainfall is thirty-five inches. Snowfall is moderate and frosts are sometimes severe.

The north-western section of the woods lies upon deposits of fluvio-glacial sands and gravels, into which the River Garry has cut a series of river terraces. In the south-eastern section sands and gravels form only a narrow strip along the shore of Loch Faskally, the remainder of the area being overlain by a varying depth of boulder clay, through which outcrops of rock frequently appear. The underlying rock is quartzite or quartz-schist of a considerable variety of types, all of which belong to the Dalradian Metamorphic Assemblage.

Prior to 1955 the rabbit population was high because of continuous invasions from neighbouring land, and complete fencing was necessary. Myxomatosis cleared the ground during the summer of 1955; some reinfestation took place later, but fencing for regeneration is no longer necessary. Three or four roe-deer live in the forest and red squirrels are present in small numbers. There are a few capercailzie and pheasants, and numerous pigeons.

The woodlands may be sub-divided as follows:

(1) Over-mature conifers	11 acres
(2) Younger conifers pure or in mixture	60 ,,
(3) Over-mature mixed coniferous and broadleaved species	69 ,,
(4) Younger broadleaved species	6 ,,

Forty acres are not at present wooded.

The older coniferous and broadleaved stands, no doubt originally planted as policy woodlands, are approximately 170 years old, and contain some excellent stems of Scots pine, European larch, beech, oak, lime and sycamore. Butt-rot is prevalent. A small stand of almost pure oak, predominantly sessile and mainly of coppice origin, is about sixty years old. The younger plantations of Scots pine, European larch, Norway spruce and Douglas fir are growing well, but have been underthinned in the past. A large percentage of the stems show signs of butt-rot due to *Fomes annosus*. The European larch is suffering to some extent from canker and die-back.

The objects of management are:

1. To produce in the woodlands an uneven-aged structure on a group basis.
2. To obtain, at the end of the conversion period, a continuous series of age and girth classes, the ages ranging from one to 120 years.
3. To improve the quality of the soil by careful selection of species and the introduction of additional broadleaved species.
4. To regenerate naturally where desirable and possible if this can be achieved without undue delay; artificial regeneration however to be fully used particularly to introduce desirable species either pure or in mixture.
5. To maintain or improve the quality of the growing stock and to achieve and sustain the maximum volume production consistent with this aim.
6. To preserve the amenities of the forest.
7. To investigate and demonstrate a system of "irregular" forest management, deliberately chosen as appropriate for "policy" woodlands.

To carry out the provisions of the plan the woods are divided into six more or less equal blocks, each sub-divided into four compartments. One block is treated each year, giving a six-year cycle. In the appropriate year all necessary operations in a block—draining, brashing, cleaning, thinning, felling, fencing (when necessary), planting—are carried out. Essential operations such as weeding and beating-up may be carried out more frequently. The conversion period of 120 years allows twenty treatments of each block.

Regeneration by planting or natural seeding is carried out in groups of 1/20 to 1/8 of an acre in area. These groups are distributed evenly throughout the block, gaps being cleared or clear-felled for the purpose. The earlier groups are square or rectangular in shape, the longer axis being north-south, but later groups will require to be more irregular in outline. The total area regenerated each year is 1.5 acres.

The species planted during the past three years have been very varied, selection having been made on the bases of soil, shelter and available light. These species include beech, oak, sycamore, European larch, Douglas fir, Norway spruce and Scots pine. The spacing in the groups is slightly less than normal, with usually not more than three species in one group.

In 1954 and 1955, groups were protected by temporary rabbit fences, but in 1956 no netting was erected.

A guide to the volume to be removed when clear-felling gaps is 2 per cent of the total forest volume, or 12 per cent of the volume of the block being worked—2 per cent being assumed an average increment to be expected.

Prior to any work being carried out in a block a complete enumeration of the crop in that block is carried out. This is done by callipering all stems at breast height and recording in quarter-girth classes. The "Hopsil" volume (volume for management purposes) is obtained from basal area volume tables. From these enumerations at six-year intervals the block increment will be calculated; this will then provide a more accurate guide to future fellings.

To ensure that all regeneration groups are cleared before the planting season commences, the enumeration is carried out in October, at the end of the growing season, and the felling by December.

The Working Plan has been in operation since the beginning of F.Y.54. In 1965, that is, at the end of the second six-year cycle, the progress to date will be assessed and the plan revised as necessary.

The crop of criticisms, both naturally and artificially regenerated, has been abundant. These criticisms have been based on such varied grounds as economics, the training of foresters, and the principles of silviculture and management. They have been protected and encouraged by the wire-netting of inexperience. Should they still flourish after the assessment of twelve years' work has been completed in 1965, some revision of the Working Plan might then appear advisable!

LAKE VYRNWY FOREST, MONTGOMERYSHIRE

Contributed by G. D. HOLMES
District Officer, Research Branch

This forest lies on the Liverpool Corporation Waterworks Estate, and has been established jointly by the Corporation and the Forestry Commission.

Areas:	Lake ..	1,120	acres	
	Forest Area ..	5,114	,,	(including 330 acres unplantable)
	Area farmed by the Corporation	11,106	,,	(carrying 9,000 sheep and 120 cattle)
	Farms and Small Holdings ..	5,560	,,	
	Other	100	,,	
	Total	23,000	,,	

Forest Staff: 45

Thinning Programme: 1956-1961—3,600 acres

Roads Constructed: Nine miles

This Estate of the Liverpool Corporation was acquired between 1880 and 1897. The area, which lies between 750 feet and 2,050 feet, forms the gathering ground for the reservoir of 1,120 acres which constitutes the principal supply of water to the City of Liverpool. The principal topographic feature of the area is the main Vyrnwy Valley, with steep-sided minor valleys. The hills are rounded and heather-clad, the underlying rocks being Ordovician shale. The soil is a shaley loam with deep peat in the hollows and glacial moraine with its associated boulder clay in the valley bottoms. The average annual rainfall over the catchment area is 70 inches.

Pre-Acquisition Land Use

Prior to acquisition, the area consisted of a number of upland farms where the raising of hill sheep and store cattle was practised. These farms were typical of those to be seen to-day in the remoter upper valleys of Wales and were made up of a limited area of enclosed fields in the valley bottom with a considerably larger area of marginal land and rough moorland grazing. The woodland area was negligible and consisted of under 200 acres of mainly natural woodlands of scrub oak, birch and mountain ash.

Post-Acquisition Land Use

Having regard to its primary purpose as a water catchment area, an attempt has been made to achieve a well balanced use of the whole area. The policy adopted has been to afforest most of the lower slopes, and to graze hill sheep on the unplantable moorland. At the same time, some of the original farm units have been retained and let to tenants and a number of small holdings have been formed for occupation by workers.

Afforestation Operations

In 1896 the Corporation consulted Dr. William Schlich for advice on the afforestation of part of the catchment area. The result was a report and recommendations on the basis of which the Corporation proceeded with a limited afforestation scheme, and by 1912 some 900 acres had been planted.

In 1914 a profit-sharing scheme was formulated whereby the Corporation agreed to afforest a further 4,000 acres by the year 1933. The scheme, in which the Forestry Commission later took a share, was completed in 1936 with some minor alterations to preserve sheltered land for sheep.

In 1946, a new partnership between the Forestry Commission and the Corporation was agreed, under the terms of which the forest area is to be worked under approved schemes of management for 999 years. The profit and loss on all forestry and ancillary operations (including housing schemes for forest workers) is shared equally by the Forestry Commission and the Corporation.

An endeavour is made to manage the forest on a five-year Plan of Operations, but the difficulty of obtaining adequate labour in such a remote rural area is one of the controlling factors. The present forest staff is hardly adequate to work the planted area of nearly 5,000 acres, much of which is in the first, second, or third thinning stage.

Timber Production

During the 1939-1945 War, 750 acres of plantations between twenty and thirty-five years old were clear-felled, producing 1,670,000 hoppus feet of timber most of which went into the collieries as pitprops. This area has since been replanted mostly with Sitka spruce and Norway spruce and a little Japanese larch and *Thuja*. No clear felling is carried out at the present time, but current thinning operations are producing 450,000 cubic feet annually and this will increase as the plantations develop. It is planned to thin approximately 3,700 acres in the next five years of which 950 acres will be first thinnings. Thinning is done partly by the forest staff and the produce sold loaded on buyers' vehicles, and partly by merchants who buy marked poles standing, and do their own extraction and loading with labour recruited outside the district and transported daily.

Choice of Species

With the exception of some small groups and belts of beech (*Fagus sylvatica*), planting has been confined to coniferous species. The main species have been Sitka spruce, Norway spruce, Douglas fir and Japanese larch. In the early years, European larch, Scots pine, Corsican pine, Weymouth pine and Silver fir were also used.

Sitka spruce and Norway spruce have succeeded well, and some plantations of the former have produced 650 hoppus feet per acre in the first thinning.

Douglas fir has proved susceptible to windblow, particularly when grown on glacial clay in exposed positions. Serious wind-fall occurred in Douglas fir plantations in 1937 following a heavy fall of wet snow and strong north-east gales. Further severe damage, mostly breakage, was done to all species as a result of the phenomenal ice storm of 1940. Snow and gales also caused damage in 1947 and 1954. In every instance, Douglas fir suffered the most serious damage, indicating that special care is necessary in selection of sites for this species. Japanese larch has grown well, but it tends to become coarse and twisted on exposed slopes. Corsican pine, Weymouth pine (*Pinus strobus*) and European larch have proved failures and the 300 acres occupied by these species require drastic treatment either by thinning and under-planting, or complete clearance and replanting.

Roads

Many of the plantations are inaccessible and a plan for the construction of fifty miles of forest roads is at present in hand. Work has been proceeding

for the past four years and nine miles have been completed. Progress is slow (approximately two miles per year) due to difficult ground and labour shortage.

The Dam and Waterworks

The Vyrnwy Works were authorised by Parliament in 1880 and the construction of the dam and works and the pipe-line to Liverpool was commenced in 1881. The work was completed in 1890 and the discharge of water to Liverpool was commenced in 1891. The catchment area draining naturally into Lake Vyrnwy is about 18,000 acres, and this has been increased to 23,000 acres by construction of 7½ foot diameter tunnels which divert the waters of two tributary streams (Cownwy and Marchnant), which originally joined the river below the site of the Dam.

The Dam measures 1,170 feet in length and contains 260,000 cubic yards of masonry. It height from the lowest part of the foundations to overflow level is 144 feet and the maximum thickness at the base is 127 feet. The profile of the outer face of the Dam has been designed to form the overflow by means of which surplus water is passed into the old river course. The draw-off to Liverpool averages about forty-six million gallons per day and an average of thirteen-and-a-half million gallons per day is discharged into the old river course as statutory compensation water. This latter water is passed through a turbo-generator which supplies electricity for house lighting and other purposes. The normal draw-off of water is at the Straining Tower where the larger particles of suspended matter are removed.

The aqueduct to Liverpool is sixty-eight miles long, and consists of three 42 inch diameter pipes with a fourth pipe of similar size now under construction. The water is passed through low pressure sand filters at Oswestry twenty miles from the lake.

Housing Schemes and Welfare

During the construction of the head-works, a number of houses were built below the site of the Dam to accommodate the dispossessed residents of the old village now submerged under the Lake. A new church and vicarage, two new chapels and ministers' houses, school, shop and hotel were also built. Between 1925 and 1930 a further twenty-one houses were built and in 1950, sixteen houses for workers and six bungalows for retired employees were erected. At the same time, a new school and a well equipped Community Centre to cater for the recreational, social and cultural demands of a growing community, were added. This Centre has proved a great boon in such a remote area and it is well patronised by all sections of the community. At the present time, the Estate comprises eighty houses (including the hotel), nine farms and twenty-two small holdings let to tenants.

REAY FOREST, SUTHERLAND

By LANGSHAW ROWLAND
Director of Forestry to the Grosvenor Estates

The afforestation work on the Reay Estate, in the far north-west of Sutherland, has attracted much attention as a pioneer venture in a region that has for long been virtually treeless. On the 29th May, 1956, a party from the Royal Scottish Forestry Society visited these new plantations, and the following notes by Mr. Langshaw Rowland were prepared for that occasion. The visitors, who travelled nearly 100 miles by coach from Inverness, were favourably impressed with the progress of the trees so far, though the problems posed by infertile soils and severe exposure are admittedly great.

Introduction

This project was first mooted in the Autumn of 1949, when the attention of the late Duke of Westminster was drawn to the serious unemployment of crofters in the Kinlochbervie and Scourie coastal areas.

From suggestions which were considered whereby the late Duke might assist in providing all the year round work, it was decided that the manner in which he could be most helpful was in stimulating the sea fishing industry and in creating new employment in the field of forestry. Accordingly, a small fishing business at Kinlochbervie was purchased, ice-making plant put in, and a transport business with a fleet of lorries acquired to take the fish 250 miles south to the markets of Glasgow, etc.

At the same time draft plans were prepared whereby areas of the Reay Forest Estate might be planted, and the details of those draft plans as they were ultimately finalised are outlined below.

Intention of Scheme

The intention was to establish and maintain a forest of 3,000 acres, with the objects of bringing the hitherto barren land into a state of productivity and at the same time ease the lot of the men unemployed or under-employed in the area. Particular attention was paid to the needs of the crofting community by providing crofters with productive work of a permanent nature, from which they were at liberty to release themselves as and when the needs of their own crofts dictated.

It was the intention to make farming, sporting interests and forestry complementary to each other, and towards this end close liaison was observed between all concerned.

Preliminary Planning and Development

The question of differentiation of hill land for utilisation by agriculture or forestry is always beset with difficulties, as is only too well known to the Forestry Commission, and although all the property was in hand, we thought it wise at the outset to consult the Forestry Commission and the Scottish Department of Agriculture, at St. Andrew's House. As a result, one or two joint meetings were held at Reay Forest, when the proposed planting areas were inspected, and it was encouraging to have the opinion expressed by officials from St. Andrew's House that "by means of the shelter which would be provided by young woods, the holding capacity of the Estate for sheep would not be decreased—in fact it was felt that it might be improved". This

effect was obtained by careful siting of the proposed plantations, the avoidance of very big blocks, and a spirit of "give and take" between the farming and forestry departments, which resulted in some of the areas we would have liked for planting being retained for sheep and vice versa. It was also necessary to provide wide corridors between the plantations, to facilitate the collection of sheep from the higher ground, and to give a means of escape to deer from poachers, to whom they would be easy prey if trapped between the road and the plantation fences.

As the scheme developed experience gained led to requests from the estate farming interests for some revision of the areas. This was only to be expected, as it would indeed have been miraculous if we had been able to follow the pattern of the scheme as originally devised, and it was only in the light of experience as to how the newly planted areas affected the agricultural management of the estate that we were able to learn our mistakes. No doubt alterations to the proposals for dedication must have caused some headaches at the headquarters of the North Scotland Conservancy, but Mr. Fraser and his colleagues bore with us and were most co-operative.

We would like to stress the fact that from the outset we have been under no illusions as to the difficulty of afforesting some of the areas, and we do not expect them all to be successful as the result in some cases may be at best a pioneer crop. Nevertheless the late Duke was fully aware of this, but as in so many of his ventures he was prepared to take the risk in the light of all the circumstances.

At the first selection of sites we were fortunate in having a visit from Mr. J. A. B. Macdonald, at that time Research Officer for Scotland, who took a keen interest in the scheme, and was extremely encouraging. At his invitation we were able to visit the Forestry Commission's experimental areas at Fort Augustus, to see the work done there on difficult land. We told the Research Branch that if they wished we would set aside areas for their department, and plant them according to their prescription. Two such areas were established in 1950, and a further two have been planted since.

Having surmounted the hurdle of site selection, our next difficulty was that of housing our key workers, and although in the early years of this scheme there were many difficulties to be overcome eventually seventeen cottages were constructed to house estate and forestry workers.

Personnel

The planning and supervision of the scheme has been done from the headquarters of the late Duke's forestry department at Belgrave, near Chester, and we have had as our resident Forester on the Estate, Mr. John Murray, who had the advantage of being a Sutherland man and well conversant with the conditions applying on an estate such as Reay Forest.

Contractors

The whole of the work has been carried out by Pulford Estates Limited, Forestry and Timber Contractors, whose headquarters are also at Belgrave, near Chester, and the practical supervision on behalf of this firm has been conducted by their Head Forester, Mr. Peter S. Barnie. At the peak of the planting programme the Company employed as many as 113 men, but the scheme has been slowed down on the instructions of the Executors of the late Duke, in order to establish a permanent staff who following the completion of planting would continue in employment. This has resulted in an ultimate reduction to thirty-five men.

Drainage

The preparation of the ground prior to planting was a heavy item. The original density of the main and subsidiary drains averaged thirty-three chains to the acre—the minimum spacing on the worst areas being 13½ feet apart. For the first few weeks the work was done by hand, in order to get the men working, but subsequently a Cuthbertson plough has been used for all the main drains, while a Ransome Solo-trac plough drawn by a Weasel tractor was very satisfactory in dealing with the more shallow work. Nevertheless, experience has shown that the original drains were nothing like deep enough to cope with a rainfall of 91 inches per annum, and the whole of the winter of 1954-55 was spent in deepening them.

Fencing

As Reay Forest carries a very large head of red deer, 7 ft. 6 in. fencing was necessary on each site. Experience soon taught us that we could not rely upon boundary lochs, even where these were of considerable size, to keep out the deer, as even in summertime they would swim across.

Although there were no rabbits when the scheme commenced, they were reported at Merkland four years ago which led us to add netting throughout.

Except for some small areas at the commencement of the scheme, the work was all done by contract at an average cost, for erection only, of 2s. 3d. per yard. We think that when it is seen how very difficult was the line of some of these fences, it will be agreed that this price was most reasonable—including as it did the haulage of the posts up the hill, and frequent setting of them in rock outcrops.

Soil

Peat is present almost everywhere in varying quantities, while in the Altanrynie section, where mineral soil is practically on the surface, there is a pan some 3 inches thick at a depth of 12 to 15 inches. The main constituents of the plant communities are: Common and bell heathers, wild bog myrtle, common cotton-grass, bog asphodel, *Scirpus* and *Molinia*. Only on the better sections do we find *Calluna* interspersed with some of the finer grasses, and unfortunately these areas form a very small percentage of the total.

Exposure

With the exception of the hill at Achfarry which faces east, the whole area is exposed to the strong westerly winds which sweep up from the coast. Frosts are not severe, but there is a tendency for two or three degrees to be experienced at any time up to early June. At no time, however, has the extent of frost damage been anything like as severe as that suffered on our Norfolk Estate on the night of June 30th, 1954. Experience has shown that constant exposure to wind more than counterbalances the effect of reasonable soil conditions, and it is useless to plant areas so exposed.

Species and Planting

In the selection of species to plant, we were largely guided by the Forestry Commission Officers, who readily gave us the benefit of their experience. The tree most generally used was lodgepole pine, followed in numbers by Hybrid larch and Scots pine. Both Norway and Sitka spruce have been included in the "flushes"; in such positions the latter is doing remarkably well throughout the forest.

Most areas show such a variety of soil condition that hardly any have been planted pure. Probably the best plot is the P.54 area on the north side of

Lochmore, where there is a good depth of mineral soil, and here mainly for amenity purposes an irregular margin has been planted which includes hardwoods such as beech, sycamore, red oak and English oak, with groups of wild cherry.

On the Duartmore Research Area an interesting mixture of conifers has been tried, outstanding amongst which is *Picea omorika*. We would have planted more of this species had we been able to obtain seed or plants, but unfortunately we were unsuccessful. Progress to date has been as follows:

F.Y. P.50. Devoted entirely to preparatory work, draining and fencing.

F.Y. P.51. 237.5 acres planted.

F.Y. P.52. 426.5 „ „

F.Y. P.53. 574.8 „ „

F.Y. P.54. 630.0 „ „

F.Y. P.55. Due to competition from Building Contractors, the labour force was sufficient only to deal with the deepening of drains, and beating-up.

F.Y. P.56. 80.0 acres planted.
It is hoped to plant 150 acres next season and thereafter 100 acres per annum to a total of 2,500.

Ground mineral phosphate at the rate of 2 oz. per tree has been used everywhere except on the very best land—the tree roots being dusted in it at the time of planting, and the balance given on the surface. It is intended to give further applications from time to time, as the need becomes apparent.

Planting Costs

These as expected have been very high, due amongst other things to the following factors:

(*a*) Completely untrained labour.

(*b*) High cost of hiring four buses to transport men to and from work (approximately sixty miles each per day).

(*c*) High proportion of time lost due to wet weather.

(*d*) Very extensive drainage necessary.

(*e*) Deer fencing throughout.

(*f*) Inaccessibility of some sites to road transport, e.g., when planting the Shark Bay area of over 100 acres at Duartmore, all the men, plants and materials had to be taken by sea from Badcall Bay, where we utilised an old pier. Lochmore North was done only by the use of boats to ferry everything across.

The foregoing items have contributed to an overall cost of approximately £100 per acre.

Dedication

The Westminster group of estates in England and Wales was among the first to enter the Dedication Scheme, and as soon as it was decided to plant in Scotland similar action was taken there.

Our original proposal for dedication was 3,048 acres. Of this area, the Commission Officers felt that they could accept approximately 1,400 acres; the opinion being that the balance of the land could not be classed as plantable, and was therefore unsuited to dedication. While we readily admitted that

some sites could not be classed as other than experimental, and that 450 acres represented rock outcrop and other unplantable land, we could not agree that all of the balance was such. We therefore made the suggestion that as in any case all areas were inspected five years after planting, to ascertain that a crop had been established, it was only fair that a similar inspection should be made of those rejected originally, and where our efforts had succeeded such areas should then be accepted and Planting and Maintenance Grants paid in retrospect.

This somewhat novel suggestion was passed on to the Commission's headquarters, who agreed to a third category, to be known as "doubtfully plantable"; such areas to be inspected ten years after planting, and if successful both Grants would then be paid in retrospect, and that they should carry simple interest at the rate of 4 per cent. This was a very fair offer, and it will be intriguing to see what will be the outcome.

General Observations

This afforestation scheme, being the first in north-west Sutherland, has drawn considerable publicity, and we must confess that we have been embarrassed by remarks published by well-meaning friends who have drawn very premature conclusions as to the success of the operations.

There is no doubt, however, that so far it has succeeded as a demonstration that forestry provides the best solution to the difficulties caused by lack of employment in the Highlands. We were invited to give evidence before the Commission of Enquiry into Crofting Conditions, and their subsequent Report laid great stress upon the contribution which forestry can make towards the solution of this problem, and we feel that their comments must help generally in the future acquisition of land by the Forestry Commission.

Not only were the contractors able to employ every man in the district who wanted work, but there were seventeen instances where young men who had left for the towns returned when they found that there was a prospect of regular employment at home.

Local conditions have altered considerably since we started our scheme, and to-day the contractors are suffering severe competition for labour from the Hydro-Electric Board and other big works in progress in the district. In 1949 no such opportunities existed, and no doubt the time will soon return when forestry will regain its position in the neighbourhood, as the greatest source of employment.

In concluding we wish to acknowledge the co-operation and help which we have received throughout the scheme from The Scottish Office, Edinburgh; The Dept. of Agriculture for Scotland; The Sutherland County Council, and last but not least, The Forestry Commission.

NOTES ON THE BRITISH ASSOCIATION MEETING AT SHEFFIELD, SEPTEMBER, 1956

By I. J. W. SALTER
District Officer, South Scotland

In his inaugural address the President of the British Association, Sir Raymond Priestly, discussed "Twentieth Century Man against Antarctica". He divided the century into the heroic age of pre-1914 in which Britain had a major part; the inter-war years when the Cambridge Group was active; and the post-war period when co-operation became imperative and interest intensified leading to greater achievements.

General Lectures

Dr. H. Godwin, as president of the Botany Section, lectured on "Quaternary History and the British Flora". In this he referred to radio-carbon dating which depends on nitrogen being transformed into heavy carbon and which is present in the form of carbon di-oxide. This gives very accurate dating up to the "decay half-life period of 5,575 years". Extensive references to pollen analysis were used to demonstrate the development of the British forests through birch, *Betula* sp., pine, *Pinus sylvestris*, and, finally, the mixed oak forest with *Quercus petraea* dominant to beech dominance, *Fagus sylvatica*.

Dr. Godwin was followed by Mr. M. V. Laurie, Chairman of the Forestry Section, who lectured on "Current trends in forest research in Britain". Mr. Laurie, O.B.E., used the same periods as Sir Raymond Priestly. Prior to the First World War the larger land owners found out how best to use their land to grow trees. The research branch of the Forestry Commission was developed in the inter-war years and dealt mainly with the immediate practical problems such as how to afforest the new types of land then being considered for forestry. Whilst the importance of the provenance of species was recognised by the Forestry Commission, but relatively little research was done on pests.

After the Second World War there was a large expansion in the research branch and a station was opened at Alice Holt. The emphasis changed from the immediate to the more basic problems and the expansion in entomology revealed the presence of many unsuspected pests. A start was made with the investigation of long-term problems, and business aspects became more prominent.

Dr. J. G. Boswell, lecturing on "Observations on some natural soils", discussed the rise in pH and reduction in titratable acidity when passing from an *Eriophorum vaginatum* community through a mixed wood of pine and rowan, *Sorbus aucuparia*, to an oak wood where *Quercus petraea* is dominant. He also referred to the absence of nitrogen in the first case; its presence as ammonia under *Deschampsia flexuosa*; and its presence as ammonia and nitrate under *Holcus mollus* in the last case. This he associated with increasing soil fauna and flora and changes particularly in the fungi in the soil. In the last two cases he discussed how the nitrogen and oxygen contents are more constant at all levels under the oak and how the nitrogen content decreases with depth under the pine.

Dr. J. Webster in "The Grass Withereth" discussed five fungal groups and their distributions, which are active in decomposing grass. Dr. P. W. Murphy in "The role of Soil Acarina in the Decomposition of Leaf Litter" presented some original results of research into the Orobatid mites. Finally in this group Dr. J. D. Ovington lectured on "The importance of litter break-

down in the woodland ecosystem". Using Scots pine at Thetford he showed how the leaf fall rises sharply during the establishment period and then levels out, and then to what extent branches and cones are added. The important point here is how much the ground flora can add to the litter. In conifer areas there are more nutrients in the ground flora, and more potassium circulates in the flora than in the trees, but the nitrogen cycles are balanced. In oak woods, however, there is a greater circulation of all nutrients in the trees.

Water Catchment Areas

Under the general heading of "Afforestation of Water Catchment Areas" Mr. R. W. S. Thompson presented a paper on "A Waterworks Forestry Scheme". In this he stated that the main reason for afforestation was to reduce bacterial pollution which occurs when the land is entirely grazed by sheep. In addition, erosion is reduced whilst there is no apparent increase or decrease in the rainfall or run-off. Both conifers and hardwoods have been used successfully in the Derwent Valley Afforestation Scheme which was visited by the section. The species now favoured for planting on these exposed and steeply sloping sites are Sitka spruce, Japanese larch, Scots pine, sycamore, oak, and ash.

On these steep slopes planting is done by turning over hinged turfs with a mattock and then pit-planting the tree at the hinge to leave a small hollow to collect water. The cost is high, at 9s. 9d. per 100 for preparation plus 6s. 3d. for planting. Some good quality Scots pine were seen but Corsican pine were growing only at the same rate as the Scots. Thinnings were being carried out using a Fordson Major tractor and an air compressor to drive two small pneumatic chain saws. This proved very efficient in the first thinnings.

The next paper under this heading was "Effect of Afforestation upon the Yield of Water Catchment Areas" by Mr. Frank Law. In this he quoted Dr. Ovington (1954) as saying that from 6 per cent to 93 per cent of the total rainfall may be retained in the canopy of the trees depending on the species and the rainfall. Also Deij in Holland has confirmed that conifers are worse than hardwoods, because of the canopy retention factor, for water catchment areas.

Mr. Law described a lysimeter experiment of one-ninth of an acre in a Sitka spruce plantation with a mean B.H.Q.G. of 6½ in. and a height range of 26 to 33 feet. Using ten rain gauges randomly positioned in the stand, plus three cups round three tree boles, and using three rain gauges outside the stand and three on poles at the top of the stand, Mr. Law reported a loss of 33 per cent of the total rainfall due to interception by the trees. However, these results from one-ninth of an acre were applied to the whole catchment area to give some staggering results. It was generally agreed that replications of the experiments were required on different types of soil, on different exposures and under different species before such sweeping conclusions could be drawn as had been presented.

The final paper in this series was by Mr. Bleasdale on "The Physicist's Approach to Water loss from Vegetation". First Mr. Bleasdale quoted the favourable and unfavourable physical factors which are (*a*) fog drip, reduced evaporation, reduced run off and increased storage in the soil and (*b*) canopy interception, evaporation from the trees and absorption by plants. These all have to be considered.

Because of these factors the siting of small-scale experiments is very important. Also afforestation to control run-off and filtration will be more

important on heavy soils where it will assist percolation through aeration.

Bernard has stated that transpiration plus evaporation from a given species are at all times constant whatever its stage of growth. From this basis Penman has derived aero-dynamic and heat balance formulae for measuring these water losses. These are useful in certain conditions, but the colour of the foliage of the trees and the increased surface exposure make the formulae break down. However, a balance is reached when an air stream passes through an extensive forest but further investigations are needed here.

In the discussion which followed Mr. J. Noel Wood said the main object in afforesting water catchment areas was to prevent pollution due to farming and public trespass. The other effects due to afforestation are small in comparison. Professor Mobbs concluded the discussion by saying that an integration of forestry and farming is what is required.

Forestry in Industrial Areas

The final subject was "Forestry in Industrial Areas". The first paper was read by Mr. E. M. Conder on "Some Problems of Private Forestry in the Industrial Areas". The chief factors contributing to these problems are the keen demand for land and the inability of trees to thrive in the area. This has led to small isolated woods which are sterilised as far as expansion is concerned, and a restricted range of species, but ease of marketing for all types of produce. There are also big labour problems because villages are combed for men for the industrial towns. Following birch and alder as pioneers, beech, sycamore and elm are the chief species. Horse chestnut, holly, plane, rowan and whitebeam are present as soil improving species. Japanese larch is the only conifer.

On coal tips and in quarry sites the results have been varied, but obvious supervision reduces considerably the public trespass and resultant damage. The high density of population otherwise leads to a high incidence of trespass and damage. It is better to leave coal tips, etc., thirty years to weather, cool and settle. Then the acid nature of them is lessened and pioneers can be more easily established.

On restored open cast sites run-off and erosion are serious and it is as well to sow grass seed and fertilise these areas from the beginning at a cost of from £25 to £30 per acre.

The amenity of these woods is important but their survival depends on the enthusiasm and knowledge of the owner in an area where exposure, soil and pollution are all adverse factors.

Mr. A. J. Grayson dealt with state forests when he lectured on "Air Pollution as it Affects Forestry". He said the establishment of an industrial zone has changed the woodland scene so that sycamore and beech are dominant followed by ash and elm, whilst the principal conifers are lacking or sub-normal. The effects of pollution were noted in 1890 and in 1910 Dallimore said they were having a severe effect.

Mr. Grayson quoted the smoke polluted industrial zone as an area of twenty-five miles radius centred on Holmfirth. This area contains three million people. The penumbra of this area shows more damage to trees than the umbra because the latter has fewer woods. The damage is caused by sulphur, oil fumes and fluorine. However, there are so many adverse factors in the area that other biological factors are needed to gauge the effects of the polluted air. The worst effect occurs after the period of main height growth.

Lead gauze has been used to measure the rate of formation of lead di-oxide due to the sulphur di-oxide in the air. These results can be linearly co-related with concentrations of sulphur di-oxide up to the limit of the concentrations found, i.e., up to twenty parts per million.

Dr. Scurfield's paper on "Atmospheric Pollution in Relation to Forestry" was read for him in his absence. In this he defined pollutants as contaminants which reduce the timber yield where the other factors are favourable for it. Generally conifers cannot survive since effects are cumulative, whilst evergreen trees such as yew and holly adopt a deciduous habit. Fruiting is also reduced. In addition transplanted conifers are more susceptible than natural seedlings, up to ten years of age, to pollution damage.

Concentrations of sulphur di-oxide have been shown to decrease with distance on the west side of Manchester and also to decrease in the summer-time. Smoke curves show the same trends. Thus leaf trees miss the highest concentrations and this explains their better survival. If 1.5 mg. of sulphur di-oxide deposited on 100 sq. cms. per month is the tolerance level, experiments suggest that all species can survive ten miles south-west of Manchester, only leaf-trees at six miles and no trees at all four miles south-west of Manchester. [Nevertheless, trees *do* grow in Manchester!—Ed.]

However, sulphur di-oxide is not the only pollutant. Thirty gases are listed in the Works Gases Act of 1950 and therefore it is difficult to trace a damaging source. When allowable concentrations are being assessed changes in topography must be noted since these changes may lead to temperature inversions with the building up of concentrations lethal even to human beings.

In summing up on the subject Dr. Wareing said sulphur di-oxide had been assumed to be important because its damage had been proved. However, it is not the high concentrations but the continuous subjection to pollution that causes the damage. Whilst visible damage to leaves is not present the continuous subjection to pollution causes increased leaf senescence or ageing.

In Los Angeles it has been found that the most damaging agents are the organic oxides of straight-chain hydro-carbons following their reaction with ozone in the upper atmosphere. These pollutants come from car fumes and oil refining. Such carcinogens are present in this country and need further investigation.

It is not known yet how far toxic gases spread in damaging concentrations, but the lower summer concentrations are due to increased diffusion as well as less domestic combustion. A complicating factor is that the effects of pollution and exposure are similar and it is therefore difficult to distinguish them.

Excursions

An excursion to Whitwell Wood, near Worksop, was led by the District Officer, Mr. W. V. Jackson, and demonstrated the effects of pollution correlated with other adverse factors. Besides smoke pollution drought is a critical factor since there is only a thin soil over magnesian limestone. Various methods of restocking with hardwoods have been developed over the past twenty-five years. Clear felling and the use of conifer nurses was replaced by strip and group systems and the latter have yielded to thinning and underplanting. Sycamore as the dominant species has given way to beech, and ash is very little used although probably the dominant species before the industrial revolution.

Sycamore are growing well except on the thinner soils where beech do better and some of the beech are very good. A lot of the beech, however, are

attacked by the felted beech coccus. Scots pine is the only conifer which succeeds here but its growth is very coarse on such a rich site.

A visit to Sheffield Corporation Waterworks nursery showed only Scots pine and copper beech looking really healthy. Sitka spruce and Douglas fir were moderate whilst Japanese larch, Norway spruce, beech and ash were very poor in the strongly polluted atmosphere.

The visit to Laughton forest as a sand oasis in the heart of agricultural Lincolnshire was extremely interesting. It has some very fine young Scots pine stands and both Scots pine and Corsican pine regenerate freely when protected. The sand is windblown and of great depth over Lias clay. The latter has led to waterlogging in parts of the forest and the formation of *Molinia* bogs. Sitka spruce was planted in these at first but this was a big mistake on account of both low fertility and low rainfall; so the spruce is now being replaced by pines.

A small stand of *Pinus ponderosa* is growing quite well but *Pinus contorta* has been used only for beating-up.

The visit to Chatsworth Estate demonstrated the results of past neglect of management. Stands planted at the beginning of the century had been left untouched until 1946. Since then under Mr. Trevor Edmondson many stands have had three light thinnings and are now looking healthy and vigorous. A good stand of sycamore was seen on an infertile soil with a rainfall of thirty-two inches.

Two factories were visited. Messrs. Oates Ltd. of Worksop kindly opened their factory on the Saturday morning and demonstrated their numerous machines for making all kinds of handles. Mainly English ash is used but some Belgian and French is imported and the rest is American imported. They said they preferred ash grown on two rotations of sixty years each, rather than one rotation of 120 years.

Messrs. Drabble and Sanderson demonstrated the manufacture of bow and hand cross-cut saws. From a tour of the factory it was evident that saw manufacturing is still very much an individual craft.

Thus the week's meeting proved very interesting and instructive in many fields.

THREE NEW NATURE RESERVES

Contributed by the Nature Conservancy

Fyfield Down Nature Reserve

Fyfield Down in Wiltshire is one of the finest remaining tracts of unreclaimed high chalk downland in England and is probably the richest in sarsen stones (see the following extract from the Geological Survey Memoir on the district by H. J. Osborn White, published in 1925), locally known as Grey Wethers, from their resemblance when seen in the distance to a flock of sheep. It is considered probable by geologists that the great twenty-foot sarsen stones in the circle at Avebury (weighing from sixty to seventy tons) were brought there from Fyfield Down nearly 4,000 years ago to form the oldest important structure in Britain and one unique in Europe. Fyfield Down has therefore the strongest claims to preservation as both an ancestral and a scientific monument of national importance.

The present Declaration covers an area of about 610 acres, about three miles west of Marlborough, which has been leased to the Nature Conservancy by Mr. G. E. Todd of Manton House.

The sarsens are large blocks of sandstone apparently derived from a bed of sand which covered the site in Eocene times. Their distribution is apparently natural, none having been erected as standing stones. They produce an effect of great botanical interest being accompanied by pockets of acid soils, on which grow acid-loving plants such as sheep's sorrel. This is in contrast to the ordinary lime-loving plants of downland. Meadow saxifrage (*Saxifraga granulata*) is abundant in the Reserve. The vegetation indicates an exceptionally high humidity, and bluebells grow in the open. A varied moss flora grows on the stones.

More than sixty breeding species of birds have recently been listed at Fyfield Down, including the wheatear, grasshopper warbler and six species of tits. The hen harrier, buzzard, peregrine, quail, hoopoe, and short-eared and long-eared owls have also been observed.

Being close to Avebury, Fyfield Down is within one of the principal areas inhabited by prehistoric man and the Celtic field system is one of the largest in England. There is a tumulus to the south of the fields and two others along the western boundary formed by the Ridge Way, which at this point crosses another ancient track known as the Herepath. There are also remains of an ancient village along the 700 foot contour, the highest point on the Reserve being about 830 feet. The grassland of the Reserve will continue to be grazed by sheep (rabbits having been virtually eliminated), and the gallops will continue to be used for training racehorses.

Permits will be necessary for those who wish to collect specimens of animals or plants, or to visit parts of the Reserve away from the footpaths. Applications for such purposes should be addressed to the Regional Officer for the South, The Nature Conservancy, Furzebrook Research Station, Wareham, Dorset.

[This new Reserve lies close to our West Woods and Savernake Forests in Wiltshire.—Ed.]

Extract from "Geology of Marlborough" by H. J. O. White

Sarsens

In the South of England the sandstone boulders known as Sarsens, Grey Wethers, Druid Stones, and Bridestones, are familiar objects of the countryside. Solitary for the most part, they not infrequently occur in small groups of natural or artificial origin, and in a few restricted areas they are congregated in greater numbers: nowhere, however, are they so plentiful as in the Chalk country near Marlborough. Here, after centuries of exploitation, these stones yet lie thick on some of the downland ridges, and thicker still in the adjacent winding bottoms, where their disposition suggests the idea of rivers of stones. There is something in their grey recumbent forms, half hidden in long grass and scrub, that awakens a lively interest in the beholder, and even when their nature is known they continue to stir the imagination, their bulk, their legendary associations, and a touch of melancholy in their wild surroundings investing them with a kind of glamour.

The principal sarsen area lies between the Kennet near Fyfield and Hackpen Hill, and includes Old Totterdown and Fyfield Down, with parts of Overton

and Clatford Downs. From it extend divergent trains of sarsens, the more important of which follow Temple Bottom, Clatford Bottom, Pickle Dean and the combe running south-westward from Monkton Down. Small groups and single stones, too numerous to specify, are distributed irregularly over other parts of the Chalk country north of the Kennet, and are met with far out on the Jurassic strata, notably in the neighbourhood of Swindon. South of the Kennet, sarsens are less abundant, but there are well-marked trains in the combes south of West and East Kennett, and in Lockeridge Dean; also smaller trains in the West Wood combes and in the northern branch of Great Lodge Bottom near Cadley. As in the country north of the Kennet, there are many sporadic occurrences on the Chalk and on older formations: sarsens are common in the northern part of the Vale of Pewsey between Wootton Rivers and Allington.

Some of the largest of the undisturbed sarsens, twelve feet or more in maximum dimension, are in Lockeridge Dean, but bigger stones, over twenty feet in length and estimated to weigh about sixty to seventy tons, are to be seen in the Circles at Avebury. The latter probably were brought from the Totterdown-Fyfield Down area.

Beneath the growth of greyish lichen, the weathered surfaces of the sarsens usually exhibit a grey-brown to red-brown, slightly ferruginous staining, and are often diversified by knobs, furrows, and basins, in some cases indicative or suggestive of irregular concretionary action, in others, of solution. Cavernous hollows and rifts, probably due to the mechanical abstraction of bodies of sand that had escaped induration, are of frequent occurrence.

As a rule, the constituents of the stone show little or no sign of arrangement: bedding, where apparent, is nearly always uneven and impersistent. Many of the rudely prismatic and tabular sarsens seem to owe their shape to jointing alone, and a large proportion of the thick slabs most favoured by the Megalithic architects are portions of bi-convex or plano-convex lenses, attributable to irregular induration rather than to unequal disposition.

As far as the writer is aware, the only fossils observed in the local sarsens are remains of plants, which are abundantly represented by tapering and branching rust-stained tubes, occasionally occupied for part of their length by silicified roots and rootlets. Starting from weathered surfaces in circular apertures of a quarter of an inch to one inch or more in diameter, the root-tubes taper inwards, the branch-tubules usually diverging at acute angles, but in some cases at right angles, to the main tube. It has been suggested that some of these roots may have belonged to Palms which occurred in England in the Eocene period.

Sections of roots or their casts are to be seen in sarsen masonry all over the Chalk country around Marlborough. Visitors to Avebury will find good examples in the standing stones nearest the eastern side of the high road from West Kennett just within the south-eastern entrance to the Temple enclosure.

Westleton Heath

Westleton Heath in Suffolk straddles the road between Westleton and Dunwich. Part of this heath is already included in the Minsmere bird Reserve managed by the Royal Society for the Protection of Birds and the Conservancy's acquisition of 117 acres on the eastern side safeguards the remainder up to the boundary of the Forestry Commission's Dunwich Forest, which lies between it and the sea.

The heath is well-known for its birds, including the stonechat, woodlark, red-backed shrike, stone-curlew, lesser redpoll and nightjar. It also has great importance as one of the few good surviving examples of the characteristic and formerly extensive East Suffolk heathlands, most of which have recently been reclaimed for agriculture or afforestation, or have been absorbed by the needs of defence.

The dry sandy and shingly soil is of low fertility and is underlaid by the Westleton Beds, sands and gravel of mid-Glacial (Pleistocene age) laid down under marine conditions. It is clothed largely in heather and is crossed or bounded by roads and footpaths to which the public are asked to keep, in order to reduce the fire risk and to avoid disturbing the wild life.

Enquiries and application for permits should be addressed to the Regional Officer for East Anglia, The Nature Conservancy, 6 Upper King Street, Norwich, Norfolk.

Yarner Wood

Yarner Wood near Bovey Tracey, Devon, was bought by the Nature Conservancy and declared a Nature Reserve in May, 1952. A part of the Wood was burnt by incendiary bombs during the "Baedeker" raid on Exeter in 1942. In this section the fire killed about two-thirds of the standing trees and left others badly damaged. It was followed by a dense growth of heather, bilberry and bracken which added to the difficulty of making a detailed survey of the woodland and its fauna and flora in order to prepare a management plan. A plan was, however, completed and adopted early in 1955, part of the Wood being set aside for scientific investigations into different methods of regenerating woodland; encouraging colonisation by insectivorous birds; and population studies of small mammals by Exeter University.

Otherwise the Reserve is being managed to re-establish woodland of the type which is believed originally to have been there. The threat of fires spreading in from Dartmoor has been countered by ploughing wide fire breaks and a good start has been made towards the long-term task of restoring the woodland.

In order to protect and diversify the Reserve, an additional twenty-eight acres have been bought by the Conservancy, adjoining the Reserve and the B.3344 road from Bovey Tracey to Manaton. Included in this addition to the Reserve are an interesting small alder wood and bog containing such plants as the royal fern (*Osmunda regalis*).

The acquisition includes Yarrow Lodge which is being converted to accommodate members of the Conservancy's staff working in the Reserve, access to which is by permit only and must be strictly limited in order to avoid interference with the programme of scientific research.

All enquiries should be addressed to the Regional Officer for the South-West, The Nature Conservancy, Furzebrook Research Station, Wareham, Dorset.

[This new Reserve lies near our Haldon Forest.—Ed.]

SUNBIGGIN TARN AND MOOR

By D. F. FOURT
Forester, Research Branch

Roughly in the centre of the triangle Penrith-Tebay-Kirkby Stephen lies Sunbiggin Tarn, just east of the village of Orton, in Westmorland. The undulating, almost treeless moorland lies at around 750 feet above sea level with ridges north and south rising to 900 feet.

Carboniferous limestone, with subordinate bands of sandstone, underlies the somewhat eroded cover of drift left by the Quaternary glaciation. The rainfall averages about fifty-five inches and there are about 225 wet days in the year, one of which was chosen for our visit. The climate, besides, is cool with high relative humidity, and the growing season (in terms of mean temperatures over 42°F.) lasts from April to October inclusive. Sheep are grazed on the large blocks of common land separated by dry stone walls. Grouse are also present and "preserved". As regards the past, it is fairly certain that dense oak-hazel woodland grew on the soils developed on the drift material. The woods should be well-drained by comparison with many others in this part of England. As was the case further south, such areas were preferred to wet moors for occupation by the Neolithic inhabitants. The valleys are usually assumed to have been left until last, so remaining undrained until the end of the first millenium A.D. There is a presumed neolithic stone circle on the moor nearby.

These uplands may have become degraded from forest to pasture under a grazing and felling regime, but whatever the causes it seems likely that a more vigorous erosion cycle was initiated by the change. This may have coincided with a wetter climatic phase. Research in the lacustrine muds of the Lake District has shown this phase to coincide with a decline in total tree pollen and an increase in grass and sedge.

The vegetation and topographical types seen were:

1. Limestone pavement.
2. Limestone grassland.
3. Heather moorlands.
4. The Tarn and surrounds.

A section of the notes deals with each. No attempt is made at taxonomic virtuosity, emphasis being on the site, its origin and development.

The Limestone Pavement

Where erosion of the drift has exposed the underlying rock, as along the top of Great Asby Scar, there is an area of well-developed limestone pavement. Weathering by solution has proceeded selectively along joints, the lines of weakness. The massive limestone is now divided into blocks, or "pavement", by deep and wide cracks, or "grikes". These may be 3 to 12 inches wide, usually about 8 inches, and from 6 inches to 6 feet deep. Both blocks and cracks are somewhat irregular, usually near rectangular or trapezoidal, due to a dominant set of parallel joints. There is also much weathering in the horizontal plane along lines of bedding. At the bottom of the grike there is usually some soil, where the micro-site is moist, basic, sheltered, shady and safe from grazing animals. These include the chief factors of ecological importance in woodlands. The question is controversial whether the plants present in the grikes are relics and descendants of the stage when woodland grew on the drift overlying the limestone before its erosion following deforestation, or whether they have come

in afresh on the appearance of a suitable habitat. The occurrence of many small and a few large glacial erratics on the pavement—often wedged in the grikes—suggest that the drift, from which they were weathered out, once covered this part completely. Also all around the pavement is a gradation from rock through limestone grassland to *Calluna* heath as the thickness of the remaining drift increases.

It seems likely that the grike type of weathering by solution along joints in hard limestone would occur long before the rock appeared at the surface. In a high rainfall area, under forest, the trees—especially oak—would root the joints early on, and the powerful leaching effect of winter rains, when the leaves are off the trees, would also help. Thus, rock fissures with tree roots in them would constitute embryo grikes before deforestation and erosion had laid them bare. The numerous woodland species present are also circumstantial evidence in favour of relict or descendant origin. It is unlikely that so many species would have immigrated from neighbouring woodlands. On this site were seen many ferns, as well as *Allium ursinum*, *Convallaria majalis*, *Geranium robertianum*, *Brachypodium sylvaticum*, *Mercurialis perennis*, *Circaea lutetiana* and other herbs. A few shrubs were seen, much gnawed and blasted, on the low cliff. They included *Fraxinus excelsior*, *Pyrus aucuparia* and *Crataegus monogyna*. There were also numerous Bryophytes.

[Afforestation work on similar limestone pavement is discussed in Mr. Crosland's article on Dalton Forest.—Ed.]

The Limestone Grassland

Where the limestone is thinly drift covered, or where the drift is basic near the surface, the formation known as limestone grassland is developed. In contrast to sites further south on calcareous rocks, the dominant—one might say super-dominant—species is *Sesleria coerulea* or Blue Sesleria. It has a somewhat low palatability and the associated species have a minor place. These include *Festuca ovina*, *Briza media* and *Carex flacca*. As soon as leaching has reduced the pH, *Calluna* comes in, rooting in the acid surface, while *Sesleria* still roots in the deeper calcareous material. The drift is quite sandy in texture, at least near the surface, and the grassland grades into heathland at its margins, except, of course, where the pavement occurs. This formation, dominated by *Sesleria coerulea* is, like the pavement, best known from the Malham Tarn area in North Yorkshire.

The Moor or Heathland

Calluna heath covers by far the largest part of this area. Here the glacial drift, fairly sandy in texture above, has been leached of its free lime, and under a burning and grazing regime, heather has become established and eventually dominant. Only where rodent disturbance or quarrying has brought about soil rejuvenation is there any break in the sward. It is still burnt over occasionally. Apart from being fairly well drained, it is now typical *Callunetum*. Very locally, where the drift is sufficiently thick, acid and compact, is the flora reduced to the "end of the line" species such as *Nardus stricta* (over-grazing), *Trichophorum caespitosum* (*Scirpus*—burning and compact acid conditions) and *Molinia coerulea* (wet but still moderately basic) with patches of *Polytrichum* species.

In spite of the current condition of "the moor", its good deep soil and drainage are adequate for oak forest, probably of a good type. It also suggests what were the probable former soil conditions on the present area of pavement. Pollen analysis and Carbon 14 scale would be most useful in further evidence on this change.

The Tarn and Surrounds

The chief feature of the visit as advertised is the tarn, with the surrounding calcareous flushes, mires and fen. The junction between the *Callunetum* and the muddy flush is fairly distinct, often abrupt and step-like. There is apparently a layer of very hard stony calcareous till below the surface, probably indurated by the permafrost effects discussed in *Soil Science* by Fitzpatrick of the Macaulay Institute (*Soil Sci.*, 1955).

There has developed an erosion platform on this layer and on its edge, and in places up through it, come the springs and flushes. The springs, with the aid of *Chara* and *Philonotis*, accumulate mounds of tufa, which themselves become invaded by an interesting flora including *Primula farinosa*. On this platform there are occasional "islands" of drift and on these a mixed flora occurs—*Calluna* or *Junci*, with *Carices*, and some calcicoles.

This erosion platform is always wet, highly basic, unstable, grazed, stony, compact, and probably frozen hard in winter. It has a patchy cover of plants, chiefly *Carex* species.

It is believed that these unstable calcareous mires are related to sites in the periglacial regions of Greenland and Iceland. Base-rich materials, always wet, and low in organic matter, provide a rigorous habitat with a specialised flora. In Britain the best known area is the Great Close Mire near Malham Tarn. The conditions simulate in many ways the usually temporary state of glacial debris, before leaching, water sorting, etc., have proceeded far. In a recent article in the *Journal of Ecology* (No. 43, 2, p. 427) describing areas at the receding foot of a glacier in Alaska, Crocker and Major have shown that pH decreases with age and increase of vegetative cover, from pH. ca. 8 down to pH. 5, by the time willows, alder and Sitka spruce have become established.

The fen, and its association of zones and species, is chiefly remarkable for its isolation, altitude and latitude. The tarn is quite shallow, and is believed to rest on an erosion platform of drift. It is fed by numerous base-rich springs rather than a stream, but a brooklet drains the area eventually, as a much silted and vegetated ditch. There are many trout in the tarn, and the lessor fished all day during our visit in the mist and rain, with remarkable success. A large and exceedingly vocal breeding colony of gulls lives here, and deposits of bird guano on parts of the grassy fen must have an effect on the vegetation.

Finally, it can be seen that this area was well suited to the diverse interests of ecologists. Due to being stationed on Windermere, many freshwater biologists were present, and they found the base-rich waters rich in life. The botanical side also is of interest and in my own case the degradation of such good soils to *Calluna* moor, the evidence of erosion and the reasons for the present soil conditions provided the main interest.

As regards the present land use of this area, it is sad that its "common" status has prevented ploughing and reseeding. If Stapledon's fields above Aberystwyth could be turned into rye-grass/clover pasture, the change ought to be easy here as a deep plough would probably bring up base-rich soil and obviate the need for liming. The *Calluna* flora is a sort of fire-induced climax, holding the area in a low state of nutrient turnover somewhat depressing to observe.

A VISIT TO CONISTON OLD MAN

By D. F. FOURT
Forester, Research Branch

Introduction

The moors, fells and mountains of the English Lake District are renowned for scenic beauty but less so for their richness in plant species. However, the vegetational history has been studied by many workers, the best known being Prof. W. H. Pearsall, who has known the area since boyhood, and who led the party on this visit by the British Ecological Society. Pollen analysis of lake muds, archaeology, and short-term studies such as that of Esthwaite North Fen, have provided an interesting background to to-day's study of vegetational patterns.

Geologically the Coniston area lies partly on Silurian shales, and partly on the Borrowdale Volcanic Series, here of andesitic lavas and tuffs. The division is marked by the Ordovician Coniston Limestone, which crosses the area from S.W. to N.E. along the foot of the more rocky portion. The physical features of the Lake District were developed by dissection of a dome during the sub-aerial erosion cycle of the Tertiary era, as discussed by Eastwood in the Regional Geology of Northern England.

Radiating broad shallow valleys conducted the drainage much as at present, modification by the Quaternary Glaciation being relatively superficial. The features peculiar to this phase are the corries or cwms on the flanks of the mountains, the U-shaped valleys, sometimes carved in the broader former landscape, and sometimes cleaning out, straightening and deepening a former valley, and the thick mantle of debris plastered over the whole area. Since the retreat of the glaciers, lakes have filled the over-deepened valleys, and much of the drift has been eroded from the steeper slopes. Several of the lakes have started to silt up, and have aged in a characteristic way as regards their flora and fauna.

The Tour

Coniston station lies near the foot of the steep-sided secondary valley carved by the glacier. The metalled road serving the slate quarries on the north flank of the mountain leads straight up this slope, which is wooded in places. Oak, ash and wych elm, with sometimes a hazel shrub layer, give an idea of the composition of the old forests. From the top of this short, but steep hill, the country slopes gently, but with many hummocks and undulations, to the foot of the rocky section, about two miles away. Several small cascades mark this steep section, the solid rock being exposed here. The streams reach this cliff after winding their way across the deep drift-covered area from springs or tarns at the foot of the rocky section. On this remnant of the broad Tertiary valley, dry stone walls or thorn hedges divide the land into small and medium sized fields. They are of the *Agrostis*, and *Agrostis-Festuca* type, and have obviously been improved by drainage, liming and phosphates. *Nardus* and *Molinia* are absent until the common range is reached beyond the last gate. The better *Junci*, *J. effusus*, and *J. conglomeratus*, occur in wet places.

Beyond the last gate the road forked, and leaving the metal-surfaced section to the slate quarries (the return route) we followed a rough track along the foot of the steep and rocky mountain block. Hereabouts the vegetation is poorer. *Nardus* occurs in large patches where the soil is thin, or the drainage not too bad, and there are numerous boggy areas dominated by *Juncus*

squarrosus, *Carex* spp., and a matrix of *Sphagna*. Both these types are evidence of a low level of nutrient turnover, due to exhaustion and overgrazing.

Hereabouts, where a good view could be obtained of the terrain and the plant associations, Prof. Pearsall made a few remarks about the local history. It is believed that this area was covered with thick oak and hazel forest to the foot of the steep slopes, and probably with more scrubby growth at least up to 2,000 feet. When the Neolithic peoples colonised the area, this plain was the part they preferred, and an encampment surrounded by a dyke, attributed to them, is situated nearby. Work on lake muds shows that about this time there was some increase in silting and a rise in the proportion of herb, grass and sedge pollen, at the expense of that of the forest trees such as oak.

At present the steeper slopes have such a thin variable cover of stony soil over the solid rock, that they would be unable to support tree-growth. It is believed that de-forestation of these scrubby slopes followed by erosion of most of the glacial drift cover occurred about this time also, the coarser material being left in fans at the foot of the slope, while the silt and clay were carried away to settle out in the waters of the nearby lakes.

As mentioned earlier, the nutrient status of the vegetation of the poor areas at the foot of the rocky section is very low. *Nardus* and *J. squarrosus* are unpalatable to stock, except for a short period in the spring when the young shoots emerge. The "production" of a site like this is chiefly cellulose and the quantity small. Lacking lime, phosphate, etc., the soil would show greater production of cellulose under conifers. Prof. Pearsall felt that this would be a more realistic land use than the existing bog, even though he believes strongly in limiting such plantings.

While on the subject of erosion, visitors from New Zealand spoke of the results of forest clearance in Central Otago. About 100 to 150 years ago the densely wooded hills of this region were settled by graziers, who felled, burnt and pastured, irrespective of slope and rainfall. Soils derived from Quaternary glacial drifts were soon stripped from the slopes, often down as far as the rock, the debris being deposited on valley pastures as vast fans of sand and boulders, the silt and clay going off down the river to the sea.

From Walna Scar, where the track was left, the ascent was steeper. The ridge was still not rocky and the soil cover thin but complete, chiefly of *Nardus* and *Festuca ovina*. Further along and higher on this ridge, areas of mountain top detritus spread down the slope, the rocks being loose, angular and patchily covered with *Rhacomitrium*. Some plants of *Selaginella* and *Lycopodium* were seen on this site type. Detailed search for small plants was not aided by high winds and heavy almost continuous rain most of the time since leaving the cars at Coniston station.

The rocky rubble of angular andesite fragments characteristic of this area has been produced by splitting off, through frost action, of such outcrops as Doe Crags, where the process is still not complete. They are little colonised except by Bryophytes. The fragments comprising these spreads of rubble get smaller until they are buried in the finer material broken off, when the mass gradually becomes suitable for rooting by grasses and higher plants. Soil accumulation at this height, with its heavy rainfall, is slow, and much of what nutrients are released by chemical weathering processes is soon removed in solution.

The route continued along the ridge until the cairn marking the top of Coniston Old Man was reached. The top is fairly well rounded, but is eaten

into on two sides by corries. The path then leads down to the edge of Low Water, a small tarn in the hollow. Near here are the slate workings and a steep but passable track leads from them back to Coniston. The usual masses of slate waste line the sides of the route. This material is almost sterile and likely to remain so for some time, as it is little weathered and hard, so that even mosses are slow to colonise.

Following the track back to Coniston away from this eyesore the skies lifted somewhat, and it was possible to appreciate the jagged skyline of the Borrowdale Volcanic area, contrasting with the softer rounded shapes of the hills of Silurian shale. Although the narrow band of limestone was crossed on this route, it did not cause much change in the flora, being buried under a deep cover of drift, or perhaps locally faulted-out.

Land Use in the Lake District

Consideration of this question is shadowed by the conservative attitude of the local people, especially their conception of the effect of any changes on the tourist attractions. However academic, certain alternatives to the present may be mentioned. The current aspect is much affected by past deforestation and present overgrazing. The former has reduced the soil cover on the steeper slopes by decreasing soil stability, the latter has in its way been the cause of a one-way traffic in soil nutrients, all going out! Pastures all over the region could be improved by lime and phosphate. The bracken-covered parts, lacking an effective treatment, would be much better under shelter trees, this plant usually being a good sign as far as afforestation prospects are concerned. This improvement of pastures in the hill areas could be extended at least to the foot of the rocky sections.

The Lake District is already utilised as a catchment area by several municipal water supply departments, and more of its valleys are certain to be brought under control as time goes by. The soft waters draining from the Borrowdale Volcanic area are very useful, but wider application of lime and fertilisers will possibly reduce this virtue. Plagues of the diatom *Asterionella* are often associated with such increases in calcium content, occurring on filter beds not designed to cope with them.

However, afforestation of watersheds has the advantage that it does not need heavy application of lime to make it economic. The deeper rooting trees would assist percolation in these somewhat compact soils, reduce silting of reservoirs, and smooth the storm flow maxima. In many countries, not excluding our own, silting causes in course of time an undesirable reduction in capacity and in water quality of lakes and reservoirs in general, but especially in mountainous regions.

[*Note.*—We understand that the origin of the strange name "Old Man" for this mountain is the Celtic *allt maen*, meaning "the stony height".—Editor.]

THE COLLECTION OF CONES FROM TALL TREES

By D. T. SEAL

District Officer, Scottish Directorate

The increasing use of seed from selected prime stands or "Seed Stands" is involving seed collectors in more and more climbing of tall standing trees. To collect cones from such trees the climber must be free to move about in the crown with safety. The use of a nylon safety line will enable him to do so.

The necessary equipment consists of:

Nylon safety line.
Broad canvas belt.
A set of strops complete with clip-hooks.
A pair of cone rakes.
Tool line.

The Safety Line is a 1¾ inch circumference nylon rope of the British Ropes Ltd. VIKING type in which every nylon filament runs the whole length of the rope.

Safety lines can be supplied in various lengths to order but standard lengths are 150 and 200 feet. In length, the safety line must be twice the height of the tallest trees on which it will be used. The 150 feet line is thus suitable for work on trees up to seventy-five feet high.

Nylon rope is used not only because of its great strength and lightness but also because it is elastic and therefore well able to withstand very severe sudden or "shock" loads. Other points in its favour are a long working life and a strong resistance to rot.

The safety line is supplied with a steel eye spliced into one end and the other end back-spliced.

The Safety Belt is six inches wide to prevent bruising when the climber's weight comes on to it. It is made of tough, rot-proofed canvas and fitted with a heavy steel eye-plate for connection to the safety line. Two light "D" rings are fitted to carry the strops and tool line.

The Strops. There are six of these in the normal set and they are made of the same type of nylon rope as the safety line. Each strop consists of a length of nylon rope with an eye spliced in each end. One of these eyes is equipped with a steel clip-hook.

The Cone Rakes. A six foot bamboo haft is provided together with two steel rakes, one large, the other small. Either rake can be fitted to the haft. The rakes are narrow with a double set of long teeth so that they can be used for stripping cones from the branches by either pushing or pulling.

The Tool Line. This is a light line carried by the climber and used for hauling cone rakes (and quite often the climber's thermos flash also!) up into the crown.

Using the Equipment

With this nylon equipment cone collection is divided into two operations: (1) Stripping cones from the tree and letting them fall to the ground and (2) Collecting them from the ground into bags. We are concerned only with (1).

Two men, both able to climb, work together. One holds the safety line while the other climbs, and they change jobs frequently so as to get a rest between climbs.

The climber wears the belt tightly round his waist with one end of the safety line clipped to the belt and with his strops and tool line also on his belt and ready for use. He reaches the crown by ladder. Once in the lowest branches his safety line hangs down and is taken once round the stem and then held by the assistant on the ground. As the climber ascends the assistant pays out line but avoids excessive slack.

Where the climber could fall, i.e., where there are few, or small, or doubtfully safe branches, he fits a strop to the stem to form a "running belay". The strop is passed round the stem and one eye threaded through the other to form a noose which is pulled tight round the stem, the clip hook being left hanging. The safety line is passed into the clip hook. In this way the running belay is completed and the climber's safety line can move up and down through the hook, but it cannot be torn away from the stem. (See photo 5 on central pages.)

Should the climber fall his assistant tightens his grip on the safety line, so making it bind to the stem and braking and stopping the climber's fall. The equipment is designed to withstand a heavy man falling, without interruption from branches, for fifteen feet and to bring him to a stop without injury from jarring.

When climbing in the living crown, strops are not usually needed because, should the climber fall, his safety line will be held by the branches, but before leaving the stem the climber fits a strop to safeguard him while he works. This last strop is fixed *above* that part of the crown where he will collect cones so that his weight will be taken by the safety line when he goes out on the branches. Covered in this way the climber is free to go safely to the outside of the crown.

Where the cones are at the very tips of long branches a rake is needed so the climber will throw down one end of his tool line and pull up the rake. Cones are stripped from the tree and allowed to fall. For most species it is a waste of time trying to collect from the branches into a bag, and far quicker and easier to collect the cones from the ground later.

This method is used for large-coned species like spruces, pines and Douglas fir. For smaller-coned species like thuya, cypress and *Tsuga* the method is different. In these species it is necessary to handpick the cones direct into bags and to work for a long time in one place and right at the tips of the branches.

For work on these species the climber makes use of the triangular "Tree Net". The net is usually 36 feet across the base and 40 feet high and is made of Italian hemp with a 12 inch by 12 inch mesh.

The apex of the net is run up into the crown by a carriage block on a guy line and, by means of guys from the base of the net, it is spread so as partly to envelope the crown. The collector stands, or rather lies, in the net and picks the small cones by hand, putting them in a shoulder bag. He works at the end of a nylon line as previously, to safeguard him from falling.

Both these methods of cone collection work well and enable seed to be obtained safely and at reasonable cost from tall trees provided one condition holds good, namely, the crop must be a reasonably good one. In poor crop years these methods, along with most others, do not pay. The principle therefore is to exploit good crop years to the full and to avoid collection in poor years.

One word of warning: Accidents arising from cone collection from tall trees have been few but they have usually been very serious. It is therefore advisable always to make use of reliable equipment. This article is merely to describe the methods. A Forest Record giving details of equipment is in preparation.

LEDMORE NURSERY

(The following notes were prepared by the staff of East Conservancy, Scotland, for a visit by the Society of Foresters on 20th September, 1956.)

The farm of Ledmore, 196 acres in extent, was acquired by the Forestry Commission in November, 1949, with the object of forming a second large nursery in the southern part of the East Conservancy, its northern counterpart being at Newton, near Elgin. When acquired, the farm was badly run-down and heavily infested with weeds.

In the spring of 1950 some twenty acres were ploughed, cleaned and greencropped. By 1951, however, the ground was still considered too dirty for large scale lining-out and it was not until the following year that this nursery was brought into production. In that year seven million seedlings were lined out. This year the numbers lined out are six million seedlings and in addition 4,275 lb. of hardwood seed and 56 lb. of conifer seed have been sown.

At the present time fifty-six acres are under nursery. As the need arises, this area can be progressively extended to some seventy-five acres. Approximately twenty acres are being worked as a Seed Orchard of Scots pine and Douglas fir by the Genetics Section, and the balance of the land has been transferred to Strathord Forest or is to be retained under agriculture for the time being.

The nursery is in charge of a Forester and an Assistant Forester. The number of workers employed varies with the seasons, being highest during the spring and summer when lining-out and weeding make heavy demands on labour. At these times about thirty workers, mostly women and boys, are on the payroll. During the autumn and winter months the staff drops to about twenty workers.

Shortage of labour has had a marked influence on our working at Ledmore. It has led to the intensive and extensive mechanisation for which this nursery has now achieved something of a reputation.

Layout of the Nursery

When Ledmore was acquired, careful consideration was given to the layout so that machines could be operated efficiently and economically. As a result, nearly every nursery operation is now mechanised either fully or in part.

Sections

These extend to not more then two acres. 360 feet has been found to be the most convenient length especially for mechanical lining-out. Odd corners and the margins of irregular shape have been utilised for the growing of hardwoods, poplar stool beds, ornamental and Christmas trees.

Roads

The roads through the nursery are 13 feet wide to facilitate turning of the tractors, other accessory roads being 10 feet. Only one permanent metal road has been laid, from the main entrance to the nursery buildings which are centrally disposed. All earth roads through the nursery are kept free of weeds by periodical runs with disc harrows.

Hedges

Only shelter belts and hedges against the prevailing wind have been planted.

Cross hedges through the nursery would constitute an obstruction to machines and have been avoided.

Mechanical Equipment

The Mounted Lining-out Plough. (See photos 10 and 11)

This has been developed from the Talbot Lining-out Plough although in its present form it bears little resemblance to the original version. The main disadvantages of the older prototype plough in nurseries not laid out for mechanisation were its overall length and the fact that it was an old-fashioned "drag" plough. By shortening it and fitting a three-point linkage for the "hydraulic lift" of a Ferguson tractor the turning circle has been greatly reduced and it can now be employed in any nursery where a Ferguson tractor can be worked. The plough has also been modified to carry a fertiliser hopper with a chute which places the fertiliser where it can be mixed with the fine soil which goes against the seedling's roots.

This plough can cope with large consignments of seedlings at short notice, with the result that is has been possible to discontinue lining-out in the autumn and confine it to the spring. With the help of two of these ploughs and by careful organisation of the available labour, mainly women and boys, 250,000 seedlings can be lined out per day at Ledmore for an average cost of under 4/- per thousand.

The strip method of lining-out is used at Ledmore. With lines 9 inches apart every sixth line is missed. This gives 36 inch wide beds with 18 inch alleyways. This method slightly increases the cost of lining-out but is well worth the extra expenditure, since better quality transplants are produced and output is increased, due to the elimination of damage by weeding. Weeding and other operations may be carried out from the alleyways in wet weather when conditions would not permit this in normal lines of transplants. The strip method also allows the follow through of other tractor-drawn implements such as the inter-row cultivator, the undercutter and the plant lifter.

The "Ledmore" Six-Drill Seed Sowing Machine and Grit Distributor

One of the lines which is being followed at Ledmore is the development of a plant suitable for the forest without the expense and losses of lining-out. It is believed that such a plant may result from undercutting one-year conifer seedlings, so producing what is termed a "one undercut one" or "1 u 1" plant.

It was with this in mind that the six-drill seed sowing machine was designed. This machine can sow seed thinly in drills so that, after undercutting, the conditions for growth are not dissimilar to those in transplant lines. The grit distributor is similar to those in general use but it has been modified to confine the grit covering to the drills. It can also be adapted to sow hardwood seed, such as acorns, instead of grit in the drills.

The "Ledmore" Undercutter

This twin-bladed undercutter has been designed to meet the conditions prevailing at Ledmore but is of general application. It is fitted with two discs which travel on either side of the beds and two pneumatic depth-control wheels. Control of depth is a most important factor if the undercutting is to be properly done. Vertical blades are also fitted to side cut the seedlings at a later operation.

The "Gunn" Plant Lifter

The mechanical loosening of seedlings with this tool before lifting is now

common practice in many forest nurseries. At Ledmore, however, it has been modified to lift transplants or drill-sown seedlings by fitting half-moon tines to the blade of the lifter. The tines travel between the lines of plants and break up the mat of roots, thereby reducing stripping to a minimum. Depth-control wheels have also been fitted to this machine.

The "Ledmore" Inter-row and Alley Cultivator

This is basically a Ferguson toolbar which has been fitted with a variety of agricultural attachments. Introduced to do interline weeding and cultivation, it straddles the beds and covers both bed and alleyways in one operation. It is also fitted with depth-control wheels.

In addition to these specially designed or modified implements, the following types of agricultural equipment are used:

The Ferguson Single Furrow Reversible Plough

This is ideal for nursery work. It allows the sections to be ploughed both ways from start to finish leaving the surface level. It also saves fuel and oil since there is no running light when turning at either end of the sections.

The Oliver Single Furrow Plough with Sub-soiler

When breaking in new nursery ground which has previously been under agriculture, this is a useful, if not essential, implement. It breaks up the plough pan, penetrates into the cold subsoil without bringing this to the surface, assists both drainage and moisture retention and builds up the soil texture desirable for nursery working.

Ferguson Ridgers

Used for ridging seedbeds in the autumn, these ridgers allow of early seedbed preparation, cultivation and sowing in the following spring. Without ridging, these operations would be unduly delayed on this heavy soil.

General Notes

Maintenance of Fertility

Good husbandry and management are given first consideration at Ledmore. The history of each individual section is recorded in book form, giving for each Forest Year the soil analysis data and manurial prescriptions, the manure actually applied and the crops raised so that chemical and physical irregularities may be observed and corrected. Strict rotational greencropping is adhered to and normally one-third of the total nursery area is reserved each year for this purpose. After growing two successive crops of plants, organic and inorganic manures are applied according to prescription. Oats and tares are then sown and ploughed in while still succulent in late July or early August. Once decompostion has taken place, the sections are ploughed back lightly in September or October to ensure a high concentration of humus in the top layers of the soil where it is needed. This method of cultivation also reduces the weed population by weathering, although actually there is no fallow ground. It is essential to make good the high degree of soil exhaustion (both physical and chemical) caused by the growing and removal of successive tree crops.

Weeding

Only in a rich, sweet, healthy soil can we grow good crops which in turn produce shade and reduce competition from weeds. Special attention is paid to reducing the weed population. It is hoped that, with the planting of shelter-belts and hedges and enclosure by the surrounding plantations, the nursery will eventually become protected from weed seeds blowing in from outside.

Ledmore is at present remarkably clean of weeds and this has been achieved in under five years solely by mechanical weeding supplemented by hand picking in the actual rows of plants. Costs have been low and it is considered that, in this nursery at least, there is no case for the control of weeds by chemical sprays.

NOTES ON FARM IMPLEMENTS USED IN FOREST PRACTICE

By H. F. PARLETT
Forester, East England

Mechanisation has increased considerably in recent years on farms and most of the equipment used in the forest originated on the farm and has been modified to fit in with our requirements; indeed, it could hardly be otherwise, for equipment specially designed for forest work, unless fully occupied, would be uneconomical. Many pieces of agricultural equipment can be used in the forest without any adaptation and I have found that a friendly farmer can help one considerably in solving equipment problems, in fact, my approach has usually been in the nature of "Look here, So and So, I want to do this or that, what do you have that might help?" In this way I have been able to try out many items of equipment.

Of course, most of our nursery implements are agricultural but it has been of great interest to move them out into the forest. These notes are the results of the successful trials that have been made during the past few years in East Anglia.

Faced with the problem of burning a rank growth of heather which grew luxuriantly up to and through a stand of naturally regenerated Scots pine, a set of heavy discs were obtained and drawn by an agricultural type Fordson tractor were put in to harrow up a chain-wide strip around the woodland. The discs were set at full cut and the driver instructed to travel in figures of eight, covering each bit of ground at least three times. The result was excellent, all the vegetation was chopped up and buried into the top three inches of soil and a very satisfactory fire-break was obtained. This was very encouraging and the same system was tried on an area of dense bracken and birch some two feet high; again we met with success and some two acres of this was treated per day, the land being left in perfect condition for ploughing.

The disc harrow is a modification of the polydisc plough with the exception that the gangs of discs are duplicated and as one gang throws the soil to the right so the following gang throws the soil to the left, thus giving a level finish; the gangs are in four sections, two front and two rear, and it is important to remember that should weights be laid across to give added penetration they should not be lashed to a pair of gangs.

It may be of interest to note that I still use these discs for preparation of ground even under most difficult conditions and can successfully deal with most types of vegetation, e.g., young birch, broom, bracken and bramble up to a height of two feet, making it only necessary to burn up the stronger stuff which is easily forked after being chopped about with the discs.

When it was first discovered that the discs were proving useful for cutting vegetation we were in the throes of starting off a new heathland nursery and it

was decided to try out our discs for the initial breaking of the land. At that time our equipment consisted of the Fordson tractor—F.C.11, a real old stager—the discs and a borrowed Ferguson with plough and cultivator, also a set of chain harrows donated by a friendly farmer who really did not need them (I still have them). The area to be cultivated was in the main covered with a dense growth of tough heather and the idea was to chop up this vegetation using the discs. Working in half acre patches the driver worked in a series of tight circles with the discs set up to cut as much as possible without creating too much draught. The Ferguson then followed around with the cultivator set very fleet with the chain harrows in tandem. In a surprisingly short time we had the rubbish collected into rolls which when dry were burned *in situ*, using home-made burners. To complete the operation the area was then cultivated and chain harrowed again to remove the residue, and was ploughed.

Part of the area was covered in dense bracken and it was considered best not to chop the roots about too much so a different procedure was adopted. In this case a drawn Ransome Cultivator was used with the object of tearing up the roots. This tool, I believe, would have been successful but it was an old machine and had to be regretfully returned to its owner. The work was continued with the Ferguson Cultivator, an implement at first not thought strong enough, but which surpassed all our expectations. These cultivations were carried out thrice at right angles in each direction and again following up with the chain harrows as before, most of the vegetation was removed at the first go. To remove the rest we brought in a pitchpole harrow after ploughing at three inches to bring the roots to the surface.

The pitchpole is a self-cleaning harrow consisting of a rectangular frame with three transverse bars on which the tines are bolted in pairs, each bar is able to revolve in the frame and with a system of cams and a trip mechanism the operator can deposit the rubbish when over-full.

Regarding the disc harrows again it is fair to say that they are not too satisfactory on steep slopes unless drawn by at least a half-tracked tractor.

The steerage hoe is another farm implement that is gradually finding its way into our nurseries. It consists of a series of hoes on stalks mounted in a frame which are steerable laterally to the line of travel; on the Ferguson type the hoe is rear mounted and an additional operator rides upon the hoe to guide the hoes between the rows.

Nursery lines must, of course, be laid out to suit the machine. Personally I use five rows and a 15 inch path; this sort of layout is particularly suited to the use of the "offset" type of lifting plough, of which more later.

It is hoped to try a modified type of hoe with this implement which will consist of a "hand" of four or five light spring tines in place of the standard A and L type hoes. These light hands will riffle the soil surface and disturb the weeds instead of sliding just beneath the surface and cutting through the weed stalk.

The steerage type hoe has the great advantage in that continuous cultivation of the soil between the lines can be carried out very cheaply, thus ensuring that the weeds are completely suppressed and that the soil is in a continued state of aeration.

I mentioned the "offset" type of plough for lifting transplants. This is a modification of the standard headland plough which is a single furrow plough designed for ploughing right up to the hedgerow; it is mounted, and offset,

to plough outside the wheeltracks; the model that I first inspected had the breast inwards, i.e., towards the tractor, and the slade outside, thus when moving forward the slice was turned inwards instead of out, as a plough furrow slice normally does.

This seemed a reasonable tool to adapt for lifting purposes, and using the groundworks of an old plough attached to the ridger frame on the Ferguson tractor a highly successful tool was developed.

It was found that a prolongation of the plough point was necessary and that the breast must be reduced to a minimum. This implement is, I believe, still in use and I have just built my second one—cost about thirty shillings.

The standard double disc plough I find is most useful for screefing purposes especially on stumpy ground; the one that I have used is the Ferguson type and consists of a pair of concave discs of about 24 inches in diameter set at an angle to the direction of travel; the angle of the discs is adjustable. There is no inversion of the furrow slice as in normal ploughing but a good screef can be obtained and the implement is, as I say, extremely useful in stony or stumpy ground.

The tool is best operated at slow speeds on hard ground as better penetration is obtained, but faster operation conversely produces a shallower screef on softer sites. It is also notable that the greater the angle of the discs to the furrow wall the wider the screef, and that the vertical angle of the discs controls the depth of the furrow. Driven properly this implement will surmount most obstacles and will keep going where an ordinary plough will fail.

I recently saw some weeding carried out with the use of a Fordson Major with a mounted Rotovator. In this case the centre tines of the tiller were reversed and the machine set astride the planted rows, weeds were cultivated into the ground up to about four inches of the plants and it seemed that this was an operation that could bear some study. Mr. Parker, of Dunwich Forest, who worked up this idea, had an 18 inch crop of gorse to contend with and it cost him, I believe, about seven shillings per acre, excluding tractor running costs. In this case it must be borne in mind that the area must be entirely stump free.

No doubt there are many other modifications of farm machinery and it would be of interest to hear of them, especially in these days of steadily rising costs.

It must be remembered that where equipment is introduced into the forest, especially where drawn by rubber-shod tractors, care must be taken to ensure that the obstructions are not too large or sharp; a damaged tyre will wipe out any saving that the machine might make.

Much of the success of mechanisation in the forest or nursery depends upon the operator and good operators are difficult to obtain. Good maintenance of machines and equipment is essential and many an operation has become economically unsuccessful due to the lost hour per day in starting the recalcitrant tractor or because lack of attention to the grease bucket has caused a moving part to wear.

It is important, too, to bear in mind that should conditions show that a machine is not carrying out its task at an economic rate the machine must be withdrawn immediately.

SOWING TRIALS OF GRADED ACORNS AT WILLINGHAM NURSERY IN 1953

By D. F. MARSHALL
Forester, East England

The following trials were laid down purely for local interest but the results may be of interest to fellow foresters particularly those concerned with the sowing of oak.

Autumn sowings are normally carried out in this nursery; although these are initially more expensive because of the extra top cover required, this is outweighed by the expense incurred in storing and preserving seed for spring sowing, together with the long period of bird and mice protection required between sowing and germination. Autumn beds are clear when the top cover is raked off into the paths compared with the more expensive weeding of the spring sown beds. Spring sowing was, however, included in the trials.

Acorns were first graded by size and the numbers in each grade counted. Equal numbers of acorns were drill-sown by grades in each bed: the beds being three feet wide with eight drills four inches apart and the acorns two inches apart in the drills. Each bed was about 28 yards long and held approximately 3,500 acorns.

The first trial compared autumn and spring sowing, and gave the results shown below as Table A.

Table A COMPARISON OF AUTUMN AND SPRING SOWING

Grade	Sowing	Seed Sown lb.	Acorns per lb.	Usable Plants Lifted			Yield/lb.		
				Grade I	Grade II	Total	Grade I	Grade II	Total
I	Autumn	39	90	.6	1.3	1.9	15	33	48
II	„	23	150	.45	1.1	1.55	20	47	67
I	Spring	18	90	.15	.55	0.7	4	14	18
II	„	24	150	.05	.35	0.4	2	15	17

A third grade of seed was introduced in a second trial under the same conditions of autumn sowing, with results as set out in Table B.

Table B COMPARISON OF THREE GRADES, ALL AUTUMN SOWN

Grade	Sowing	Seed Sown lb.	Acorns per lb.	Usable Plants Lifted			Yield/lb.		
				Grade I	Grade II	Total	Grade I	Grade II	Total
I	Autumn	40	88	1.0	.6	1.6	25	15	40
II	„	27	127	.9	.75	1.65	33	27	60
III	„	20	180	.55	.95	1.5	27	47	74

It is obvious that the larger the grade of acorns the smaller will be the number of plants produced per lb. sown. The results of the graded sowings as given above show that in actual plants lifted a much greater number of Grade I plants is obtained from sowing the best seed. This is true whether the sowing is done in autumn or in spring.

WORK ON THE LIMESTONE SOILS AT DALTON FOREST, WESTMORLAND, 1951-1955

By J. V. CROSLAND

District Officer, North-West England

The main block of Dalton Forest, 296 acres in extent, is situated on the Westmorland-Lancashire border, one mile to the east of Burton-in-Kendal and adjoins the Kirkby Lonsdale road. The nearest main line railway station is at Carnforth, five miles distant to the south. The general character of the ground is shown in photos 12 and 13 on the centre pages, and the layout is illustrated in the map below.

There are large areas of a similar type in the locality, these being generally of a better quality than the area under report. They have no agricultural value even for sheep grazing, but working for rockery stone is occasionally carried out.

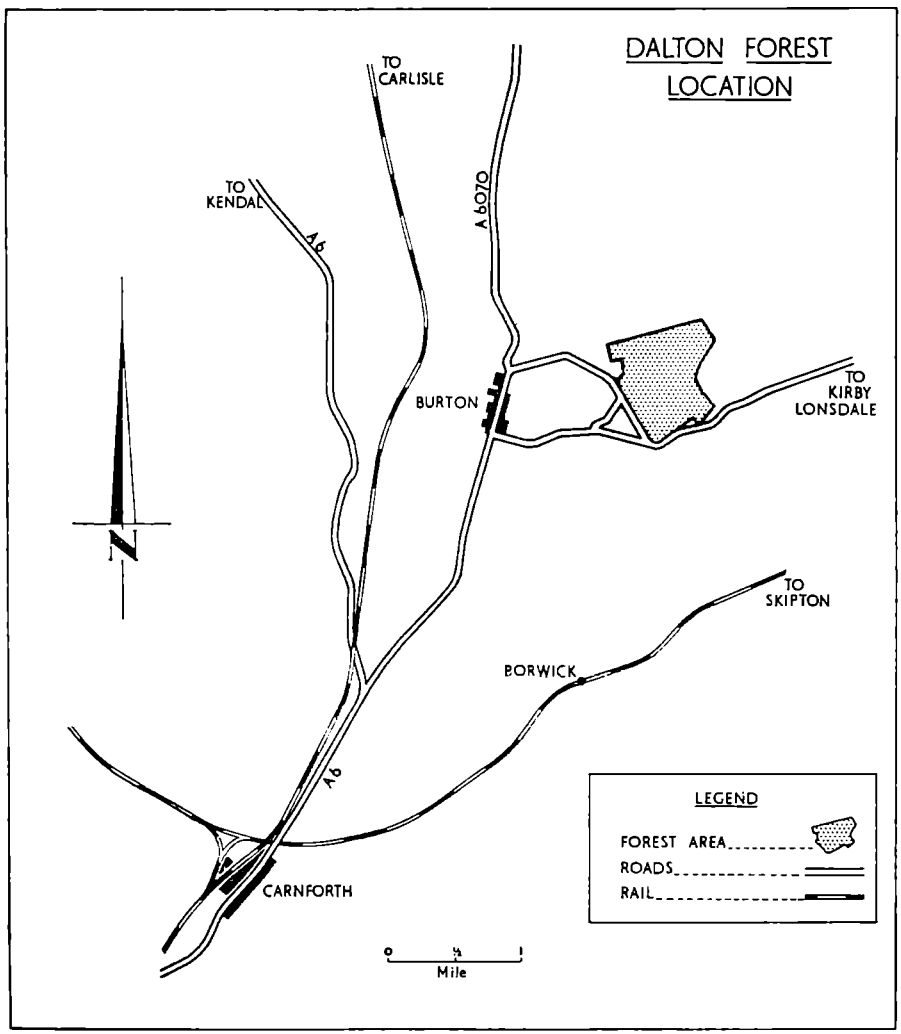


Fig. 27. Situation of Dalton Forest, Westmorland.

Elevations range from 350 feet above sea level in the west to 870 feet in the east. Exposure is severe due to a westerly aspect and the proximity of the sea, the coast being only six miles away. The prevailing westerly and south-westerly winds sweep over the area with unabated force and in winter are often salt laden. The area does, however, lie in a maritime district and little snow falls, for the northerly and easterly winds are "Helm" winds here; their moisture has been previously deposited on the Pennines. Frosts are not usually severe and the rainfall averages 50 to 55 inches per annum.

An interesting geological formation of Carboniferous limestone underlies the area, outcropping over fifty acres in the form of fissured limestone pavement. The rock is in the form of large rectangular limestone blocks with narrow cracks or "grikes" between, and the soil can be seen at the base of each block. It is a relatively soft, variable and impure form of limestone which breaks down fairly easily under the influence of the weather. The rainwater forms shallow scoops in the surface of the stone by dissolving the calcium, so giving a rippled

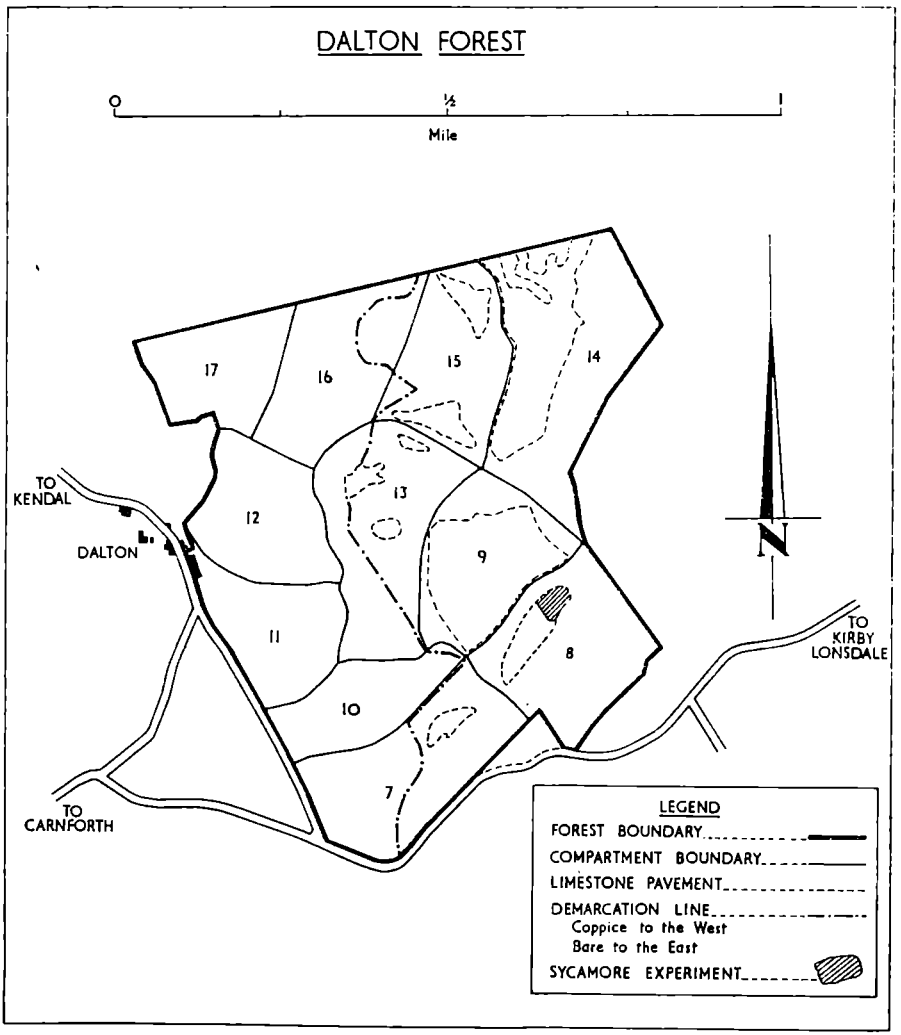


Fig. 28. Plan of Dalton Forest.

Photo 1. Her Majesty the Queen, accompanied by the Earl of Radnor, Chairman of the Forestry Commission, unveils the commemorative plaque recording the planting of the Commission's one millionth acre. Eggesford Forest, Devon, 8th May, 1956.

Photo 2. Her Majesty the Queen, together with Mr. C. A. Connell, Conservator of Forests for South-West England, chats with forest workers and their families after the ceremony. The Earl of Radnor, Mr. James Stuart (Secretary of State for Scotland) and Head Forester J. D. Robbie of Blackhall Forest, may also be seen in this picture.

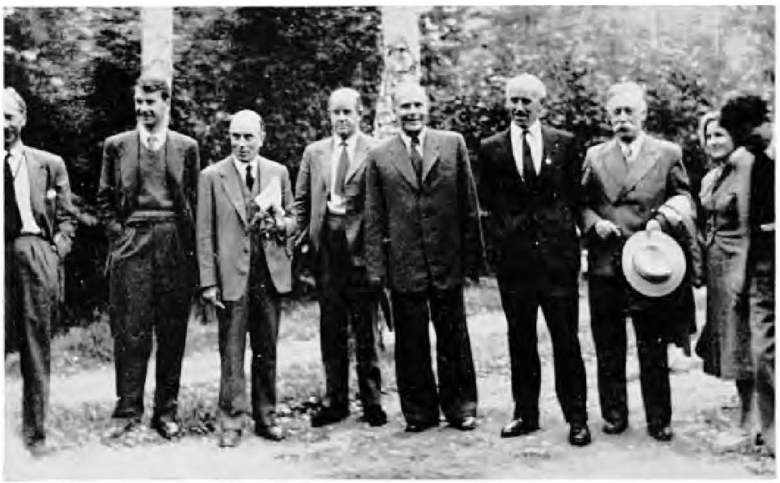


Photo 3. Members of the Commission party who visited Russia, seen in a birch grove near Moscow. *Left to right:* John Williamson (Conservator, South Wales), Peter Norman (Interpreter), James Macdonald (Director, Research and Education), Jim Thom (Conservator, Scottish Directorate), P. Shinov (Russia), Sir Henry Beresford-Peirse (Deputy Director-General), Professor Timoseev (Russia), Miss Ina Morogova (Interpretess) and Dr. Frederick Hummel (Research Branch).

Photo 4. John Q. Williamson seen with two Russian foresters at a log dump near Lake Ritsa in the Caucasus Mountains, 3,000 feet above sea level. The woods are mainly of spruce.

Photo 5. District Officer D. T. Seal fits his safety line into the snap link of a safety strap, whilst ascending a tall spruce to gather its cones.

Photo 6. A herd of European bison in the birchwoods of a Polish reserve.

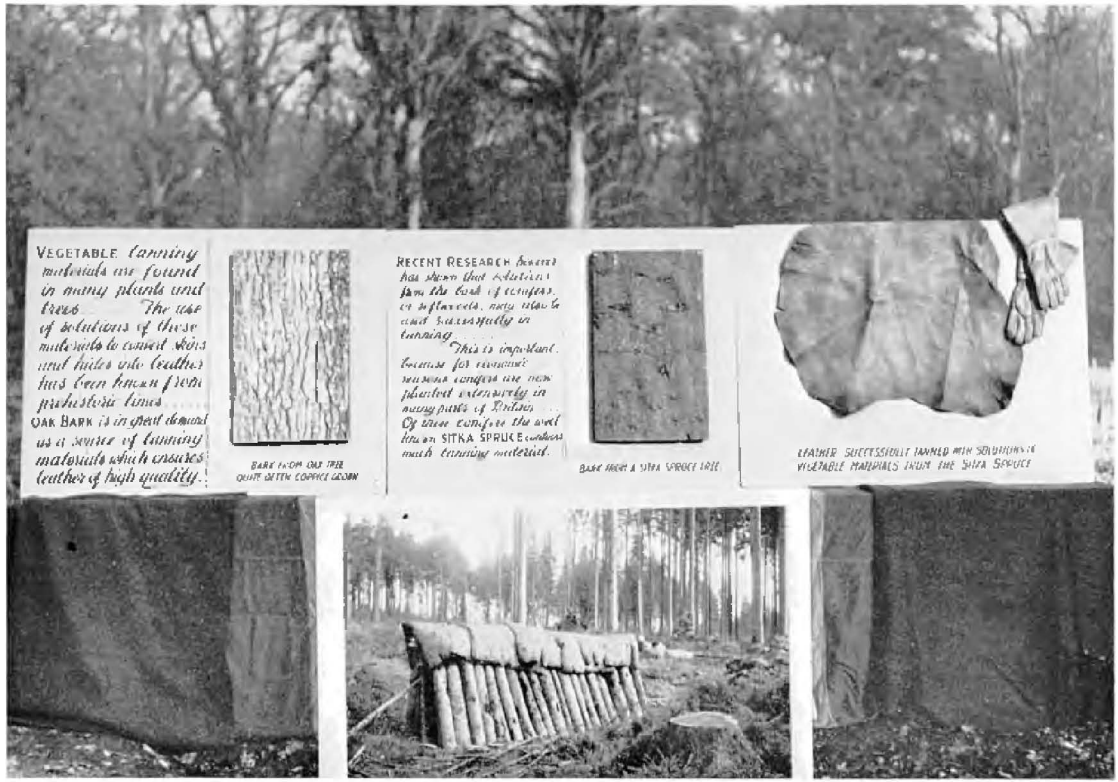


Photo 7. A view of the exhibit of oak and Sitka spruce tan-barks shown by the Commission at agricultural shows in 1956. *Inset:* Rolls of Norway spruce bark stacked for air drying in the Forest of Schneegattern, Upper Austria.

Photo 8. Mixed conifer plantations established on derelict gravel beds, once stream-washed for tin, in the Glynn Valley, Glynn Forest, Cornwall.

Photo 9. Maritime pine has proved the most successful tree in these acquired plantations in Glynn Forest, near Bodmin, Cornwall.

Photo 10. The Ledmore lining-out plough at work in Wauchope Forest Nursery, South Scotland.

Photo 11. Details of the Ledmore lining-out plough, showing, from right to left: main share of throw up earth against tree roots, skimming blade, compressing wheel to firm earth against trees, main roller to compress earth, and disc to cut face for next row.

Photo 12. General view of the limestone plateau at Dalton Forest, Westmorland, looking south-west towards Morecambe Bay.

Photo 13. Sycamore planted in grikes amid the limestone at Dalton Forest.

Photo 14. One-year old seedling showing the method of planting on the Hardlee Flow, and the exceptional early season's growth. This photograph was taken on 15th May 1953.

Photo 15. The Hardlee Flow, Wauchope Forest, after ploughing for planting; hand-deepened drain on right.

Photo 16. Planting a willow bed, pushing the cuttings in, to correct depth.

Photo 17. Cutting the mature willow crop: cut stools in the foreground.

Photo 18. Roadside ditches used as storage pits for graded willows; pollard willows beyond. Isle of Athelney, Somerset.

Photo 19. One of the highest plantations in Britain. Good European larch on top of a steep gully at 1,900 feet elevation in Loch Ericht Forest, Inverness-shire.

Photo 20. The most northerly plantation in the British Isles, around Kergord House, Shetland Islands. Note the good lay-out for shelter, and the wind-pruning on the right. The hardwoods are mainly sycamore.

Photo 21. Cross-cutting logs for wood wool, on the McConnel portable saw bench at Mortimer Forest, Herefordshire.

Photo 22. Shredding billets for wood wool in a factory at Coatbridge, Lanarkshire.

Photo 23. Charcoal burning in Sussex. Stacking rough branchwood around the pole that will later form a central flue.

Photo 24. Charcoal burning. *Left:* A completed stack protected with straw prior to covering with earth. *Right:* A stack has been reduced to charcoal, about to be uncovered.

Photo 25. Colonel R. G. Shaw, Machinery Development Officer, supervises trials of the Kingslaw barking machine in Mortimer Forest.

Photo 26. Bogged! What happens when a tractor hits really soft ground in a Border Forest. The machine was eventually recovered undamaged.

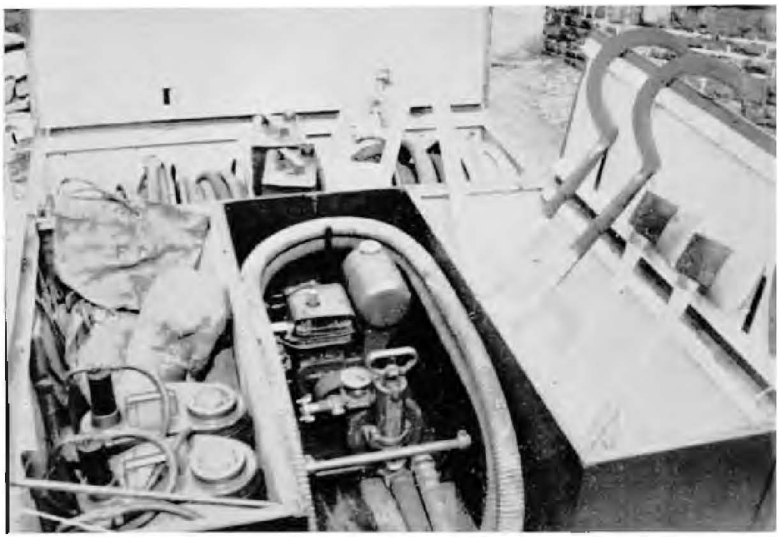


Photo 27. Interior of the Fire-fighting Trailer designed by Assistant Forester I. W. England, showing hand pumps, power pump, tool box, and hose box.

Photo 28. The trailer ready for the road.

Photo 29. The monarch of the forest: a fine red deer stag in Latvia.

Photo 30. Red deer hinds.

Photo 31. Ravens beside the carcase of a red deer stag.

effect. Frost too plays an important part in the breakdown of the parent rock, as water frozen in the scoops expands.

The resultant soil is shallow, sandy with a small admixture of clay and rather gritty, varying from one inch in depth on the higher parts to a maximum of fifteen inches deep in pockets on the western boundary. Drainage is very free and during heavy rain the friable soil is often washed away.

Now that the rabbits have been exterminated the main injuries to which the crops are liable include drought and swinging in the strong winds. Voles have caused some damage, but only a few isolated trees have actually been killed.

There is little information on the area's former history but there has been no concentrated technical management for many years. The previous crop was coniferous, containing European larch, Scots pine and Norway spruce. Ash and sycamore then seeded up naturally under the conifers, as the conifer crowns thinned. Felling of the crop commenced during the war and was completed by 1948, by which time the Norway spruce were dead. The natural hardwood growth was also cut and resprouted to give the present coppice, this being badly damaged by rabbits and occasional sheep. The area was then leased to the Forestry Commission in 1949.

Vegetation

From the botanist's point of view the area is one of great interest, for a wealth of calcicolous plants grow strongly. These include the blue mountain grass (*Sesleria coerulea*) and the birds-foot sedge (*Carex ornithopoda*). Many other species are present and those found to date, together with the shrubs and trees, are listed in Appendix.

There are three well defined vegetational zones:

(*a*) The outcrops of limestone pavement where vegetation is confined to the fissures. The rigid fern (*Aspidium rigidium*) and limestone polypody (*Gymnocarpium robertianum*) are typical plants, whilst ash, sycamore, yew and occasionally elder grow from the bottom of fissures, down to a depth of three feet.

(*b*) The open grassland areas where the main species are blue mountain grass with a little bracken. Some small patches of heather also occur where leaching has taken place.

(*c*) The coppice areas which carry a profusion of plants with heavy bracken, blackberry, raspberry, wild strawberry and wood sedge predominating. All the shrubs are concentrated in this zone. The major native tree species is ash, with lesser numbers of oak, hazel, aspen, wild cherry, birch, rowan, yew and an occasional rock whitebeam. Other species include sycamore, lime, sweet chestnut, beech and Scots pine.

Silvicultural Operations

(*a*) The Limestone Pavement

In 1951 a small experiment was laid down on the pavement to see whether it was possible to establish any tree growth by direct methods, and whether the outcrop could support growth sufficiently to assist in the breaking down of the rock formation.

The elevation was 620 feet above sea level and exposure moderate to severe. Five hundred sycamore transplants, aged one-plus-one, and eighteen

inches or over in height, from south-west England, were used and the experiment covers one acre.

A ball of damp soil was placed around the roots of 400 trees and held in place by a piece of sacking. The latter was then tied by a piece of string round the collar of the tree. The trees were then pushed in the fissures and a little loose soil added, to keep them upright and reduce swinging.

Adjoining this area, where the soil depth averages four inches, the remaining 100 plants were planted, using a crowbar to break up the partly broken underlying rock.

The results to date are given in Table A.

Table A GROWTH ON LIMESTONE PAVEMENT

	Deaths	Average Annual Height Growth (inches)			
Forest Year	In Fissures	In Soil	In Fissures	In Soil	Remarks
1951	140	10″	1½″-2″	2″-3″	Dry season
1952	Nil	Nil	1½″-2″	2½″-3½″	
1953	Nil	Nil	3″	6″	
1954	Nil	Nil	3″	8″	Generally wet with high winds
1955	Nil	Nil	8.7″	14.7″	Very dry season

The planting was not completed until the 3rd May, 1951, and this coupled with the dry season was responsible for many of the deaths in the first year.

In broad terms this experiment has been successful to date, for the actual mortality rate is not high. The end result will not be seen for many years, but it is hoped that the accumulation of leaf-fall in the fissures, the resultant increase in moisture, and the physical forces exerted by the growing trees, will all speed up the breakdown of the limestone and the production of soil. It seems possible that, despite the bad conditions prevailing at this site, sycamore may prove to be a suitable pioneer on this type of ground.

An attempt has been made to introduce beech into the fissures but without success. The plants were tied to a stick and lowered down fissures varying from two to six feet in depth. A hole was scratched in the soil at the bottom of the fissure, into which the roots were pushed and the plant left attached to the stick. The string could then be cut with a razor blade on the end of a stick when necessary after establishment.

The 1954 season was, however, very wet and it is thought that the plants were drowned, as there has been no successful establishment.

A trial sowing of ash was made in April, 1955. The site chosen had fissures averaging six inches in depth and vegetation included a few ash and sycamore sprouts up to two feet in height, with a little blue mountain grass in the shallow fissures.

The sowing was broadcast by hand at four pounds of seed to the acre. No preparation was made prior to sowing. There have been no signs of any seedlings to date and a prolonged drought subsequent to sowing must have caused many deaths.

(*b*) **The Bare, Grassy Areas**

Planting commenced on this type of ground in 1951, using the mattock and normal screefing methods. The arrangement of plants was two rows of beech to one row of Scots pine.

The area studied is a dry bank with a southerly aspect. The major part carries a vegetation of *Sesleria* interspersed with a little bracken. A small three-quarter-acre patch of ash coppice situated in the centre was cleaned and underplanted with pure beech at the same time as the mixed planting. The average height of the coppice at the time of planting was four feet, and the work was completed in late March 1951.

Mortality rate on the bare area was high and extensive beating up was necessary in 1952. No deaths have been recorded in the coppice.

Table B compares the rates of growth between the bare and the coppice to date.

Table B COMPARISON BETWEEN BARE GROUND AND COPPICE

Type	Average Annual Height Growth (in.) F.Y.55		Average Total Height at 1/10/55 (in.)		Soil Depth (inches)
	Beech	Scots Pine	Beech	Scots Pine	
Bare	6.0	9.3	23.8	31.9	3.8
Coppice	9.8	—	38.5	—	8.0

Plants used were one-plus-one beech, and two-plus-two Scots pine. Of 8,200 Scots pine planted in 1951, 6,500 had to be replaced and relative figures for the beech are 23,900 and 10,000.

It is assumed that the deeper soil under the coppice has given the best growth due to its higher moisture content. The separate effects of the coppice, firstly by reducing the moisture losses from the soil and, secondly, on transpiration from the plant, are difficult to assess. It is thought, however, that the shading of the soil and consequent reduction in evaporation is the prime factor.

Experience has shown that losses can be greatly reduced by adopting the following four practices :

(1) The use of a hinged turf for planting. A turf eighteen inches square is cut on three sides and rolled back. This puts *grass to grass*, in effect giving two thicknesses of soil for planting.
Furthermore, a certain amount of water is held up by the hinge, and this percolates down to the roots. This turfing is best completed in advance, as some binding then occurs between the two layers of grass, prior to planting. There is also possibly some slight mulching effect produced by the two layers of grass.

(2) Planting should whenever possible be completed before Christmas in each season. This reduces losses through drying out during the spring droughts, which regularly occur.

(3) Differential weeding of the beech and Scots pine should be adopted. Cutting around the beech should be left as late in the season as possible, as this avoids sun scorch and helps in the retention of any moisture

that may be available. Normal weeding is carried out in the Scots pine. In an average year the beech rows are weeded once and the Scots pine twice.

(4) The use of big plants should be avoided if at all possible. A tree six to nine inches tall is big enough, as there is no competitive weed growth apart from the light bracken.

(*c*) The Coppice Areas

The word coppice is used for ease of nomenclature, and although little real coppice is present, the stems are, in the main, sprouts from cut-over natural regeneration.

Work in the coppice was commenced in 1952. After inspection small groups were cleared where the stocking of coppice and natural regeneration was poor. Restocking was then carried out with pure beech at four foot six inches spacing. These groups were restricted to a quarter of an acre or less, and the surrounding coppice averaged six feet in height at the time of planting.

The ash shelter has been of great protective value and has resulted in increased height growth. Table C illustrates this point.

Table C GROWTH ON PROTECTED AND UNPROTECTED AREAS

Type	Av. Ht. Growth (in.) during 1955	Av. Ht. Growth (in.) at 1/10/55	Soil (in.)	Remarks
Unprotected	3.5	13.2	7.9	In the centre of large blocks near houses P.53-Co.11
Protected Groups	8.2	21.9	6.6	Bracken patches interspersed with coppice P.53-Co.11

The plants used were one-plus-one beech. Here the beech development is best where the soil depth is least, showing what useful protection the ash affords.

Those areas where sufficient stocking of natural and coppice growth was present have also been worked over. The treatment consisted of thinning out the stems to such a spacing that the highest growth rate could be obtained, consistent with keeping as dense a canopy as possible, so reducing ground vegetation to a minimum.

The average number of shoots averaged between nine and twelve per stool, and this number was reduced to three or four.

Long-handled secateurs were used for this work in preference to bill-hooks, so avoiding broken tools and reducing the risk of accidents on this rocky ground. At the same time the secateurs give a clean cut which helps the stock to throw further coppice shoots for ground cover.

In the main the coppice has responded well, ash averaging between twelve and fifteen inches in annual growth and the sycamore eighteen inches. Thinning of the coppice was first carried out in 1951, and it is probable that the next thinning will be due in 1957.

Other species planted include Norway maple and whitebeam. The former

has been used for amenity purposes and is growing strongly even on the most exposed sites. Whitebeam has been planted under a light ash cover, fifteen to twenty feet in height; it has shown good development to date.

A small area has been set aside for the trials of various species. The site is of good quality with high ash side shelter. Species on trial include western hemlock, western red cedar, Douglas fir, *Cryptomeria japonica*, *Metasequoia*, *Nothofagus*, Lawson cypress, sessile oak and red oak. Best development is shown by *Cryptomeria japonica*, western hemlock, and Lawson cypress.

A few black walnut have also been planted in selected deep soil pockets throughout the coppice. There were formerly good walnuts growing in soil pockets in the south-west corner of the area.

Discussion

On this site of rather unknown quality two main factors have to be considered, although these are largely interdependent.

(1) The short-term factor, that retention of the maximum amount of moisture is essential in any efforts to establish a tree crop.

(2) The long-term factor, that one of the main objects of management must be to make more soil.

All operations are influenced to a great extent by these factors, and none more so than the choice and arrangement of species. Beech was chosen as the main crop for the following reasons :

(*a*) That there are good beech trees on similar sites in the locality; shallow-rooted but windfirm.

(*b*) That the high availability of basic nutrients in the soil should favour the early rapid growth of the species.

(*c*) That the heavy leaf-fall on this basically rich soil should assist in the formation of a mull humus; even though there is relatively high rainfall coupled with exposure to strong winds.

(*d*) That this heavy leaf fall, heavy shade and resultant retention of moisture, should speed up the breakdown of the limestone pavement.

(*e*) That being a shade-bearer this species can in future rotations be managed on the group selection system, so avoiding any need for the clearing of large areas.

The moderate to severe exposure and the absence of any shelter on the bare, grassy areas led to the necessity of using a conifer nurse for the beech in its early life. For this purpose Scots pine was chosen. Its main attributes are that, on this thin lime-rich soil it grows very swiftly in the early years, but suddenly falls off in the rate of growth at between fifteen and twenty years of age. Only scattered trees grow on to maturity in pockets of deep soil, and such pockets are few in Dalton Forest. Scots pine under similar conditions have reached a volume of fifty to sixty hoppus feet over-bark at about 120 years of age; but the general production is well below Quality Class IV.

The pine does appear to be doing the job expected of it, and the following figures show the comparative rates of growth of beech and Scots pine for the most exposed area on this forest at an elevation averaging 750 feet above sea level.

Type	*Av. Annual Ht. Growth (in.) F.Y.55*		*Av. Total Ht. (in.) F.Y.55*		*Soil Depth (inches)*	*Remarks*
	Beech	*Scots Pine*	*Beech*	*Scots Pine*		
Bare Grassy Area	2.7	6.2	12.0	21.6	4.3	Cpt. 14 P.52 severe exposure

Plants used were two-plus-one beech and one-plus-one Scots pine.

A possible alternative to Scots pine is Corsican pine which may have a longer life on this type of soil. The value of this species has yet to be proved, for although the soil is often dry, the relatively heavy rainfall coupled with a less than normal ration of sunshine, may lead to a poor development, coarse timber and associated attacks by *Brunchorstia*.

In normal practice the conifer nurse is rightly considered to serve the additional purpose of giving some intermediate financial returns, and under such conditions a 50 per cent planting of the nurse species is usual. Here, however, its sole use is to help establish the beech in the shortest possible time, and its future is so uncertain that it would possibly be a waste of money and incorrect silvicultural practice to use it in greater proportion.

A further point in favour of the arrangement used to date is that small "white" woods, including beech, birch, ash and sycamore, find a good market in the local turnery industries. A typical order specifies random lengths between two and four inches diameter. If present progress is maintained it seems probable that this type of produce will be available in beech in about twenty years time from planting. It may be earlier because even on the bare areas, where there are pockets of soil, beech growth is very rapid. An example occurs at 750 feet in Compt. 14 where a beech which was nine inches tall when planted in 1952 showed an annual height growth of eighteen inches in F.Y.55, while its total height to the end of that year was fifty-eight inches; the soil was only fourteen inches deep.

In the treatment of coppice and natural growth the aim has been to retain the maximum amount of soil cover, at the same time giving the young shoots room to grow strongly. This in turn means that the maximum amount of water is retained in the soil. At the start of operations it was difficult to decide whether to inter-plant the whole of the coppice, which then averaged three to five feet in height, or to plant the bare patches and allow the other coppice to grow on to marketable size before group replanting and underplanting. Its development has been slow, but it is now obvious, in view of the local market for small turnery wood, that it can be sold when subsequent replanting is carried out. The planting of beech in groups, with ash side shelter, say fifteen to twenty feet in height, should be a successful and economical operation.

Conclusions

The following conclusions can be made in view of the experience gained to date:

(1) Economic afforestation of the bare areas is probable within the first rotation.

(2) Every endeavour must be made to retain moisture on these areas and that this task is assisted by early planting, use of hinged turf, very careful control of weeding and the use of small but well-rooted plants.

(3) The management should not involve any clear felling at any stage in the life of the crop.

(4) The maximum amount of cover, consistent with silvicultural requirements, should be retained.

(5) The introduction of a shade-bearer in groups, either cleared or by underplanting, may be the most economical and beneficial method of restocking where there is already some tree cover.

(6) Beech appears to be satisfactory as the main crop species and is being adequately nursed in its early stages by Scots pine.

(7) Further investigations should include trials of Corsican pine as a nurse to the beech, the use of sycamore as a pioneer species, and the trials of direct sowing, both broadcast and in cultivated patches, particularly of sycamore and ash.

Thanks are due to Mr. D. Keens, Forester-in-Charge at Dalton Forest, for his accurate record keeping and careful measurements in the field.

Appendix 1: Labour Costs

The following table gives the labour costs in shillings and pence for various operations. No allowance has been made for overheads or material. The costs have been brought up to date by adding to the original price the appropriate difference between the basic wage at that time, and the new wage rates introduced on the 10th November, 1955.

Operation	1951	1952	1953	Remarks
Fencing	32/5	42/3	33/–	Piece-work price lowered in 1953 but the same type of ground worked in all three years.
Preparation of Ground	158/5	107/2	132/–	Burning lop and top. Very variable in quantity.
Hinged Turving	—	101/5	—	The P.53 turving was carried out in advance in F.Y.52.
Planting	87/7	84/8	115/6	—
Beating-up	—	52/5 (P.51)	27/6 (P.51)	No B.U. required on P.52 after hinged turving and selective weeding.
Weeding	44/4 (P.51)	23/11 (P.51) 29/6 (P.52)	36/4 (P.51) 29/8 (P.52) 27/6 (P.53)	Note large drop in cost following introduction of selective weeding F.Y.52.
Firming	—	—	19/3	Necessary in both Scots Pine and beech following severe gales Dec., 52, and Jan., 53.
Cleaning Coppice	48/–	68/5	112/3	Increase in price due to growth of coppice and natural regeneration.
Wage Rates as Percentage of those at 10/11/55	80	86	91	Calculated on basic minimum wage of 134/– per week in 1955.

Appendix 2: Beating-up

The following table shows the amount of beating-up necessary on those parts of the forest which have been the subject of special study:

Compt.	Planting (Thousands)			Beating-up (Thousands)			Remarks
	Scots Pine	Beech	Forest Year	Scots Pine	Beech	Forest Year	
7	8.2	23.9	51	5.0	10.0	52	Bare and dry
				1.5	Nil	53	
8	12.0	20.9	51	5.0	12.5	52	Bare and dry
9	4.0	6.5	52	Nil	Nil	—	Bare and dry
14	13.5	30.0	52	Nil	2.0	54	Bare and dry
11	—	8.0	53	—	1.5	54	In coppice
13	—	9.0	53	—	Nil	—	In coppice
16	—	4.0	53	—	Nil	—	In coppice

The use of hinged turving and late weeding were introduced in Forest Year 52. It is interesting to note the sharp reduction in bearing-up carried out on the bare areas planted that year.

Appendix 3: Trees and Shrubs

The following trees and shrubs have been seen on the area:

Sessile Oak	Ash	European Larch
Pedunculate Oak	Sycamore	Scots Pine
Broadleaved Lime	Rowan	Hazel
Sweet Chestnut	Hawthorn	Guelder Rose
Birch	Crab Apple	Dogwood
Elder	Bird Cherry	Spindle Tree
Aspen	Wild Cherry	Rock Whitebeam

Appendix 4: Ground Flora

The following list details the flowering plants, ferns and grasses noted on the area. The list is not fully comprehensive and no complete botanical survey has been carried out, the species shown having been seen in the course of normal working inspections.

Anemone nemorosa	Wood Anemone
Ranunculus auricomus	Goldilocks
Aquilegia vulgaris	Columbine
Helianthemum cauum	Hoary Rock Rose
Geranium pomguineum	Bloody Cranes Bill
Oxalis acetosella	Wood Sorrel
Anthyllis vulneraria	Kidney Vetch
Rubus idaeus	Raspberry
Rubus fruticosus	Blackberry
Geum urbanum	Common Avens
Fragaria vecsa	Wild Strawberry
Meum athamanticum	Meum
Scabiosa columbaria	Small Scabious
Aspidium rigidum	Rigid Fern
Carex ornithopoda	Bird's Foot Sedge

Aira caryophylla	Silvery Hair Grass
Calluna vulgaris	Heather
Lonicara periclymenum	Honeysuckle
Primula vulgaris	Primrose
Primula veris	Cowslip
Sesleria coerulea	Blue Mountain Grass
Polygonatum multiflorum	Solomon's Seal
Convallaria majalis	Lily of the Valley

Appendix 5: Soil Nutrients

The following table gives the results of soil samples taken under the ash coppice and on the high exposed areas planted with beech/Scots pine mixture.

Locality	Sample	Water % Fresh-weight	pH	Elements in mg./100 g. oven-dried soil				
				Sodium	Potassium	Calcium	Magnesium	Phosphorus
Ash Coppice	1	33.19	5.64	8	11	170	15	0.1
	2	33.42	5.13	6	9	90	22	0.1
	3	33.94	5.63	7	9	173	24	0.1
	average	33.52	5.47	7	10	144	20	0.1
Beech/ Scots pine	1	49.86	5.73	8	28	239	28	0.3
	2	41.93	4.44	3	15	33	20	0.1
	3	46.79	5.19	9	28	269	24	0.2
	average	46.19	5.12	7	24	180	24	0.2

The weights of the various elements shown are exchangeable and were extracted with 0.5N acetic acid.

AFFORESTATION OF IRONSTONE WORKINGS IN NORTHAMPTONSHIRE

Contributed by G. BACKHOUSE, *Conservator, East England*
and M. NIMMO, *District Officer, Research Branch*

The Northamptonshire ironstone area covers a large part of the centre of the county; the ore is found chiefly as a sedimentary deposit in the Jurassic measures, primarily in the Northampton Sandstone beds of the Inferior Oolite, immediately above the Upper Lias Clay. The general strike of the ironstone is south-westerly, and there is a gentle dip to the east or south-east. The ironstone field is dissected by several rivers and in the plateaux between the rivers the ore bed is at a considerable depth—a factor which in the past resulted in underground mining being developed.

The total thickness of the ore bed varies between about six feet and 15 feet, the average being 10 feet; the overburden of the ore bed varies in different localities but is made up generally of the following succession:

Lower Oolites

Great Oolite Series:	*Feet*
Cornbrash—limestone	5-15
Forest Marble—clays and nodules	3-15
Great Oolite—limestone	7-25
Upper Estuarine—clays and limestones	7-35

Inferior Oolite Series:	*Feet*
Lincolnshire limestone	0-77
Colleyweston slate—limestone	0-10
Lower Estuarine—sands and clays	0-15
Northampton sand—ironstone and sandstone	0-30

It can be seen, therefore, that the overburden can be very variable and may comprise surface soil and debris, the sands, clays and limestones of the estuarine series, or the hard Lincolnshire and Great Oolite limestones. In addition, the region has undergone considerable glacial erosion and has been subsequently covered by very extensive sheets of drift, chiefly boulder clay.

The iron ore yield is about 19,000 tons per acre. The ore has an average iron content of 32 per cent. Working has been almost entirely by open-cast methods, formerly by hand or by steam face shovels, but now also by draglines.

The early workings of ironstone in this neighbourhood were generally left in a rough and derelict condition because the cost of restoring the land was greater than the value of the land itself. It was, at one time, possible for the ironstone operators to remove the ore and leave the site without having to restore it. Some of these old workings were brought back into agriculture, others, as at Boughton, were planted with trees, but there still remain extensive stretches of this land in Northamptonshire and the adjoining counties which are derelict. Fortunately, it is now no longer possible to leave the worked-over land untreated and a Central Ironstone Fund has been set up from which grants of £35 per acre are available for restoration to use. If the land is restored to forest, the normal grants for planting and maintenance are also available from the Forestry Commission, so that an owner may obtain about £52 per acre in all. There are extensive deposits of ironstone in this part of England and working will continue on a large scale for many years to come.

Present methods of working leave the deposits in a series of ridges and furrows, the "hill and dale". For agriculture it is necessary to level the land, but for forestry this is not essential, nor always advisable, although on land which is covered, as much of it is, with large blocks and boulders of limestone subsequent working may be difficult.

In a highly industrialised country like Great Britain, industrial wastes are of great importance on account of the area they occupy, and the ironstone workings are only one example out of many. The waste heaps round collieries in the mining districts have been brought to the notice of foresters who have been asked to advise on planting them with trees; while the opencast working of coal, which is proceeding at a great pace, has resulted in the destruction of substantial blocks of woodland. British clay workings and gravel workings, the latter consuming annually about 3,500 acres of land, are of little direct concern to the forester because most of them rapidly fill with water.

Boughton Estate

This estate, which is owned by the Duke of Buccleuch, consists of some 11,000 acres, of which 1,850 acres are dedicated woodlands. Boughton was one of the first estates to undertake afforestation on the deposits left by ironstone working and some of the earlier work will be seen.

The soil throughout the estate is varied but generally heavy, consisting of Boulder Clays overlying geological formations ranging from the Upper Lias to the Oolite Clays. The areas worked for ironstone produce a "soil" consisting of a variable mixture of clay, limestone, or sand. Workings were generally much shallower at the time of planting (1909) than today, and the unevenness of the ground is less severe. The rainfall is about twenty-four inches a year and the elevation between 250 and 350 feet above sea level.

The ironstone plantations, amounting to nearly 150 acres, were formed to make use of the land which in the past had been worked out by opencast ironstone mining and left derelict, the earliest dating from 1909. In these cases the land was left in hill and dale and the "soil" consists of solid clay, rock or sand, or a mixture of all three. There is no humus or surface soil and neighbouring trees are as likely as not planted in completely different conditions. The drainage is, however, usually free. The planting of such ground was at first experimental and a large variety of species was tried. After forty years' experience European larch, sycamore, oak and ash are usually planted.

It is, nowadays, however, the policy to roughly level the ground before planting as, owing to the steepness of the "hill and dale" left after extracting iron ore with modern machinery, it is considered that the management of woodlands under these conditions cannot be economically or successfully undertaken.

Grange Road Plantation

This is an area of some 35 acres planted in the winter of 1954-55 with a wide variety of tree species on land that was levelled after the extraction of the iron ore. The general planting scheme is three rows of larch alternating with three rows of oak with hornbeam and grey alder equally spaced throughout. Small plots of other species are grown in pockets where the soil is different; shelterbelts of sycamore, etc., surround the area.

The following species may be seen. Oak, red oak, sycamore, beech, hornbeam, alder, poplar, several pines and spruces, larch and *Thuja plicata*. Of these the oaks and sycamores are intended as final crop species; beech partly as a soil improver and in places as a final crop; larches, pines and spruces mainly as nurses and species for intermediate yield; poplar on the moister areas; alder as a soil improver and nurse species; hornbeam as a soil improver, and *Thuja* only as an experiment (so far not very successful).

"C" Pit

This is an area of nine acres where the main interest is in the poplars which are mainly of black Italian type. The older part of the area was planted in 1909 with a mixture of larch, Scots pine, beech, sycamore, *Robinia* and poplar, and the fifty-eight of the last-named species which remain have an average girth at breast height of six feet.

The remainder of the area was planted in the winter of 1922-23 with European larch, and in the winter of 1928-29 some sycamore were introduced.

After thinning in 1954 the estimated average standing volume over the whole of the nine acres was about 1,200 hoppus feet per acre.

Glebe Pit ("F" Pit)

An area of twenty acres, half of which was planted in the winter of 1910-11 with a mixture of oak, ash, beech, hornbeam, sycamore, elm, poplar and European larch.

Further areas were planted from 1916 to 1918, some of which were felled during the 1939-45 war and have since been replanted. An area of twelve-and-a-half acres gave an estimated standing volume of 2,000 hoppus feet per acre after the last thinning in 1954.

"B" Pit

Planting started here in the winter of 1908-09 and this was one of the first unrestored areas to be afforested. The following species were used: oak, ash, sweet chestnut, acacia, grey alder, poplar, Scots pine, Austrian pine and European larch.

Further plantings were made at intervals up to 1936. Of the original planting about fifty of the poplars remain, their average girths at breast height being five feet. After thinning in 1953 the estimated volume left standing, including all species, over the whole area, was 1,200 hoppus feet per acre.

"G" Pit

This small area of 2½ acres was planted in the winter of 1915-16 with sycamore mixed with Japanese larch; but only very few of the latter now remain.

Further plantings were made at intervals up to 1921 with beech, ash, sycamore, poplar and larch.

The estimated volume per acre of the area of sycamore, standing after a thinning in 1953, is about 1,000 hoppus feet.

Corby Estate

This estate, which is owned by Messrs. Stewarts & Lloyds Minerals Ltd., is centred around Corby, in the past a very small village but, owing to the iron-ore workings, now a rapidly developing centre of the steel industry.

There are already some 700 acres of dedicated woodland on the Corby Estate and almost all of the plantations are unrestored ironstone workings which consist of a conglomeration of sub-soil and may contain, in varying quantities, limestone, sand, estuarine and boulder clays. It is frequently difficult to distinguish where one type starts and the other finishes, but the most difficult areas from the afforestation point of view are undoubtedly those containing a high percentage of boulder clay. The drainage of the lighter areas is often excessive and drying-out occurs in the early years of growth, while on the heavy areas water collects and forms ponds in low places. Most of the area lies between 300 and 400 feet above sea level and the rainfall amounts to twenty-four inches per annum.

After working for ironstone has been completed the land has generally been left in high ridges and deep hollows—known as "hill and dale". The 700 acres of plantations are made up of three main blocks. The nursery, of about two-and-a-half acres, supplies all plants for the afforestation schemes, and a stock of 200,000 seedlings and transplants is maintained. About fifty acres a year have been afforested for the past twelve years.

As soon as an area is available for planting, rides are bulldozed across the

banks. These are made at distances of about 200 yards and are fifty feet wide. Normal rabbit fences are then erected.

When planting was first started on this type of land it was considered best to leave it a few years before planting took place—it then being considered essential that the exposed sub-soil should first be allowed to weather. It has since been found that trees can be planted with equally good results immediately after the land has been worked. This latter method has the advantage that the trees become well established before serious weed-growth develops. It is still found desirable, however, on the areas of heavy boulder clay to wait for two or three years before planting, since these banks tend to subside and slip considerably. Even here, fencing should be done at once to prevent the entry and establishment of rabbits. Myxomatosis has not entirely eradicated rabbits and it is not yet considered advisable to plant without fencing. Planting done before Christmas usually proved more successful than later.

To facilitate extraction of thinnings, and also for drainage, no trees are planted along the bottom of the dales.

On the heaviest boulder clay areas the only species to have grown well so far is the common alder. Oak grows very slowly. On the limestone areas the best results to date are from sycamore, European and Hybrid larches.

On the light soils sycamore, European larch, Corsican pine and Scots pine grow well.

Planting is usually in mixtures of which the following have been used. On light and limestone soils, an intimate mixture of:

40 per cent European larch.
40 per cent Sycamore.
20 per cent Corsican pine or Scots pine.

On heavy soils: Oak and alder.

Rate of Growth:

Species	*Year of Planting*	*Soil*	*Average Height Spring, 1956 Feet*
Alder ..	1942/3	Heavy Boulder Clay	21
European larch	1943/4	Limestone	19
Scots pine ..	„	„	12
Sycamore ..	„	„	15
Hybrid larch	1947/8	Lime mixture	15

Cowthick Plantation

This area was planted during the winter of 1948/9 with European larch, Scots pine and sycamore. Part of the plantation was made on land levelled after working and part on unlevelled land. A comparison of the growth can easily be made on the two sites. In the early years it has been obvious here that growth has been more rapid on the unlevelled area.

A good view may be seen, along a ride on the left-hand side of the road, of typical areas of a 200-acre block of plantations on an unlevelled area of "hill and dale" on the better limestone soils. The plantations were formed in the winter of 1943/44 with European larch, sycamore, Scots pine and Corsican pine, and were beaten up in 1945/46.

An area of four acres on very heavy boulder clay, unlevelled after working, and planted in the winter of 1942/43 with oak and alder.

It will be noted that the oak has been greatly outgrown by the alder, and the mixture poses debatable problems for future treatment. Some thinning of alder has recently been done to relieve the best oak.

The rest of the area was planted in the winter of 1942/43 with 75 per cent European larch and 25 per cent ash. The ash failed and the area was beaten up with Japanese larch and European larch in 1944. It is interesting to compare growth here with that of the plantations on the limestone soil. The effect of fumes from the steelworks is noticeable on the trees in this plantation.

PLANTING THE HARDLEE FLOW

By E. J. B. HARDCASTLE, *District Officer*
and F. McNICOL, *Forester, South Scotland*

The Hardlee Flow forms a basin in the middle of the Hyndlee Section of Wauchope Forest, near Bonchester Bridge, Roxburghshire. It is approximately 100 acres in extent and the fibrous peat varies in depth from ten to fifteen feet. Prior to planting on this totally undrained site, the vegetation was mainly *Scirpus*, *Eriophorum*, *Calluna*, *Erica tetralix*, *Narthecium* and *Sphagnum*. The elevation is around 1,000 feet, with very little slope, which added to the drainage difficulties. "Flow" is a usual name for a peat bog in the Border country.

According to the original acquisition report this area was considered unplantable, and it was not until Forest Year 1952 that it was decided to plant nineteen acres as a guide to the future treatment of the area. Drains were ploughed at ten feet apart, with a Cuthbertson Single Furrow plough, and turves were cut and laid for the five-foot planting distance. The drains were ploughed wherever the run of the ground allowed it, and every fifth furrow, i.e., about fifty feet apart, was deepened by hand to a depth of three to four feet.

Nine of the nineteen acres were planted with a mixture of *Pinus contorta* (one-year seedlings) and Sitka spruce (2+2 transplants) in a 1:1 mixture, three rows of spruce alternating with three rows of pine. The remaining ten acres were planted with Scots pine (2+1 transplants), Sitka spruce and *Pinus contorta* in a 1:1:2 mixture. Three rows of Scots pine and Sitka spruce were planted alternately, alternating with three rows of *Pinus contorta*. The high Cuthbertson furrows were "stepped" on the leeward side to form a deep wedge-shaped shelter for the plant. All planting was done by the "V" notch method, using a converted entrenching tool which is the normal planting tool at Wauchope. There was no appreciable difference in the sites chosen. Ground mineral phosphate was applied at the rate of one ounce approximately for the *Pinus contorta* and Scots pine, and two ounces for the Sitka spruce. There was good growth in the year of planting, and quite exceptional growth in the subsequent three growing seasons to the time of writing. The average heights of the plants are now:

Sitka spruce	32 inches
Scots pine ..	22 „
Pinus contorta ..	20 „

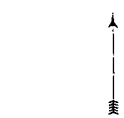
Losses throughout have been very few, and most of those that have occurred were in the one-year lodgepole pine seedlings, which were beaten up in the following year. As a small experiment a few dozen birch, *Thuja plicata*, and Lawson cypress were introduced, and to date are thriving. A particularly noticeable change in the vegetation has taken place with *Molinia*, *Deschampsia flexuosa* and even willowherb coming in as a result of the drainage, and in the latter case manuring. The ground itself is now firm underfoot, whereas prior to drainage it was almost a swamp. A second application of ground mineral phosphate, at the rate of one ounce per plant, was given to all species in Forest Year 1954 as a precautionary measure against any tendency to check.

The general improvement in the site and rate of growth of the 1952 planting was so encouraging by that summer that it was decided to plough and plant the remaining eighty-one acres in Forest Year 1953. To give greater continuous mulching it was decided to increase the Single Furrow Cuthbertson ploughing interval to fifteen feet, and plough with the Double Furrow machine between, thus still retaining the five-foot planting distance. The ground was so wet that it was necessary to use a D.4 and D.2 tractor in tandem to avoid bogging. The high furrows were stepped for planting in the same way as for the 1952 area, and the planting method was also similar. The eighty acres were planted as follows:

(i) Ten acres were planted using a mixture of one-third each of Sitka spruce, Scots pine and *Pinus contorta*, alternating in pairs along the furrows.

(ii) Twenty acres were planted with a 1:1 mixture of Scots pine and *Pinus contorta* in pairs along the furrows and alternating with a mixture of three-sixths *Pinus contorta*, one-sixth Sitka spruce, one-sixth Hybrid larch and one-sixth Douglas fir, i.e.:

S.P.	P.C.	P.C.	D.F.
S.P.	S.S.	P.C.	P.C.
P.C.	P.C.	S.P.	H.L.
P.C.	D.F.	S.P.	P.C.
S.P.	P.C.	P.C.	S.S.
S.P.	H.L.	P.C.	P.C.
P.C.	P.C.	S.P.	D.F.
P.C.	S.S.	S.P.	P.C.
S.P.	P.C.	P.C.	H.L.
S.P.	D.F.	P.C.	P.C.
P.C.	P.C.	S.P.	S.S.
P.C.	H.L.	S.P.	P.C.



(iii) Thirty acres were planted with a 50 per cent *Pinus contorta* and 50 per cent Sitka spruce mixture alternating in pairs along the furrows. Scots pine, Sitka spruce and Douglas fir transplants were used, and Hybrid larch one-year heathland nursery seedlings and *Pinus contorta* one-year seedlings and one-plus-one transplants.
In addition, twenty-one acres were taken over by the Research Branch. The species used there—in addition to those already mentioned—were *Tsuga heterophylla*, *Picea omorika*; a differentiation was made between the Inland and Coastal varieties of *Pinus contorta*.

All species planted in 1953 have shown remarkable growth, like those planted in the previous year. It is perhaps of interest to add that a forest road has now been built across the Flow.

The results of the planting and drainage have been so successful, that

together with the rapidly changing ground vegetation, it may be difficult in years to come to convince the visitor that this area was indeed so unpromising. The work is illustrated by photos 14 and 15 in the centre pages of this Journal.

TINE PLOUGHING AT SPEYMOUTH

by F. J. DONALD,
District Officer, East Scotland

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As its name implies, Speymouth Forest lies near the mouth of the river Spey on the coast of the Moray Firth, the geographical and administrative centre being at Fochabers about five miles inland. With recent acquisitions the total area of the forest is 12,000 acres of which about 6,500 acres are poor exposed moorland. There is evidence that the Dukes of Gordon attempted to establish plantations on this very poor ground but all that remains of these plantings are groups of stunted pine some of which are no more than six feet tall and probably over eighty years of age.

The main "High Moor" area is a plateau dissected by the valley of the Fochabers Burn and rising to Whiteash Hill (866 ft.) in the north and Slorach Hill (717 ft.) in the south. It is exposed to winds from all directions but the most troublesome winds are from the north-west blowing from the Moray Firth. The climate is comparatively mild for this latitude and the rainfall is about twenty-eight inches per annum. The underlying rock is Old Red Sandstone Conglomerate covered by very deep compacted glacial till derived from the same material.

Over most of the area the vegetation consisted of sparse stunted heather, *Scirpus*, crossleaved heath and lichen. In small depressions there were patches of *Sphagnum* with bog asphodel. Under a skin of peat there is a layer of strongly leached drift over a well developed "iron pan" at from nine inches to eighteen inches. Below the "pan" there is the almost unaltered red glacial till. The untreated areas are examples of some of the poorest-looking ground to be devoted to economic forestry.

Experiments at Teindland, on the other side of the river, had demonstrated that economic tree crops could be grown on a similar site given adequate cultivation and an application of phosphate. The idea of cultivating poor ground for the establishment of tree crops is by no means new, and there are examples of tree crops at least 120 years old growing on "lazy bed" cultivation at Dunecht and the Black Isle, and old text books refer to the benefit of "trenching" for the quick establishment of tree crops. The great difficulty was that the cost of cultivating by hand was prohibitive for economic forestry and horse drawn ploughs could not give adequate cultivation on difficult sites.

With the development of tracked vehicles of sufficient robustness and power, the development of ploughs suitable for rough hill ground was only a matter of time. The early ploughs used in forestry were only bigger and stronger varieties of the ordinary agricultural ploughs. On some sites, very deep ploughing was necessary to break up the "iron pan" and with ploughing down to eighteen inches or more using the conventional design of plough, great heaps of earth were thrown out from an equally deep furrow.

While the trees grew well enough after this type of cultivation it was recognised that the trees planted on these heaps tended to be unstable and there was considerable controversy as to the best position for planting; the two main parties being "in the furrow" and "through the slice". It was also recognised that the very rough ground surface left after ploughing would lead to considerable difficulties of extraction, particularly on slopes where the ploughing was on the contour and extraction would of necessity be down the hill.

In the years immediately after the war, ploughing in Speymouth was all done with the conventional design of plough, but since the Tine Plough made its appearance in 1950 this design of plough has been used almost exclusively. The Tine Plough consists of a land-board of two inch armour plating pointed at the leading and lowest end to which is fitted five inch broad hardened steel sock. A mould-board is fitted fairly high to one side and is adjustable. The plough is generally mounted on a Cuthbertson carriage but some models are fitted direct to tractors with a hydraulic lift.

The effect of the plough as it is drawn through the ground is to give a fairly broad shattering to a depth of about eighteen inches and to throw out a furrow to a depth of from four to nine inches according to the setting. The plough then gives the necessary depth of cultivation by distributing the soil, and no great furrow is thrown out which would be a hindrance to extraction.

The present planting programme in Speymouth is 700 acres per annum and, as most of this is on ground which must be ploughed, considerable organisation is necessary to get the best use out of the equipment available. The heather is first burned to facilitate ploughing and to expose obstacles such as boulders, tree roots and wet areas. Road lines and rides are marked by ploughing a furrow on each side. The ploughing is then organised to give the longest lines possible, the plough being lifted when the marked rides are crossed, and to give the maximum of ploughing time for the total working time of the equipment.

In 1952 with the use of headlights and working a double shift an average of sixty acres per week was ploughed with one plough, the maximum for one week being seventy-eight acres. A detailed costing of a three week period, allowing for all possible charges including transport, depreciation, fuel, wages and overheads, showed that 193 acres had been ploughed for a total cost of £309 16s. 8d. or £1 12s. per acre.

The original ploughing with the tine plough gave a furrow which was approximately nine inches deep. It had, however, been decided after much thought that the best planting position was in the tined area in the bottom of the furrow, and it was evident that all that was necessary was to remove the skin of peat so that a setting to give a furrow of only four inches deep was necessary over most of the area. The setting for a shallow furrow has the added advantage of reducing the drag on the tractor and so permits deeper cultivation by the tine.

One unexpected but very satisfying result of the ploughing was the development of vertical drainage. Prior to the ploughing, the "iron pan" being impervious to water had led to waterlogging of the surface layer and considerable run-off during very wet weather. This run-off had cut channels in the peat and eventually into the red till, forming deep steep-sided gullies. With vertical drainage and contour ploughing this run-off had been arrested. areas which had previously been very wet have dried out, and virtually no traditional drainage has been necessary.

For all species one-plus-one planting stock gives the best results and has been used for almost all the planting. This small planting stock, planted in

the furrow, has the benefit of two years' comparative shelter during which to become established. In addition, planting is easy and an average of 1,200 plants per man per day is the normal. All species are given 1½ ozs. of ground mineral phosphate per plant spread round the roots during the summer after planting.

Speymouth is a pine area. Scots pine has been the main species used with European larch in sparse mixture. On the very exposed sites, *Pinus contorta* has been planted, in pure blocks and in mixture with Scots pine. Belts of Japanese larch have been planted as fire breaks. In addition a number of other species such as beech, red oak and birch have been planted in small groups.

The rates of growth observed so far have been very encouraging. The following examples of the P.53 planting taken in the autumn of 1955 are typical:

Lodgepole pine.	Top height	26 inches
	Average current growth	10 ,,
Scots pine.	Top height	20 ,,
	Average current growth	9 ,,
Japanese larch.	Top height	40 ,,
	Average current growth	16 ,,

Within a few years after ploughing the changes in vegetation are very noticeable. There is a fairly strong growth of *Deschampsia flexuosa* and the heather becomes vigorous. In the furrows there is a wide variety of agricultural weeds which are thought to have been introduced with the nursery stock.

So far we know that a vigorous tree crop has been established on these poor sites at a very reasonable cost, but, as the system of cultivation is only five years old, little is yet known of the probable root development. On other types of ploughing it is known that the trees develop an eccentric root system which tends to follow the line of cultivation. In tine ploughing it can be supposed that the main root system will be confined to the narrow tined area. We hope that weathering of the undisturbed drift between the furrows will allow root penetration to give the trees added stability and a plentiful supply of nutrients, but recent investigations suggest that a more complete cultivation is necessary on such sites.

JAPANESE LARCH ON AN AREA OF RANK WEED GROWTH

By R. B. HART

Forester, South Scotland

By its extremely fast growth and luxurious foliage and consequent heavy litter fall, Japanese larch has come to be recognised as a very useful tree tor the reafforesting of felled and neglected woodland, where the quick suppression of weed and coppice growth is very desirable. These sites having generally a good forest soil, the weed growth is usually very rank in bracken, willow herb, whin, bramble, grasses, etc., as well as coppice or natural growth of birch, and the raising of a Japanese larch crop has its own difficulties peculiar to this type of site. The main essential, after good planting, on such fast growing areas is

to *weed sufficiently*, and it is on this very practical point that the writer would say a few words, in the strong conviction that it is the lack of sufficient weeding which causes so many ugly and mis-shapen trees in some Japanese larch plantations.

Normal weeding is quite inadequate, i.e., once during the summer. Two, or in extremely growthy areas three, weedings during the first two years, are essential to keep the lower branches from being suppressed and rotted, and to allow the plant to grow upright and as a *balanced tree*. Where this is neglected, or cannot be done for lack of time, although there may be few actual deaths, many of the plants put all their growth into the leader, and at the end of the first season are spindly with little side foliage. In the second and third seasons they become very twisted and top heavy because the stems have not thickened sufficiently to hold them upright in dense weed growth. This results in many cases in the plants lying on the ground or having badly twisted stems and poor root hold. Ploughing is of great assistance in weed suppression, and good growth above and below ground. Where ploughing is really effective the good form and natural balance and firm root hold are very marked.

Where "lying over" occurs frequently, as it may in some particularly weedy and exposed areas, it is necessary to do something about it in order to get a worthwhile crop, and staking has been tried quite successfully on trees three to six feet high. The best method has been to use two suitable side branches twisted to form a figure eight and tied with twine behind a stake driven firmly into the ground. This has been found to assist many trees to straighten, to become better balanced and to gain a good roothold after another growing season, though in some cases it will take two growing seasons.

Two weeds that are very destructive on young Japanese larch trees are whin and bramble, which if not kept well suppressed have the effect of causing much malformation of trees up to five or six feet high by continual whipping and bruising of the stem and branches. This damage is similar to that caused by late thinning.

Finally, it may be of interest to mention that in the July, 1956, issue of *Entopath News*, in an article on the blowing of young poplars, it is mentioned under "A Controversial Point" that "there is a strong impression . . . that those trees which have been pruned soon after planting, have been more often blown over than unpruned trees". May a parallel not be drawn between the behaviour of the Japanese larch which has been "pruned" by heavy weed growth and its root system badly restricted, and the poplars pruned soon after planting which will also be top heavy, ill balanced, and of poor root system?

THE ECONOMIC APPROACH TO WEEDING IN THE ESTABLISHMENT OF TREE CROPS

By B. R. HAMMOND
Forester, South-West England

There can be little doubt that a considerable percentage of the cost in producing a satisfactorily stocked tree crop is absorbed by weeding, and a closer study of this operation may well prove of value.

It is, I feel, important to bear in mind at all times that the purpose of

weeding is to allow the young trees to develop without *damaging* interference, and to ensure their leaders have unobstructed passage in their upward growth.

In practice it is more usual than not to find a weeding "complex" in the minds of the worker, his attitude generally is "I planted the trees, and I am here to see that they grow to the exclusion of everything else". This is no doubt an admirable supposition, but in a strict economic sense, quite a misguided one.

All who have had charge of weeding operations know only too well the constant reminders necessary not to weed small grasses, etc., which are doing no harm to the growth of the tree crop whatever, and it is common to find after the efforts of the weeding gang, pathetic lines of small trees standing naked and unashamed, amidst a forest floor resembling a trim brown waste—this is possibly of considerable pride to the workers, but is largely wasteful and quite unnecessary.

The first essential therefore is to instil into the minds of the forest workers, just how much work is needed (a very difficult and unthankful task) and secondly and of even more importance, to give them clear and concise instructions as to which weeds are definitely harmful, and which do little or any harm.

It is the latter point that is not fully understood by a large number of people, and a short review of the more common weeds may be of interest.

Possibly the most harmful and universal of all forest weeds is bracken, and the common fault in dealing with this is failure to attack it early by whipping rather than by cutting it at ground level later on with a hook. It might be argued the weed is so vigorous that it is impossible to deal with it in this way over large areas, but it cannot be denied whipping is faster and thus cheaper than cutting, and the weakening effect in early whipping is of immense value, and another important but less remembered point is that the whipping of uncurled fronds minimises considerably the fire risk that results from the withering of fully expanded fronds if cut later on.

Apart from bracken, the majority of forest weeds localise themselves according to soil types, elevation, proximity to the sea, etc., but generally they can be classed as woody, herbaceous, or grassy.

Of the woody type of weeds, possibly heather, honeysuckle, blackberry and broom constitute what may be described as the black sheep, which must be ruthlessly attacked from the early years—all can well be left until the end of June before cutting. A point to remember here is, if by close inspection only a very small percentage of plants are actually being smothered, it is better to let these few struggle for existence and to delay the weeding so that it need only be done once, rather than put the men in, and have to go back again in another two months. Experience has shown that the percentage of complete loss through heavy wood weed type suppression is very small, providing the crop is thoroughly weeded before snow, or weight of weed growth, bury the small plants.

The herbaceous weeds include such prolific croppers as willow herb, foxgloves, nettle, wood spurge, dog's mercury, etc. Possibly the effect of all these, with the exception of willow herb, is considerably overestimated as to the damage they do. The smaller ground weeds such as dog's mercury and bluebell, can safely be completely ignored, and with the exception of the denser patches of willow herb, one weeding towards the end of the growing season should be sufficient. Many of us have witnessed men diligently cutting dog's mercury and bluebell, a pointless and thoroughly wasteful procedure which should be utterly stopped.

Of the grasses, here much depends upon the species to be grown, and the type of grass; on many occasions on downland chalk areas, where beech is the major species, considerable harm can be done by over-cutting of even dense grass. It should be always borne in mind that beech is particularly susceptible to sun scorch, and grass protection is invaluable as a safeguard against this, generally weed your grass areas late (if necessary at all), except where oak crops are to be grown. Oak is particularly unhappy in dense grass, and here it may be necessary to weed more often and more thoroughly than in any other weed crop excepting bracken.

Another important point as regards the economics of weeding is careful study of the area concerned. It is for example easy to overlook the fact that trees grow, as well as the weeds, and with such rapid growth as is found in larch, for example, an area that may look as if it requires immediate weeding may look quite happy six weeks later. A rough but probably correct guide therefore is to concentrate early weeding on your *slow-growing* light-demanding species, and leave your light-demanding *fast-growing* ones until later, with your shade-bearers always the last.

There are several factors that conflict with this guide however, which cannot make it one always to be followed, and it is here that the skill and knowledge of the supervisor is of such importance.

For example, study of the site, especially as regards to moisture content and moisture holding ability, is essential. How many foresters for instance have wished sincerely in long periods of drought, that they had not been so zealous in weeding early, on dry exposed sites. Although possibly a slow-growing light-demander is planted, it may be vitally important to delay weeding to protect the crop, and it may be necessary to weed your wetter areas first, merely to retain this protection on the more exposed sites.

Viewed broadly therefore weeding is a complex and extremely difficult operation if the main purpose of it is kept to the forefront, that is to get a satisfactory number of trees out of the weed growth, in the quickest possible time, at the lowest possible cost.

Lastly the main economic factor, that is the men who do the work, should be made to understand that, however carefully they clear the weeds from the trees, in cold hard cash their efforts are undesirable if more than the minimum necessity of work is done. In ten years time all traces of their handiwork will have disappeared, and only sad red figures on the debit side of the cost account be left to remind them of *weeding costs.*

A NOTE ON SOME MIXED CONIFER PLANTATIONS IN MID-WALES

By G. J. FRANCIS

District Officer, North Wales

In March, 1932, brief notes appeared in the Forestry Commission Journal on a plantation near Carno, Montgomeryshire. The following notes aim to give a summary of the observations made in 1932 and a record of observations made in 1955. In addition a description is given of a plot of pure Sitka spruce adjoining the mixed conifer plantation—the pure Sitka was not described in the notes made in 1932.

Summary of Observations made in 1932

Situation. An exposed hill top at 1,200 feet.

Climate. Moist: rainfall probably between 50-60 inches per annum.

Soil. Seven-inches dark loam on a compact sub-soil of red-yellow clay loam.

Vegetation. Fine grasses, bracken and gorse.

The following notes were given on small plots of regular mixtures:

A. Japanese Larch/Corsican Pine

Fifty per cent mixture in alternate rows at 4½ feet spacing.

Japanese Larch
Wind bent, slight tendency to corkscrew stem. Height 21 feet.

Corsican Pine
Straight and well shaped. Height 16 feet.

B. Japanese Larch/Sitka Spruce

Fifty per cent mixture in alternate rows at 4½ feet spacing.

Japanese Larch
As for A but more branchy. Height 19 feet.

Sitka Spruce
Leaders have suffered from whipping by Japanese larch branches. Forking of leaders is in evidence. Height 16 feet. 40 per cent of Sitka spruce suppressed by Japanese larch.

C. Norway Spruce/Corsican Pine

Two rows Corsican pine, one row Norway spruce, at 4½ feet spacing.

Norway Spruce
Those in canopy of good form. Height 10 feet.

Corsican Pine
Good form. Height 15 feet.
65 per cent of Norway spruce suppressed.

D. Norway Spruce/Scots Pine

Fifty per cent mixture in alternate rows at 4½ feet spacing.

Norway Spruce
Good form. Height 10 feet. 50 per cent suppressed.

Scots Pine
Poor form. Height 13 feet.

No plots of these species planted pure for comparative purposes.

Japanese larch too quick growing for Corsican pine and starts too quickly for Sitka spruce, though the Sitka spruce will probably overtop the Japanese larch if they do get stronger.

Sitka spruce much more liable than Norway spruce to damage to its leader.

Corsican pine/Norway spruce seems to be a bad mixture and the Norway spruce/Scots pine has little to commend it.

It would appear that pure Norway spruce would obtain a better result than the Scots pine under these conditions of soil and climate.

Past Treatment and History

The mixed conifer plantation was planted in 1920 by the late Lord Davies of Llandinam on the advice of the late Mr. Fraser Storey; a pure plot of Sitka spruce was planted in 1915. Beating up was carried out for two years after planting and great care was taken to beat up the area exactly species for species. Thereafter there is no record of any treatment until 1952.

Early in 1952 the plantation was purchased by the Forestry Commission and in August of that year a thinning was carried out. Although the thinning was followed by gales and the area faces the direction from which the worst gales came, no windfall occurred. In the gales of November-December, 1954, very slight windfall occurred. The damage was confined to two or three groups of a few trees in the pure plot of Sitka spruce and individual isolated trees in the mixed conifer plantation.

Condition of the Crop in 1955

A. Japanese Larch/Corsican Pine

Japanese larch rather windbent and constitute 85 per cent of the crop. Almost all the Corsican pine has been crowded out. The Corsican pine do, however, show signs of benefiting from a thinning carried out in August, 1952.

Japanese Larch—Mean Height=42 feet. Top Height=49 feet.
Corsican Pine —Mean Height=33 feet. Top Height=38 feet.

B. Japanese Larch/Sitka Spruce

The Japanese larch are rather windbent; they make up 70 per cent of the total crop and their growth is vigorous. The Sitka spruce are of good form but half of the original crop has been crowded out by the Japanese larch in the earlier years.

Japanese Larch—Mean Height=46 feet. Top Height=50 feet.
Sitka Spruce —Mean Height=46 feet. Top Height=50 feet.

C. Corsican Pine/Norway Spruce

Corsican pine is generally of poor form with very thin crowns. However, it does show signs of benefiting from the thinning. Many of the Norway spruce have been suppressed, but where they and the Corsican pine are of similar height, they are of good form. There is evidence of *Fomes annosus* in the Norway Spruce. The incidence of occurrence does not appear to be high nor the state of infection to be advanced.

Corsican Pine —Mean Height=33 feet. Top Height=38 feet.
Norway Spruce—Mean Height=33 feet. Top Height=39 feet.

D. Norway Spruce/Scots Pine

Norway spruce generally of good form, particularly where thinning and suppression have resulted in a group of pure Norway spruce. Scots pine was of very poor form and rough growth whether occurring in pure groups or in mixture with Norway spruce.

Norway Spruce—Mean Height=33 feet. Top Height=39 feet.
Scots Pine —Mean Height=32 feet. Top Height=34 feet.

A Pure Plot of Sitka Spruce

Adjoining the mixed conifer plantation described above is a pure plot of Sitka spruce planted in 1915. The site of this plot is a fairly steep slope, and

the vegetation on either side of the plot consists mainly of bracken. The natural drainage is good and the soil conditions similar to those in the mixed conifer plantation. The site is exposed and the aspect east elevation 1,100 to 1,200 feet.

Until August, 1952, when a first crown thinning was made, no treatment of any kind had been carried out. The thinning was cautiously done and very few windfalls have occurred. There is still considerable evidence of previous neglect. The crowns are poorly developed and the stems show comparatively little taper.

Sitka Spruce—Mean Height=55 feet. Top Height=60 feet.

The following volume measurements were obtained in this plot. Yield Table Figures are included in brackets for comparison. (Quality Class V.)

Thinnings		1,000 cu. ft. per acre (1,660)
Standing	..	4,015 „ „ „ „ (3,190)
Total Yield ..	..	5,015 „ „ „ „ (4,850)

(The volume of 1,000 cu. ft. per acre thinnings is an approximate one.)

Discussion

The outstanding point in the history of this plantation has been the complete lack of attention. In fact there is no record of any treatment having been carried out until 1952. This has probably contributed to the suppression in the earlier years of the less vigorous species in the mixtures, e.g., Corsican pine and Norway spruce in mixture with Japanese larch. In the case of the only pure crop, Sitka spruce, the lack of treatment has resulted in the development of poor crowns and stems with little taper. Generally speaking the total crop yield does not seem to have been affected; however the standing volume after thinning is greatly in excess of the yield table figure. This point is illustrated by the figures given for the pure Sitka spruce plot.

Sitka spruce is generally vigorous and healthy, and the exposure has little or no effect upon it. Japanese larch is generally windbent but vigorous in growth. The Norway spruce tends to be suppressed in all the above mixtures, except occasionally when with Scots pine. On this site Scots pine is invariably of very poor form and rough growth. Corsican pine does grow moderately well but has thin foliage and very poor crown development. It does not appear that it will survive much longer on this site.

SOME NOTES ON THE MANAGEMENT OF NATURAL ASH CROPS

By B. R. HAMMOND

Forester, South-West England

In the Forests of Moccas and Aconbury, Herefordshire, two units lying to the north and west of Hereford respectively, on sites which have good fertile loam soils over the Old Red Sandstone, and both being at elevations from 300 to 900 ft. above sea level, extensive areas of natural ash exist, of varying age, and of exceptionally fine quality.

The two Forests are interesting as regards this prolific ash growth, as groups can be found of many different ages, and lessons can be learned from their present condition which may be of interest for future guidance.

It appears that the past practice, before the woods were taken over by the Commission, has been to treat natural ash as a crop capable of taking care of itself up to twenty-five years or even older, and the policy appears to have been to leave the natural clumps severely alone. When labour or other work allowed, the clumps were inspected and the better trees selected in the normal way.

Recently at Moccas I have had occasion to examine many of these clumps carefully, and the first point that has struck me is that in my view a very large percentage of fine ash has been spoiled by this system. Coarse, forked and bad-shaped trees have in many cases destroyed well-shaped trees, and in many instances large areas now exist comprising only short misshapen ash, which have completely dominated the finer and straight-boled trees.

It appears to me therefore that natural ash must have careful treatment from the start, as from my own careful inspection I have observed that ash at from four to six years of age is very mixed in type, but at this age there is ample good quality stock. Whereas I have personally thinned clumps of from fifteen to twenty years of age, and had difficulty in finding sufficiently good trees to form an even and reasonable stocking, and in many cases bad-shaped trees have had to be accepted in order to keep a reasonable ground cover and canopy.

There is little doubt that all the natural ash on the two units concerned could have been of first quality, but the policy of waiting so long before attending to the crop has resulted, in my view, in irreparable wastage and loss of much of the best of the crop, and I would strongly advocate attention to natural ash from a very early stage.

It is apparent in most ash crops, when natural, that the abundance of seed produces a great density of seedlings, possibly far more than any other crop, except some naturally regenerated conifer stands, or an occasional heavy sycamore mast. Although this may be highly desirable, unless almost immediate steps are taken to assist the crop, the very excessive density may cause inherent weakness of stock from the start. Although I have no concrete proof, other than by close observation of young ash at this stage, I am of the opinion that this weakening which must occur through great density, has a close relationship to later attack by the ash shoot moth. This may possibly be borne out by the fact that in crops of from twenty to thirty years, noticeable exceptions to damage from this moth are the well grown healthiest looking trees, which although not often as heavy in trunk form as the affected trees, as a general rule occur in the more open areas of the crop. This is not easily seen, as in dense untreated ash the density is such that there are few places where trees are not closely packed together; but even when this is so, observing closely the stem position of such trees from their neighbours will as a rule confirm this fact.

A further point in connection with terminal bud damage is the method employed in removing bad-shaped stems. Most foresters know the length of ash in a dense crop makes removal an awkward business, the tree to be removed is often forked or crooked, and after cutting catches in the standing crop, with a result it is shaken and wriggled to free it, which often causes considerable damage. I would strongly recommend care being used in the removal of every such tree, never pushing it forward through the crop, but withdrawing it carefully backward, thus doing as little damage to the terminal buds of the standing trees as possible.

To sum up therefore, I would suggest natural ash crops be inspected as soon as possible after appearance, dense masses should be thinned, by hand if necessary, and crowding in growth eliminated as soon as possible.

During the next ten years careful watch should be kept, and each year, all coarse, forked and whip trees also eliminated, and well grown but forked stems, pruned.

The stocking should be reduced yearly until a stem spacing of at least four-and-a-half feet is reached by ten to twelve years.

This will no doubt reduce considerably the volume of early thinnings, but in my opinion will ensure a far higher percentage of well shaped stems from which it will be far less difficult to select the later final crop, while the major thinnings will be of far greater value.

CULTIVATION OF WILLOWS FOR BASKET MAKING

By K. G. STOTT, B.Sc.
Willow Officer, Long Ashton Research Station, Bristol

Basket making is one of the oldest industries in this country. Evidence of its great antiquity is provided by wickerwork fragments which were unearthed from the Glastonbury Lake Village, 100 B.C. By comparison, the growing of willow as a commercial crop is comparatively recent, dating only from about 1800 A.D. Willow growing flourished in the nineteenth century but owing to foreign competition it declined, and of 6,000 acres grown in 1925 only 2,000 acres now remain, and of these 1,300 acres are in Somerset.

Isolated willow or "withy" beds occur in the river valleys of East Anglia and the Midlands but the majority of willows grown in Britain today come from the moors in the Langport area of mid-Somerset. Of all the Somerset moors only those drained by rivers Yeo, Parrett and Tone have been found suitable for willow growing. They have abundant water and good drainage, due to a well maintained system of ditches and pumping stations. The soils are not acid and consist of clay and alluvial deposits overlying well humified peat. The soils in which willows are grown are designated as to the Midelney and Sedgemoor series in the Soil Survey of Great Britain. They are fully described in the Survey's memoir—*The Soils of the Glastonbury District of Somerset*, H.M.S.O., 1955. In some moors the soil is continually being enriched by silt deposited during the winter floods. Though these conditions are ideal, the successful modern development of basket willows in Somerset and the predominance of the area today owe much to the late Mr. H. P. Hutchinson, Willow Officer at Long Ashton Research Station from 1922 to 1939.

The willows (*Salix*) are a large genus widely distributed throughout the world and the many species are frequently further sub-divided into varieties. In Great Britain the majority of basket willows grown commercially are varieties of *Salix triandra*, though those of *Salix viminalis* and *Salix purpurea* are locally important in the Midlands and East Anglia.

In Somerset, where *Salix triandra* variety Black Maul predominates, willows are grown in rotation with grass. In the preparation of a willow bed, grassland is first ploughed in the autumn and then repeatedly harrowed the following spring.

It is most desirable that the willow cuttings, usually only about twelve inches long, should be planted in clean land. The cuttings soon break into growth and during their first two seasons they must be carefully and frequently weeded. This was formerly done by hand-hoeing but now small power-driven cultivators are used. From the third year onwards any weeding required is done early in the season by sickle. The shoots or "rods" from each stool grow rapidly and by the end of the growing season may reach ten feet in height. The rods are cut annually but are not considered fit for sale until the third year after planting.

Throughout the growing season willows are easily damaged by wind, hail and frost and are attacked by a number of insect pests of which the Button Top Midge, *Rhabdophaga heterobia*, the Willow Weevil, *Cryptorrhynchus lapathi* and Willow Beetles of the genera *Galerucella* and *Phyllodecta* are particularly important. Also in some seasons, the Willow Rust, *Melampsora amygdalinae* and the Black Canker fungus, *Physalopora miyabeana* may cause serious damage. Control is in many cases difficult since the nature and lay-out of the crop make it impossible to take advantage of recent developments in spray machinery.

The willow rods are cut during the winter and spring, are tied into bundles and then stacked ready for carting away. In some of the flooded moors this is still done by boat using the ditches as waterways. After carting, the willows are graded by length. The freshly cut bundles are known as "Green" but after they have dried out and are no longer alive they are termed "Brown". Poor quality material is marketed in these forms, but better quality material is usually first processed by the growers into one of two grades "Buff" or "White".

Processing consists of peeling the bark off the rods and then drying them. "White" rods are prepared by peeling away the bark from the rods during the short period when they are just beginning to grow. At that time the bark comes away easily from the wood leaving pure white rods. Some potential "white" rods are left until the spring before being cut and peeled, but the majority are "pitted" before they are peeled. "Pitting" consists of standing cut willow rods in water in the winter as soon as they have been cut, leaving them there until spring and peeling them when they have begun to sprout.

In the preparation of "Buff" rods, the bark is softened by boiling the willows in open tanks for several hours. It can then be easily removed, but owing to the release of decomposition products, the wood is stained a rich reddish brown.

When peeled, both "Buff" and "White" rods are spread along any convenient fence to dry in the sun. They are then bundled and stored ready for dispatch to basket makers all over Great Britain.

Illustrations of willow growing appear on the centre pages as photos 16, 17 and 18.

EUCALYPTUS AT WHITTINGEHAME ESTATE, EAST LOTHIAN

By G. M. L. LOCKE

District Officer, Research Branch

Whittingehame Estate, owned by Lord Balfour, lies in the county of East Lothian five miles south-west of the town of Dunbar and six miles east of Haddington.

Here grow some notable *Eucalyptus* trees, one of which is probably the oldest outside Australia. This parent tree is estimated to be 104 years of age and has a height of ninety-six feet and an overall girth at breast height of twenty-two feet. At two feet from the ground it divides into three stems which afterwards divide into six main limbs.

In 1861 it was killed down to ten feet from the ground, but in 1894 it endured a temperature of —2°F. without serious injury. It ripens seed every year about September, and the seeds germinate and grow equally well if sown in autumn or spring.

The seed of this tree was probably obtained from Tasmania, and Elwes and Henry give the following information about the tree.

> "*Eucalyptus whittingehamensis* . . . varies from *E. gunnii* in the absence of glaucous bloom on the branchlets and the leaves of the adult plant. . . . This tree is considered by Maiden, who has seen branchlets both of the parent tree and of its seedlings, to be *E. gunnii* but it does not match any of the specimens in Kew herbarium, . . . It resembles *E. acervula* in the absence of glaucous bloom on the branchlets and in the size and shape of the leaves; but has only three flowers in each unbel and bears different fruit. It is certainly not *E. urnigera*. Seedlings of the parent tree show considerable variation in the foliage, which in some specimens together with the branchlets and flowers, is glaucous, and this points to a hybrid origin. Moreover, some of the seedlings at least are considerably hardier than the parent. I have not been able to make a study of the seedling trees in the fruiting stage; but I suspect that the Whittingehame tree is a hybrid, with *E. gunnii* as one of the parents. The peculiar urn-like shape of the fruit suggests the possibility of *E. urnigera* being the other parent, though the tree at Whittingehame does not resemble the latter in foliage".

Both *E. gunnii* and *E. urnigera* are frost-resistant, and the seedlings appear to have inherited this resistance together with the tolerance of *E. gunnii* for wet soil conditions.

Nearby on the site of the old castle is an ancient yew tree under whose branches, tradition has it, the murder of Darnley, the Regent of Scotland and husband to Mary, Queen of Scots, was plotted in 1567.

ARAUCARIAS AT MONREITH ESTATE WIGTOWNSHIRE

By G. M. L. LOCKE

District Officer, Research Branch

Monreith Estate, owned by Sir Aymer Maxwell, Bt., lies on a peninsula known as the "Machars of Wigtownshire" which is bounded on the west by Luce Bay and on the east by Wigtown Bay. The elevation of the peninsula seldom exceeds 250 feet, and on the west coast attains this elevation within a short distance of the coast. The centre of the area is undulating and the farms are interspersed with large areas of moorland or "mosses" which are usually areas of undrained or partially drained grazing land.

Monreith lies close to the west coast and occupies a fairly level area of land with a north-westerly aspect and with elevations ranging from 100 to 150 feet.

Little Rashnock Plantation has an area of two acres and is one of the very few plantations of *Araucaria araucana* in this country. It stands on a small isolated knoll and is only partially sheltered by the surrounding plantations. The date of planting is believed to be 1910 but ring counts taken in 1956 show the age to be forty. The seed was not taken from any of the large *Araucarias* on the estate but is reputed to have come from the avenue at Castle Kennedy Estate, near Stranraer, which is the property of the Earl of Stair.

The following information on the stand was taken in January of this year.

Area of plot=two acres.

Number of trees=705.

Average quarter girth, breast height=6 ins.

Average total height=25 feet.

Tallest tree=36 feet.

Average height to 3 in. diameter top=21 feet.

Total volume=3,170 hoppus feet per acre.

Mean volume per tree=4½ hoppus feet.

There is evidence of coning on several of the trees, but the plantation has been open to grazing and any regeneration has been destroyed. There are several distinct types of tree present of which the two main ones are (*a*) a tall slender type and (*b*) a squat, short-boled type. Height increments of all types are now generally small and amount to only a few centimetres per annum. Quite a number of the trees have also died recently from an obscure cause.

This plantation, although of considerable interest, is unlikely to encourage the growing of *Araucaria* as a commercial proposition in this country. Its use as shelterbelt species is, however, well worth considering. In more sheltered spots, specimen trees have shown fairly rapid growth but it is a species which is now out of fashion and existing specimens are confined to parks and gardens. The species was first introduced into this country in 1795 but it was not widely planted until 1844 when William Lobb sent a considerable amount of seed to this country and most of the older trees date from this introduction.

NOTES ON SOME NORTH AMERICAN TREES

By D. L. SHAW

Forester, North Wales

Though the trees described are not accepted, so far, as major species in our afforestation schemes, we have planted them over a restricted area, and as amenity features, and these notes may provide some background interest.

Eastern White Pine (*Pinus strobus*)

The white pine is the largest conifer growing east of the Rocky Mountains. At maturity it stands from 90 to 150 feet tall, occasionally attaining 200 feet. History records that this tree figured on a seventeenth century Massachusetts coin and on that colony's flag, which flew from colonial ships in the American War of Independence Revolution.

White pine rarely grows in pure stands, but in association with deciduous trees such as maple, beech or birch or with other pines. Up to the early years of the present century, this tree furnished the best known and lightest quality timber to the American trade. Matchmakers and shipbuilders relied for years on this tree. The wood is soft, light, even-grained and easy to work. Due to its conformation and colour it has been popular as an ornamental tree. Since 1909 white pine blister rust infestation has been widespread, in the United States as well as in Great Britain.

Western White Pine (*Pinus monticola*)

Discovered by David Douglas in 1831, seeds of this species were sent to Britain, but not until 1850 did it become cultivated here. The range of the western white pine extends from Vancouver Island in the north to northern Idaho, western Oregon, southern California and the middle Sierra Nevada. Grows from near sea-level in British Columbia to elevations between 3,000 and 6,000 feet in Oregon. The largest known specimen flourishes near the town of Elk River in Idaho—219 feet high with a breast height circumference of twenty-one feet three inches. Trees seldom bear fertile cones before reaching forty years. The wood is valuable, white, straight-grained and free of flaw. Generally, western white pine grows in mixture with western hemlock, Douglas fir and lodgepole pine. Western white pine grows in regions where temperature varies from —26° to +98°F., and in rainfall areas of between 15 and 60 inches annually. Unfortunately it too is attacked by white pine blister rust.

Western Hemlock (*Tsuga heterophylla*)

Captain George Vancouver, the English explorer, was in all probability the first white man to see the western hemlock, when he came upon it in the Puget Sound area in 1792. The species abounds from Pacific beach areas up to mile-high mountain levels where annual rainfall varies between 60 and 100 inches. The western hemlock is most abundant in Washington, Oregon and western British Columbia and is the largest of the ten known species of this North American and Asiatic genus. In British Columbia a height of 160 feet is not uncommon. Generally western hemlock is found in mixture with other conifers. The wood is fairly uniform in texture and straight-grained, and does not splinter as readily as eastern hemlock. Three times the quantity of western hemlock timber goes into pulp than into lumber. The bark's tannin content averages between 12 to 22 per cent, and much of it is used for tanning leather.

Northern Red Oak (*Quercus borealis*)

This tree is of high amenity and ornamental value and is very fast growing in America. It has an extensive range—Canada, through the North-east United States to Alabama, west to Arkansas and thence north to Kansas, Nebraska and Iowa. Northern red oak thrives in areas where annual rainfall lies between 30 and 55 inches; it dislikes very wet or very dry sites, and is nearly always found in mixture with other oaks, maples and poplars. The reddish-brown wood is heavy, hard and shock resistant. Main uses of the timber are flooring, household furniture, boats, railways sleepers, posts and general construction. One disadvantage, however, is that the timber is difficult to dry and thus tends to shrink and split.

This tree was introduced into England and France during the first half of the eighteenth century and notable plantations exist to-day in Germany, Belgium and France.

PREVENT FOREST FIRES

By DENNIS HEALEY
Information Officer, Headquarters

The newspaper—national or local—can be the forester's greatest ally in the prevention of forest fires. Factual statements about fire danger and fires are almost always assured of a prominent place, and pay dividends by helping make the public more aware of what they and the nation stand to lose by a moment's carelessness.

The reader, perhaps not having access to cuttings from the Press throughout the country, may not be aware of the extent of the support the Commission receives each year in the cause of fire protection. Here is a reproduction from the front page of the *Weekly Scotsman* for April 25th, 1956. It speaks for itself, more especially when it is known that it introduced a page of photographs about fire prevention.

PREVENT FOREST FIRES

Already this year, the nation has lost as much young timber by fire as in the whole of the previous ten years put together. This startling fact underlines the need for great care during the present danger season. Because it is vitally important to all of us to preserve a national asset which is restoring beauty to the hills, we asked the Forestry Commission to give us a statement on the problem. Here it is:

Forest fires can be caused by sparks from a railway engine, by the carelessly-thrown-away cigarette end, by any kind of thoughtless action with flame. To the forester busily engaged at present in completing his planting operations for the year, the recent prolonged dry spell has been a nightmare.

Since the beginning of the year, the Forestry Commission have lost approximately 1,700 acres of young plantations from fire. This figure compares with a yearly average of around 77 acres over the past ten years. The chief cause has been damage from railway engines setting fire to the dry vegetation and thence to the young trees. Muirburning on neighbouring land has also set off several fires which have escaped from those in charge and burned into young plantations.

It is difficult to assess the damage in money values, but what is more important is the loss of so many years of growth, and consequent delay in replacing the plantations. Such is the speed of these moorland fires that the work of many years is burned up in the course of a few hours.

The Forestry Commission have their own fire fighting squads at all large forests ready to go into action immediately a warning is given. In addition, close liaison is maintained with local fire brigades which have already this year showed their efficiency in helping to fight forest fires. Military assistance is also available if required in cases of real emergency.

Elaborate protection methods are laid down at all forests. The Fire Notices, and the red-and-white-painted fire-beater stands will be familiar to most people. Look-out towers connected by field telephone to fire control points are an essential part of the fire-protection arrangements. Patrols are employed to warn picnickers and other people of the fire danger during periods of drought.

It is true that the forests of Scotland are small in area when compared with those of Canada and other countries, but it is this very lack of forests which makes it all the more important to protect those which we have. With the spring and summer months ahead, the danger to Scottish forests from fire will increase and it is hoped that all who use the countryside will be aware of this danger and take precaution accordingly. The scarred hillsides which result from fires are not only a reminder of thoughtlessness, but will also have been the cause of death to birds and animals trapped by the flames.

"Prevent Forest Fires" ought to be the watchword this summer.

FIRE ON THE HILLS

By Dr. C. H. GIMINGHAM

The following article, which presents a new angle on fire problems, is reproduced by kind permission of the Editor of Arbor, *the Aberdeen University Forestry Society magazine.*

Smoke will rise again this spring from countless fires scattered over Scotland's hills. Year by year, strips or blocks of moorland receive this drastic treatment and temporarily become scenes of black devastation—of gaunt, charred heather stumps projecting from the ashes of former vegetation.

Sometimes the fires are carefully controlled and portions of the hillsides burnt in planned rotation, so that each sector has its turn once only in eight, ten or more years. But all too often burning is indiscriminate and its extent is determined rather by chance effects of wind and weather than by good management. Flames may be allowed to spread over whole hillsides or blocks of moorland, and sometimes to run to altitudes well above the limits of the type of moorland for which they were intended. Nor is the legal restriction of muirburn to the early months of the year always adhered to, for in parts of Scotland there are heath fires during the summer which have not all been started by stray cigarette ends, camp fires, or sparks from passing trains. Accidental causes such as these, however, add to the total of fires begun deliberately—especially during fine, dry summers such as that just past. There can be no doubt that fire exerts an annual influence upon the vegetation of hill country which has profound effects. These effects, moreover, have been accumulating over the years ever since the beginning of man's onslaught upon the natural forests which once clothed much of the areas which are now heath and moor.

This cumulative cause of change in the moorland habitats of plants and animals is therefore one worthy of serious investigation. The practice of burning probably first became a regular feature of hill management in the drier, eastern parts of the country. Here it can be made to serve the interests either of grouse culture or sheep farming, since the dense, even-aged stand of vigorous heather which follows burning in these regions provides good cover for grouse and valuable grazing for sheep. In wetter districts on the Atlantic side of the country, however, burning may be employed for the purpose of reducing the shrubby components of the vegetation and allowing the spread of grasses, again for the benefit of sheep.

In a country such as Aberdeenshire, climate and soils alike favour the dominance of heather when trees are excluded. Periodic burning is then an efficient way of keeping the heather crop pure, young and productive over extensive tracts of country. With this as the aim, the necessity of regular and controlled burning can best be judged from observation of areas in which the practice has been discontinued, such as parts of Dinnet Moor. Sheep seek out and thrive upon the young green short-shoots produced on the ultimate twigs of the bush, but when, in the absence of fire, tussocks approach the age of twenty to twenty-five years the production of fresh short-shoots is greatly retarded, at least on the upper branches. In this way as the plants age, so their grazing value falls.

At about the same age, the density of the canopy is reduced, for in time the central frame-branches sag under the weight of shoots carried at their tips and begin to die back. This produces a gap in the middle of each old bush, and with the fall in productivity goes a lessening in the provision of cover. The formation of gaps in the canopy initiates a sequence of events which begins

with colonisation by lichens and mosses and may lead in a relatively short time to the entry of birch seedlings, as at Dinnet where the establishment of increasingly dense birch scrub is in progress.

If, on the other hand, the heather community is burnt at the appropriate stage, when the plants are just reaching maturity and before degeneration sets in, this process is arrested. Instead, the ageing community is replaced by a new one composed of young fresh shoots of heather, providing an abundance of succulent short-shoots for grazing and before long re-establishing a closed canopy. This desirable condition, however, is not reached at once but is normally preceded by a series of stages occupying several years, depending upon the severity of the fire and the nature of the environment. The first stage in the recolonisation of a burnt area is usually the appearance of lichens and mosses upon the ashed surface. This temporary community probably modifies the micro-climate close to the ground and allows replenishment of moisture in the surface humus, thus permitting regeneration of the heather. If the fire has not been unduly severe, this regeneration will take place mainly from the "stools" of the old plants and the dominance of heather may be re-established in a few years. Great heat, however, will destroy all the old plants and regeneration is then confined to the growth of seedlings, a slower process often allowing temporary dominance of other species such as wavy hair-grass (*Deschampsia flexuosa*) or bell-heather (*Erica cinerea*) in the drier habitats, or various mixtures of blaeberry (*Vaccinium myrtillus*), cowberry (*V. vitisi-daea*) and crowberry (*Empetrum nigrum*).

In this way heather is prevented from becoming "leggy" and tree invasion is precluded. It might be suggested that these ends are achieved with relatively little damage to the land, and with the production, into the bargain, of a world-famed tourist attraction in a landscape of uninterrupted heather, to be seen in all its purple glory in late summer. Where controlled burning is associated with a dry climate and freely-drained soil this claim may be justified, but, even so, attention must be given to the long-term effects of the treatment, which may be greatly aggravated by ill-considered use of fire.

It is sometimes suggested that burning may actually increase the fertility of the soil, by releasing minerals from ash more readily than they would be returned through decay. There may indeed be a temporary increase of this kind, but over a period of time the result is wastage, owing to the ease with which minerals from the ash are dissolved out by rain water draining through the soil or running off the surface. Of even greater significance, perhaps, are the effects of continued culture of heather alone for generation after generation. Heather litter gives rise to a highly acid humus, which markedly increases the acidity of the soil. The pH under heather plants invading grassland is normally as much as a whole unit lower than that under the grasses only six inches distant. Raw humus, unfavourable for the establishment of seedlings of many species, accumulates; leaching of the upper layers of mineral soil is intensified; and under certain conditions the formation of an iron pan in the "B" horizon is initiated. This in turn may impede the drainage and gradually convert the whole community into some form of peat bog. Alternatively, where there is a delay in the re-establishment of heather following burning, the danger of its replacement by bracken becomes acute.

Even more disastrous results may follow from unrestrained burning in the wetter west of Scotland. While the grazing value of a hill may be temporarily increased by burning off the heather and other shrubs, an inevitable result is the spread of purple moor-grass (*Molinea caerulea*), mat grass (*Nardus stricta*) or deer-hair sedge (*Scirpus caespitosus*), all virtually useless. Such changes may

be irreversible, or practically so in view of the cost of reclamation. Burning of the vegetation cover of peat bogs is regularly followed by peat erosion through the cutting back of drainage channels. So far from increasing grazing value, complete destruction of the habitat may ensue, and water once stored on the hills runs down to valleys already annually threatened with floods.

These facts bear directly upon problems of afforestation in Scotland. In the first place, it is obvious that more than any other factor, fire is responsible for preventing natural re-colonisation of our moors by trees. Further, such re-establishment of woodland as will occur when burning ceases is often limited for a while to birch, owing to the scarcity of seed-parents of pine over considerable distances. Eventually mixed pine-birch forest might reappear in suitable areas, but the fact remains that serious degradation of the soil has been widespread and even partial remedies will take many years. The only way to effect such repair is to re-afforest with carefully chosen species; but the damage has already been enough to place many difficulties in the way of renewing forest cover, since in some regions tree growth for years to come may be so poor as to be uneconomic.

Sheep farming and grouse shooting are part of the economy of our hills and provision for them must remain. But they would gain, rather than lose, if it were possible to set aside tracts of country over which burning would be discontinued. For a time management could be restricted to the encouragement of such tree colonisation as would take place naturally, even if its economic value were negligible. This alone would contribute to a restoration of the balance of wild life, provide additional cover and shelter for game or stock, and begin to restore the water balance of the hills and valleys. In time some of these woods could be improved or replaced by plantations, if rehabilitation of the habitat were sufficiently advanced.

The withdrawal of these areas of land from the sheep farms would naturally demand an increase in the productivity of the remainder. Admittedly this requires capital, but it is not an impossible task. Foremost must come a return to good husbandry, including the proper planning and control of a tool which can be either a useful instrument or a menace—fire on the hills.

POSTCRIPT.—The Nature Conservancy in Scotland are well aware of the problems discussed in this article, and for many of the ideas contained in it I am indebted to Dr. D. N. McVean, of the scientific staff of the Conservancy. Active preparations are being made for giving widespread publicity to the long-term dangers of indiscrimate burning, and for offering practical advice on how to manage the burning of moorland so that permanent damage may be reduced to a minimum.

INTRODUCING PYROLOGY

By WARWICK DEAL

Forester, East England

The fire on the 9th April, 1956, which spread from a private woodland site across open heath into the Forestry Commission plantations at Hempstead Wood near Holt in North Norfolk to the point where it was finally checked over one mile away was, in many ways, a classic. Taking into account the speed at which it travelled, the variety and quantity of vegetable matter it consumed,

the height and heat of the flames, its gigantic three chain leap over the heads of the Cromer Fire Brigade, there has been no equal in local living memory.

If one were to be asked, however, which lesson the experience pressed home the hardest I think one would be compelled to reply that, above all else, it demonstrated the need for a more technological approach to the factors that combine to determine the development and behaviour of forest and heathland fires. For example, no attempt has yet been made to determine—statistically or otherwise—the thermal effect brought about by the various wind forces upon differing kinds and conditions of ignited vegetable matter. Further we have no information relating the rate of combustion with the speed of fire; again, there exists no work which gives the calorific values of, say, heather,

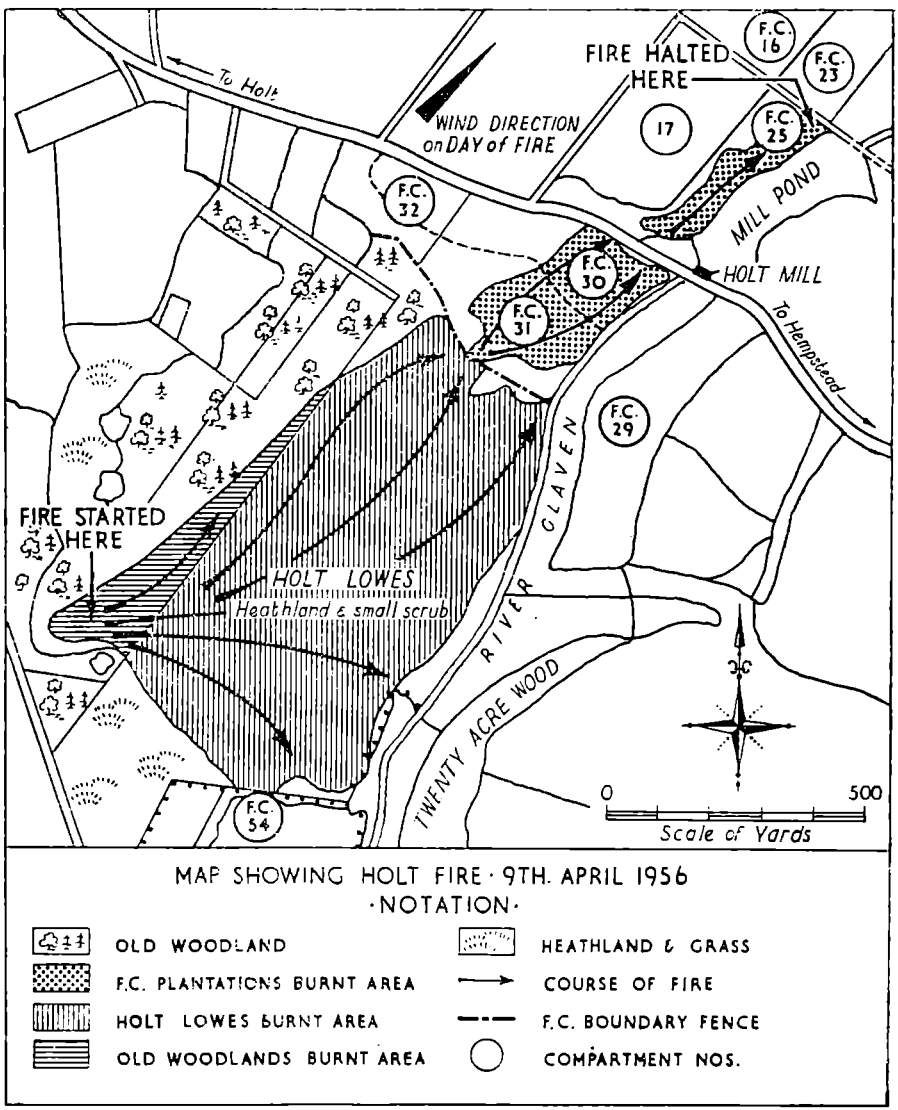

Fig. 29. Course of the Fire at Holt Forest.

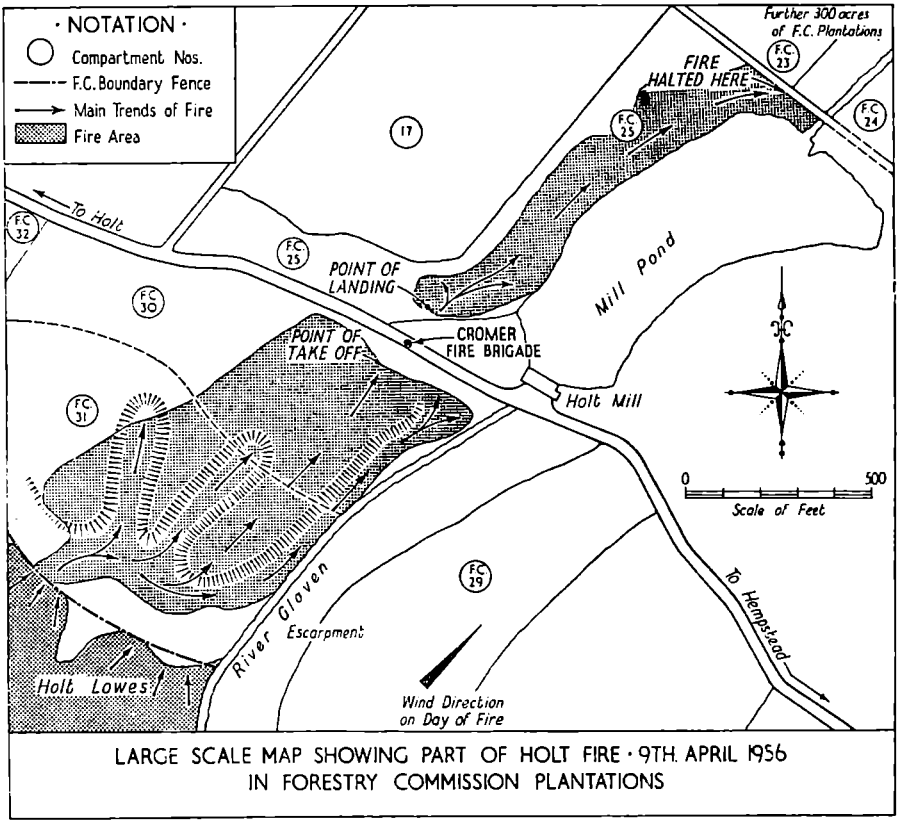

Fig. 30. Detail of the Spread of the Holt Forest Fire.

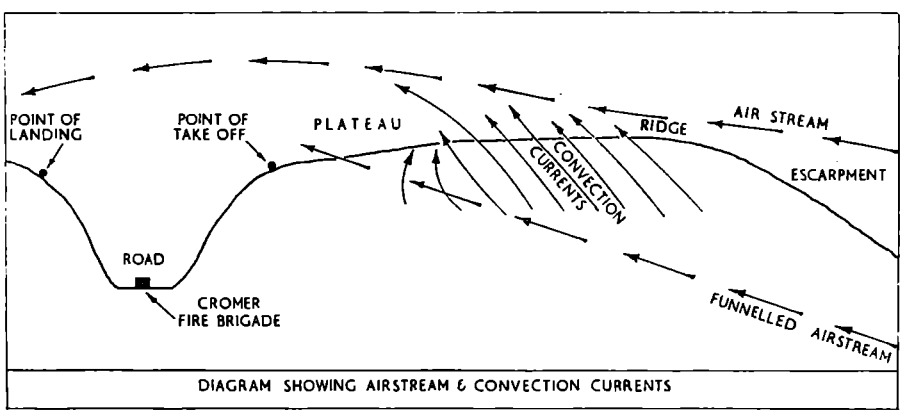

Fig. 31. Cross-section of Holt Forest, to show how the fire jumped the road.

gorse or bracken and only one, it appears—the American Crosby-Fiske-Forster *Handbook on Fire Protection* which deals with the calorific values of any form of vegetable matter at all. Moreover, there is no recorded instance of any attempt having been made to deduce and tabulate from the calorific values that have been established the rate and ceiling of convection to be expected under given circumstances.

That the need for this and other information is not merely academic but practical I hope to show. So much of our initial "sizing up" of a fire at our arrival upon the scene is dependent either upon some approximate previous experience or, worse, upon a series of intelligent guesses. We may, if we were fortunate, have been present at a fire which, under similar elemental conditions travelled quite rapidly across a *Calluna* heath—such as the one we have before our eyes—and entered some plantations . . . but here the analogy ends for the plantations then bear no resemblance, either in age or in species, to the plantations now. From that moment onwards our methods of combat become speculative and our timing suspect.

In the Holt fire of April, 1956, there were, of course, also unpredictable elements. On the other hand it would be difficult to pay too great a tribute to the eight fire brigades, the R.A.F. and Army personnel and to our own men who fought magnificently and with the highest degree of competency possible under our existing system and it speaks well that, whilst the fire consumed 140 acres outside our fences, it devoured, under far more favourable conditions, only twenty acres within; further, that had the fire not been stayed where it was it would certainly have spread to another 300 acres of highly vulnerable plantations. Notwithstanding, there did remain these factors which, due to lack of technical information, could not be calculated. A description of the fire will demonstrate what I mean.

Fig. A shows (*a*) the start of the fire in the extreme south-west on an old private woodland site where a timber company had been engaged in burning lop and top, (*b*) its spread north-eastwards across open heath to Commission plantations, (*c*) its leap across a road-cutting three chains wide (the road itself was twenty-five yards wide and metalled) over the playing hoses of the Cromer Fire Brigade, (*d*) its continuation through an eleven-year-old stand of Corsican pine and (*e*) its final extinction in a bottleneck of the wood.

Fig. B is an enlargement of the scene of the fire in the Commission plantations depicting the north-west slope of the Glaven Valley and two gulleys. It will be observed that the valley and the adjacent gulley run south-westerly-north-easterly, the precise direction of the wind (it was Beaufort Scale—Force 7) at the time of the fire.

Fig. C is an elevation showing the ridge between the gulley and the valley and also the road cutting. Prior to the fire the vegetation on the ridge was mixed conifer, *Rhododendron ponticum*—much of which had already been cleared—plus dehydrated bracken and willow herb from the previous summer's growth.

For those interested, the calorific value of softwood with a moisture content of 10.4 per cent is 8,330 British Thermal Units per pound. The wood of a growing pine has a much higher moisture content and therefore a lower calorific value. Values of other species mentioned above do not appear to have been worked out but, as a possible substitute for bracken and willow herb, wheat straw is recorded as being 6,290 B.T.U.s per lb. Most hardwoods fall between these two figures but, it may be supposed that the foliage of rhododendron would be much higher.

To comprehend the behaviour within the Commission boundary, culminating in the leap already referred to, it would be helpful to carry in one's mind a picture of the topographical set-up shown in Figs. A and B.

Once across the Commission fenceline the fire fanned out once more, spreading swiftly up the valley and the adjacent gully but creeping more slowly up the escarpment and so on to the ridge. In consequence of their alignment with the wind direction the valley but, more particularly, the gulley served as highly efficient wind funnels. The effect was twofold. Firstly, the concentration of air led to a higher rate of combustion within the funnels themselves which, in turn, increased the temperature, thus creating strong convection currents; and, secondly, the channelled airstream rushing out at the narrow end gave added impetus to the onrush of fire once it had passed. Returning to the first point and the convection currents, the effect of this powerful uprush of air upon the higher slopes and the ridge was, of course, to promote greatly intensified combustion at a more exposed altitude.

It now becomes possible to piece together the various factors that combined to further the "great leap". Firstly, we have the primary fire making its way up over the escarpment on to the exposed ridge. Secondly, we have the powerful convection currents rising up out of the valley and the gulley, carrying with them intense heat and flame to supplement the primary fire. Thirdly, we have the unification of the primary and the secondary fires with the product being urged forward by the compelling wind. And fourthly and finally, we have that vital additional impetus given by the wind funnels at the critical moment immediately prior to the take-off so that the whole inferno was hurled across the cutting and deposited on the far side. (See Fig. C.)

Not even during the attempted enemy incendiarism of the New Forest during the early war years did I witness such a conflagration as took place prior to the "leap". It seemed, almost, that the Cromer Brigade and engine would be vaporised but due to the very convection currents referred to above they remained unharmed. As they described it to me afterwards the fire just jumped from one crest to the other completely over and outside their range of hoses. A similar situation, in a minor key, was responsible for the initial invasion by the fire of Commission territory, but it suffices to deal with the present phase only.

The final halting of the fire in the bottleneck of the wood a quarter of a mile further on was, comparatively, a routine matter but, although we had foreseen the danger of it crossing the road-cutting and had taken what we had considered to be adequate precautions, its final behaviour exceeded our calculations and we were powerless to check it at this juncture.

That such a set of circumstances may seldom, if ever, unite to again produce such a result is beside the issue. Other causes will combine to create other effects. And that brings me back to the point I am trying to make.

If our knowledge of the relationship between wind forces and rates of combustion, or between calorific values and rates of combustion; and our comprehension of the effects of topographical features, airstreams, convection currents were to be less "dilettante" and more *measured* and technical; and if these and other correlative matters were to be welded into an *operational science* the *precise* nature of the fire hazard of any given site could always be accurately determined and the necessary precautions taken in advance. In addition, our fire hazard forecasts would be less hazardous and more cast iron.

May I suggest that within the next decade an effort be made to establish such a science and further, may I be permitted, in anticipation, to designate that new science 'PYROLOGY"?

A HANDY TRAILER FOR FIRE FIGHTING

By J. W. ENGLAND
Forester, South Wales

As speed is the most important factor in dealing with outbreaks of fire in or near plantations, it follows that every second of time that can be saved in moving to the scene of the fire is vitally important.

Forest fires in common with all other types of fire have generally a comparatively small point of origin which, if reached in its early stages can effectively turn the balance immediately in one's favour, either by heading the fire off and changing its direction or extinguishing it altogether.

To reach the scene of the fire quickly, though essential, is not in itself enough and may be quite ineffectual. What can be effective and decisive is to reach the fire quickly with the appropriate amount of equipment and men.

The human factor is so variable and subject to a great many other considerations that it would be quite outside the scope of this article to deal with it.

It is possible, however, to deal with the quantity and type of equipment. Obviously in these Islands the nature of the ground, type of vegetation and the age of plantations—as a whole—can present a very wide and diverse range of fire types, from peat and surface fires to crown fires with possibly a combination of all three, which may require different items of equipment in order to deal with the situation effectively. It often happens that the actual requirements may invariably be ascertained only on the spot.

To attempt then to foresee requirements in the urgent moments of the first alarm and to load men and equipment into a limited vehicle space inevitably leads to time wasted, added confusion and damage to equipment and injury to men or both.

It appears desirable to have a *fire fighting unit* compact, well equipped and ready with its crew to move off instantly, with the transport normally available for fire protection to take the crew, the essential point is to have a specially designed trailer housing the fire fighting equipment. Depending upon the area to be covered a number of these small compact units could be built up to provide an efficient fire fighting force. One advantage being the efficient co-relation of units, to the size of the fire.

I have designed a light trailer with these points in mind and a brief description follows:

The trailer consists of a light metal frame of angle iron attached to a pair of wheels (an axle and wheels from a light car are ideal), the wheels falling within the perimeter of the bed. A flat bed of three-quarter inch boards completes the base—the wheels being boxed over.

The towing attachment is secured to the axle and the frame; to comply with legal safety requirements, it must include an automatic brake.

A superstructure of laminated board is arranged to form three boxes or compartments. These are placed on the two sides and one end of the bed and leave a well in the centre open to the end where the hitch is. When the trailer is detached from the towing vehicle a Portable Hathaway Pump which is contained in the well is then readily accessible for quick and easy removal.

The rear box or locker houses the reels of hose placed on end and either

side of a small compartment containing *one* two-gallon tin of petrol and one two-gallon tin of oil for the pump, a loose tray on top of these holds spray nozzles, two-way adaptors, spare washers and tool kit for the pump.

One side locker contains knapsack sprayers, supply of sacks and canvas buckets. The other is for tools and contains such things as felling axes, billhooks, grasshooks, slashers, spades, heavy cutting pliers (for emergency use in tackling fences), bow saw. As these are all edge tools, pockets and brackets are installed to secure them in place and protect the cutting edges. Electric hand lamps and heather burners complete the equipment, and first aid kit. A supply of heaters is carried in a rack beneath the bed of the trailer.

Lids are fitted to all the lockers which should be locked when not in use to ensure that the complement of tools is always complete.

Finally, twin rear lights are fitted and the cable carried forward along the hitch to a clip where a plug instantly connects it to a point in the towing vehicle's normal lighting system. Reflectors, "T" sign and registration number of towing vehicle completes the outfit.

The complete trailer and its equipment can be handled readily by one man. It is illustrated in photos 27 and 28 on the centre pages.

[This idea has obvious applications on a private estate, where it would be extravagant to keep a full-sized lorry on stand-by duty for fires. We have heard of a landowner who has already bought and equipped a trailer in this way.—Ed.]

NOTES ON FIRE PROTECTION AT LYMINGE FOREST, KENT

By S. WATKINS
Forester, South-East England

After a number of years at a forest the forester gets to know the people who visit his district during the holidays or on their afternoons off. People come out from the towns for perhaps the day or a few hours' pleasure and relaxation in the quiet parts of the forest; meeting these people sitting about in the forest having a picnic or taking a walk through is often a worry during the fire danger period. I have myself been very worried on meeting people smoking when in the forest; at the time one feels like being very rude to them but this way of approach can be very harmful to what we are trying to accomplish, which is good relations with the general public. A deal of good can be done by being friendly with visitors to the forest, even if at the time they are giving cause for alarm. A quiet talk about the forest and one's job, the bird and animal life, different species of trees and plants, how the trees live and grow. These people will soon have confidence in you and relations become friendly, questions will soon be asked about the forest and the people will take note of the destruction a forest fire can do. I find these people visiting the forest every year and bringing their friends to look you up, now they have become interested in trees and nature, to ask and see more about the forest. This way of approach to people I am sure reduces the fire risk from the general public, and some of the forester's worries when he knows that some of the general public will do all they can to give a helping hand.

May I suggest perhaps a small pamphlet might be produced, setting out some interesting points on tree and plant life, with the devastation a forest fire can do to these things, so that a forester could hand it out to people he meets who are interested?

THE CONTROL OF DEER IN COMMISSION FORESTS, WITH PARTICULAR REFERENCE TO ENGLAND

By J. S. R. CHARD, *Conservator, North-West England,*
and J. B. STOCKS, *Divisional Officer, English Directorate*

General

The number of deer in Forestry Commission forests is steadily increasing as the area under plantations builds up, and their range of distribution is being constantly enlarged. This process obviously cannot be allowed to continue unchecked, but present methods of control are open to a good deal of criticism, and an informed section of public opinion is already beginning to take a close interest in how they are carried out.

It behoves a Government department to set a good example and a uniformly high standard in matters of this sort. It has been stated that the policy of the Forestry Commissioners is to pay due regard to the preservation of fauna, but so far in the case of deer little guidance has been given as to how this might be implemented without detriment to other interests.

This paper reviews the position with particular reference to conditions in England and makes suggestions for the future.

Species of Deer

Two native and three introduced species are present in some numbers. Listed in order of importance, these are roe, fallow, red, Japanese sika, and Chinese muntjac. Other introduced species such as Siberian roe, Chinese water deer, and Indian axis or chital deer, are reported from time to time as escapes but their status is doubtful and insignificant.

Distribution in England

Roe are most plentiful in the Border forests of Cumberland and Northumberland, but extend throughout those counties and into adjoining parts of Westmorland, Lancashire, Yorkshire and Durham. In the south their main stronghold is in Dorset (especially Wareham) overlapping into the fringes of Devon, Somerset, Wiltshire and Hampshire (including the New Forest). Other centres occur in West Sussex, and on the Surrey-Hampshire and Hampshire-Berkshire borders (Alice Holt and Bramshill). Finally there is an expanding zone of distribution in East Anglia, based on Thetford Chase.

Fallow occur locally in practically all counties as escapes and outliers from deer parks, but are less frequent in the north. Long established and often numerous herds are present in such forests as the New and Dean, Sherwood, Cannock, Wyre, Mortimer, Rockingham, Yardley, Thetford, Savernake, Arundel, Brendon, Dunster and Haldon.

Red are most plentiful in the Exmoor area of Somerset (especially Brendon and Quantocks), and outliers extend into Devon. In the north they are numerous in much of the Lake District (especially Grizedale) and turn up regularly in parts

of Durham. Small herds are established in the New Forest, Sherwood and Thetford. See also photos 29, 30 and 31.

Sika are well established in Dorset (especially Wareham), the New Forest, and parts of Kent. There are a few in Somerset, and in the north they have a scattered distribution in North Lancashire and Westmorland.

Muntjac are at times numerous in Bedfordshire, Buckinghamshire, Hertfordshire and Northamptonshire and appear to be permanently established at Ampthill, Salcey and Hazelborough. They have turned up as far afield as Leicestershire, Warwickshire, Middlesex and Essex, and recently in Norfolk.

Damage to Forestry

Deer damage may be of four types; browsing, fraying, rubbing and stripping. Male deer, from their size and habits, generally cause more extensive and wanton damage than females.

Browsing is the most widespread type of damage and reaches a peak in late winter and spring when feed is scarce. This corresponds with the planting season and deer are attracted to newly planted trees from curiosity. Some species are more palatable than others, hardwoods, silver firs and pines being notoriously vulnerable. Sporadic browsing rarely causes permanent injury to the crop, which becomes safe once the majority of leading shoots grow out of reach. On the other hand losses from selective and persistent browsing are often devastating, and without special measures replacement can become impossible.

Fraying is caused solely by male deer when cleaning their antlers of velvet, and except in the case of roe each animal confines its attention to a few trees only, although these are often in prominent positions.

Rubbing is associated with the casting of the coat in red and sika deer. Rough barked trees of pole size or larger are used and may be worn down to the cambium.

Stripping (or peeling) of bark is only resorted to in response to serious mineral deficiencies (particularly by males when growing new antlers), or at times of acute food shortage (particularly when deer are trapped in a limited area by deep snow). Pole crops of smooth barked trees are most vulnerable. Stripping is not resorted to by roe or muntjac.

Roe tend to cause greater damage than other species for the following reasons (*a*) they are localised in habit, returning persistently to favourite spots, (*b*) they invade plantations at a younger and therefore more vulnerable stage of growth, (*c*) they are more prolific and breed at an earlier age, (*d*) the bucks fray in spring, not autumn, thus the sap is running and the bark slips freely.

Fallow, red and sika deer move their ground frequently and generally give only passing attention to plantations in the youngest stages of growth, so that damage only becomes serious if the herds are large. Muntjac are so small that trees quickly grow out of their reach.

Deer damage can be very unsightly, but speaking generally, its permanent effect on the crop often tends to be overrated.

Damage to Agriculture

Fallow, red and to a lesser extent sika deer get a good deal of their food by raiding agricultural crops on adjoining land, and the damage caused in this direction may become intolerable long before any forestry losses are noticed. Roe and muntjac are comparatively minor offenders in this respect.

Existing Methods of Control

Dogs and foxes attack the young, but except in the case of fallow, and more particularly of muntjac, whose numbers are periodically decimated by severe winters, the adult deer population is virtually free from natural controls and must be regulated artificially. Deer fencing is rarely employed in England.

With perhaps limited exceptions, the typical approach to control is that deer are allowed to increase more or less unmolested until serious damage becomes apparent or complaints are received from neighbours. The numbers are then drastically and indiscriminately reduced, and the situation is left to repeat itself. In many cases the total stock of deer is never definitely known.

The methods of destruction employed have included snaring; driving, lying in wait, and running with dogs, all to shotguns; and to a limited extent, lying in wait and stalking with rifles.

Snaring is generally prohibited under State Forest Memorandum No. 43.

Driving is an expensive operation which to be successful requires elaborate organisation and a large number of men and guns. The results are unpredictable and the number or proportion of deer killed cannot really be regulated. Unfortunately it is a common experience that many are only wounded and have to be followed up afterwards, not always successfully. Also male deer, which it is more necessary to destroy, tend to keep to the rear and so have greater chances of escape. A further objection to driving is that in order to avoid disturbance to game it usually has to take place after the shooting season when the deer are out of condition. The co-operation of shooting tenants, neighbours and County Pests Officers is often called for, and in these circumstances when things go wrong the Commission is liable to receive a large measure of justified, but undesirable, criticism and publicity.

There is nothing in the standard sporting lease to prevent shooting tenants from killing deer, and unfortunately it is a common experience for them to attempt to do so in the course of ordinary cover drives, usually with small shot.

Lying in wait or stalking deer at feed is often attempted by warreners, but with the limitations of a shotgun the majority are fired at at extreme range and the proportion to get away wounded is high.

The same practice is frequently adopted by the occupiers of adjoining land to protect their crops when numbers have been allowed to get out of hand, and in some areas the majority of deer carry shot pellets from this source.

Running with dogs can give satisfactory results with experienced men in areas which are suited to it, such as the New Forest. The passes by which deer will leave a cover when the dogs are put in are known or can be judged, and so close shots are obtained. Unlike lying in wait it can be conducted at any time of day, and not just at dusk or dawn, but in large uniform blocks of forest the method has much less chance of success.

Stalking with a rifle is at present generally discouraged because of the presumed risk to employees and members of the public. To people experienced with deer this risk is much exaggerated but it does exist if the weapon is used from ground level in flat terrain. The correct and safe method of using a rifle is discussed below.

Numbers Destroyed

The numbers destroyed in England by the Commission in recent years are as follows:

Year	Species	N.W.	N.E.	E.	S.E.	S.W.	New	Dean	Total
52	Roe	46	351	—	8	39	40	—	484
	Fallow	6	—	4	5	51	65	1	132
	Red	1	—	—	—	—	—	—	1
53	Roe	48	189	—	1	34	22	—	294
	Fallow	25	—	18	23	33	175	—	274
	Red	—	—	—	—	6	—	—	6
54	Roe	62	171	3	8	17	50	—	311
	Fallow	19	—	1	5	40	139	2	206
	Red	—	1	—	—	—	—	—	1
55	Roe	69	180	16	19	33	55	—	372
	Fallow	15	5	4	9	5	107	—	145
	Red	—	1	—	—	—	—	—	1

Cost and Value

No separate records are kept of expenditure on deer control. The amount of abortive work imposed by the limitations of using a shotgun is high, and at a conservative estimate at least three man-days will have been spent for every deer shot. This means that with other direct expenses and overheads the cost per head must be about £7, or a minimum total of nearly £4,000 a year.

A small part of this cost is recovered from the sale of carcases but the full value is certainly not realised. Animals which have been badly wounded, shot out of season, and inexpertly butchered depress the price of venison and give it a bad reputation which it certainly does not deserve. As a rough guide, allowing 25 lb. of edible meat from roe, 60 lb. from fallow and 90 lb. from red deer, if all the venison was marketed it would bring in about £1,000 at 1/- per pound. The value of prime venison properly killed at the right season should be at least half as much again.

The potential sporting value of deer shooting has hitherto been largely ignored but again as a rough guide, if all deer could have been shot under licence at a minimum charge of £5 for a red stag, £3 for a fallow or roe buck and £1 for a hind or doe, the rental would be of the order of £1,500.

It should be emphasised that the above are minimum and conservative figures in every case.

The Basis for Improved Control

(i) *Increased Knowledge.* An essential preliminary to any improvement in methods of control is to increase the knowledge of deer and their habits amongst Forestry Commission staff at all levels, and the means of achieving this will need to be examined. It may be noted in this connection that the British Mammal Society, of which the Commission is an affiliated member, has sponsored a Deer Group whose object is to promote the study of deer in Britain.

(ii) *Planning for Control.* The rational and essential basis for control is first of all to assess accurately the stock of deer resident in each area of forest as well as the damage done by them and to ascertain the range of any marked seasonal movements. This stock should then be reduced to, or allowed to build up to, the number which the ground is estimated to be capable of carrying without risk of undue damage. Thereafter, based on the breeding potential and periodic re-assessments of stock and capacity, the number of mature deer to be killed annually to maintain equilibrium can be prescribed. The removal of

this surplus stock needs to be done selectively and humanely, and should be regarded as a crop like any other product of the forest.

(iii) *Assessment of Stock.* This is conveniently undertaken at the two periods of the year when deer are most easy to observe: during the mating season or rut, and in late winter when they can be concentrated at feeding points; also after any heavy fall of snow. With experience a fair estimate can also be made from tracks, fraying stocks and other signs.

(iv) *Capacity of the Ground.* Only limited data are so far available for this country and estimates must obviously vary widely according to local conditions. More luxuriant ground cover and mild winters prevent direct comparisons with continental experience where however, heavy deer populations are often maintained artificially for sporting purposes. It is suggested in the meantime that densities should not be allowed to exceed an average of one roe to forty acres, one fallow to seventy acres or one red deer to about 120 acres of woodland. Where more than one species is present these figures must be exclusive.

(v) *Breeding Potential.* For each species there is a minimum number below which the stock is unlikely to succeed in perpetuating itself. The data again are not well tested but the limits appear to be of the order of six to eight roe and twelve to fifteen fallow or red deer, subject in each case to the inclusion of a due proportion of each sex and age, and the occasional infusion of fresh blood. Stocks of this size are capable of yielding a surplus of one or two animals a year, provided these are removed selectively. Larger populations, in suitable conditions, appear to increase at the rate of about 25 per cent annually in the case of roe, and around 15 per cent annually in the case of fallow and red deer.

(vi) *Selective Killing.* The key to the problem of selective killing in dense woodland is the method of shooting from above. For this purpose permanent stands are erected at strategic points and movable seats are used temporarily over the intervening ground. From a height of 15 to 20 feet scent is carried clear of the area, deer can be watched undisturbed over a wide field of view, and since the aim is always towards the ground, a rifle can be safely used. The deer themselves will give warning of any other persons in the vicinity.

Various aids to management can be employed to bring deer within range of these points, but they need not be elaborated in this context. They include the calling of roe, the placing of salt licks, the liming of selected rides or deer glades, the lopping of browse, and the provision of feed in hard weather. Most of these practices have concurrently the direct result of abating damage or diverting it from more vulnerable localities.

(vii) *Restriction of Shotguns.* It is not suggested that it would be desirable, or even practicable, for shotguns to be replaced by rifles in all circumstances. But if deer are to be killed humanely the limitations of a shotgun must be more clearly recognised and to this end the following rules are recommended: (*a*) only SSG shot should be used, (*b*) aim should be taken only at the neck, (*c*) shots beyond 20 yards range should not be attempted, (*d*) no red deer should be fired at, (*e*) all wounded deer must be accounted for.

(viii) *Limitation of Driving.* The unselective and frequently inhumane results of driving deer are such that it is recommended that it should only be resorted to in exceptional circumstances and by special authority.

(ix) *Introduction of a Close Season.* Provided the shooting is done efficiently, there is with one exception nothing inhumane in killing deer at any time of the

year. The exception is in the case of suckling females, whose young would then be left to starve. It is, however, wasteful and may therefore be held unethical, to destroy such large animals as deer when they are out of condition and no proper use can be made of either the meat or hides, and in the case of males, of the trophy or head. It is also obvious that if females are killed indiscriminately before their young are born there will be no replacement of stock, and the final result will not be control but extermination.

The main argument against a close season is that if rigidly applied it would not allow deer to be killed as damage occurred. Special authority could, however, be granted for the destruction of recognised rogues, and the point finally loses force if the stock of deer has been regulated to the capacity of the ground beforehand. For this reason it is recommended that if an official close season is agreed to, it should not be introduced by general decree, but gradually, area by area *after* effective control has been established in each case. A time limit of, say, five years could, however, be set for its general adoption, at least in England.

The periods during which deer of different species and sexes are in prime condition do not vary to any significant extent in Britain from those already recognised on the Continent. If clean heads are not required, the seasons for male deer can be started a little earlier, but the maximum periods during which regular shooting should be permitted are as follows:

Red stags, and sika bucks, from 1st July to 21st October.

Fallow bucks from 1st July to 1st November.

Roe bucks, from 1st May to 1st December.

Hinds and does, from 1st October to 1st February.

In the case of muntjac, which breed at all times of the year, no definite seasons can be prescribed, but the principle of not shooting bucks in velvet or does with young ought still to be adhered to.

The Means of Application

(i) *General.* On the Continent the control of deer by methods similar to those outlined above is achieved extensively through the medium of sporting leases and annual or periodic licences, and brings in very substantial revenues. In this country there are many areas, particularly in forests much frequented by the public, where emphasis on the sporting aspect does not at present commend itself, but elsewhere it offers considerable and worthwhile possibilities. Immediate application is, however, complicated by the fact that rights to kill deer are not at present separated from the existing sporting leases. There need be little conflict between the two interests, as at the stage when deer begin to become numerous in a forest other game is generally in decline.

(ii) *Long-term leases* of the deer shooting are more appropriate to large blocks of forest with established deer populations in districts where strong sporting interests already exist. It is desirable that they should not be granted to individuals but to a syndicate or organisation with sufficient members, resources, and expert direction to ensure the required intensity of control. In this connection the recently formed St. Hubert Sporting Organisation appears to have exceptional advantages. Pilot schemes are being introduced at Grizedale and elsewhere.

(iii) *Licences.* The possibility of issuing licences to individuals for shooting a specific number of deer under controlled conditions has not yet been fully explored, but it appears from enquiries received that a considerable demand

exists for such facilities. If the legal and insurance requirements can be clarified it should provide a convenient means of dealing with the limited or occasional surplus of deer in some of the smaller forest areas, but will call for more continuous supervision than in the case of a lease.

(iv) *Direct Measures.* With the possible disappearance of the rabbit it may become unnecessary to continue employing warreners or keepers at the majority of forests. When potential long-term leases are excluded very few areas will be left of sufficient size or carrying enough deer to make local control a full-time job, and if suitable men are to be retained they will no doubt have to be organised on a mobile basis. This may have advantages if it raises the status of the work and enables them to be specially picked and trained, and for this purpose a new grade of "stalker" might be created. A correctly trained and keen man could cover a large area.

(v) *Appointment of Game Warden.* As a first step a game warden, Mr. H. A. Fooks, has been appointed, with his headquarters at Grizedale Forest in North-West England. He has specialised knowledge of deer, and experience of Continental methods of control.

Summary

The deer population is increasing as the Forestry Commission's operations are extended. Five species between them are established over the greater part of England. Roe potentially can cause the greatest damage to forestry, while fallow and red deer are generally more injurious to agriculture. Present methods of control are on the whole spasmodic and ill considered, and tend too frequently to become inhumane. Despite this, substantial numbers of deer are already being killed annually. The operation is unnecessarily costly and potential returns which would help to offset this are not being fully realised.

A preliminary to improved methods is increased knowledge of deer and their habits. Rational control must be based upon accurate assessments of stock, and the regulation of this, by selective and humane methods, to the capacity of the ground. Selective killing in dense woodland is made possible by shooting from above. Humane killing requires restrictions in the use of shotguns and limitation of driving, and the case for and against a close season is considered.

While undue emphasis on sporting aspects is undesirable, it is considered that in suitable conditions satisfactory control could be obtained through the medium of long-term sporting leases and probably of short-term licences. It is suggested that direct measures merit the employment of specially trained staff.

THE ROE DEER

By H. A. FOOKS

Game Warden, North-West England

Roe deer have been called the "Fairies of the Woods" and their elfish charm and graceful movements certainly bear out this name. Even when found living in the proximity of man, they never lose their shyness in the same way as would the red or fallow under the same circumstances.

In spring and summer their coats are a foxy red unrelieved by any other colour except on the lips, which are black with a white patch near the corners

of the mouth. Although they actually have a tail, this is not visible, yet most old prints and some modern drawings as well, show them with tails which would not shame a fallow.

The main charm of these animals is, to my mind, their restlessness and repeated display of some graceful movement or pose; for example the old buck continually throw up their heads whilst grazing. Should roe be seen early on in the afternoon it can usually be taken for granted that they are young animals. The older they grow the fonder they get of the half-light of the dawn and dusk.

As summer advances into early autumn, that is between the last week in July and the first week in August, the doe comes into season and the buck during this period, like most other deer, will scarcely eat. The advent of the heat in the doe is made known to the buck by scent and by her oft-repeated calls. These calls are hardly audible to the human ear at more than a few yards distance. They are an incessant "peep-peep-peep", rather short and sharp and soft in tone and could easily be mistaken for the call of a bird. Under favourable conditions, the buck can hear this call over half a mile. I have called roe many times across open moor for long distances; yet my wife, who has been sitting not more than one hundred yards away, has not heard the calls. Both buck and doe have an alarm bark very similar to that of a dog. That of the buck is shorter and deeper than the doe's. A third cry is one that cannot be mistaken for anything else except what it denotes—terror and anguish. It is a rather quavering and high pitched scream.

The old buck are at this time of the year far less wary than usual but, in spite of this, it is amusing to watch some of the old stagers taking precautions. Buck will follow the scent of a doe and it is quite common to see one following a line like a hound. Whilst following a scent the buck's pace is usually an intermittent trot.

Like most woodland creatures, the senses of the roe are very acute, and from personal experience I should say that their sight and hearing are better than that of the red deer, but their powers of scent not quite so good at long distances.

For several months after the rut, the old buck become almost nocturnal and to those who do not know their habits, seem to disappear altogether.

The expenditure of energy during the rutting period must be quite incredible and buck will normally cover does between sixty and seventy times during the course of ten to fourteen days. In the intervals of copulation, the buck drives the doe at full gallop, and although the ground on which this takes place may be restricted, the actual distances covered must be very large. The rut is the climax of the previous eleven months' horn growing, grazing and resting which should result in the buck being in prime condition or in the correct term—"in pride of grease". At the end of the rut the buck is but a poor shadow of his former self and is unfit for human consumption. At this time too he again becomes very wary owing, no doubt, to his exhaustion; and he may know that this may have impaired his normally acute senses and will therefore take no risks during the hours of daylight.

At the approach of winter, the pellage changes from red to a grizzled grey and the hair itself becomes longer and more brittle; at this season a curious second rut takes place. This once led to the belief that this was the "true" rut. This made the period of gestation only some five months when in actual fact it is nine; it is only comparatively recently that the discovery was made that

the embryo was in the uterus of the doe in what may be called a suspended state of animation. From November onwards the embryo continues to grow abnormally fast. Perhaps this "false rut" is introduced by nature to stimulate certain secretions connected with the growth of the embryo.

In any case most buck have shed their horns by this time of year and as the culminating period in the annual life of a male deer is the growing and cleaning of his antlers prior to the rut, it would seem that a male denuded of his antlers would not be in the most suitable state to fight off any rivals.

Driven by hunger the roe will in winter, like any other starving animal, browse on anything it can find and they can scarcely be (but are) blamed for this. The buck unfortunately has one very destructive habit and this is his predeliction for young growing conifers on which to polish his horns. He does not confine himself to a single one but will thrash all and sundry as the spirit moves him. The damage is often more apparent than actual as it is normal forestry practice to plant many more trees than are expected to mature.

To the stalker no animal offers more fascinating sport yet the buck is only stalked with a rifle by a handful of enthusiasts. The vast majority of roe, both buck and doe, meet their end in drives or die of wounds, unfound.

The horns of a roebuck, if size is the criterion, are nothing to speak of, measuring when good, between eight and ten inches. But if beauty of form, colouring and general appearance mean anything, then the roe horn holds its own.

Many thousands of pounds are spent annually in pursuit of the red stag, yet were the roebuck more generally known and his very sporting qualities recognised, then the stalking of this animal would become a popular sport and possibly a lucrative one to the landowner. Incidentally, a roebuck will yield forty pounds of flesh.

The roe is an intelligent beast and deserves a better fate than to be fired at with shot guns at varying ranges, often to creep away and die a miserable and lingering death. Let us hope that lovers of the country-side may see the day when all deer are treated, not with sloppy sentimentality, but at least with fairness. They are, after all, one of the most beautiful heritages of our woodlands.

FIGHTING THE PINE BEAUTY MOTH WITH THE TODD INSECTICIDAL FOG APPLICATOR

By R. C. KIRKLAND
Forester, Research Branch

The activities of insect defoliators represent a perennial hazard to the extensive conifer plantations of the Forestry Commission, and means of combating them are, therefore, never far from our thoughts here at the Entomological section of the Forestry Commission Research Station.

The aerial spraying against the Pine Looper Moth, to which we had recourse during the summer of 1953, enabled us to gain valuable experience in the organisation and costing of such an operation, and revealed some of the difficulties in the use of this medium. Since then we have considered the use of

several alternative methods of application of insecticides to forest areas, with practical trials of one of them, namely the Todd Insecticidal Fog Applicator (T.I.F.A.). This machine appeared to be admirably suited to the job, having many obvious advantages over the aerial spraying method, chiefly as regards the treatment of small areas of forest at an economic cost, and ready access on routes suitable for tractor drawn apparatus. However, contrary to reports of excellent results obtained elsewhere, notably in Germany, our preliminary trials proved most disappointing, and it was decided that first-hand experience of the operation of the machine by trained personnel should be obtained.

The Bavarian State Forest Service was carrying out control measures against caterpillars of the Pine Beauty Moth, using several "Tifa's" in the same general locality, and as a result of their very willing co-operation I was enabled to work with one of their teams for seven nights during the middle of June.

Area of Operations

The area of this operation comprised some 19,250 acres of forest, predominantly of Scots pine, covering a large area of country some twelve to twenty miles south-west of Nuremburg. The forest area is composed of several large blocks and many scattered small woodlands and is situated on ground best described as gently undulating. The more fertile land is cultivated, whilst the forest occupies the higher ground and the less fertile and usually heavily leached areas, together with those areas which are too wet for cultivation. The soil is derived from a sandy boulder clay, and the elevation varies around 1,000 feet.

Organisation

The owner of the largest area of forest under treatment was the Bavarian State, but a large amount of woodland also belonged to Faber-Castell, whilst small strips were owned by local farmers.

Apart from the complications of mixed ownership, two methods of treatment were in use: all accessible areas, in theory, being treated by Tifa, and only those areas too wet for ground operations being treated by helicopter. In practice, it appears that many of the smaller areas, even where accessible, were nevertheless treated from the air, being so much more quickly dealt with by this method.

For the purpose of costing the operation, the total expenses incurred by both Tifa and helicopter are combined and an average figure per hectare arrived at. Faber-Castell is considered able to pay fully for the areas of his forest treated, whilst the small landowners will pay one-third of the cost of treatment, the remainder being paid by the State.

It is estimated that ground application (by Tifa) may cost about thirty marks per hectare (£1 an acre) and aerial application twice that sum. If this appears rather an excessive charge it must be realised that, whereas in our own aerial application the diluent was water, the Germans are adamant that the use of diesel oil is essential in this connection.

Description of Control Area

The delineation of the area to be treated must have been most difficult owing both to the continuity of the forest throughout this part of the Bavarian state, and to the widespread presence of *Panolis flammea*, and appears to have been determined rather by topography and distribution of forest than by distribution of population of *Panolis*.

An average large block of forest contained a very unevenly distributed

population, ranging from a count of 1.5 pupae to 20 pupae per square yard, based on pupal counts carried out in the winter or early spring over strips some three to five square yards in area. One strip was considered sufficient for each forest "complex", and two per fifty acres for larger homogeneous blocks.

The larger blocks of even-aged plantations were of fifty to sixty years, with small areas forming an approximate age-class series known as complexes. The older Scots pine is slow grown but very clean, with small crowns, about 50 ft. at fifty years.

Organisation of Tifa Operation

The Tifa action was operated entirely by Bavarian State forest employees, under the field direction of Forstmeister Brendel. Four teams, each with a standard machine, were in action in four zones, and one machine was held "in reserve".

Each Tifa team was in the charge of a forester, with a driver and two operators; a fourth man did the duty of an "observer" and watched the movements of the fog in the canopy, reporting them by hand signals to the forester in charge. The local forester was also present, having made a valuable contribution to the success of the operation by the preparation of sufficient racks for the progress of the machine in all directions, and aiding with the night "navigation". The teams were in lodgings in villages adjacent to their zones of operations. They went into action only at night, usually from 7-30 to 8-0 p.m. until 6-0 a.m., and during the day any necessary maintenance was done. One mechanic was stationed centrally, and he serviced all mechanical equipment.

Preparation of Areas for Treatment

Preparatory inspection of areas was made in the company of the local forester, and the layout of existing rides and racks studied and transferred to a large-scale map of the forest. Further racks were planned in order, ideally, that the Tifa could be towed through the plantations at approximately 100 yard intervals, allowing for a wind direction from any of the cardinal points. After removing the trees from the racks, all rides and racks were "blazed" in such a way that the headlights of the towing vehicle would easily pick out the route to be followed.

Procedure

Fogging rarely started much before sunset and finished within thirty minutes after sunrise, and was not carried out in any but the lightest breeze. Weather reports, obviously, were a useful overall guide, but working within such close limits of atmospheric conditions it was the local weather that was of paramount importance. Within the locality, for example, fogging may be possible on one aspect and not on another, and the position may be reversed during the night. It is necessary, therefore, that the man on the spot makes all decisions, and that the operation is flexible in its arrangement.

Having decided that fogging is practicable it is necessary to test the wind direction and arrange a route accordingly. During the night, however, air currents may change direction, and close observation and recording of the movements of the fog cloud is vital.

The general aim is to work always at right angles to the direction of the air stream, covering the ground systematically and progressing into the wind. By this means it is intended to avoid being confused by one's own fog, but in practice the ideal night is also one on which there is so little air movement within the plantation that the fog hangs everywhere.

In spite of the fact that swathe widths up to 400 yards are obtained under good conditions, these are not accepted, for security reasons, as being a "dead cert." and 100 yard intervals remain standard price.

Fogging ceased shortly after sunrise, when it was obvious that the fog was ascending through the canopy and no longer remaining in it.

Rate of Application

The dosage aimed at was eight litres per hectare, but varied in the field between six and ten litres per hectare, depending on the density of the crop, the weather conditions prevailing, and the local topography.

At a droplet size of twenty microns, the consumption of insecticide was 100 litres per hour, and to obtain the desired rate of application the machine travelled at a speed of two miles per hour. For more dense complexes speed was reduced, as it was also if the fog cloud drifted more rapidly.

An average night's work resulted in the treatment of 175 to 200 acres, but varied from only 125 to as much as 300 acres according to weather conditions prevailing, the nature of the crop and lay-out of the rides and the topography of the area.

Observations on Fogging Practice

(1) Better work is done at night than under dawn conditions.

(2) Better penetration and duration of fog obtained by proceeding down internal rides under the canopy than by following the perimeter. Air currents in this situation may be stronger and from a different direction than in the forest.

(3) Breakdown of D.D.T. through excessive heat is not considered probable. The temperature of the mixture itself does not vary, though after a long period of continuous operation the distributor head may become very hot. In fact, no adverse affect on the success of the fog has resulted when the distributor head has become red-hot.

(4) A sparse or bluish fog may be caused by inefficient mechanical functioning, which, if the symptom is sufficiently obvious, can easily be rectified.

(5) As the final criterion of successful functioning of the machine is the rate of consumption of insecticide, it would be desirable to have some running check on this rather than await the period of two hours of operation which is necessary to consume one drum of insecticide. Either an accurate system of "dip-sticking" or the use, for the machine, of a calibrated container might be feasible.

(6) The cooling of the air immediately above the canopy produces conditions of a local inversion in still air only. *Under these conditions* the fog is sealed from above within the canopy.

(7) An apparently satisfactory and extensive fog may, in fact, be largely mist formed by very humid air within the plantation.

(8) Visual estimates of the extent of the fog are largely discounted as unreliable, and the 100 yard rule strictly adhered to.

NEEDLE DISEASES OF CONIFERS

By T. R. PEACE

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Many different species of fungi occur on the needles of conifers. Some cause considerable defoliation, others grow and fruit on the needles without withering them, while members of a third group occur on needles which have been killed by other causes or which have fallen naturally. In addition there are certain sooty moulds, which follow aphis attack, feeding on the aphid excretions, or which occasionally occur, unaided, on needle surfaces in very damp sites; these are of no importance. In fact, even the first three groups are not clearly divided. Often a fungus, which is parasitic under some circumstances, may be harmless under others, while many fungi which cause defoliations, continue to live and fruit on the needles after they have fallen. Often the heaviest reinfection arises from these fallen needles.

The effect of attack by needle fungi is in the first instance to weaken rather than to kill the tree. Except during the first year of their life, most conifers can withstand the complete loss of one year's needles without permanent injury, but if defoliation is repeated the tree eventually dies. In a few cases, particularly with conifers such as *Thuja*, where the needle is not very distinct from the shoot, needle diseases are normally accompanied by shoot die-back. Even in more conventionally constructed conifers the next stage, after a series of defoliations, is often the die-back of twigs.

Most needle diseases would be far more serious, if they attacked severely year after year. Fortunately in most cases, this does not happen. Although in certain instances localised heavy attacks have obviously been associated with abundance of infective material, there is not of necessity any direct connection between the abundant potential spore-bearing material and the severity of attack. There is thus generally little evidence that attacks build up from year to year. Presumably climate has an overriding effect, so that abundance of infective material is only followed by another heavy attack, when the climatic conditions are suitable. In many cases there is evidence that successful attack requires a very exact coincidence between spore production on the one hand, the susceptible stage of the young developing needles of the host, and suitable weather conditions. This coincidence may only take place under certain climatic conditions. On the other hand there are several needle diseases, in which infection appears to take place at any time during the summer when weather conditions are suitable. These tend to occur more on conifers with long growing seasons, such as larch or *Thuja*.

No real needle fungus is known which is capable of attacking all kinds of conifers. *Botrytis cinerea*, which causes a serious die-back of lush young conifers in some nurseries, and which has a very wide host range, is not strictly a needle fungus. It attacks the succulent shoots as well as the needles. It is a very difficult fungus to control by spraying; probably, because of its profuse and rapid spore production, it builds up again very quickly after partial destruction by fungicides. It is also able to infect and grow at surprisingly low temperatures, so that it can stage an attack under moist conditions at almost any time of the year.

The true needle fungi are best considered under the genera which they attack. Only those occurring commonly or capable of actual or potential economic damage are listed.

Pine

A considerable number of fungi have been recorded on pine needles, and the real importance of some of them has never been evaluated. *Lophodermium pinastri* is certainly the commonest, and there seems little doubt that it is capable of causing severe defoliations unaided, both in the nursery and in the forest. The position is further confused by the susceptibility of most pine species, and particularly of Scots pine, to damage by cold dry winter winds. Often it is very difficult to evaluate the relative importance of the two agencies, for the fungus rapidly invades needles killed by cold or physiological drought.

Fortunately the fungus seldom attacks two years running, so that the trees have a chance to recover. Defoliated nursery stock usually survives, if left *in situ* or carefully lined out, but cannot be used for field planting. In plantations only weak and suppressed trees normally succumb.

Control in the nursery by spraying has been recommended on the continent, but has scarcely been attempted in Britain. There are known to be strong varietal differences in susceptibility to *Lophodermium* and since there are also variations in reaction to cold wind injury, the whole problem is very confused. It would be a whole-time project for several years to solve it.

Quite recently another needle fungus *Sclerophoma pithyophila* (*Phoma acicola*), has occurred widely on Scots pine, especially in the Thetford area, causing considerable defoliation. It attacks the needle bases first, causing a characteristic needle droop, before they actually fall.

The only other needle fungus worth noting on pine is the rust fungus, *Coleosporium senecionis*, which attacks two-needled pines, chiefly in the nursery. It does little damage, for the needles remain functional, and in any case it is easily controlled by removing the alternate host, usually groundsel (*Senecio vulgaris*).

Spruce

There is no really serious and generally distributed needle disease of spruce. There are two rusts, the first of which, *Chrysomyxa rhododendri*, is found mainly on Norway spruce, but occasionally on Sitka, and is as yet comparatively rare, being strictly limited to the immediate neighbourhood of the alternate host, *Rhododendron*. Further south in Europe, where the disease is native (it must be an exotic in Great Britain, because we have no native *Rhododendrons*), it is often severe.

The other, *Chrysomyxa abietis*, occurs principally on Norway spruce, but occasionally on other spruces, and has no alternate host. Its success appears to depend on a very nice balance between the fruiting of the fungus and the flushing of the spruce, and, since this is seldom achieved in Great Britain, serious attacks are comparatively rare.

Rhizosphaera kalkoffii occurs very commonly on spruce needles, but there is as yet no evidence of it being a primary parasite. All efforts at artificial infection have been unsuccessful. It is the commonest fungus on the needles of spruce affected with "top dying", which is now thought to be due sometimes to direct drought and sometimes to excessive water loss from the crown. It has also been found in two forests on browned young shoots of Sitka spruce, but is not suspected of being the primary cause of this so-far unexplained trouble.

Lophodermium macrosporum has been found on the browning needles of Sitka spruce in the nursery. Its real importance is not yet known.

Larch

Meria laricis, long known as a cause of needle cast of European larch, and serious mainly in nurseries, has recently been found also on Japanese and Hybrid larch, which were hitherto thought to be immune or at least very highly resistant. Its importance on European larch has declined, because the reduction in quantity of the species in our nurseries, coupled with higher fertility, and consequent better growth and more frequent transplanting, has led to less opportunity for carry-over of infection on the fallen needles lying beneath the plants. In any case it is fairly easily controlled by spraying.

We do not yet know what importance to attach to its appearance on Japanese and Hybrid larch. The attacks so far recorded were not very severe.

Several species of the rust genus *Melampsora*, with species of *Populus* as alternate hosts, occur on larch needles. Despite their frequent severity on poplar, they are comparatively rare on larch, and do no damage.

Douglas fir

This genus suffers from two well known needle diseases, both of which must have been introduced originally from America. The better known, *Rhabdocline pseudotsugae*, causes severe and repeated defoliation on attacked trees, and eventually death. In the past it was thought to be confined to Colorado and Intermediate Douglas fir. This is assuming that the species can be divided into three regional groups; (1) Coastal or Green from the seaboard of Oregon, Washington and British Columbia; (2) Intermediate, Grey, or Fraser River from the interior of British Columbia; and (3) Colorado or Blue from the Rocky Mountains. In general the attack on Colorado Douglas was severe, and only very occasional trees escaped; whereas on Intermediate, attack was more variable, and usually enough trees remained to make a crop. Recently the position has altered. The fungus has been found on Coastal Douglas, particularly on trees of Vancouver Island origin, normally behaving with the same variability of attack as is the case on Intermediate Douglas. Many trees have now been recorded with *Adelges* and *Rhabdocline* attack on the same tree; hitherto this was regarded as a rare phenomenon. In addition several outbreaks have occurred on Intermediate Douglas fir and on plantations of unknown seed origin (but certainly not Colorado) to a degree of severity where the fungus really is threatening the survival of the crop. Quite obviously a re-evaluation of this fungus is called for.

The second needle disease of Douglas fir, caused by the fungus *Phaeocryptopus gäumannii*, generally causes much less defoliation for a given level of infection than *Rhabdocline*; indeed a tree can be heavily infected, and show little except a slight yellowing of the foliage. Study of more than 150 trees over a period of years appears to indicate that the fungus, which is almost universally present in the west of the country, normally has little effect on the health of the trees. But a few cases of severe defoliation, associated with this fungus, have been found. It is not known whether seed origin has any bearing on this disease.

Thuja

One really serious needle fungus, *Keithia thujina*, occurs on *Thuja*. It is generally a nursery disease, but does occur occasionally in plantations to a damaging degree. In the nursery it can be very serious indeed, causing die-back and often complete death of both seedlings and transplants. Efforts to avoid the disease by raising *Thuja* in isolated uninfected nurseries, bringing in *Thuja* only in the form of seed, have proved rather disappointing, as more than half

the test nurseries have become infected. In some cases the fungus probably came from infected trees in the district, but in other instances no source of infection has been found within a mile of the nursery. Nevertheless, *Thuja* should only be brought into new or at present uninfected nurseries as seed. Such nurseries will prove valuable sources of healthy plants as long as they remain uninfected.

Control by spraying has so far proved unsuccessful. Extremely severe attacks in 1954 stress the need for further work on the control of this fungus.

Tsuga

No serious needle fungi have so far been found on *Tsuga*.

Silver fir

Rehmiellopsis bohemica is associated with death of needles of *Abies alba* (*pectinata*) and other species of Silver fir. It is unlike most other needle fungi, in that attack on the needles is followed fairly rapidly by death of shoots. It has been known for a long time, but of recent years, if it has occurred, it has not been sufficiently serious to attract attention.

Cypress

No serious needle fungi have so far been found on any species of *Cupressus* or *Chamaecyparis*.

Discussion

It has already been noted how many of these needle fungi are specific to one tree genus. Since all the genera here considered, with the exception of *Pinus*, have been introduced into this country, it stands to reason that the fungi now attacking them must also have been introduced. Several of them were considered unimportant, or were even unrecorded in their country of origin. This clearly indicates the desirability of continuing the present restrictions on the import of conifers into Great Britain, for there are still a large number of damaging foreign fungi, which we do not yet have in this country.

As far as the Forestry Commission, or indeed Great Britain as a whole, are concerned, research on the diseases listed above is not as active as one would like. Experiments on control by spraying are planned for *Keithia* on *Thuja*, and the observational records on isolated nurseries will be continued. More fundamental work on the biology of the fungus is being undertaken at Nottingham University.

A re-evaluation will be made on the status and possible future importance of *Rhabdocline* on Douglas fir and *Meria* on larch, in view of the apparent widening of host range, which has occurred with both fungi. A study of possible strains of *Meria*, and their relationships to the different larch species, is in progress at Southampton University. Dr. Malcolm Wilson at Edinburgh is studing *Chrysomyxa rhododendri*, with especial reference to its host range, and the safety distance of spruce from rhododendrons. Defoliation and browning of pine is so frequent and widespread that ultimately a thorough investigation will have to be made.

On the whole, considering the large number of fungi which can attack conifer needles, we are lucky that, apart perhaps from *Keithia* on *Thuja*, no one disease ranks as a really serious threat, and that several important tree genera have as yet no serious needle pathogens.

FOREST ENGINEERING ECONOMICS

By E. R. HUGGARD, B.A., B.A.I. (Dublin), A.M.I.C.E.

The following article is reproduced by kind permission of the Editor of Y Coedwigwr, *the magazine of the Forestry Society of the University College of North Wales, Bangor.*

Any theory of Economics is necessarily extremely complicated and the greatest fault of this article will be the over-simplification of the problems involved. As forest engineers, we have not been especially acquainted with the conditions governing the manipulation of money. At the same time economics are a major factor in almost every decision which has to be taken and it is imperative that sufficient thought be given to the subject in order to achieve a practical solution to the problem in hand. Innumerable situations present themselves where correct decisions can be guaranteed only after calculating the estimated costs of alternative methods. Almost every problem has several solutions calling for different methods of execution and in nearly all cases the best solution is the most economic.

In order to illustrate the meaning of the various terms used, I am going to try and find out whether it would be more economical to purchase a lorry for carrying stone from a quarry, or to have it delivered by the quarry owners at an agreed rate per ton. Let us assume that I required thirty tons of stone per day, that being the amount of stone which one lorry will carry over this particular haul. The cost of delivery of the stone by the quarry owners would be 5/- per ton. Now if, instead, I purchase a lorry I will start by having to borrow *Capital* (£1,000) to pay for the vehicle. On that capital, I shall have to pay *Compound Interest* at an agreed rate, at the present time probably 5 per cent. The fact that one might have the requisite money available instead of having to borrow it makes no difference for in that case one would be losing at the rate of 5 per cent compound interest when the money is withdrawn from its present investment and paid in exchange for the lorry. Each piece of plant or vehicle will have a useful *Life*, at the end of which it will have only *Scrap Value*, which is very often nothing. In our case, we estimate the life to be, say, five years, at the end of which the lorry will have a scrap value of £100. This means that it has a *Depreciation* of £900 over a period of five years, i.e., £180 per year. The estimate of the rate of depreciation is influenced by the amount of *Maintenance* given to the vehicle and so, in deciding the life to be five years, I have assumed that a sum of £60 per year will be spent on maintaining the vehicle in working order. The *Running Costs* of the vehicle account for all the money spent on the day-to-day expenses of keeping the vehicle working. In this case they include the driver's pay, the cost of fuel, oil, replacement of tyres, etc. To this must be added the *Overheads*. These consist of the expenses not directly connected with the actual running of the vehicle but, nevertheless, necessary to maintain the organisation. Here they include garaging, road tax and insurance and, when there is a supervisor, part or all of his salary. To arrive at an answer to my problem I will calculate out the cost per ton of stone for delivery should I be prepared to invest in a lorry.

Interest on Capital (£1,000) at 5% compound interest allowing for a Redemption payment of £180 every year to cover appreciation	£160
Five payments of £180 Redemption. (The odd £100, scrap value, to make up repayment of whole loan is repaid after sale)	£900
Maintenance cost at £60 per year	£300

Running costs:

Fuel, oil, tyres, etc., £1 5s. per day.	
Driver's pay, insurance, etc., £2 2s. per day.	
Total—£3 15s. x 1,300 working days ..	£4,227
Overheads:	
Garaging at £25 per year. Total for 5 years=£125.	
Tax, insurance, etc. for 5 years=£280.	
Total	£405
Total Cost	£5,992

Total stone carried=30 tons x 1,300 days=39,000 tons.

Cost of delivery per ton= $\frac{£5,992}{39,000}$ =3/1 per ton.

Cost of delivery by firm=5/- per ton.

Therefore, assuming our estimates of cost to be reasonably correct, it would be a profitable proposition in this case to purchase the lorry and to carry out the work oneself. You will notice that, due to having to estimate the life of the lorry and the working hours per week, etc., there is an element of risk in such propositions. That is particularly so in the case of estimating for one item alone. However, for a fleet of vehicles an extremely close estimate can be obtained as an average for the various expenses to be expected. So I stress the great importance of keeping cost records of all kinds, for if they are intelligently used, they will be the foundations on which future organisation will succeed.

This proposition of the lorry is a fairly simple choice in which the economics are reasonably straightforward, but it could be only part of a larger and more comprehensive plan which in itself may form an alternative to some other scheme. On the other hand there are several smaller propositions within this very problem which could be considered. For instance, economics will help you to decide whether the money spent on garaging is repaid by smaller depreciation and more working hours. Or whether, if more money is spent on maintenance, the working life of the vehicle could be prolonged. Due to other factors, the practical man knows that the economically correct solution is not always the correct or the practical one. Nor can every conceivable alternative be costed and acted upon, else the whole organisation would become blinded with economic science. Alternatives can be divided into three main groups. Firstly, those which should always be costed and compared, being decisions of importance concerning work or investment to which there is more than one solution. This important group includes all the major decisions where each case is different and in which all the relevant economic facts are accounted for. In our example the question whether to purchase the lorry is a major one, and the solution is largely dependent on the facts of that particular situation. Included in this group are such important propositions as costing the different methods of timber extraction, the purchase of plant and vehicles and indeed almost all the major decisions of the forest organisation. The second group consists of minor decisions of which one is convinced of the correct solution as a result of having compared the costs of a similar alternative. That allows us to make the correct decision from experience rather than from a comparison of the actual costs. In our example, I suggest that the question of whether to garage the vehicle belongs to this group. In other words, I am convinced as a result of experience and having costed a similar situation previously that garaging more than amply pays for itself and I am ready to accept that, unless there are some special circumstances to be considered. This group includes hundreds

of everyday alternatives in which experience will automatically supply the answer. The decisions need not necessarily be concerning trivial problems but rather they are easy decisions to take on account of their one-sidedness. For instance, it would obviously be uneconomic to purchase a low loading trailer if there are only a few pieces of plant to be moved about and a trailer can be hired for the occasional instances. Note that that is true "if there are only a few pieces of plant to be moved". Should the complement of plant increase and movement become more than occasional, then the decision whether to purchase a low loader becomes a major one; it moves into Group 1 and demands examination of the economics involved. The third group comprises all decisions of a trivial nature and it's just not worth the trouble and time to examine the difference in cost of the alternatives. Some will question this on the grounds that no detail is too small to ignore, but it must be so, else progress would get bogged down by superfluous detail. I must add, however, that what is trivial in an isolated case may become important when quantity is concerned. Is it not true that if every civil servant spent a second less in the office each day, the saving on paper to the exchequer would run into thousands of pounds?

While agreeing that the comparison of costs is necessary we shall examine them with reference to choosing the best method of timber extraction. As previously mentioned the economic factor is only one of several which will determine the correct answer. The chief factors determining the correct method of timber extraction include the limitation of capital, availability of plant, the nature of the terrain, the length of the haul, the size and quantity of the timber to be moved, the availability of labour, the existence of roads or waterways and the climatic conditions. All these factors can be rolled into one—the economic factor. For one must extract at the smallest possible cost making full use of all the available benefits created by all factors; we have to decide what is the cheapest form of extraction for a particular area under certain conditions. Now no worthwhile comparison of costs is possible without access to accurate records. It is only by being able to estimate the costs of the various methods of extraction over different lengths of haul and the cost of road construction that we will be able to carry out our extraction in the most efficient manner. An accurate estimate of the various methods will not in itself solve the problem. Extraction is a complex business in which a combination of methods has to be correctly moulded to give the most economic results.

In a large area where there are few roads, the cost of haul from stump to road exceeds by far the value of the timber. On the other hand, if a huge mileage of new road is constructed in a small area, the cost of the road construction would be equally excessive in relation to the value of the crop. Somewhere between these limits there is an ideal density of roads per unit area. The correct density of roading in any area depends on the quality and quantity of the crop, the cost of road construction and the cost of haul from stump to road. It is a matter of economics to work out the ideal density. Taking into account the capital required, compound interest for the period of the loan, which may be taken to be the rotation of the crop, and the redemption payments, one is able to calculate the amount which each cu. ft. of timber from that area will have to bear as its share of the cost of road construction. The greater the mileage of road constructed in any one area, then the greater will be the cost borne by each cubic foot of timber. The haul from stump to road is in inverse ratio to the mileage of road constructed for the very reason that the haul becomes shorter as the road density becomes larger. When a graph is drawn showing density of road (miles per square mile) on one ordinate and the total cost of extraction on the other (road construction cost plus cost of short haul)

then it is apparent that at a certain density the cost of extraction is at its cheapest. In Great Britain the average figure is from seven to eight miles of road per square mile of forest.

To determine the most economic method of extraction from stump to road one has, in the first instance, to decide which methods are possible and then to cost one against the other. I list those factors which determine whether any particular method is possible or impossible.

Factors affecting Choice of Method	Remarks
Availability of plant	Obviously only that plant which is procurable can be used. All plant and equipment used, even if they would otherwise be lying idle, must be costed.
Length of haul	Has major effect on the choice of method but makes no method impossible.
Nature of terrain	Steep gradients tend to eliminate the horse and tractor, indicating resort to the winch, chute or aerial ropeway. Wet peat suggests use of the winch in some form. Level ground eliminates the chute and aerial ropeway.
Timber size	Both the aerial ropeway and chute are limited to size. Manpower can cope with weights up to 75 lb. only. Animal power is severely handicapped unless friction is cut to a minimum.
Availability of labour	With the rising standards of living, machines are tending to replace manpower.
Existence of roads and tracks	A sufficiency of tracks indicates use of the sulky.
Existence of waterways	A cheap and efficient means of transport where suitable waterways exist.
Climatic conditions	Skidding on ice and snow is very economical where such conditions are prolonged and can be anticipated.

Having decided on the possible means, one method or a combination of methods is costed against another. One must be wary about introducing a combination of methods because one of the golden rules of transportation is to *avoid double handling*. The practical difficulties of extraction are not discussed here because this article is aiming at encouraging the student to consider the economics of the case and if that is done then the purpose of the article has been achieved.

As already stated, economics enter into almost every sphere of forest organisation, and a few examples are given below.

The standard of the road is a matter of economics. The higher the standard the less the maintenance costs, the faster the speed of the traffic, and the less the wear and tear on traffic. This must be weighed against the extra capital cost. In Great Britain the standard set is almost the lowest possible and just sufficient to carry the loads at slow speeds, and necessitates being prepared to cope with any failure as and when it occurs.

The selection of the road line is largely dependent on the estimated cost of the work. Even though a certain density is required the actual line of the road will be located to avoid expensive hazards.

The economics of piece work must be worked out accurately prior to any scheme being put into force. The introduction of piece work is often a failure because the employer just adds on a little to the rate and hopes for the best. Sometimes just because the worker earns (as a result of hard work) a bonus frightening to the employer, the latter cancels the scheme in spite of the fact that he too is obtaining cheaper production.

Yet another example is the storeman who is in charge of tools and equipment to a value of, say, £500. If, instead, the store was left in charge of the workmen who used the store, the entire stock would have to disappear every year to be equal to the wages of the storeman. Such cases of false economy do occur quite frequently and deserve a careful examination. On the other hand a ganger apparently doing very little may mean a tipper doing an extra journey every day which would more than pay for his salary.

A study of economics means profit instead of loss and only by making a profit can we succeed.

BRITISH FORESTRY DEVELOPMENT IN THE EARLY TWENTIETH CENTURY

By D. L. SHAW

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Prior to the establishment and subsequent operations of the Forestry Commission in 1919, Great Britain did not possess or encourage a forest policy based on the economic needs of the country. Unlike several countries on the continent of Europe we had no forest tradition and acquired the grievous distinction of being the largest importers of raw and manufactured timber in the world. It is certain that some estates practised sound silviculture in the last century and a limited, local forest tradition was sustained. But interest now became national in character. Home resources without replenishment of felled stock, could never satisfy the growing needs of commerce and industry. and no systematic attempt on a national scale had been made to restock felled woodland areas or investigate the thousands of acres of waste land with the purpose of planning afforestation projects. Abortive studies of these problems were made in the early part of this century and an examination of these will indicate the growing concern of various bodies to the question of establishing forestry on a national scale. Alas, it took the hazards of the First World War to reveal the urgency of the question.

It is of interest to record that in 1885 a Select Committee of the House of Commons was appointed to ascertain whether by establishing a Forest School or otherwise, our woodlands could be made more remunerative. This committee was twice re-appointed and reported in 1887, suggesting establishing forest schools, the creation of a board to organise instruction; the holding of examinations, and the publishing of a syllabus and handbook. No effective action was taken on this report.

The 20th Century—Initial Phase

Several committees were created to deal with forestry in the first decade of the century, but little in their reports and recommendations was adopted and put into practical effect.

In 1902 a Board of Agriculture Departmental Committee was set up "To study and report on the present position and future prospects of forestry, and the planting and management of woodlands in the United Kingdom". This Committee reported and recommended the introduction of demonstration areas, plots as examples of good management near Oxford, Cambridge and Edinburgh, instruction in forestry at agricultural colleges, technical advice for woodland owners, modification of the estate duty on timber and the planting of municipal water-catchment areas. Some of the proposals were put into effect.

In 1907 a Committee was appointed by the Vice-President of the Department of Agriculture to report on the condition of forestry, the preservation and extension of existing woodland, and to outline a financial scheme for afforestation. The report aimed at the afforestation of 700,000 acres. A start was made, but it was very slow—1,000 acres were planted in ten years—much less than the area deforested during the period.

In 1908 the problem was attacked from a new angle. The Government enlarged the terms of reference to the Royal Commission on Coast Erosion, asking for a report and requesting whether it was desirable to make an experiment in afforestation of reclaimed lands and waste land with the use of idle labour during periods of depression. The Committee reported in January, 1909, and recommended the afforestation of 150,000 acres annually up to an aggregate of no less than nine million acres. This suggestion was taken no further.

In 1911 the Secretary of State for Scotland nominated a departmental committee "To report on the selection of a suitable location for a Demonstration Forest area in Scotland and on any further steps which should be taken to promote silviculture in Scotland".

This committee reported in the same year suggesting:

(*a*) The formation of a demonstration forest of 4,000 acres.

(*b*) A limited number of trial State forests.

(*c*) One University course to provide forest education.

(*d*) A survey to determine the extent of likely afforestation areas.

(*e*) State loans to assist woodlands owners.

(*f*) Amendment of the law affecting the taxation of woodlands to estate and succession duties.

Only in respect of (*c*) and (*f*) was some action taken.

In 1912 the President of the Board of Agriculture and Fisheries appointed an advisory committee in regard to a forest survey, experiments in silviculture and forest demonstration centres and the instruction of woodmen. The committee reported in the autumn of the same year recommending:

(*a*) A survey of seven selected districts in England.

(*b*) The creation of experimental forests of not less than 5,000 acres each in the seven districts.

(*c*) The creation of a demonstration forest.

(*d*) The inauguration of laboratory research and experiments.

(*e*) Provision for the training of skilled woodmen.

A demonstration forest in the Forest of Dean was started and a beginning made with the limited survey.

It follows from all these various activities that though no consolidated forest policy emerged, much value was derived from the enquiries, for the research involved increased the knowledge necessary to success in an undertaking which in practice was new to the United Kingdom. But the fact remained that Britain still had to pay heavily for imported timber; furthermore, we paid for foreign labour in fellings, conversion, manufacture and in transport. World utilization of timber was rapidly increasing and the area from which the United Kingdom could receive supplies was diminishing. Improvements in the conditions of life, rapidly expanding in many of the timber-producing countries of Europe, resulted immediately in a rise in the consumption of timber per head of population, hastening the approach of the day when it might be difficult to satisfy British needs at any price.

The Second Phase—Emergence of a Forest Policy

The incidence of the First World War emphasised the necessity of timber to military operations. The scarcity of shipping and submarine activities gradually severed the United Kingdom from accustomed sources of timber supply and the demands of our overseas armies and industries at home found the country with no organised forests and an insufficient supply of timber. Requisitioning of such timber as the State or the individual possessed became necessary without consideration of the economy of early or partial fellings. The area of forest in the United Kingdom prior to the outbreak of the First World War was estimated at 3,315,000 acres and amounted to 4.3 per cent of the total area of the country. Of the forest area 96.3 per cent belonged to private individuals, 2.6 per cent to the State and the remainder (1.1 per cent) to corporations, ecclesiastical bodies, etc. Roughly this area of woodlands worked out at one-tenth of an acre per head of population, against half an acre per head in Germany and France.

As the 1914-1918 War progressed our woodlands were seriously depleted. Practically the whole supply of mature coniferous timber was cut and severe inroads made into younger coniferous plantations. The best ash and a considerable volume of the best oak was also used up. By 1916 British forestry was in dire peril. In July of that year the Forestry Sub-Committee of the Ministry of Reconstruction was set up "To consider and report upon the best means of conserving and developing the woodlands and forestry resources of the United Kingdom, having regard to the experience gained during the war". The report of this sub-committee served as the basis of the Forestry Act of 1919 and the establishment of the Forestry Commission.

Proposals of the Forestry Sub-Committee

The average quantity of timber imported during ten years before 1914 was over 500 million cubic feet per annum, and the sub-committee estimated that to produce this quantity of timber at home, no less than nine million acres of *additional* land would require to be afforested. They also calculated that the *additional* area of woodland required to make the country independent of overseas supplies for three years of emergency was 1,770,000 acres of conifers and 100,000 acres of hardwoods.

In the case of conifers a rotation of eighty years was assumed and theoretically one-eightieth of the area should be planted each year, but owing to the grave depletion of the existing stock of timber it was proposed to plant two-thirds of the area in the first forty years and one-third in the second half of the rotation.

In the case of hardwoods it was proposed to plant 1,000 acres annually. The sub-committee further recommended that private owners should be

encouraged to replant felled woodlands and that the standard of forestry be increased by research, technical education and advice. Finally, they proposed the appointment of Forestry Commissioners provided with the necessary funds and staff, to undertake the policy of the Government.

In 1919 came the Forestry Act, and the establishment of the Forestry Commission—and for the first time in its history, the United Kingdom had a forest policy and the instrument with which to insure its application.

A NOTE ON FORESTER TRAINING

By H. CRUICKSHANK
Education Officer, Faskally

In the reports, submitted by District Officers and Foresters, on Assistant-Foresters of about six months' standing, such comments as the following invariably occur: "Has very poor control of a squad of men"; "Control of labour is his weakest point, but he will, I am sure, improve with experience"; "Could be in time quite good in controlling labour"; "He handles his squad well, but is somewhat impetuous"; "He handles his squad well and has plenty of initiative".

These comments illustrate the emphasis which is rightly placed on an important aspect of an Assistant-Forester's duties; they also indicate the inherent differences in the capabilities of individuals. Do they, as well, point to a defect in our present system of forester training?

The subject of "man-management" has received increased attention at all levels during the past few years. At Northerwood, courses have been arranged to include this aspect of the work, and in the Training Schools efforts are being made to meet an obvious need. Yet it may be anticipated that in spite of all our efforts, these faults will continue to be observed and to be expected when supervisors first take up their posts in the field. Why? Because "man-management" as a subject cannot be taught adequately. The theory can be expounded and discussed, *ad nauseam* even, but unless a man is a "born supervisor" the only way he can learn the art is by bitter experience.

George Bernard Shaw, in his wisdom, stated that a good recipe for success is arrogance, tempered by experience and defeat. Whilst this opinion is open to argument, Shaw's qualification "tempered by experience and defeat" is fundamental.

How is the problem tackled in the Forester Training Schools? In what is virtually the only possible way, by giving each man, in his turn, charge of a gang of his fellow-students. First, of course, before a student can take charge of an operation he must himself have done the work and be reasonably proficient in the manipulation of the appropriate tools. In this respect the twelve months' preliminary practical work in the forest, prior to entering school, is invaluable, otherwise too long a period in school would have to be devoted to the attainment of the necessary manual proficiency.

The student appointed in charge of an operation is fully informed regarding the work to be carried out by his gang. He is required to plan how he will set about the job, how best to allocate his men for maximum efficiency and to

decide the number and type of tools he will require. All these details he discusses in advance with the Forester-Instructor, who is ready with guidance and advice, and when necessary, instructions on technique, methods and records.

The Forester-Instructor accompanies the gang in the field, gives such demonstrations and instruction as he considers necessary, discusses the operation in detail with the gang, and gives any further necessary guidance to the student in charge. He remains with the gang until he is satisfied that the work has been adequately organised and is being efficiently carried out.

The Forester-Instructor then leaves the gang to carry on working and the student in charge to continue to organise and supervise the operation. Later, perhaps that afternoon or the following morning, he returns to assess the quality and quantity of the work done and at the same time the adequacy or otherwise of the student supervisor. During his inspection the student in charge accompanies him, discussing the points which have arisen, the difficulties encountered and overcome. The Instructor questions and criticises, discusses mistakes and modifications, sometimes issues fresh instructions. Occasionally the work may have to be re-done. All the time the student supervisor is learning forestry technique, and how to organise and control his men to best advantage.

In addition to their field supervision, second year students are each appointed for a period of two or three weeks to a position of authority in the school. The title of this post and its exact responsibilities vary from school to school. Whether a student is referred to as School Foreman, Assistant-Forester or Orderly Officer is immaterial; he is given responsibility for such matters as the issue and control of tools, time-keeping, discipline and practical records.

This training in supervision and responsibility sounds very good in theory. Each man is getting the valuable experience he needs, and is learning a technique which he will put into practice as an Assistant-Forester in the field. But is he?

Two objections spring immediately to mind. In the first place opportunities in the school of taking charge are limited. The limits are the duration of the practical work and simple arithmetic. During the two-year course approximately 225 days are devoted to practical work. If the gangs were always to consist of three men, theoretically each man would be in charge for one-third of the time; if of five men for one-fifth of the time. But unless the gangs are of reasonable size there is little need for detailed organisation and supervision. In many operations such as planting and brashing one supervisor to a gang of ten is quite sufficient. Hence in such cases supervision is limited to one-tenth of the practical time. Again, in forestry there are so many operations, each with their own variations, that it is obviously impossible for each student to be given experience in charge of all operations.

The second point is that the members of the gangs are neither inexperienced nor unruly forest workers. They are fellow-students, who may indeed become unruly at times, but who have much in common with their temporary supervisor and know that they in turn will be called upon to supervise their fellows. They may not work as hard as piece-workers and the unit costs may not always be as low as one would wish, but seldom do they really test the mettle of the would-be supervisors.

On the other hand, to give a student charge of a forest squad for a short period, a system which would afflict the squad with frequent changes of supervisor, would not only be divorced from reality but completely farcical.

What then is the answer? I would suggest that a great responsibility rests

with the Forester under whom an Assistant-Forester is first posted. This Forester should appreciate that his assistant's training, far from being complete, is in fact beginning a new phase with his assumption of responsibility. If the Forester recalls his own hesitant beginnings he will realise it cannot be otherwise. And if he treats his new assistant accordingly the solution may be in sight.

For the first time the Assistant-Forester is in charge of forest labour. Previous "experience and defeat" at school will help, but new and different problems face him, demanding more of his tact and understanding of men than ever before—more perhaps than he can sometimes be expected to possess. The guidance, advice and support of an experienced and sympathetic Forester is essential at this stage. The very knowledge that he is not standing entirely alone will give the young supervisor increased confidence in himself and he will thus be better equipped to avail himself of every opportunity to progress towards proficiency.

In this article I am not trying to manufacture excuses for deficiencies in our educational system. Forestry is an occupation which is not learned in two, or even ten years; at school the groundwork is covered, but in all branches proficiency comes gradually with experience and guidance from older men. The management of labour is perhaps the outstanding example of this truism. If District Officers and Foresters can be convinced of this need and of their direct responsibility in furthering the education of their young junior supervisors, that awareness of the problem, coupled with their sympathetic co-operation, can lead to its solution.

EDUCATION FOR ADMINISTRATION

By L. G. BARTER

Senior Executive Officer, Directorate for England

Management can be defined as the direction of the energies and capacities of others to the end which it is desired to achieve. Although, incidentally, it may involve detailed work on the part of the executive, the essence of his job is that he is co-ordinating and carrying out plans through others. It has been declared that full efficiency in any organisation is impossible without collaboration, and I think it is pretty evident that collaboration is an act of will which can hardly be forced. I am convinced that the fundamental organisational problem of any enterprise is the building up of an harmonious human relationship for joint effort in the most effective conduct of that enterprise. There is ample evidence that the final measure of the strength of an organisation is the collective strength of the individuals engaged in it, each individual accepting his own share of responsibility for the final result.

An efficient organisation is based on three assumptions, the first that each individual concerned in it has something of value to contribute, secondly, that some means is found of permitting the development of each individual to the utmost of his capacity, and thirdly, that the experience of the group is related, integrated, and made effectively available. The greatest and most enduring power is developed jointly by employer and employed, and is *co-active* as opposed to *coercive*.

Unities are determined, not only by their constituents but by the relation

of the constituents to each other. Mr. Black is one person and Miss White is another person; but put Miss White with Mr. Black and the result is very different from a dull grey.

Unrelated experience is partly wasted, but when energies are released and allowed to interact, the result generally is progress. Capacity and experience are united, not only to carry out the purpose, but to create higher and better purposes. Full efficiency is, therefore, only reached when means exist to draw from each member of a team his fullest possibilities, when the experience of each is related and employed in the common purpose. There is no longer room in modern society for the individual who is so efficient, and *self-efficient*, that it is impossible for others to work with him. Integration invariably requires intelligence, perception, and imagination, and it is with individuals possessing these qualities that responsible administrative posts must be filled.

Education has achieved a place of high importance in administration. Great industrial concerns employ education officers and technical instructors; Government Departments assist officials to attend courses of instruction. The complexities of an industrial civilisation call for greater understanding, skill, and knowledge to be attained through education, for education is systematic instruction given in preparation for the work of life. Much industrial and vocational dissatisfaction is due to a failure on the part of the employee to realise the setting and purpose of his work. When a man is so buried in the details of a job that he is unable to see its broad outlines, he is said to be unable to see the wood for the trees. The purpose of instruction in administration is, therefore, to show the student the outline of the whole wood, and the relationship of one to the other, of different parts of that wood.

SHOULD WE GO BACK?

By T. S. HARVIE
Assistant Forester, South Scotland

A child learns by example and by experience, and this method of learning is not exclusively for children.

A forester gains knowledge every day by experience, and experience is gained by example also. Fortunately the young forester can benefit from the knowledge and experience of his seniors. If, however, the forester could re-visit the forests where he has worked previously, and see the results of his labours, to see both the successes and the failures would be of great value to him.

Would it not be of benefit to the forester to see the plantings of four or five years ago? To see the failure of certain species on certain sites, knowing, as he would, the vegetation on the area before he planted it, and also the successful growth of plantations, the choice of species of which had proved correct. I think that if a forester could re-visit his "old plantings" it would make a far greater impression and would prove much more helpful in deciding future choice of species than the complicated tables of "vegetative communities" so neatly put into groups which one seldom finds clearly defined "on the hill".

The treatment given to backward areas is another point which would benefit from a visit in a few years time. Did the manuring and extra draining really help to get the trees out of check?; or was the choice of species wrong? If we went back after some years had elapsed these questions might be answered. Information on treatment of "difficult areas" and the results of the different treatments are interesting and undoubtedly they are of value, but personal experience of a problem will make a more lasting impression than second-hand information will, however good.

A visit to your "old forest" would give you an opportunity to see how your successor was tackling the problems that you yourself had experienced. He may have gone about solving the difficulties in a different way from you and you might learn from his methods. Conversely, he might learn from yours!

Thinning is another aspect of the forester's work which would, I feel, benefit from a visit in, say, three years' time. One could ascertain from the state of the plantation whether the thinning had been too severe or too light or, if it was correct, you would be able to see the improvement of the crop and the behaviour of the elites and the "lower storey". To see all these things would, I am sure, make for better thinning in the future.

Your previous forest may have been in production and a visit to it may reveal different techniques in the methods of extraction, and the use of different equipment may give you ideas which might help in making a better job of your present extraction work. A forester who is now working to establish a forest and who has no production work in progress would benefit from a visit to his "old forest", as such a visit would help to keep him in touch with new methods being used in extraction, thinning, etc., and will show him the need for laying out extraction lanes while he can still see the lie of the land across the compartments. A forester who is continually on the establishment side of forestry is liable to dismiss the extraction worries as being in the dim and distant future and not to prepare for them at all. A visit to your old production forest will keep you up to date and will encourage you perhaps to do something about these problems.

On my last visit to a forest where I used to work I was amazed at the number of new roads that had been made, and at the difference that these roads made to the extraction problems. Areas that had seemed so inaccessible now gave little or no trouble in getting out the timber, and the protection of the forest as a whole against fire has certainly been increased by the breaking up of the area into smaller blocks by roads. I got the impression that, far from standing still, there had been a steady progress towards more efficient extraction and much greater mobility throughout the forest. After a visit such as this one sees the work of establishment in a different light and one sees farther ahead to the days when the forest will be in production. In fact, one can see the wood through the trees.

A forester does, by necessity, live a life of relative isolation from his colleagues, and a visit to another forest gives an opportunity to exchange ideas with his opposite number which is bound to be of mutual benefit.

DISCOUNTS AND DECIMALS

By H. S. FROST
Executive Officer, East England

Most people know that 2½ per cent is equivalent to sixpence in the pound, and that for 10 per cent and 25 per cent the amounts are divided by ten and four respectively.

There are, however, many other percentages in common use which present a little more difficulty, requiring direct arithmetical methods or reference to a ready reckoner.

These can often be worked out quickly by the following short-cut method, either with or without the aid of the "FACIT" Calculating Machine to be found in Conservancy Offices. (Foresters' indents not accepted!)

Example

2 per cent of £73 18s. 5d.

Method

1. Ignore the 5d. (9d. or more should be rounded up to the next shilling).
2. Convert shillings to decimal of £1=£73.9.
3. Multiply by 4 (2×2) and move decimal place 1 point to left=29.56.

This is the amount in shillings which is £1 9s. 6½d.

The principal, of course, is that the decimalised sum is multiplied by one-tenth of twice the rate of discount. In the example given, this reduced the following calculations:

× 2÷100 (to obtain amount in pounds).

×20 (to reduce to shillings).

Where the discount is fractional, say ⅛ per cent, the decimalised sum should by multiplied by 2×⅛=¼, or *divided* by 4, when moving the decimal point one place to the left will again give the answer in shillings.

In practice it has been found that this method gives quicker and more accurate results even with such simple rates as 2½ per cent, 5 per cent, etc.

A FISH HATCHERY

By D. J. FOURT
Forester, Research Branch

At Wraymires near Far Sawrey in the Lake District we visited the fish hatchery attached to the Freshwater Biology Association. It operates to supply stock for the laboratories at Ferry House, and for growth studies conducted in the group of tarns higher on the hill behind, and in some tanks in the hatchery grounds. The species kept are all trout and char, namely Brown trout (*Salmo trutta*), Rainbow trout (*Salmo irideus*), Windermere char (*Salvelinus alpinus*) and American Brook trout (*Salvelinus fontinalis*). The water comes from the tarns

mentioned earlier, as a piped supply, a convenient relic from a small hydro-electric supply system constructed by the former owner.

It was understood that research into hatchery procedure is not conducted here, a well-tried method being employed. This sort of work is probably carried out at the Brown Trout Research Laboratory at Pitlochry, although private hatcheries all over the country have been finding better methods by observation and experience since early in the last century. This can be gauged by the fact that transplantation of trout ova to the Antipodes by a group of breeders, with all the problems of transport, etc., had been completed successfully in 1864.

It has long been known that trout are migratory, cold-water fish, which to judge by their distribution must have ascended every river from the sea as soon as the retreat of the glaciers allowed. Around 44°F. is optimal for the hatching of trout ova, and if a temperature of 58°F. is reached at any stage, death supervenes.

The method used at Wraymires is called the dry fertilisation process. The hen fish is taken from the water when ripe, and gently stroked along the belly from behind the gills to the anus, the expelled ova falling into a shallow pie dish. In a similar way, milt from a male fish is added, and the mass stirred up gently—often using the tail of the male fish! After allowing a few minutes for impregnation, cool water is poured in and out until the pie-dish is clear again. The eggs are then spread out on grilled trays in a stream of cool clear water, the whole in a dull half-light. The hatchery house is tall, and thick walled for coolness, and from one end flow the troughs or flumes of water. In these are placed the hatching trays 3 ft. long by 9 in. broad and 6 in. deep, with the grills the narrow way, made up of $\frac{1}{4}$ in. glass rod, $\frac{1}{8}$ in. apart, just sufficient to retain the eggs. The infertile and diseased eggs are soon spotted and removed, as disease at this stage spreads rapidly. In nature the eggs of trout and salmon are a delicacy to larger fish of the same and other species. This egg stage in trout normally takes place under fine gravel, permeable enough to water, but protecting against predators.

When the eggs hatch the young fish swim about clumsily, with the large egg sacs beneath them. This stage is passed in the hatching tray, but as soon as the egg sac is absorbed, and the fry are ready to feed, they are removed lower down the flume into a trough without the glass-grilled tray, and here fed on the trout-hatchery staple food. This is finely chopped liver, from the local slaughter house, which has been condemned as unfit for human consumption. The trout stay here till they are about 1 in. long when they are moved out of the hatchery house into the open air.

Here they live in one of two sorts of small concrete tanks sunk in the ground. The deep rectangular variety is laid out in a series, discharging one into the other. The round type are units on their own, and their overflow goes to waste. The fry live here for the rest of their first year. Below is a diagram of the round type. It is about 5 ft. across, and 2 ft. deep round the edge.

It can be seen that the action of the two water jets is to provide aeration, to slowly change the water, and very important, to induce a rotating current. The fry swim head to stream, and the food is kept off the bottom, and does not decay so rapidly. The advantage of this type is that it is capable of holding larger numbers of fry per cubic foot of water supplied than the trough type, but it is more likely to warm up in a hot season. It then needs shading, and a more rapid turnover of water.

In the trough type the same water passes down a chain of tanks. These are around 7 to 8 ft. long, 2 ft. deep and 2 ft. across. Water enters by a low fall at the head and causes some swirling and agitation but not a set pattern of currents as in the circular type. Water leaves by a screened exit at the lower end to fall a foot or so to the next tank. A series of about eight of these occupy the one side of the hatchery.

Close by is a group of stock ponds, made of concrete, and of various sizes, mostly about 30 ft. by 10 ft. by 3 ft. deep. They hold one and two-year-old fish of the species studied, and even a few three-year rainbows used for breeding, of considerable size. This species does not breed freely in the wilds in Britain thus continuous stocking is needed to maintain the head of fish in a water. The rainbow trout, especially the Shasta, grows larger and faster than the brown trout. It too has been introduced to many other countries, such as South and East Africa, New Zealand, Australia, Chile, Argentine, and parts of Europe. In many places, rather like *Pinus radiata*, they grow at least as well as in their native California.

In the stock pools studies are carried out on "production" under different conditions, such as unlimited food, or age of stock. All the fish are netted and weighed at intervals. The food of these is still chopped liver—probably not chopped so fine as the fish are large!

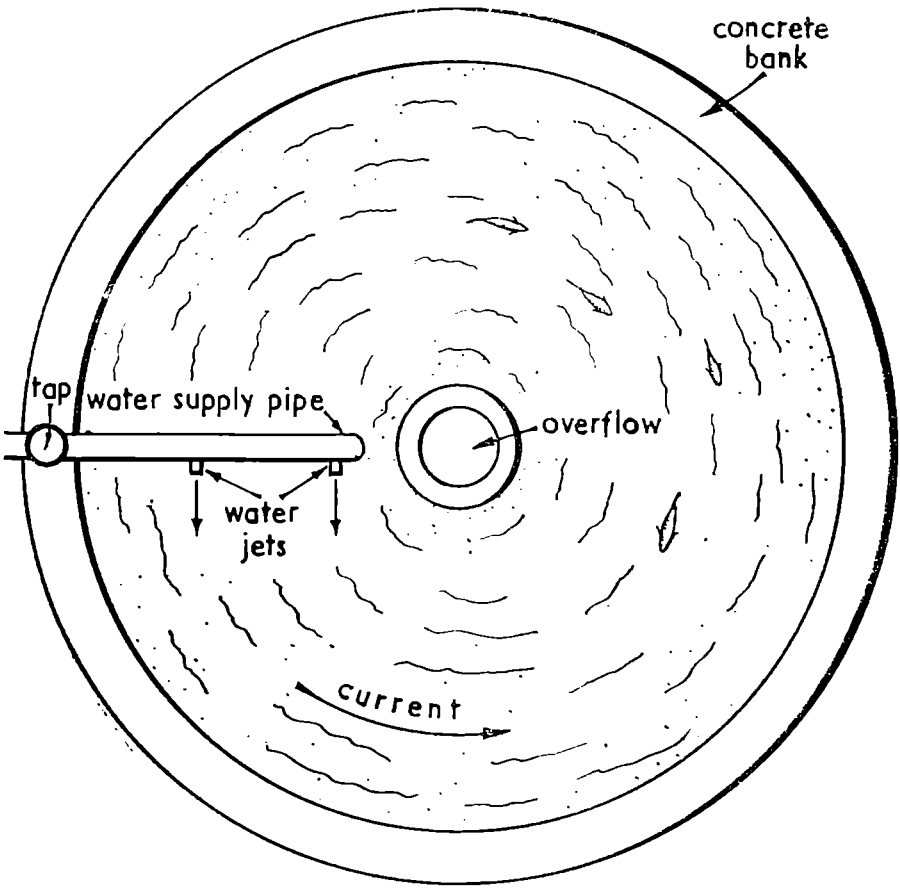

Fig. 32. Plan of round fish tank.

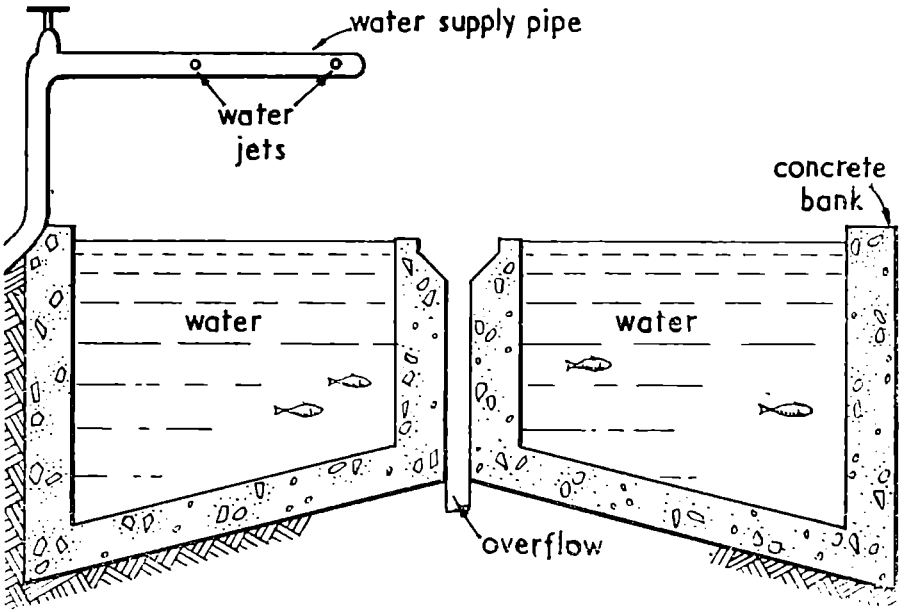

Fig. 33. Cross-section of round fish tank.

After experiments these fish and any others not needed are used for stocking various local waters. It is believed best to use one-year-old fish, but two-year-olds are sometimes used, where the fishermen concerned can afford it. If three-year-old fish—in rainbows about two pounds weight—are used there is a serious risk that the regular feeding received in the hatchery will cause them to loose their fear of man, and become tame, and in the angler's paradox get too easy to catch!

The artificial tarns on Scaife Heights behind the hatchery are also used for studies in production, but under natural condition of food supply. The pools are netted or drained occasionally, or fished with rod and line, and records kept of the fish caught.

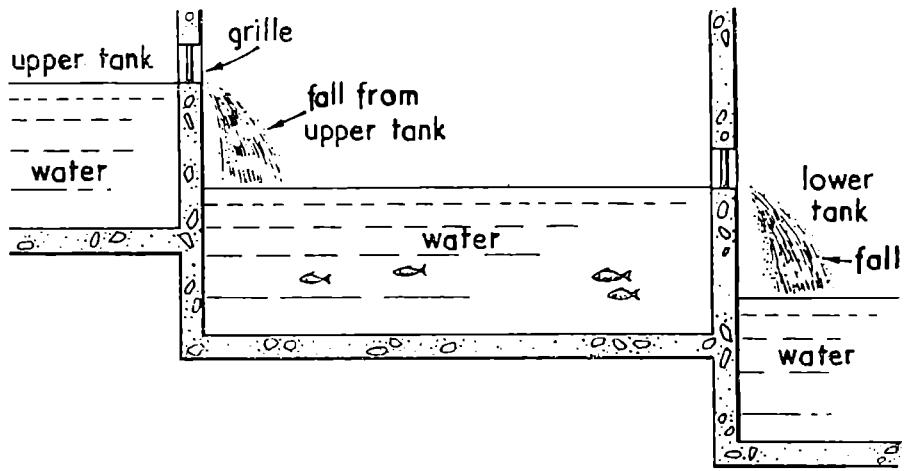

Fig. 34. Rectangular fish tanks arranged in series.

For further interesting reading see *Life in Lakes and Rivers* by Macan and Worthington, a New Naturalist volume. Both the authors have been or are at the Freshwater Biology Association, and the book includes the famous story of the netting and tinning of Windermere Perch during the late war, to be sold as "Perchines"!

GREENFINCHES AND LAWSON CYPRESS

By JAMES MACDONALD
Director, Research and Education

I have a young hedge of Lawson cypress in front of my house and in 1956 it coned very freely as a result, no doubt, of the good weather in the summer of 1955. The cones were small but many of them carried good, well-formed seed although the plants are only six or seven years old.

At various times during December I noticed small groups of greenfinches, six or seven birds, busy on the young trees of the hedge and, watching them closely, I found that they were eating the seed of the cypress, which they were systematically clearing from the cones. Not only that, they were picking from the ground any fallen seed which they could find. After several days' work, they had consumed all the seed on the hedge plants and our garden saw them no more. But, on several subsequent occasions, I found greenfinches at work in the same way on trees of Lawson cypress not far away.

So far as I am aware, there is no record of attacks by greenfinches on the seed of this tree and it would be interesting to know whether it has been noticed elsewhere. Lawson cypress is such a prolific producer of seed that it would not be surprising to learn that it had attracted the attention of seed-eating birds.

BRITISH TIMBERS

By E. G. RICHARDS
Divisional Officer, Research Branch
Reproduced, by permission, from the journal Wood

Over the centuries foresters, timber merchants, craftsmen and manufacturers have gained a wealth of experience in the growing, conversion and use of the many species of trees which are native—or have come to be regarded as native—to Britain. Of the many traditional hardwood species English oak, beech, ash, elm and sycamore are probably most important, while of the conifers Scots pine and European larch can claim pride of place. It has been necessary during the last thirty years or so to plant on a much wider scale a number of coniferous species which had previously played a relatively minor role in British forestry. Thus, Sitka spruce, Norway spruce and Japanese larch feature largely in the coniferous plantations formed since the end of the First World War; Douglas fir and Corsican pine, though important species of these newer plantations, have not been planted so extensively as the three species just mentioned. It is proposed to mention first some of the qualities which distinguish the timber of our principal hardwoods and the well-known

conifers Scots pine and European larch, and then to discuss in more speculative vein a few of the timber qualities of the newer exotic conifers.

The history of the timber trade in Britain is closely linked with our ability to exploit many different types of markets throughout the world since the construction of the fleets needed for this task for long influenced our forest policy and home timber trade, particularly in regard to oak. In a most interesting account *Forests and Sea Power* by R. H. Albion, we read: "It was not enough that the King's ships be built of oak. It had to be English oak. The outstanding point on this whole question of relative timber quality (seventeenth to nineteenth centuries) is the persistent and not altogether unreasonable belief held by the Englishmen that above all other timbers in the world, the oak of England was the choicest material for shipbuilding". The author then shows that this belief persisted until comparatively recent times and we are left in no doubt as to the place that oak held and maintains in the esteem of the British public. The quality which earned for English oak this loyalty was its strength, and it was claimed that in this respect homegrown oak was superior to imported timber produced by the same species (*Quercus robur* and *Quercus petraea*). This was probably due to the faster growth rate of English oaks caused by their environment (particularly climate) and by the then current silvicultural practice.

In addition to its use in shipbuilding, of course, English oak was widely used as a constructional timber where strength was required. For such uses as panelling, wooden screens and furniture, its attractive texture and appearance made oak a favourite material with craftsmen over the centuries. Natural durability is another of its valuable properties and one of which there is abundant evidence in many of our historic buildings. The qualities which have given English oak its high reputation are still esteemed to-day for such diverse purposes as the manufacture of railway wagons and furniture, decorative veneers and barrels, ornamental carving and garden fences.

While a fast rate of growth plays an important part in determining the strength properties of English oak, the same factor has an even greater influence on the strength of high quality English ash. This timber, from the species *Fraxinus excelsior*, is particularly an English product, for there is no other country in the world which, using the same species, can produce a wood equal to that grown here. In its strength qualities, particularly in bending and resistance to impact, ash excels. For this reason ash is highly valued for use in sports goods and tool handles; probably only hickory can compete with it in this respect. The ease with which it can be bent without loss of strength also makes ash an adaptable material for work in coachbuilding and aircraft construction; for example, in the First World War English ash was used extensively by the Air Board. Sawn ash has a pleasing appearance, and a timber with a specially attractive figure can be obtained from the burrs which sometimes occur at the butt of large trees. However, it is from young trees that the most valuable timber is produced. Trees of about 10 in. to 12 in. diameter at breast height, containing a high proportion of fast-grown timber, realise the highest price per cubic foot. Above this size the unit price usually decreases. This possibility of an early financial return makes ash a very attractive tree to many growers and the special qualities of well-grown English ash should ensure for it a continued market.

English elm, the timber of *Ulmus procera*, is another wood which is almost exclusively produced in this country, since imported elm is usually the product of other species. It is a timber which has to some extent suffered an ill-merited obscurity, for it too played a small but important part in our maritime history.

Toughness, its characteristic quality, made it especially valuable for planking and other large timbers in wooden ships, and the large sizes and long lengths in which it could be obtained made it a reliable substitute for oak in the keel. In more recent times its reputation has rested on its use as a heavy duty timber in, for example, the construction and repair of wagons, and its beautiful appearance as a sawn timber makes it particularly suitable for furniture and panelling. Several outstanding examples exist of its latter use, one of the best being in the board room of the Forest Products Research Laboratory. One difficulty experienced with elm is its tendency to distort badly after conversion; advances in the technique of kiln seasoning have helped to solve this problem. It has never been a forest tree, being grown as an ornamental species mainly in avenues and groves. Owing to its exacting soil requirements and its liability to Dutch elm disease it is not likely that it will ever be used as a plantation tree. A continuing supply of elm will, therefore, be available only if it maintains its place as an important species in the large reserves of timber which our hedgerow and ornamental trees comprise.

Small specialised markets are perhaps a characteristic of the home-grown timber trade and a good illustration of the way in which they work can be found in the growing and disposal of sycamore (*Acer pseudoplatanus*), or plane as it is commonly called in Scotland. While the scale on which it can be grown is limited, the market for it, though active, is also restricted. The ease with which the timber can be turned makes it useful for many purposes, and its pleasing appearance in texture, colour and figure enhance its value especially as a surface veneer. The sawn wood is also employed for a variety of purposes such as butchers' blocks and bread boards.

It may be appropriate to conclude these notes on the timber of British hardwoods with a few remarks about beech, the timber of *Fagus sylvatica*. This tree, second only in importance to oak as a hardwood forest tree, occurs throughout Great Britain. Only in the south, however, is it believed to be native. Beech is one of our strongest hardwood timbers, but it is its good working qualities and suitability for bending and turning that recommend it to the furniture trade. These properties also make it useful for coachbuilding. Although not very durable, it can be readily treated with preservative.. The full list of uses to which beech can be put is one of the most comprehensive of any timber and justifies its reputation of being one of the most useful hardwood timbers grown in this country.

Among the softwoods now grown in this country, there are two which hold a special place in the homegrown timber trade by virtue of their long established use and their proven value: Scots pine (*Pinus sylvestris*) a native species, and European larch (*Larix decidua*) which, although it has come to be recognised as a familiar tree in our landscapes, particularly in Scotland, was virtually unknown in this country before the seventeenth century.

Scots pine is similar in its structure and qualities to the imported Scandinavian red deal which comes from the same species. It is a timber with a very wide range of uses and now forms a large proportion of the home-grown pitwood supplies both in the round and as sawn mining timber. For box and packing case manufacture it is one of the best of home timbers. At growth rates of twelve (and over) rings to the inch it compares favourably with imported Baltic redwood in the working properties required for general joinery. Its value for many purposes is increased by the ease with which it can be treated with preservatives, and the heartwood is moderately durable.

European larch is a species which at one time was a particular favourite of the estate owner, so much so that for a time it was planted somewhat

indiscriminately, often on unsuitable sites. Consequently, a number of plantations showed poor growth, the pendulum swung the other way and larch fell into disfavour with many foresters. It is now receiving renewed attention as more becomes known of its silvicultural requirements. Aside from this, the larch has had an undoubted success in a variety of uses. One of its greatest virtues is the durability of its heartwood and this has made it a favourite material for fencing, particularly when sawn posts or stakes are employed. For many other estate uses a durable timber is also required; gates are an obvious example, and uprights and beams for farm buildings are others. For all these purposes European larch has proved to be ideal. Like other materials, it has its disadvantages, chief among which is the difficulty sometimes experienced in the initial stages of its conversion. This is due to the very resinous nature of the timber which sometimes causes the saw to bind.

For special purposes such as telegraph and transmission poles, where even the long life given by untreated larch is inadequate, the difficulty experienced in treating the timber with preservatives may be regarded as a disadvantage. Here again, improved techniques, including incising the wood before treatment, have helped to solve this problem. Despite these difficulties, European larch has been used extensively in many forms and in one market in particular, the mining industry, its strength properties are highly esteemed. The boat-building industry also finds it a valuable material particularly for the "skin" in fishing boats and similar vessels, and in the shipyards it is used in larger sizes for purposes such as shoring.

As already mentioned, over the last thirty years Sitka spruce, Norway spruce, Japanese larch and—to a lesser extent—Douglas fir and Corsican pine, have found a very definite place in both private and Commission planting schemes. While the timbers of Sitka spruce, Norway spruce and Douglas fir have for years constituted an important part of our softwood imports, only comparatively small quantities of mature home-grown timber of these three species and of Corsican pine and Japanese larch have ever been marketed in this country. The bulk of home-grown supplies so far marketed on a regular basis has, in fact, come from young plantation thinnings. It follows almost without saying that most of our present knowledge of the qualities of the home-grown timber of these five species is based on the behaviour of comparatively young material. For example, all five species have been used extensively and successfully in the coalmines. Two factors are important here; strength and ease of handling. The strength of seven species of unseasoned home-grown pitprops has been tested by the Forest Products Research Laboratory (F. H. Armstrong, *Forestry*, XXI.i) and, *inter alia*, Sitka spruce, Norway spruce, Japanese larch, Douglas fir and Corsican pine showed satisfactory strength, provided that they had not less than an average of six annual growth rings per inch of radius. As, on average sites in Britain, the rate of growth for these four species averages more than six rings per inch, Armstrong's conclusions are encouraging to the grower. Moreover, only in a very few instances has it been found necessary, in practice, to reject—as being too weak—properly prepared pitprops cut from trees with even faster rates of growth than six rings per inch. Strength and ease of handling can both be impaired by poor preparation and, in recognition of this fact, home producers have made real progress in improving the general standard of preparation of home-grown props in recent years.

In conclusion it might be fair to say that while the performance of home-grown pitprops in the Second World War, and subsequently in the more competitive days of peace, has laid the foundation of a healthy home-grown trade, there are still many problems to be solved. For example, it may be

found that early thinnings of one species from one locality make poor props because the incidence of low-strength props is above average. On the other hand the home producer is supplying increasing quantities of peeled, seasoned (and therefore probably stronger) props; and fast-grown wood we now know is not necessarily weak wood.

The performance of these five species in relation to three other major existing outlets for softwoods deserves mention. These outlets are fencing, boxboards and building. For fencing, young timbers of species which show good natural durability in their later years have often been used with disappointing results. Thus, one hears of cases where posts of very young Japanese larch showing no heartwood formation have had a shorter life than posts of, say, Douglas fir cut from older material. On the other hand Japanese larch posts with well-defined heartwood will probably last as long as European larch posts of similar size and with a similar percentage of heartwood. The strength of even the fastest growing of our conifers is adequate for most fencing purposes, and where one is dealing mainly with sapwood any lack of natural durability can generally be overcome by employing one or other of the recognised preservative processes. Out of a total of approximately twelve million cu. ft. of timber sold or used by the Forestry Commission in Forest Year 1953, about one-and-one-third million cu. ft. were invoiced as fencing material at the time of disposal; moreover, a proportion of the Commission timber sold standing or in the length to merchants will also have been converted to fencing material.

For the manufacture of packing crates and boxes, the spruces and the sapwood of Corsican pine are suitable where "colour" is a disadvantage; where "colour" does not matter, Douglas fir and the heartwood of Corsican pine may be added to the list. The larches have a reputation for being difficult to nail without splitting, and are not readily saleable for boxboard manufacture. Fast rates of growth often result in lighter timbers and this can be important from the consumer's point of view.

It is often erroneously supposed that the fast-grown exotic conifers will never make satisfactory building timbers. This is not so. The tests hitherto conducted by Forest Products Research Laboratory indicate that, provided the timber is graded, it is possible to obtain, from fast-grown Sitka spruce thinnings of twenty-eight years of age, constructional material equal in strength to, say, Yugoslavian whitewood. From Sitka spruce thinnings of forty to fifty years of age, building timbers equal in strength to the average of imported Baltic redwood have been cut. Forty-year-old Japanese larch gave building material of strength above the average for imported Baltic redwood. The grading was carried out on a practical basis and took account of such factors as rate of growth (annual rings per inch), incidence and position of knots and slope of grain. Since knots affect the appearance and ease of working as well as strength, the question of the desirability of pruning has often been debated. Zehetmayr (*Wood*, May, 1954) points out that there is no established practice in Britain and that in fact experts throughout the world have in the past tended to differ rather than agree on this matter. On the assumption that pruned timber will always be dearer than unpruned, and so long as knots are not present in sufficient numbers to reduce the strength below the desired minima for the commonly used sizes, there is little to be gained by pruning timber which—because of other characteristics—is suitable only for carcassing. In the case of timbers suitable for joinery work the situation is somewhat different and the higher initial cost of completely knot-free pruned timber may often be more than offset by subsequent saving of rejects, by improved appearance, greater ease of working and, perhaps, greater sales appeal.

Before leaving the subject of our newer exotic conifers it may be pertinent to refer to their use as pulpwood. Fibre building boards have, for a number of years, been made from home-grown conifers and the spruces have been used in the manufacture of groundwood pulp. The low-density wood which is often associated with very fast rates of growth does not necessarily produce inferior pulp. In fact for certain types of pulpwood fast growth may be an advantage.

THE BRANDON DEPOT, THETFORD CHASE

Contributed by G. BACKHOUSE, *Conservator, East England and* M. NIMMO, *District Officer, Research Branch*

The Brandon Depot, which covers an area of twenty-five acres and employs forty-four persons including a forester in charge and nine supervisory and administrative staff, handles 200,000 hoppus feet of forest produce per year, comprising nearly all the thinnings from Thetford Forest. During the war, pitprops produced from thinnings at Thetford were despatched by rail from Brandon. A small reserve of pitprops was accumulated in a depot at the railway sidings and maintained in order to provide stocks to complete wagon loads. At the end of the war it was decided to concentrate the conversion of all thinnings from Thetford at Brandon, and it is from this nucleus that the Depot has gradually extended to its present size.

Organisation Policy

Detailed investigations have shown that the differences in cost between preparing pitwood in the forest and at a central depot are small but the supervisory and administrative difficulties of the former are very great. The thinnings come from seventeen separate beats and are eventually converted into up to fifty sizes of pitprop, three specifications of pulpwood log and several sizes of fencing stakes, posts or selected poles. The depot is also a help in that some purchasers collect the produce with their own vehicles which often are unsuited for use on forest rides. Perhaps the most important factor dictating the choice of central conversion of produce is the danger from bark beetle. About 40 per cent of the volume felled in thinning, namely that part most suitable for pitprop production, is peeled at the time of felling. The remainder, which is not required to be peeled, provides favourable breeding conditions for the beetle, and must be removed from the forest within three weeks of felling. Thinning and extraction go on throughout the year, but other seasonal operations and adverse weather conditions inevitably cause some fluctuation in the rate of supply to the Depot. At the same time despatches of converted produce, though they are mainly against reasonably long-term orders, also fluctuate. The Depot has therefore to act as a cushion to the variations in supply and demand. This means that there must at all times be adequate stocks of raw material and of the finished product. A proportion of the latter in the form of pitwood has to be held in stock for a period of eight weeks for seasoning. The average daily throughput of the Depot is 180 tons. The handling of this through a reserve stockpile and thence through the various stages of processing, storage and loading, simple though they are, would amount to a formidable daily tonnage to be moved. To avoid such handling, the poles, as they are brought in from the forest, are stacked in long drifts to an average height of six feet. The saw benches work along these drifts and the finished products are stacked and stored on the ground left free by the receding stack of poles.

This procedure is made practicable by adequate ground space and comparatively mobile machinery. It has the advantage of great elasticity but against this must be considered the cost and difficulty of introducing mechanisation. It has been felt for some time that a much higher degree of mechanisation was possible and desirable. At the same time serious consideration was being given to disposing of the Depot to the timber trade, so no large capital expenditure was considered justified. But in 1955 it was finally decided to retain the Depot and plans for mechanisation are being worked out.

Organisation of Work

Thinnings are brought to the Depot daily by a fleet of fourteen Forestry Commission lorries, four of which are articulated vehicles, and two of which are fitted with mechanical loading devices (H.I.A.B. Hoists of Swedish design). The remainder are standard four to five ton thirty-horse-power lorries (Fordson, Bedford and Austin makes). The average haul from the forest to the Depot is six miles, and each lorry delivers an average of four to five loads per day.

The thinnings are loaded in five categories:

1. Peeled poles from four inches to seven inches butt diameter and three inch top diameter under bark. These are the straight poles capable of yielding at least 50 per cent of their length as pitprops.
2. Peeled butts suitable for pitprops. These are cut from the heavier poles and are either seven feet long by five inches top diameter, or random lengths six feet and up in length, with a six inch top diameter.
3. Unpeeled poles four to seven inch butt diameter and three inch top diameter under bark. These are considered too rough or crooked to be capable of yielding 50 per cent of their length as pitprops. They are converted mainly to pulpwood or wallboard billets.
4. Small unpeeled poles, trimmed to one-and-a-half inches top diameter, which are too rough or crooked to yield pitprops, together with the tops of the poles in (1) and (3) above, trimmed to one-and-a-half inches top diameter. These are mainly used for fencing stakes, harvest tripod poles and small sizes of pitprops. The remainder is used as pulpwood.
5. Unpeeled butts, otherwise like those in (2) above, but unsuitable for pitprops. Wherever possible these are sold in the forest, usually for boxwood, but in order to clear compartments from which the remainder of the produce has been removed, small quantities of butts are brought to the depot and sold as pulpwood or boxwood.

The proportion of categories by volume of the present intake is:

(1) and (2). Peeled poles and peeled butts 40 per cent.

(3) and (5). Unpeeled large poles and unpeeled butts 20 per cent.

(4). Unpeeled small poles and tops 40 per cent.

These proportions seem likely to persist for several years.

These categories are unloaded each in its own sector of the Depot. Unloading is by Coles crane (five tons, fifty foot jib) or by hand. By confining the delivery of certain categories as far as possible to certain days of the week it has become possible to unload up to 70 per cent of the lorries by crane. This permits quicker turn-round of lorries and higher stacking of the poles, with a resulting saving in ground space. Cross-cutting is by means of five to six horse-power mobile benches with either petrol of diesel engines. Twelve benches are employed on an average, six on cutting pitprops, two on unpeeled

large poles and four on unpeeled small poles and tops. About 5 per cent of the pitprops produced are under eight cm. top diameter and are cut from tops and small poles and peeled by hand in the Depot. Recently a debarking machine (Kingslaw) with a throughput of fifty hoppus feet per hour has been introduced and nearly 50 per cent of the volume of unpeeled large poles is being converted to mechanically peeled pitprops. The place of this machine in the organisation has not yet been fully worked out, but it will obviously be an important factor in the plans for mechanisation.

Loading is all by hand, an operation that accounts for nearly one-third of the total man-hours. The overall cost of loading is ¾d. per cubic foot as compared with 1½d. per cubic foot for cross-cutting and stacking.

Most of the pulpwood is despatched on the purchaser's transport. Pitprops, which are mostly sold direct to the National Coal Board, are increasingly being despatched by road owing to the high railway freight charges. For some of the longer rail hauls, for which only a part of the freight charge is recoverable from the National Coal Board, as much as 1s. per cubic foot may have to be borne by the Forestry Commission.

Details of the produce sold are given in the table opposite.

Santon Downham Village

This village has been developed over the course of the last twenty years on the site of the old Downham Hall and its outbuildings. The old Hall itself was demolished about 1920, and the Forestry Commission acquired all the outbuildings together with a large area of forest land. Some of the outbuildings were modernised and converted to give thirty-seven workers cottages ; while the others were adapted as stores, offices, etc. By 1947 more local supervisors and forest labour were required and a further forty-two houses were built. To-day the population is over 400 and although full urban amentities are not available, the village has electricity, water, sewage, post office, stores, village hall and men's clubroom, while facilities for sport and recreation are being developed. While the Forestry Commission may help to initiate community life, its object is to encourage the inhabitants to use their own initiative in all community efforts.

The Santon Downham Forest Administration Centre was formed partly from adapted old buildings, but other new additions have had to be made, and its functions include the District Office, the Fire Control Centre, Machinery Workshops, Seed Extraction Plant, Tool Stores, Estate Yard, etc.

Here stands a recently erected building made of timber cut from small thinnings of conifers grown in different parts of Great Britain. This structure was erected for testing as part of a programme of research into the utilisation and marketing of home-grown timbers conducted by the Forestry Commission. So far the results have been satisfactory.

BRANDON DEPOT—THETFORD CHASE—TYPES OF PRODUCE SOLD

Assortment	Length	Top Diameter	Peeled or Unpeeled	Price	Per cent of Annual Production by Volume	Annual Production	Remarks
Round Pitwood	1½ ft. (x 3 in.) to 4½ ft. 3 ft. (x 6 in.) to 8 ft.	2 in. (x ½ in.) to 4½ in. 5 in. (x ½ in.) to 8 in.	Peeled	4/10½ per hoppus foot	38%	13,000 tons	The usual rule is that length in feet=top diameter in inches, but from 4 in. top diameter and down there are a considerable number of special sizes.
Pulpwood and board mill material	3 ft. to 14 ft.	1¼ in. to 10 in.	Unpeeled	61/- to 87/6 per ton, free on transport	47%	25,000 tons	A quarter of this total tonnage is sold as metre-length billets. 2 in. diam.
Posts, stakes and selected poles	3 ft. to 16 ft. 8 ft. and up	1 in. (x 1 in.) to 5 in. 2 in. (x 1 in.) to 5 in.	Peeled or Unpeeled	Based on 5/- per hoppus foot	6%	650,000 pieces	Mostly sold direct or via merchants to farmers in East Anglia. 90,000 posts, struts and strainers are creosoted at Santon Downham annually.
Boxwood	1½ ft. and up	4 in. and up	Unpeeled Peeled	2/3 per hoppus foot 2/6 per hoppus foot	7%	3,300 tons	Off-cuts from pitwood, or unpeeled butts in the length.
Firewood	—	—	—	55/- per ton, free on transport	2%	1,000 tons	All waste resulting from the process of conversion to above classes of produce.

NOTE: Figures in brackets, 2 in. (x ½ in.) to 4½ in. means that top diameters of 2 inches increasing by ½ inch steps are acceptable, i.e., 2 in., 2½ in., 3 in., 3½ in., 4 in., 4½ in.

THE ARI SAWMILL AT STRACHUR

Contributed by R. LINES
District Officer, Research Branch

The "Ari" system was developed in Sweden where special attention has for many years been given to the technique of handling and sawing small-sized logs. Basically the success of the system depends upon three sawing units—slabbing saw, re-saw and edger—designed to match each other and linked by an ingenious arrangement of conveyors.

Logs are brought in by a conveyor, timber passes automatically from one machine to the next and sawn wood and waste is removed by conveyors. The whole is geared to provide for a steady flow of material through the mill. The equipment of the mill at Strachur in the Argyll National Forest Park was installed under the supervision of the manufacturers, A. B. Maskinfabriken, Ornskildsvik. The mill building was constructed of home-grown timber.

The Cowal Ari-Sawmilling Co. Ltd. was formed in July, 1953; finance was provided by Adam Wilson & Sons Ltd., Troon, timber merchants working in the area, and the Forestry Commission, which is, of course, particularly interested in expanding the markets for thinnings. The two parties have nominated the board of directors of the company, and an independent chairman has been appointed.

When considering the type and location of the mill the directors felt that a comparatively small unit situated within the forest area was preferable to a large unit in an industrial area far from the source of raw material. In addition, it was considered desirable, in view of the depopulation of the Highland areas, to create further community life around a forest industry. Despite difficulties in obtaining suitable labour, mainly because of lack of houses, sawing started in 1954, and production has progressively increased to date. The mill is at present producing at the rate of 185,000 true cubic feet per annum and consumers are satisfied with the quality. There are thirty-one employees, including sales and office staff.

All the raw material is brought to the mill by road transport and the logs are unloaded on to the storage bank. They vary from six to eighteen inches in diameter and from six to twenty-four feet in length, the average log being fifteen feet long by seven-and-a-half inches top diameter.

From the storage bank the logs are rolled on to the mechanical chain log conveyor and are conveyed into the mill at approximately six feet above ground level. Any twisted logs are cross-cut on the storage bank by electric chain saw, prior to being rolled on to the conveyor. The logs are automatically stopped at the first breakdown bench (slabbing saw). This saw makes the initial cut in the log which is then mechanically conveyed to the re-saw. The re-saw then breaks down the slabbed log into dimension sizes and for this purpose the slabbed log is returned and passed through the re-saw until it is completely utilised. This stock is mechanically conveyed to the edger. Square-edged timber is conveyed by gravity conveyors to the outlet end of the mill.

The average output is at present 650 true cubic feet of sawn material per day, of which 30 per cent is boards one-inch thick or under. The working of the mill is a team operation, and a bonus scheme, based on output, is in force which covers all men employed both inside the mill and outside.

Slabs from all benches fall down on to a mechanical conveyor operating beneath the mill floor at right angles to the benches, and are then conveyed

to an endless belt which carries them out to the boiler which supplies steam for the kiln. Sawdust is extracted by a normal suction plant to a cyclone at the boilerhouse, or exhausted to the open.

The kiln is of the "progressive" type, with three compartments, and is unlike most units used in this country in that conditions remain stationary whilst the timber moves through the chambers, as opposed to the normal compartment type where conditions have to be altered and the timber is stationary. This system has the advantage of simplicity. Drying conditions remain unchanged, and no daily sampling and weighing, with attendant laboratory and recording equipment, are required. All steam valves, ventilation adjusters and air circulating fans, once set, remain untouched or run at constant speed. In other words, a kiln operator is not needed and in this mill two men do all the loading, unloading and cross-cutting. The use of a progressive kiln is confined to those cases where species of similar drying characteristics are being handled, the thickness and initial moisture content of the timber varying only slightly. The moisture content of timber entering the kiln is approximately 80 per cent and the moisture content after kilning is about 20 per cent. The output is 300 cubic feet of timber (two inches thick sizes) per twenty-four hours. The internal length of the progressive kiln installed at Strachur is seventy-five feet divided into three zones each twenty-five feet in length. Timber loads four-and-a-half feet wide and six feet high are accommodated.

Conditions in the kiln when *Picea sitchensis* one-and-a-half inches and two inches thick is dried are as follows: first zone—dry bulb temperature 43°C., wet bulb 40°C., relative humidity of 81 per cent; second zone—dry bulb 49°C., wet bulb 43°C., relative humidity 72 per cent; third zone—dry bulb 52°C., wet bulb 43°C., relative humidity 61 per cent. Steam pressure used is 3½ lb. per square inch. No steam jets are employed.

On leaving the kiln timber is squared with a "Wadkin" pull-out cross-cut saw and is later stacked and loaded to road transport with a fork-lift truck. The timber is sold mainly for case and crate making and housing construction, the sales area covered being Glasgow to Edinburgh and as far south as Lincolnshire. The company has its own transport with specialist equipment for bringing the logs to the mill and for deliveries of sawn timber to consumers.

Problems encountered have been almost entirely concerned with labour, due to inadequate housing to attract men into the area. However, the Argyllshire County Council has recently completed a small housing scheme in Strachur and houses have been made available for mill employees. Operators have rapidly mastered the technique of handling the Swedish machinery.

THE CHIPBOARD FACTORY AT ANNAN

By J. A. B. MACDONALD
Conservator, South Scotland

For a number of years Weyroc chipboard has been produced at Weybridge in Surrey from sawmilling and wood-working waste collected in the London area. Two years ago the company decided to erect a new, much more up to date and largely automatic plant at Annan, on the north shore of the Solway, mainly to use thinnings collected from forests and estates within fifty to sixty miles of the factory. Within this radius are many of the Forestry Commission

areas in Kirkcudbrightshire, Dumfries-shire and Roxburghshire on the Scottish side of the border; on the English side forests and estates in Cumberland, Westmorland and Northumberland are also within range.

In the beginning the promoters of the scheme, who really had little knowledge of forestry, talked a great deal about the part the factory would play in utilising material which had previously been left lying in the woods. Before the erection of the factory was finally agreed and prices had been fixed, it had, however, been agreed that about two-thirds of the material which would be utilised in the factory would come from pitwood grades, and that the factory would indeed and to a considerable extent be directly competing with the pits. In the early days of the factory the material required had to be unpeeled and from one-and-a-half to eight inches in diameter and in long lengths, the price being 80/- per ton delivered. Before long, and largely because timber merchants found both specification and price unattractive, the factory decided to offer an alternative specification which was for peeled poles six feet six inches long by two to seven inches in diameter, the price to be paid being 4/8 per hoppus foot delivered at the factory. After tests it was agreed that the hoppus measurement would be half that of the total volume of the closely packed load in true cubic feet. A certain amount of material half the length, i.e., three feet three inches would also be acceptable, which made it possible to reduce the amount of waste in conversion. As to straightness, the material could be slightly less straight than for pitprops.

Haulage rates have varied from about 5d. to 10d. per cubic foot up to the maximum distance of sixty miles. Usually the work is done by contractor but if the distance is suitable it has been found profitable to use Commission lorries, especially those which would otherwise be doing little between collecting workers in the morning and taking them home again at night. The amount loaded on to a five ton lorry is about 200 hoppus feet and on to a ten ton lorry approximately 400 hoppus feet. Weight, of course, varies with season and seasoning, the factory requiring the material at about thirty-five to forty-five hoppus feet to the ton. Practically all conifers are acceptable but no hardwoods.

So far as profitability is concerned chipboard, under the new specification, has undoubtedly paid South Conservancy better than ever pitprops did, but it still appears that timber merchants prefer to make pitprops. Whether this is because of commitments or habit, or because they honestly believe pitprops pay better, it is hard to say. Two things are certain—there is much less palaver about chipboard production as all the lengths are the same, and there is no need for costly separation into stacks of different diameters. Because of this, payment is much quicker, there being no need to wait long periods until a truck load of one size has at last been achieved.

The finished board, being largely of spruce, is a thing of beauty and much more uniform than the Weybridge board made from industrial waste. It is turned out in vast quantities—at least 163 tons per week with a surface area of 160,000 superficial feet or, if you like, three-and-two-third acres. It is selling so well that already the factory is being expanded to meet current demand.

To produce it the peeled poles are chopped into two types of flake or fragment. For the top and bottom surfaces fine flakes rather like the parings from a pencil sharpener; for the centre of the board much coarser flakes are produced. When all have been sprayed with resins and arranged in mattresses about four inches thick they are first heated and pressed, and then trimmed and sandpapered. The whole process is controlled electrically with hardly any men and is almost uncanny.

THE PREPARATION OF WOOD WOOL AT MORTIMER FOREST

By KLAUS WAHLE
Forest Worker, North Wales

The sale of wood wool to a local firm is an important factor in the economics of Mortimer Forest. The species required are 75 per cent Douglas fir and 25 per cent spruce and the price compares very favourably with pitprops of the same top diameter. The produce is cut into two foot lengths with top diameters ranging from five to eleven inches, larger diameters are accepted up to twenty-two inches if they are split or sawn down the middle.

The operation starts in the plantation, where the poles are felled and peeled. The butts are then sawn off at five inches diameter in any lengths of a multiple of two feet plus an allowance for waste in conversion. When extracted to the roadside the butt lengths are stacked separately from the tops and small poles with the tops practically level and all facing the same way.

For conversion a piece of angle iron is bolted on to the table of a McConnel sawbench at exactly two feet from the blade. This acts as a stop and ensures that all lengths are dead accurate. The sawyers slide the pole along the bench to the stop and then push it on to the blade; as the table springs back the two foot length rolls forward so that the pole can be pushed up to the stop again in a continuous motion. The whole operation is fast, safe and simple and the operator who removes the two foot lengths and throws them on to their respective heaps is kept very busy. Photos 21 and 22 illustrate the preparation of logs and the manufacture of wood wool.

The two foot lengths are stacked for drying according to their top diameter, five, five-and-a-half or six inches, etc. Each stack is lettered, also according to their top diameter. A few lengths in the five inch stack are marked with the letter A, the five-and-a-half inch stack are lettered B, and so on. This simplifies matters when dispatching or stocktaking and does away with the necessity of remeasuring at any future date.

WHAT CAN THERE BE IN A LADDER?

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It is doubtful whether it would be possible to build up a clear history of the development of the ladder, but it seems reasonable to suppose that the first ladder may have been constructed from two branches of a tree with a series of shorter branches attached by lianas as rungs.

After all, what more can there be in a ladder than the two side pieces and the rungs? Fundamentally, of course, there is nothing more in it than that, but different trades have, through the years, evolved many modifications to meet their special needs, and it is only when we delve more deeply into the subject that we realise how many different types of ladder are made to-day.

It is obvious, when you think of it, that the ladder made for the fruit picker in our Kent orchards would be looked at askance by the National Fire

Service, and your window cleaner would take a poor view if he had to carry around a ship's ladder to enable him to reach your first-floor windows.

Each trade needs its own particular kind of ladder, just as craftsmen in other trades need different tools. From the huge hydraulically operated tower or fire-escape, down to a simple two-section eight-foot extension ladder similar to that used by the window cleaner, the Fire Service has a number of different ladders peculiar to its needs. One, in particular, which has no use in any other trade or profession, is the hook ladder. This is a very light eight-foot single-piece ladder with, at the top end, a large wrought-iron projecting hook, two feet long, with some ten large teeth in it. The fireman standing on the ground can raise this ladder over his head and hook the projecting ratchet on to any convenient coping. If there is no such ledge available he can break the first-floor window with the projecting hook, hook and hang the ladder over the sill, and clamber up to gain a foothold where the ladder is hooked, then, detaching it again, he can raise it over his head to hang it on to the next convenient spot. In this way he can reach places inaccessible to him by the larger ladders at his disposal.

Have you ever noticed that every window cleaner carries a short ladder with a pointed top as part of his outfit? These are called Vee ladders or "Jumbo's" and they are used to give a single point of rest on the frame or sash bar when cleaning shop windows.

Another ladder in considerable demand years ago by coachmen had a padded top, and yet another used in the past was a rather heavy concave type utilised by dustmen for mounting the side of the old-fashioned dustcarts to enable them to discharge the contents of dustbins into the cart through the open top.

Farmers and agriculturists generally use a pole-sided ladder. This is constructed from a selected imported whitewood spar which is split straight down the centre, each half forming a "stile"—as the side is called—the resulting section being a half-circle. Ash or oak rungs are used and, provided there is no serious defect in the grain, this constitutes a very strong and natural form of ladder, each stile being the exact counterpart of the other. The conventional form of this ladder increases in width from the top downwards by $\frac{1}{8}$ inch on each rung. There are two notable departures from convention, however. In the first, a fruit picker demands a ladder very much wider at the bottom to give him greater stability when the top is resting in the branches of a tree, so, although construction is normal for three-quarters of the length, the last few feet sweep out much wider and the foot of the ladder is generally about thirty inches wide. The other alternative is for thatchers, who require their ladders to be made with the pole sides reversed; that is to say, with the round face on the inside, so that when they are working at their craft both hands are free and they can maintain their balance by pressing their knees against the inside of the stiles, obtaining a firmer and more comfortable grip from the round surface than would be the case with the flat.

On new construction work, because the short distance between one lift and the next on a scaffold demands nothing longer, the building industry uses the conventional pole ladder—with the curve of the pole on the outside—but the painter and decorator more often than not has no scaffold and needs a ladder which will reach from ground level to his point of work. Even so, the pole ladder was his only answer until the invention of the telescopic extension ladder some hundred years or so ago. This invention gradually and inevitably displaced the pole ladder of up to eighty-five or even ninety rungs, for even twenty-five to thirty years ago it was already a problem to find prime-quality

spars of sufficient length to produce these long ladders. The transportation of such long ladders, too, was always a problem for the contractor, it being illegal to pass through the centre of London after 7-0 a.m. with a load exceeding forty feet in length without police permission, and the Railways charged a minimum of two tons for any ladder exceeding twenty-four feet in length. Since these conditions still apply to-day, the extension ladder has almost entirely replaced the long pole ladder.

In days gone by when we had the old-fashioned cast-iron lamp-posts in London the lamp cleaners of the Gas, Light and Coke Company used a very light ladder. The stiles, which were, of course, very specially selected and suitably reinforced, measured only 2¼ ins. × ⅞ in., weighing only a few pounds. The ladder was in two sections, extending to fourteen feet, and was easily carried on the shoulder of a man on a bicycle. Nowadays with the modern tall overhead lighting standards which illuminate the streets of our big cities a "tower ladder" is used for maintenance. This is of box-like construction with three, four and even five sections telescoping into each other. Although sometimes mounted on power-driven trucks for speedy transportation, the more everyday pattern is equipped with wooden wheels and a pair of handles rather like short shafts.

Ladder making is a vast subject, and the variations to meet differing requirements are endless. For instance, various types of rung are used, not only for different trades but for different parts of the country, and it is an odd thing about ladder specifications that whereas the London building trade require their ladders to be fitted with rungs spaced at eight-inch rise, contractors in the Midlands and North of England demand them to be nine inches apart. Most farmers and agriculturists specify a ten-inch rise and many of the ladders in use by the National Fire Service are eleven-inch rise.

Tilers and slaters working on roofs use a wide flat board with battens screwed to the face of it. These are called "duck ladders", after the similar device which is provided for chickens and ducks to gain access to their roosting houses.

The pilot comes aboard ship on a rope ladder, and during the war, when submarines were creating havoc with our convoys, scrambling nets were hung overside to rescue torpedoed seamen in quick time.

Here and there one sees a few light alloy ladders in use, but generally speaking, craftsmen prefer ladders made from wood. Metal ladders become very cold and sometimes dangerous in the winter. Frost and rain make them slippery, and electricians will not have them because of the risk of electrocution.

Steeplejacks require a parallel-sided ladder with a socket on the foot so that the ladders can be mounted one on top of the other to an indefinite height. The sections are usually fifteen feet long and twelve inches wide, but a projecting bracket at the back keeps the ladder an even distance from the vertical surface being scaled. Some steeplejacks use a light type of such a ladder for inspection purposes and one of heavier construction for working upon.

Basically, ladders are constructed in one of two ways. The sides or stiles are sawn either from prime clear Douglas fir, in which case one stile will not be an exact replica, so far as grain is concerned, of the other, or the stiles are two identical halves of one pole which has been split in half longitudinally.

Most ladders used for indoor work, and also extension ladders, have the Douglas fir stiles. Thus a problem particularly connected with long ladders is the strength of the stiles when these cannot be guaranteed to be identical.

In order to explain the solution to this problem, let us imagine one long ladder leaning against a wall. After various tests a heavy weight, considerably in excess of that of the average man, is suspended from various rungs approximately half-way up the ladder, to discover the extent to which this will "bow". To counteract this natural bend the ladder is, in effect, bowed artificially in the opposite direction. This process is carried out in the course of manufacture and the method adopted is to place two ladders horizontally parallel separated by blocks at each end. The centres of the ladders are then clamped together and the clamps gradually tightened until the ladders come some way towards one another in the centre, the ends remaining the original distance apart. The stiles having been grooved along the underside, a hole is bored through the width of the stiles at each end. Through one hole is inserted a high-tensile steel wire which is secured by a stout staple. The other end of the wire is inserted through the hole at the opposite end of the stile, the bent stile and wire combined then having an appearance not dissimilar to an archer's bow. Men working gradually towards the centre from the ends of the two ladders under construction deal in rotation with each of the four stiles, securing the wire into the grooves with staples. When the wires have become too taut for any further staples to be inserted, the clamp is removed releasing the tension from the stiles, at which time it is possible to staple the remaining wire into the groove. As the wire, from the commencement, has been slightly shorter than the stile, the ladder will then have acquired permanently a slight bow. When this ladder comes to be used, the wire should be on the underside, the ladder thus forming a slight arc away from the wall. A man then climbing the ladder and reaching approximately half-way will tend to straighten the ladder, but the wire, which will not stretch, prevents any bow in the opposite direction. In addition, of course, the stiles are permanently reinforced by the insertion of the wire.

In spite of modern machinery and mechanical aids to production, ladder making still remains something of a craft. The assembly of a pole ladder is all done by hand, although small holes to indicate where the rungs are to be inserted are made by machinery. It then becomes a matter of craftsmanship to enlarge the holes with a hand tool and to ensure that these are only large enough to allow the rungs, which are wide in the centre and taper to a point at each end, to be inserted up to an accurate mark. When all the holes have been checked the rungs are fitted loosely into both stiles and the whole is hammered firm, any slight protrusions of the points of rungs on the outside of the stiles being sawn off and ultimately smoothed on a sanding machine.

In addition to the glue which is employed, three or four mild-steel tie rods are fitted beneath certain rungs for additional strength.

Great care must be used in the selection of timber, but what has been rejected for one purpose must be used for another—thus a ladder factory will also turn out a variety of smaller wooden articles, such as trolleys and kitchen steps.

Of the particular ladders themselves, the two most romantic—because, perhaps, used in the most dangerous circumstances—must be those employed by steeple-jacks and the Fire Brigade, but the basic principles are the same in all cases and the same scrupulous care is used in manufacture.

THE USE OF WOOD IN MUSICAL INSTRUMENTS

By J. MOGFORD
Executive Officer, Headquarters

The relation between music and wood has always been an intimate one. From the dawn of history mankind has employed reeds, wood, gut and skins to produce a bewildering cacophony of squeaks, twangs and bangs. Neolithic men fashioned flutes from odd pieces of wood and bone and the twang of the hunter's bow was to prove the forerunner of all stringed instruments.

A relatively complicated instrument like the harp was already known in early Sumerian and Egyptian times and paintings and carvings from that era frequently show in great detail the type of instrument used. The properties of the vibrating string were examined in great detail by the Greeks and they were, perhaps, the first people to observe the exact relationship between length, mass and tension—much to the everlasting despair of the majority of schoolboys.

With the obvious exception of the brass instruments, all other musical instruments depend in some measure on the use of wood. To-day the "wood-wind" family of instruments largely belie their name as many are now constructed from plastics, metals and other synthetic materials. The clarinet, oboe, cor anglais, and bassoon still depend, however, on the vibration of a wooden reed.

Because of the large variety of timbers used perhaps the stringed instruments are the most interesting to the forester. They vary in size from the tiny medieval rebec (an ancestor of the violin) to the modern concert grand piano. Although the Greeks were the first to thoroughly examine the properties of stringed instruments, the quality of the sound produced was limited until the fundamental step of refining the soundboard was achieved. When such attempts were first made is unknown but by the middle of the seventeenth century such masters as Amati, Guarnerius and Stradivari could fashion a piece of spruce, a little over a foot square, in such a manner that in the hands of a master it would amplify and modify the noise of a vibrating string to such an extent that a large hall could be filled with a delightful sound.

The Cremona makers, in common with modern luthiers, employed a piece of quarter-sawn, straight, fine grained European spruce 6/64 in. thick under the bridge; tapering to 5/64 in. at the bouts. The ribs, back and neck were usually made of sycamore—preferably using timber with the "fiddle back" figure. The finger-board tailpiece and pegs were of ebony or similar dark decorative wood.

The tonal quality and power of all the stringed instruments depends largely on the quality of the soundboard. Too fine a grain will produce a harsh, thin note and too wide a grain will give a woolly note lacking in clarity. The art of the instrument maker depends to a great extent on his ability to select as well as his skill in manufacture. Although spruce is the only wood used in soundboards a bewildering variety of timbers is used in the other component parts.

Early harpsichords, because of their light stringing, were constructed with beech or ash frames (occasionally from softwoods too) and pear and holly used for the jacks—the picking mechanism common to the virginals and spinets of Elizabethan times. The key covers were frequently made of box, which age mellows to a delightful colour. The wrest planks, into which the tuning pins were driven, were usually of beech.

In contrast the modern grand piano, with an internal tension of some twenty to thirty tons, requires a steel frame but the rest of the instrument is almost entirely wood. The keys are frequently of lime and the action of hornbeam, yellow birch or similar type of wood. All manners of English and foreign hardwoods are used for the cabinet work, although rosewoods and mahoganies are probably the most popular. The wrest planks are still made from beech, but modern methods of construction, the use of improved glues, and the complicated methods of lamination all increase strength and reduce movement of wrest pins to a minimum. Maple is sometimes used in lamination with the beech.

The manufacture of musical instruments is a fairly conservative process treading well worn, proved paths but in the last fifty years or so great efforts have been made to produce new musical instruments using synthetic materials and electronic processes. Some of these attempts have been successful in their own rather limited spheres but I would venture to suggest that as far as can be foreseen the majority of musical instruments will continue to be made from wood.

CHARCOAL BURNING IN SUSSEX

By D. L. PARNALL

Forester, South-East England

Many people believe that charcoal burning is a dying art, only carried out in a few scattered localities, such as the New Forest. I also believed this until I was posted to Vinehall Forest, Sussex, in 1953 and discovered a private firm making extensive use of the metal kiln method of charcoal producing.

The firm operated in their own woods, on private plantations and on the Commission areas, and the great advantage to the Commission was that the operation could be carried out in woods that were inaccessible to anyone else, due to the road situation. All tracks and rides in the Sussex Weald become a morass in winter if used more than two or three times, as they are on the clay, yet I have seen full loads of charcoal on a trailer behind a spade-lug tractor move out with ease, due to the light weight in spite of an impressive bulk.

In Sussex the commonest woods—apart from the chestnut plantations—contained hornbeam, ash, maple, birch, oak "tellers" and odd sweet chestnut and beech trees—all of which were acceptable to the burners. Alder and willow were taken, provided they were well mixed with other woods, but hawthorn—however large—was never touched—and I was unable to discover any good reason for this refusal. An interesting point is that oak produces the most weight of charcoal per kiln, yet sweet chestnut, although as heavy when green, produces a very light weight.

I now propose to describe the methods used in the wood for converting wood to charcoal.

The Hearth Method

This is the original method which has been used for centuries, and it produces the best quality charcoal. It is still used in Sussex and Kent, although it is a dying art, as the operator needs to be born to the trade. I met only one man doing this, and he was burning on a private estate adjacent to Brightling

Forest, Sussex. The illustrations to this article are by courtesy of the Sevenoaks Press, and were taken when two Sussex men ventured into Kent to make charcoal, at Mildmay Forest. (See photos 23 and 24.)

The method may be well known to some who read this, but I will describe the operation as I saw it. Throughout the summer the scrub oak and other pole wood was collected from the felling area, sawn into four foot lengths and stacked on the site. This is usually near a stream or pond, as water is essential. A circular hearth is prepared by screefing the turf off, and then levelled. On this, the wood is stacked in a cone, as can be seen in the illustrations. It is then covered with straw, damped, and covered with burnt earth to finish off. The earth is to make the stack airtight, in order to ensure a slow combustion. The method of lighting the stack is not usually seen, and although I have a good idea how it is done, I do not propose to reveal it. [We suspect it is done by dropping glowing charcoal down a central flue.—Ed.]

The stack is allowed to burn for two to three days, according to the state of the wood and weather conditions. Constant watch is necessary, to see that the fire does not break through the earth covering. The top of the stack acts as the chimney, and this is closed when the operator judges the wood charring to be complete. The stack is then allowed to cool, water being carefully applied if necessary, care being taken not to over-apply it, as the charcoal must not be soaked. The stack is then opened, the charcoal bagged and kept under a sheet till collection. Prices obtained for it ranged from £40 to £60 per ton.

The Kiln Method

This is the method used by the firm previously referred to, who operate from St. Leonards-on-Sea, and range as far north as Lamberhurst, near Tunbridge Wells.

In comparison with the Hearth Method, the Kiln method is relatively unskilled, a fact which could lead to its adoption by the Commission and private owners.

It is, basically, an adoption of the method described in May, 1944, in the Forest Products Research Laboratory Leaflet No. 35.

The kilns are constructed in two or three parts, and the body is $\frac{1}{8}$ inch mild steel with flanged top rims of 3/16 inch mild steel. The bottom ring, which is subjected to the greatest heat and pressure, is constructed of $\frac{1}{2}$ inch steel. A common type of lid is flat, with a sliding trap door for a chimney. One point is that the smoke boxes and pipes are eliminated to-day, their place being taken by holes dug under the bottom ring after it has been positioned and levelled.

The kilns are usually seven feet in diameter and six or ten feet high. The larger kilns are normally used, but when finishing off a wood, the smaller ones are introduced. The kilns are taken into the wood sectionally on a trailer and erected on as level a site as possible near to the piles of poles. First of all the bottom and the second rings are erected. Holes are then dug, usually running north, south, east and west, and pieces of wood are placed parallel between two of them. "Brands", which are incompletely burned pieces of wood from previous kiln burnings, are placed on top at right angles, and an old sack soaked in Tractor Vaporising Oil is placed between them. The relevant holes are marked on the outside of the kiln.

The tractor usually has a power take-off and a bench mounted behind the driver's seat. The poles are sawn into pieces about four feet long and thrown

haphazardly into the kiln after the "brands" have been carefully covered. The third section is put on when necessary, the kiln filled to the top and the lid hauled on to the top. The flanges between each section, and on which the lid rests, are then sealed with burnt earth, the chimney being left open.

The operator then obtains another sack soaked in Tractor Vaporising Oil, lights it, and pushes it in one of the marked holes with a stick, thus igniting the kiln. This method was always used and differs from the one described in the Leaflet No. 35, which said: "Light at the top". This may be the difference between theory and practice, or else just a local variation.

One thing about the kiln is that water is *not* needed, and in wet weather kilns have to be drained by trenches at the base, otherwise they can often be extinguished by moisture.

The burning time is again from two to three days according to the wind strength, and kilns do not need such continuous attention as a hearth does. When the operator is satisfied, the holes round the base are closed initially, and then the lid. A kiln usually cools within twenty-four hours without any trouble. When opened they are not more than half full of charcoal, which is bagged and removed whenever possible. An old four-wheel drive Chevrolet was successfully used for this purpose at Vinehall. Usual yield for kiln was twenty-four to twenty-eight bags.

At Vinehall, poles cut when preparing planting ground were sold felled at 25/- per 100 in 1954, and in 1955 Brickhurst Wood was sold standing at the rate of 15/- per ton of charcoal produced, weighed over a weighbridge. This may seem cheap, but the wood lay half a mile from the nearest hard road and was three-quarters of a mile to its farthest extremity. The firm paid £4 per ton weight (green wood) to have it felled, and this was done by power saw, the wood having been neglected for forty years or more. Some of the hornbeam and sweet chuestnut were twelve inches in breast-high quarter-girth, although grown from stubs, and these very large poles were sawn by the feller into four- or six-foot lengths, and afterwards split by the charcoal burners. Overhead cover was left, and this was achieved by marking a sample area of some two acres. after which the cutters gang were able to continue without continuous supervision. Some areas of smaller growth were ignored, and these were cut by Commission workers, the resultant poles selling at 30/- per 100.

The last method to be described originated in Germany, and can only be used in large areas of forest. This is the Wood Distillation Factory, one of the few examples being in the Forest of Dean. The idea of the factory is that the gases which come off the wood after the first twenty-four hours of heating are collected and passed through large condensers, producing different liquids at different temperatures as they cool. About fifteen different products are obtained, including a residue that resembles creosote, but has an even more repulsive smell; it is supposed to be a much better preservative and insect repellent. If the gas is liquefied without refining, it is called "pyroligneous acid".

In conclusion, I would like to say that where the firewood market is very unstable and where extraction conditions are very difficult, it would be advantageous to reintroduce the kiln method of charcoal production, as was done in wartime, especially as charcoal has a very large and growing use in industry to-day. These uses range from face powder to rayon and other synthetic products.

CONIFER BARKS AS A SOURCE OF TANNINS FOR THE LEATHER INDUSTRY

By J. R. AARON
District Officer, Research Branch

The Nature of Vegetable Tannins

When a tannin-bearing material is analysed to determine its usefulness to the leather industry, the total water soluble content is first assessed. This is then divided into two fractions, the tannin content and the remainder which is referred to as the non-tan content. The chemical nature of tannins is obscure and a number of varied organic compounds come under the definition ". . . a water soluble substance of high molecular weight capable of entering into chemical union with perishable skin proteins converting them into tough durable leather . . .". Tannin content alone does not decide whether a vegetable tannin material is commercially acceptable, because, while the precise chemical nature may not be of great interest to tanners, the colour which the tannins impart to the leather is of great consequence, particularly if the leather is to be dyed. Red colours in a tanning liquor tend to darken the skin and are thus particularly unsuitable for many grades of leather. Consequently, a quantitative assessment of the degree of "redness" likely to be given by a tannin-bearing material is a very necessary feature of the analysis. The "redness" is expressed as units given by a 0.5 per cent tan solution when examined in a standard colorimeter.

As a general rule tanners prefer a material which will produce a water extract with a tan/non-tan ratio of about three and a red colour of lower than three units. A particularly favourable analysis is given by wattle bark which is imported in large quantities from South Africa. It has a tannin content of 35 per cent, a non-tan content of 10 per cent and a red colour of 1.5 units. In contrast oak bark has a tannin content of about 12 per cent, a non-tan content of 10 per cent and a red colour of ten units. Despite this apparently *unfavourable* comparison, oak bark is used to-day for the manufacture of high quality sole leather.

The Requirements of the Industry

About 100,000 tons of tannin-bearing materials are imported each year principally from South Africa, Argentina and India. These may take the form of the actual plant tissue or a concentrated extract.

Native oak bark is also used by about one dozen tanners. Although their total requirements are only of the order of 2,000 tons per annum, the tanners have difficulty in obtaining all the oak bark they require. This may be partly due to the difficulty of getting sufficient labour to undertake peeling during the short sap peeling season in late spring, and partly due to the difficulty of harvesting, especially from oak coppice, at prices which the tanners are able to pay.

Home-grown Tannin Materials other than Oak

A preliminary analysis of the following types of vegetable tannin materials has been undertaken:

(1) The bark from tree species such as Scots pine and Sitka spruce which are being peeled on an increasing scale for the production of pitprops.

(2) The barks and woods of those species which have been used in other countries as a source of tannin and are not uncommon in British woodlands.

Sweet chestnut wood chips are used in France and Italy for the preparation of an extract which is frequently imported by tanners in Britain. After leaching, the residual chips are either pulped or used as fuel. Hemlock bark is used in North America; the species involved is mainly eastern hemlock on account of its proximity to the Canadian tanneries, but western hemlock has been tried from time to time and is said to be satisfactory. Norway spruce bark has been used from time to time in Germany; at present it is believed that it is used only in Austria, Eastern Germany and in certain other east European countries. It is said that birch bark and larch bark are used in Russia. Larch bark was also used at one time by tanners in Scotland.

When the results of these preliminary analyses became available, it was decided, as a first priority, to investigate further the tannin contents of the larches and the spruces, taking into account the vigour of the tree, the position of the bark on the tree and the quality class of the stand. Other promising species such as sweet chestnut may be studied later.

ANALYSES OF TANNIN-BEARING MATERIALS

Species and Area	Material	Source	Authority	Tan Content (1)	Non-Tan (1)	Red Colour (2)
Scots pine	Bark	Thetford	B.L.M.R.A.†	11.7	13.8	1.6
Corsican pine	Bark	Thetford	B.L.M.R.A.	12.4	15.9	1.3
European larch	Bark	Alice Holt	B.L.M.R.A.	12.5	10.5	4.5
		—	Rottsieper	12.8	6.5	—
Japanese larch	Bark	Alice Holt	B.L.M.R.A.	14.3	18.1	6.0
		—	Rottsieper	23.2	12.5	—
Norway spruce	Bark	Gwydyr	B.L.M.R.A.	18.1	14.3	2.6
		—	Rottsieper	17.8	11.1	—
Sitka spruce	Bark	Gwydyr	B.L.M.R.A.	19.8	13.4	3.0
Douglas fir	Bark	S.W.(E)	B.L.M.R.A.	8.9	8.3	12.0
Western hemlock	Bark	Gwydyr	B.L.M.R.A.	19.9	8.3	6.7
Oak (Q. robur)	Bark	Alice Holt	B.L.M.R.A.	12.6	6.9	6.0
	Bark	—	Rottsieper	12.7	8.9	—
	Wood	Alice Holt	B.L.M.R.A.	1.0	2.3	19.0
Sweet chestnut	Bark	Alice Holt	B.L.M.R.A.	18.9	11.8	6.0
		R.I.B.*	B.L.M.R.A.	11.5	11.9	6.0
		—	Rottsieper	7.5	1.5	—
	Wood	Alice Holt	B.L.M.R.A.	4.3	2.0	5.0
		R.I.B.*	B.L.M.R.A.	6.5	1.9	2.0
Birch	Bark	Dean	B.L.M.R.A.	6.7	9.9	2.4

* Rural Industries Bureau.
† British Leather Manufacturers' Research Association.
(1) Percentage of moisture-free bark.
(2) Intensity of colour on Lovibond Colorimeter given by 20.5% tannin solution.

It was also decided that where early promise shown by a species was maintained in the more comprehensive assessment, a further study would be made of the bark of that species produced by the normal hand and mechanical peeling methods at different times of the year.

Sitka Spruce Bark

In all, thirty-one samples of Sitka spruce bark were analysed. They gave an average tannin content of about 17.5 per cent; the maximum of 22.5 per cent came from the butts of average trees in a Quality Class I stand in Port Clair Forest, Inverness-shire, and the lowest, 12.9 per cent, came from suppressed trees in a Quality Class II stand in Blengdale, Cumberland. The non-tans varied between 13.9 per cent and 7.6 per cent with an average of 12.2 per cent; and the red colour varied between 1.8 and 10.0 units with an average of 4.9. The tan/non-tan ratio always fell between 1.1 and 2.2, with an average of 1.4.

Samples from dominant trees gave a significantly higher yield of tannin than suppressed trees, although Quality Class I stands did not necessarily have a higher content than Quality Class III stands. There was no significant difference between the amount of tannin in the tops or the butts of the trees; however, the bark from the butts had a more favourable tan/non-tan ratio. It was also observed that a low red colour was associated with a high non-tan content and vice-versa.

The British Leather Manufacturers' Research Association have tanned sheepskins using Sitka spruce bark from Gwydyr Forest, North Wales; their comments on the quality of the leather are given below.

"We consider that the texture of the leather is very satisfactory. This is, of course, determined by the characteristics of the skin, but it does show that a satisfactory leather feel can be produced by the spruce bark. The smell of the leather is certainly characteristic of this bark, and for some purposes in tanning light leather for pocket books, gloves and the like, this smell might be a good selling point. The general level of colour is an agreeable shade of tan which would be very satisfactory for some uses. For other purposes the colour would be too dark, but in any case we would not recommend tanning with one material only, but would use spruce bark with other materials in a blend".

Sitka spruce bark has been considered from time to time by the Canadian leather industry but it was found to be too costly to harvest by hand on account of its thinness. That is to say it has a low yield of bark per tree compared with western hemlock. It also has the disadvantage of being remote from the leather industry which is mainly in eastern Canada.

Results to date indicate that bark obtained by mechanical methods of peeling has a lower tannin content and a higher red colour than hand-peeled bark. Similarly, bark taken from trees which had been poisoned with sodium arsenite in the spring to facilitate peeling in the ensuing autumn and winter, had a considerably reduced tannin content and an inferior colour.

Norway Spruce Bark

Nearly one hundred samples of Norway spruce bark were analysed. In view of the fact that the first sample (ex Gwydyr) gave an encouraging analysis of 18.1 per cent tannin and a red colour of only 2.8 units, the overall results are very disappointing. The average tannin content was only 9.4 per cent and fewer than a quarter of the samples had a tannin content in excess of 14.0 per cent. The tannin content ranged 2.4 per cent to 18.5 per cent. The non-tans varied from 3.9 per cent to 12.8 per cent with an average of 8.9 per cent, and the red colour from 2.8 to 22.5 units, with an average of 9.1 units.

The variation between forests was notable, the best analysis being given by samples from a stand at Culloden, which had an average tannin content of 12.2 per cent and an average red colour of 3.4 units, and the worst by Inverliever with an average tannin content of 6.6 per cent and an average red colour of 13.4 units. It is now thought that these poor results were due to failure to dry the bark immediately after peeling, and it is hoped to further analysis by using an improved technique of drying in the forest.

Statistical analysis has revealed that there was about a fifth more tannin in the bark from the butts than in the bark from the tops, and that in some forests there was a significantly higher tannin content in the bark from dominant trees.

European Larch Bark

Nine samples of European larch bark have so far been analysed. The tannin content appears to be about the same as that of oak, ranging from 4.5 per cent to 14.5 per cent with an average of 11.5 per cent, the non-tans ranged from 3.5 per cent to 1.00 per cent with an average of 8.7 per cent and the red colour ranged from 2.9 units to 8.8 units with an average of 4.7 units.

Japanese Larch Bark

Nine samples of Japanese larch bark have been analysed, and the results are promising in that they show a most favourable tan/non-tan ratio which usually exceeds two.

The actual tannin content varied between 5.7 per cent and 25.4 per cent with an average of 16.9 per cent, the non-tans varied between 1.7 per cent and 10.0 per cent with an average of 7.3 per cent, the red colour always fell between 2.8 and 11.6 units with an average of 5.6 units.

Conclusions

From the results available so far it seems that apart from the traditional use of oak bark, only Sitka spruce and Japanese larch barks are produced in large enough quantities and have sufficiently attractive analyses to merit industrial investigations.

So far as is known, Sitka spruce has not been used in North America on account of its low yield of bark per tree, but the tendency towards the greater use of mechanical debarking machines, resulting in local accumulations of bark, may mean that this material can be harvested at low cost. There are, however, indications that mechanically-peeled bark is much inferior to hand-peeled both in tannin content and red colour to hand-peeled bark, a point which requires further study.

It is unlikely that the trade will use either Sitka spruce, or Japanese larch tannin alone because of certain technical disadvantages; they are more likely to incorporate it in a blend with other materials.

Norway spruce has not given satisfactory results so far, but these may perhaps be improved by using better drying techniques. It may become a proposition in times of national emergency, and in this connection it may be mentioned that its use in Germany during the Second World War increased six-fold.

European larch bark is clearly a borderline case and may find a use as a "make-weight" with other more suitable conifers.

Sweet chestnut bark and wood may also perhaps be considered if the spent chips could be pulped, but the acreage of this species is comparatively small and in any case remunerative markets already exist for sweet chestnut wood.

An exhibit of tan bark was prepared for the 1956 *agricultural shows, and appears in photo* 7.

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