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EDITORIAL

We are again happy to begin our Editorial by recording the honours conferred during the year on Forestry Commission men. The New Year Honours List announced the award of the C.B.E. to Mr. W. H. Guillebaud, Deputy Director General, and also the award of the British Empire Medal to Mr. W. G. Gray, Head Forester at the Research Nursery at Kennington. In the King's Birthday Honours List in June, the C.B.E. was conferred on Mr. O. J. Sangar, Director of Forestry for England.

Mr. Sangar, who gives an account in this Journal of the activities of the European Commission for Forestry and Forest Products, has had the honour of being elected Chairman of that body for the second year in succession, and will officiate in the same capacity at the Fourth Session in 1952.

The Commissioners

We welcome Mr. Stanley C. Longhurst, who was appointed a Forestry Commissioner in September, 1951. Mr. Longhurst brings to the Commission a special knowledge and experience of the timber trade which will be particularly valuable now that the State forests are contributing more and more to the annual out-turn of home grown timber.

The Commissioners holding office at the end of the year were:—

Lord Robinson, O.B.E. (*Chairman*)
The Earl of Radnor, K.C.V.O. (*Deputy Chairman*)
Mr. J. M. Bannerman, O.B.E.
Major Sir Richard Cotterell, Bt.
Mr. J. E. Hamilton, M.C.
Mr. Stanley C. Longhurst, J.P.
Mr. Lloyd O. Owen, J.P.
Major John Stirling of Fairburn, M.B.E.
Mr. W. H. Vaughan, O.B.E., J.P.
Professor J. Walton, F.R.S.E.

The Forestry Act, 1951

"An Act to provide for the maintenance of reserves of growing trees in Great Britain and to regulate the felling of trees; to amend the procedure applicable to compulsory purchase orders under the Forestry Act, 1945; and for purposes connected with the matters aforesaid".

The above is the heading of the new Act passed in August, 1951, the main provisions of which came into force on 1st October, 1951. Among the important measures contained in this Act may be mentioned: the duty of the Commissioners to promote the establishment and maintenance in Great Britain of adequate reserves of growing trees: the power of the Commissioners (who from 3rd January, 1950 were the felling licence authority under the Control of Growing Trees (Felling and Selling) Order 1950 but who now derive that authority under the new Act) to attach conditions to felling licences, Dedicated woods excepted, to secure the restocking of the area felled, and also to issue felling directions.

The Act enables the more modern procedure of the Statutory Orders (Special Procedure) Act, 1945, to be applied to compulsory acquisitions under the Forestry Act, 1945, resulting in a more expeditious and less expensive procedure for all concerned.

The Home Grown Timber Advisory Committee and the Regional Advisory Committees, which were previously in being with the same functions, now become statutory bodies with a proportion of the members appointed after consultation with organisations representing the owners of woodlands, and timber merchants, and, in the case of the Regional Committees, with organisations concerned with the study and promotion of forestry.

Obituary: Mr. A. L. Felton, O.B.E., M.C.

We regret to record the death in July, 1951 of Mr. Felton, formerly Conservator, South East England. Mr. Felton's death is a great loss to his many friends and those who worked with him regret the passing of a cheerful and unfailingly kind colleague.

25, *Savile Row,*
*London, W.*1.
December, 1951

JOURNAL OF THE FORESTRY COMMISSION, No. 22, 1951

THE EUROPEAN COMMISSION FOR FORESTRY AND FOREST PRODUCTS

By O. J. SANGAR
Director, England

Initials are the fashion today, and the above Commission is generally known as the "E.C.F. & F.P." It is the child of F.A.O. and works in close collaboration with the Economic Commission for Europe, of which more anon. For F.A.O. which, being interpreted, means the Food and Agriculture Organization of the United Nations, we have to thank President Roosevelt; in 1943 he foresaw that there could be no lasting peace unless all peoples of the world had enough to eat and decent living conditions; with this in mind, he convened the now famous Hot Springs Conference, and there it was decided to start what is now known as F.A.O. This organization actually got going in 1945; its aims are to promote, for all mankind, better standards of living and, to this end, to conduct a world-wide war against want as an alternative to a world-wide war amongst nations. All members of the United Nations are eligible to join, and to co-operate in the elimination of waste, in increased production, and in the wise distribution and utilisation of the food and other products that they make available. The task is no easy one; in the last five years production has increased 5 per cent. and population by 12 per cent., whereas, even initially, many millions were below the true "subsistence" level.

At an early stage it was recognised that trees are one product of the soil which is essential to the well-being of mankind, and that forestry must be an essential factor in any endeavour to realise the aims of F.A.O. It was appreciated also that forests serve not only to grow trees, as a product of the soil, but that they also serve the community in many other ways such as the conservation of moisture and in reducing or preventing torrents and avalanches. Therefore a Forestry Division of F.A.O. was set up, organized on the same footing as the other divisions such as Agriculture, Economics, Fisheries or Nutrition. Following the general procedure, there are Regional Commissions which deal with local problems or aspects of general ones; these advise the local F.A.O. organization, which is in turn responsible to the F.A.O. Conference; the latter is world-wide, and orders the work which F.A.O. can undertake on the funds provided by member-governments.

We thus come to the European Commission for Forestry and Forest Products—the "E.C.F. & F.P." as we will call it. This Commission is in a sense the Forestry Parliament for Europe. Its Fourth Session was held at Rome in October, 1951, and was attended by 33 delegates representing 16 member-governments, most of whom sent their Directors-General or the equivalent officer. The United Kingdom delegations have in the past included the Director General, Mr. A. H. H. Ross, Mr. J. R. Thom and Mr. R. H. Smith from the Forestry Commission and also Mr. F. W. Holden and Mr. J. C. Westoby from the Board of Trade; the writer has attended all four sessions and has acted as Chairman for the last three. Discussions are confined to matters of long-term policy and of technique. Questions of economics and, more particularly, of current dealings in timber between European countries, are the function of a separate organization known as the Economic Commission for

Europe; its special Timber Committee does its best to arrange that each country gets its fair share of European supplies of sawn timber, pitprops, etc.

Since its First Session, at Geneva in 1948, the E.C.F. & F.P. has therefore concentrated on matters of Forest Policy, technique, and statistics necessary to guide policy. On the latter point there is invaluable collaboration with E.C.E. in a study known as the Timber Trends Study, which seeks to relate observed production with consumption over a period of years, and therefrom to forecast the trend in the years to come. Such information will help member-states so to order the afforestation and re-afforestation work they undertake that, subject to their own special conditions and requirements, the supplies grown will match the consumption demand; even thinning policies may be affected, i.e., whether to thin heavily and now produce pitprops and pulpwood with a final yield of quickly-grown wide-ringed timber, or whether to thin lightly in order to keep a larger reserve of standing pulpwood and pitwood for a longer period of the rotation, and ultimately produce sawtimber of higher quality. In this and other studies, great attention has been paid to the avoidance of duplication, and to securing the relative information with the least work in the simplest and most useful form.

One particularly interesting point as regards forest policy arose during the Third Session. F.A.O. had found that the governments of many underdeveloped countries did not realise what forests could do for agriculture and for general well-being; they also lacked guidance as to the pattern to be followed in formulating a forest policy. With this in mind, and on the recommendation of the World Forestry Congress at Helsinki in 1949, F.A.O. drafted a basic scheme which endeavoured to reduce the essential principles to a "Least Common Denominator", applicable throughout the world. On this draft they consulted the E.C.F. & F.P. and other regional Commissions, together with the Forest Services of the United States and Canada. In the outcome, the F.A.O. Conference at the end of 1951 accepted and recommended to Governments something which it is hoped will strengthen the hands of foresters and stimulate and guide governments throughout the world in making the best use of their forest resources, whether actual or potential.

The Timber Trends Study is not yet complete, but preliminary indications are that throughout the world, and especially in Europe, the pitwood and pulpwood demand is increasing relatively much faster than that for sawn timber, and far faster than probable production; this situation has greatly influenced recent discussions on silviculture, and at least two European countries have already taken action to discard or revise their traditional practices.

The importance of the production from trees in hedgerows and otherwise outwith the forest proper is now appreciated, and in this connection there is much attention to poplar through the International Poplar Commission.

With the help of I.U.F.R.O. (the International Union of Forest Research Organizations) arrangements have been made to facilitate the interchange of seed and plants; the latter is limited to plants for scientific purposes, but good progress has been made in standardising the testing, description and authentication of seed on a commercial scale.

Arrangements have been made for full reports and quick notification of pests or diseases which suddenly make an appearance or become more widespread or virulent in any one country; this is particularly important when two countries (such as Yugoslavia and Austria) are not divided by any major physical feature, or when dealing with a widespread and fatal disease such as the Chestnut Blight. This disease is considered so important in the Mediterranean countries and in North America that the F.A.O. Conference agreed to the setting up of a special Chestnut Commission.

On all sides there are the familiar complaints of public lack of knowledge and interest, and there has been much discussion on the subject of publicity and education, but little progress has been made except as regards arrangements for the cataloguing and interchange of films.

Two other points deserve mention; one is the study of logging techniques and the training of woods workers, the other is the control of torrents and avalanches, together with soil-conservation. In both cases it has been decided to set up sub-commissions; logging techniques and training of workers will include all forms of mechanisation and handling or conversion from the standing tree to the product; already special descriptions and lists of the various types of machines and tools have been prepared and issued to member-governments; illustrated descriptions are also given in *Unasylva*, the quarterly publication of F.A.O.'s Forestry Department. We in the United Kingdom are not seriously concerned with forests as a means of controlling avalanches and floods, but it is a very different matter in Switzerland, Austria, the alpine regions of France and in Yugoslavia; the attention of the sub-commission will be concentrated upon such countries in the same way as there is already a special sub-commission on problems peculiar to the Mediterranean region.

In the E.C.F. & F.P. we all feel that year by year we are getting closer to grips with our common problems, and making more and more real progress towards their solution and towards helping one another. When foresters, many by now old friends, from sixteen or more European countries get together and strive to reach some solution of their common problems and to discuss their successes and their failures, as much good is done over the luncheon-table, perhaps, as in formal session.

There is one particularly refreshing feature one cannot fail to note; the United Kingdom is no longer the Cinderella amongst European foresters; it is generally appreciated that since 1919 we have successfully tackled many problems of a nature and in a way which has no parallel elsewhere in Europe, and that the 1951 Forestry Act puts us, as regards legislation, in the first rank. Representative foresters from countries with a reputation extending back over a century or two now frequently defer to British foresters for their knowledge, experience and accomplishments; it is good to find that such is the case, and to learn from good friends and colleagues from other parts of Europe that it is their earnest desire to come here and study what we have accomplished.

THE BRITISH ASSOCIATION MEETING AT EDINBURGH, AUGUST, 1951

By M. V. EDWARDS
Silviculturist, Research Branch

At the Festival of Britain Meeting held in Edinburgh in August, 1951 under the Presidency of the Duke of Edinburgh, the scientific progress made in the last hundred years was reviewed. In the Forestry section, the Chairman, Sir Henry Beresford-Peirse, Bt., described what has been done in this country, starting with the introduction of exotic conifers in the 18th century, the formation of a State forest policy in the earlier part of this century and the recent developments in private forestry organization. On the technical side he drew attention to development in nursery practice, in afforestation technique and to recent genetical work. Professor Stebbing then made a survey of the progress of forestry in the British Commonwealth. His address was honoured with the presence of the Duke of Edinburgh and Sir Edward Appleton, Vice Chancellor of the University, and he was given a special vote of thanks to mark the termination of his work as Professor of Forestry at Edinburgh.

The foreign guest of the Section was Dr. van Vloten, Director of Forest Research at Wageningen, Netherlands, the well-known pathologist, who took part in all the proceedings.

Among the main themes of the meeting were the "Thinning of Young Conifer Crops" and the "Utilization of the Produce". Dr. William Reid and Mr. Hollingsworth of the National Coal Board described the uses of timber in mining, and the members later had an opportunity of descending a mine to the coal face and actually seeing how the timber is used. The desirability of smooth props free of anything that can scratch is very obvious when crawling in a narrow seam, even as a visitor, but much more so for the miner using his tools in a confined space.

Mr. C. W. Scott from Princes Risborough described some of the technical qualities and uses of thinnings. He pointed out that the optimum rate of growth in many cases is about four rings to the inch. Changing now to the silvicultural aspect, Mr. Hiley dealt with the need for a definite basis for the grade of thinning, and Sir George Campbell, Bt., talked about thinnings under the rapid growth conditions in the West of Scotland and from the private owner's standpoint.

At the weekend there were excursions to see the results of different thinning grades in practice, carried out regularly and to fixed standards from the time of first thinning, at Bowmont Forest, Roxburgh; and to see ploughing, extraction by chute, and conversion to pit props at Loch Ard forest and the Glasgow Corporation woods at Loch Katrine.

The meeting then turned to pathological subjects, and here Dr. van Vloten described his original researches on the relationship between *Phomopsis pseudotsugae* damage to Japanese larch and brashing, both as to season and method. Dr. Malcolm Wilson described the general history of forest pathology and made special reference to recent work by Mr. S. N. Banerjee on fungi causing swelling and fluting of the bole in Norway and Sitka spruce.

AMERICAN COMMENTARY

By C. A. CONNELL
Conservator, North-East England

This account is intended to give a glimpse of America, its customs, habits and current thoughts, as well as touching on forestry matters.

I was sole United Kingdom delegate among thirty-three persons representing twenty-one nations on a training Mission sponsored by the United Nations Organization and presented by the U.S.A. Forest Service. The subject was forest fire protection. Most of the delegates were forest officers, but some were in allied professional jobs such as forest engineering and forest insurance. Seven of us were English-speaking by birth, the others by tuition previously taken or obtained on the trip—this gave rise to much fun and some embarrassing moments, especially when broadcasting.

New York

My first glimpse of America was in the very early morning, 5 a.m. to be precise, when the street lamps on the waterside boulevard of Brooklyn outlined the route to Manhattan and the skyscrapers of New York City. The dawn broke as the Queen Mary crept up the Hudson River to Pier 90 and the gradual emergence of the famous New York waterfront out of darkness into full brilliance of August sunshine within forty-five minutes was quite breath-taking and a fitting prelude to the wonders of a fantastic country.

We docked about 8-30 a.m. and I had until 10 p.m. that day in New York. After seeing the City as a whole from a taxi and on foot, and visiting the places one is expected to "do", such as Times Square, Grand Central Park Rockefeller Centre, Fifth Avenue and 42nd Street, I decided that I had seen enough.

Night train took me to Washington, D.C. The sleeper on this occasion was exactly as seen on the films and I half expected to see Mack Sennett walking down the centre aisle with dozens of heads popping out in sequence from behind dark brown twill screening curtains of upper and lower berths. Later in the tour I travelled on Transcontinental Limited trains and had a very comfortable room with washing facilities, toilet, bed, and air conditioning. The feeding facilities on these Limited long-distance trains are excellent, but prices run high. I considered I had reached the ultimate in expense when breakfasting on the train to Asheville in North Carolina—for a slice of melon, a bowl of cornflakes and milk, and a glass of milk, I paid the equivalent of 8s. 9d. Most of us drank milk regularly instead of coffee or Coca-Cola. Tea, of course, is not tea by English standards and everyone avoided it.

Washington

Washington—what a lovely city—the finest I have seen in Britain, Europe and U.S.A. It has no skyscrapers; it is spacious, clean, wonderfully planned and full of interesting buildings which the Americans call historic but which, by our standards, are new-born! Between the White House and the Treasury is an open space with a wonderful variety of native American hardwood trees, mostly oaks, and here I often paused for five minutes to play with the innumerable grey squirrels. They are quite tame and five or six will congregate round you, even climbing up your trouser leg to take anything edible from the hand. Presumably because these squirrels are adequately fed by the public and the fallen acorns, no damage whatsoever is to be seen on the very many trees. I think the secret of Washington's beauty and charm comes from its modernity It has been planned, designed and built to avoid all the undesirable features so glaringly obvious in cities of the Old World. The Capitol struck me as rather more impressive than our Houses of Parliament, largely because the siting is much more spacious. In fact the vista from the Capitol to the Lincoln Memorial some two and a half miles in length and a furlong wide struck me as the finest in my experience.

I was able to explore Washington thoroughly, as the Forest Service Headquarters are here and the Mission started and ended in these Headquarters, eight days in all being available to us.

North-West Pacific Region

Leaving Washington, we flew some 2,200 miles westward across the Continent and started our forestry proper in the North-West Pacific area, known to the Forest Service as the "Northern Rocky Mountain Region". Our tour here embraced the States of Washington, Idaho and Montana and consisted of living in two woodland camps and travelling out from them in lorry or coach.

The forests here are entirely coniferous, the main species being *Pinus monticola*, *P. ponderosa*. *P. contorta*, *Pseudotsuga taxifolia*, *Larix occidentalis*, *Abies grandis*, *Tsuga heterophylla* and *Thuja plicata*. The terrain is mountainous and studded with large and small lakes.

Forest fires are chiefly caused by lightning and because of their often lazy development in gullies and steep-sided valleys are not easily or rapidly spotted through an observation post system. Hence the development of aerial detection. A flight by single-seater plane is made at fixed intervals, often two-hourly, and contact to base is by radio. The fighting force is generally airborne, the men being known as "smoke-jumpers", parachuting down in numbers from two to twenty. They are maintained as to supplies and reinforcements also by parachute methods, and eventually find their way back on foot to a point where transport can pick them up. When the fire develops into a long and arduous affair, likely to last longer than three days, for instance, long-term supplies are sent to badly-accessible parts by mule-train, though food continues to be provided by air-drop.

We stayed a week at a mule remount depot in Montana and had everything demonstrated. The mules are sent anything up to three days journey by road by special Forest Service mule transporters (motor lorries) before starting off as a mule "string" up the mountain. A train consists of nine mules, one pack horse and one packer, who rides the horse, an old-stager, docile and canny. The capricious young mules are at the end of the train and have to conform to discipline! I saw a fully-loaded mule train wending its way slowly but without any hesitation up a wooded mountain side that I could climb only on all-fours.

The actual extinction of fires in these parts is based on felling the burning trees, or perimeter ones, and earthing them over, within a narrow perimeter earthy base line made either by man-power (15 to 20 inches wide) or by T.D. 18 bulldozer (blade width). It is incredible what can be done by a shovel and axe as the sole tools, and we certainly can learn a lesson from the Americans on how to make earth take the place of water.

The organization behind aerial detection, smoke-jumping, mule trains and so on is very large and very costly. At Missoula in Montana a complete airfield outfit is maintained by contract with a charter firm and against the executive offices is located the "parachute loft", dealing with the folding, repair, storage etc. of personnel and cargo parachutes for a number of National Forests, some 10 million acres of them. Here, too, are available on instant call throughout the danger season sixteen smoke-jumpers with thirty more within one hour's reach. Each smoke-jumper is responsible for his personal gear, a necessary safety precaution, and the plane goes off with the appropriate cargo packs which follow down on their own parachutes after the smoke-jumpers have jumped. A spotter goes on each mission and it is his responsibility to choose the dropping zone, jumping height, and to gauge the right moment for jumping. He seldom jumps himself on such occasions but is, of course, an "old-hand" at the game, now too old for the intense physical efforts called for from the smoke-jumpers. A twenty-five-mile-per-hour wind is an absolute bar to jumping, while even velocities of ten to fifteen miles per hour are too dangerous under certain circumstances. A smoke-jumper never jumps from below 1,000 feet, normal altitude is 1,200 to 1,500 feet, but cargo chutes are dropped from much lower heights and message canisters free-dropped from immediately above treetop level. On the day of all these demonstrations our party, forty in all, lunched off hot soup, hot meat, potatoes and peas, fruit salad and hot coffee, eaten from paperware with expendable plastic cutlery, all dropped in two containers from one plane which was based sixty miles away. The meal was a standard one, taken at random from aerial stores, heated up, and despatched.

The Remount Depot, some twenty miles west of Missoula, is a village and organization in itself, providing ten mule "strings". The Forest Service have built the whole place and now employ muleteers, veterinary people, motor mechanics, cook, domestic helps, etc. and also run an 8,000 acre farm adjacent to provide food for the mules—the whole a costly item.

The communications system, the framework into which everything else I have mentioned is pieced, consists, in the Northern Rocky Mountains Region, of 11,000 miles of telephone line and 700 radio stations, the latter having a capital value of three and a half million dollars (equivalent at current exchange to 1.24 million sterling). Imagine the value of this one type of equipment alone in the ten Regions comprising the U.S. Forest Service, and even then there has to be added the value of that belonging to the State Forest Services, which cover much more forest area than that belonging to the Federal Service, and one gets some appreciation of the scope of fire prevention work in the U.S.A.

Enormous as the build-up may seem to us here, and of course quite unthinkable as a pattern for Forestry Commission development, it falls into proper perspective when viewed against the wealth being protected. One third of America is clothed with productive forest, 720 million acres to be exact, and of this 180 million are in the charge of the U.S. Forest Service. Most of this forest is not producing increment to capacity, so assuming a very modest annual increment per acre of 75 cubic feet of really good timber (the Americans leave the poorer stuff) at even an English price of 2s. 6d. per cube standing, the national annual income to the U.S. Forest Service is just on 1,700 million pounds sterling! One can then afford to spend money on relevant methods of protection, whereas in the United Kingdom the minimum costs of running similar methods would be uneconomic compared with even our income in the year 2,000 A.D., which, based on the same assumptions, might give the Forestry Commission a notional figure of 38 million sterling. Moreover the methods are not applicable to British forestry circumstances in general. One wants at least 1½ million acres of forest in one block to make an aeroplane patrol worth while.

So, farewell to Region 1 with its 28 million acres of Forest Service forests and another 25 million in different ownerships, all coniferous and all looking exactly the same when viewed from 17,000 feet in an aeroplane! Goodbye to the 17 Forest Supervisors, the 104 Rangers (District Officers), the 4 Research Centres and 6 Experimental Forests and "No Fires!" to their chief, Pete Hanson, Regional Forester at Missoula.

Across the Continent to Chicago and the Gulf of Mexico

"The North Coast Limited", luxury train of the Northern Pacific railroad, took us the 2,000 or so miles from Missoula, Montana, to Chicago, climbing up to Butte (5,490 feet), a town built over an underground of countless mine shafts and tunnels of what is believed to be "the greatest mining camp on earth". Copper is the main product, but zinc is also produced in quantity, together with intermixed gold, silver and lead. From Butte the track dropped to the 1,000 foot general level of North Dakota and Minnesota and then wound its way south-eastwards through Wisconsin to the meat-packing terminus. All this took two days and two nights, and gave us a chance to see much of the vast stretches devoid of trees but intensively managed for arable and stock farming, between, roughly, the Yellowstone National Park and Lake Michigan.

Half a dozen of us had a quick glimpse of Chicago from a taxi, decided we did not like the City and, made our way on foot along the only attractive part, the boulevard flanking Lake Michigan, to the world famous Marshall Field Natural History Museum. Here we wandered among fascinating exhibits of wild life from all over the globe, of relics from ancient Egypt, and of marine fauna of the Seven Seas. Outside, as we hurried along about lunchtime to the airline office the temperature was around 40 degrees, so we had on pullovers, overcoats and gloves. Little did we realise that we were in America, the land of vast distances, extremes of climate and the ubiquitous airplane, and that in five hours we should be gasping in a temperature of 96 degrees, but so it was.

Our Constellation, after routine stops at St. Louis and Memphis, touched down at New Orleans carrying a party of Forest Officers as near naked as decency allowed. The Gulf of Mexico was bright with the bluish tinge of continuous forked and sheet lightning, the air was heavy to breathe, and the faces of the negro porters glistened with sweat. Then came blessed relief—three hours in a fast moving coach with all windows wide open. And so we arrived at our Southern headquarters, the Edgewater Gulf Hotel, a super luxury place with every modern device including, Yes! Heaven be praised, full air-conditioning in the bedrooms. When I entered my bedroom, it was beautifully cool and I knew I would sleep peacefully. Out of curiosity I slipped down into the courtyard—time, midnight—temperature, 96 degrees. We were in "the deep South", right enough!

The Southern States

The forest fire problem in the States of Mississippi, Alabama and Georgia is entirely different from that in Region 1. Fires are entirely man-made, with a large element of incendiarism arising from a deep-seated antipathy to forestry, which is thought to be inimical to agriculture, and particularly to cotton production. Detection needs to be immediate; attack is relatively easy in this slightly undulating country; varied and dense ground vegetation calls for a different fighting technique from snag fires. So there is no aerial organisation, instead, detection is by a network of observation towers, attack is on four wheels, and fire-fighting concentrates on encircling the conflagration with a fire-trace, manually or mechanically formed, and thereafter counterfiring from it.

The Fire Index meter for these parts is a "rate-of-spread" meter, whereas in the Rocky Mountain Region it is an "inflammability" meter.

The predominating and most valuable species, which once covered the deep South as virgin stands, is Longleaf (*Pinus palustris*). (See Photo 1). With it are the other commercial timber trees, slash, loblolly and shortleaf pines (*P, caribaea, taeda* and *echinata* respectively). Although oak is the climax type on these poor sandy soils it is generally scrub and worthless. (See Photo 2). When the pine forest is removed the oaks predominate and prevent pine from coming in, especially where fires are frequent. Once established, the oaks are hard to eliminate. There are two common species of "scrub oak", black jack (*Quercus marilandica*) and blue jack (*Q. cinerea*). Ordinarily these are found in association with the commercial oaks, red, white and post, which however do not develop into good trees on these sites. The oaks are killed by girdling, and also by cupping and poisoning with ammonium sulfamate to prevent heavy suckering. The assistance thus given to pine regeneration is supplemented in places by planting.

A typical hardwood brush understorey in slash pine stands contains yaupon (*Ilex vomitoria*), gallberry (*Ilex glabra*) and wax myrtle. A wildfire through the crowns of such a stand on a day of high fire danger would certainly result in heavy mortality among the pines and resistance to control would be high. But such dense underbrush can be killed by controlled burning, effected under conditions of heavy overcast of cloud with light misting, wind velocity up to eight miles per hour and twenty four hours or so after a good rain. Yaupon, 15 feet high, has been killed by such a controlled "burn" without damage to slash pine trees less than 10 ft. high.

Fire is also used as an instrument of silviculture for eliminating the inevitable Brown Spot (*Scirrhia acicola*) on longleaf pine in heavy grass "rough".

Controlled, or "prescribed" burning, to use the official designation, is done when the longleaf seedlings resulting from natural regeneration are two years old. The fire burns off the pine needles and the grass, thus eliminating the disease and vegetational competition; relieved of these two burdens the naked pine stem with its sturdy bud, both resistant to a quick-passing fire, develops phenomenally and a good plantation results.

A major forest industry in these parts is that of "naval stores" production. The name is a carry-over from the days of wooden ships, and denotes production of turpentine and rosin from longleaf pine resin. After about twenty-seven years of age the trees to be thinned are tapped for resin. A typical stand would have 102 trees per acre, 4 inches and up in breast-height diameter over-bark, of which 17 trees would be marked for tapping. There would be an average of 27 faces per acre, since trees 12 inches diameter and over have 2 faces. 2-face trees have a bark bar of 4 inches between the faces, which may have a depth of 18 inches the first year and 17 inches each of the remaining 2 years. After this cupping for three consecutive years the trees are felled and cut into the products for which they are best suited, sawlogs, poles or pulpwood. Each face is chipped (i.e. bared to induce resin flow) by a new method developed by the U.S. Forest Service, whereby only the bark and cambium layer is removed from the tree and the streak stimulated with a fifty per cent. solution of sulphuric acid. About 32-34 streaks per year are put on each face, at intervals varying from 7 to 14 days. The old method of chipping with a wood-hack gouged out some of the wood and impaired final utilisation, but the bark method has little effect on the commercial value of the trees, if cut soon after cupping.

This "naval stores" utilisation is profitable. The Forest Service lets out the cupping rights much as we sell our thinnings standing. The normal income is 8½ cents per face per year. The average yield is 22 cwts. of gum per 1,000 faces per season and the gum sells at 22 dollars per cwt., delivered distillery. The Forest Service then sells the trees standing and I saw one contractor felling these thinnings after three years of cupping, peeling and converting into pitwood, transporting to Mobile (Alabama's large port on the Gulf) for shipping to Belgium!

One day was devoted to going over a variety of wood-using factories in Mobile, an industrial city about the size of Coventry. A "naval stores" distillation plant, a telegraph and transmission pole depot, a veneer mill and a paper mill were visited. The last mentioned was the most impressive. This mill, one of the five in the deep South and of the twelve in the U.S.A., is owned by the International Paper Company and turns out prodigious quantities of brown and white packaging paper. The annual consumption is 320 million cube per year (the United Kingdom felling quota for F.Y. 52 is 33 million cube) and part of the output goes to a manufacturing section of the factory which produces 30 million paper bags every day of a five-day working week! Bevies of immaculately dressed young women were tying up bundles of 100 bags. I noticed that in the time taken to tie neatly but swiftly the 100 bags, the next 100 were produced by a relentless and untiring machine which printed, pasted and folded the paper unwinding from a 3 foot diameter roll. Incidentally this Paper Company owns about eighty-five per cent of the forest land needed to maintain its requirements of wood on a sustained yield basis, and has a forestry staff of 197 graduate Forest Officers. Their main job, as that of most forestry people in the States, is to keep fire, and pigs where appropriate, out of the woods, which then regenerate adequately.

In working northwards we passed many cotton fields, generally sheltered by woods which showed signs of wildfire damage in the past. The cotton growers believed the devastating cotton weevil, which can decimate a cotton crop, was produced by and developed under forest conditions and could only be controlled by forest burnings. Hence the wildfires. This belief still persists among the older generation, but education by the Forestry Service is having the proper effect on the younger people.

The Appalachians

After the Mission had been accomplished, those of us from Europe did not depart to our homelands as did all the rest, but were taken by the Forest Service back to Washington via the Appalachians, which stretch from North Carolina to Virginia and present a wonderful picture of varied hardwoods with conifers at the higher altitudes.

Based on Asheville for three days, we were taken first to the famous Biltmore Estate of the Vanderbilts, about six miles out of the town. Here Gifford Pinchot was the first Forester, 1892-95, and his successor Dr. C. A Schenck started the first forest training school in 1898. I was particularly pleased to see this property, for it was the only example shown to us of an integrated agricultural-forestry undertaking as we know it here in Britain. Joy of joys, I saw silviculture being practised in our manner; for instance, properly stocked conifer stands properly thinned. We had exciting conversations with the Biltmore Estate Forest Officer on increment, thinning grades, choice of species, vegetational types and the co-ordination of labour as between the 3,000 acres of woodland and the enormous dairy farm of three times that size. Gifford Pinchot's ghost still walks to some purpose! Of fire protection here there is nothing to record—the integrated husbandry virtually eliminates risk.

But to return to the Appalachian Mountain Range, we motored on a Sunday to the southern end, the Great Smoky Mountains National Park. Here were hundreds of Americans enjoying the most exhilarating view from a beautifully laid-out car park at something more than 5,000 feet elevation—peak succeeding peak, clothed in the dark green of conifers, with warm sheltered and enticing slopes and valleys between, brown, golden and altogether colourful from a variety of hardwoods.

There followed what was to me one of the highlights of the whole trip, the journey along the Blue Ridge Parkway. This is a superb motor road running from the Great Smoky as near the ridge of the Appalachians as possible, on the eastern side, and stretching for 465 miles, to the Shenandoah National Park in Virginia. From Asheville to the next town, Roanoke, is 241 miles—along we sped through forest on both sides, never a hamlet, never a shop, just one petrol station, and the loopway to Mount Mitchell. This is the highest peak in America east of the Mississippi River, and one can stand on the absolute tip, elevation 6,684 feet. All around are conifers, *Picea* and *Abies*, and there is a magnificent long-distance view eastwards on to the plains of North Carolina and Virginia.

The coach trip of a little over 420 miles on this day brought us to a small pleasant town in West Virginia, Elkins by name. It has a Forest Service Supervisor's Office and is central for a large area of semi-derelict hardwood forest which is being regenerated partly naturally and partly by what we would call planting through coppice. There are oaks, beeches and, most stately of all, the Yellow Poplar (*Liriodendron tulipifera*). This tree is grown in mixture and pure, and I saw blocks of pure *Liriodendron* five acres in extent, the boles clean and straight for 100 feet, plus a 40 foot crown. The breast-height diameter was 20 to 24 inches and the age rather more than 50 years. I was entranced by this tree, which one sees in the United Kingdom only as short-stemmed branchy-headed ornamental specimens. It is highly prized in West Virginia for its lumber.

Elkins is famous in the State for its annual Forest Festival, the fifteenth of which was held in 1951 a fortnight before my arrival. The Festival is dedicated to the development of West Virginia's outdoor recreational facilities and designed to proclaim the states scenic beauties to the four corners of the nation. The forest queen, Silvia, and her glamorous retinue are chosen each year from among the young women of the township.

West Virginia is half a forest State and half highly industrial; soft coal, chemicals and steel figure high up in the industrial out-turn, while ten million acres is the extent of the productive woodland. Incidentally I saw the oddest coal train in West Virginia that I have ever seen, 2 steam locomotives pulling, 2 pushing and 3 in the middle urging on the others!

This State has a good fire prevention record. In 1907 there were burnt 1.7 million acres; this was before any protection was practised. So effective has been the fire prevention work of the Federal and State Forest Services that the average loss for each year of the last five has been only 240 acres—surely a wonderful achievement with 10 million acres at risk.

After this it was Washington, New York, the "Queen Mary", Southampton and my desk in Briar House at York, mercifully empty through the efforts of a wonderful staff.

So "Farewell" to the Americans, a charming people, probably the most enthusiastic in the world, certainly the hardest working among the free nations, and without question very timber-minded. If they practised silviculture as they practice fire protection there is no saying what their woodland potential would produce for the World.

A TOUR OF DANISH FORESTS

By J. T. WILDASH

Forester, South-West England

(Mr. Wildash took part in the Danish tour arranged by the Royal Forestry Society of England and Wales, which took place in the summer of 1950).

11th September, 1950.
Plant Breeding Station of the State Forests, Humleback

The Plant Breeding Station was started in 1946 as an independent institution under the state forestry service. The daily management is under the charge of H. Barner, Deputy Superintendent, who led the party on the short tour. Dr. C. Syrach Larsen is attached to the station as Adviser. The object of the plant breeding station is to supply the state forests with seed of the best quality from known trees of the finest provenance.

Seed Plantation of Hybrid Larch

This area was the first visited and was approximately two acres. The trees were spaced at twelve feet apart and each alternate row was of European larch graftings all taken from one tree of known fine form. The rows between the European larch were planted with Japanese larch seedlings of known ancestry.

It is intended to collect the cones from the European larch, and in fact 1½ kilos have already been collected, although the plot was only planted in 1946. It is intended to lay out seed gardens for all species eventually, and the trees encouraged to breed cones early for the purpose of starting sample plots. Uniformity of trees is not essential in a seed garden, and in fact this plot was not uniform. The necessity of placing these seed gardens in an area where there is little fear of pollination from outside sources was stressed.

Seed Plantation of Ash

In this seed plantation of ash 1,000 plants were grafted in 1946, or budded in 1945, and planted in the area in the spring of 1947 at a spacing approximately 13 ft. x 13 ft.

Dr. Syrach Larsen said that ash has this peculiarity: some trees are male, some female, and some both male and female. The trees in this plot were laid out thus: 13 female plants were in 2 rows and 13 male plants in 2 rows next to them. The area should start seed production at 10 years old. This plot was established on soil which was really not ash soil, as by doing this the trees were encouraged to seed earlier. Artificial means were also resorted to such as bruising bark, root pruning and semi-ringing. Dr. Larsen said that the seed from young trees was as viable at 15 years old as it was from a tree much older.

Beech Plots

A beech plot was also seen from various races. The races can easily be picked out at this early age, about four years old. The possibility of raising beech of superior form was discussed and the great advantages which would accrue therefrom. The early thinnings of beech could possibly be eliminated and much wider spacing could be resorted to, with a possibility of planting between the beech a crop of more value as thinnings.

In the same area were seen what is called "tree shows". These areas were planted with various species with a view to selecting individuals from known races for establishing tree gardens for seed production.

Dr. Larsen discussed the possibilities of breeding further hybrids which might be useful in the forest but said that he had never yet been able to cross artificially, Norway spruce with Sitka spruce.

Inspection of Main Buildings of the Plant Breeding Station

Mr. Barner said that the most important trees to Danish forestry were not natives, and even with beech the Danish strains were not necessarily the best to grow. It was therefore important to find the right strain, and to do this it was very necessary for the Research Staff to work in close contact with the forest staff who were in a better position to select the correct strains. Having decided on the strain, it was the Research Staff's job to breed it in sufficient quantities to supply the State Forestry Service. The deciding factor at the present time as to the amount of seed sown is the degree of seed available from either Danish trees or from seed dealers, who have not in the past been reliable enough to supply the type of tree seed the forester wants. Therefore the seed station was founded with an object of supplying seed of the finest strains to the State Forestry Service for all their requirements. So far it has been found possible to store conifer seed up to five years. Both temperature and humidity have to be strictly controlled and the humidity is controlled at 6 per cent. of dry weight of the seed and the temperature at +4° to 6° C. The seed is stored in air-tight containers made of glass after it has been "de-winged". It is most important that no damage is done to the seed in de-winging as any damage will detract from the viability. A very small variation of temperature and or humidity can greatly influence germination.

The importance of being able to trace the source of the seed when emerging from the seed stores was obvious and a description of the stand, soil, climate, etc. is recorded for each batch of seed. Also graftings are followed with identity numbers of each batch together with their full history.

The kilns for seed extraction were seen. The cones are usually heated to 40° to 50° C. and it is most important to dry the cones prior to extraction and heating. Kilns were electrically heated with a thermostatic control and the heating was going on at the same time as the cones were in the drums for extraction. On being taken from the drums the seed was de-winged by an electrically driven machine driving *soft* brushes which cleaned the seed.

The seed was stored in three large refrigerators at a temperature of + 4° C. in glass containers labelled with the origin etc. of the seed. Cobalt paper is used to find the humidity and calcium chloride to regulate it. Also a chemical was mixed with the seed to check fungus. The necessity of soaking the seed prior to sowing was stressed.

Nodero State Forest District

Provenance Experiments with Larch

The two plots we saw were of Polish larch and Scottish larch. Age approximately twenty years old standing about nine feet apart over a ground vegetation of grass. The Polish plot, which was of good form and free from canker, had been thinned three times, and it was proposed to go on thinning it every two to three years. It was proposed to under-plant with beech after the next thinning. The larch of Polish origin was far and away better than the Scots origin larch. The Scottish larch showed some signs of canker and was of very much inferior form and growth. It was noted that one or two fine stems in the Polish plot had been half-ringed to endeavour to encourage seed production.

Norway Spruce Natural Regeneration

This regeneration was about twenty years old. It was extremely dense and very small being eight to ten feet high. Next to this was an area of planted Norway spruce 15 years old, which had outgrown the regeneration that was five years older and looked much healthier. The question naturally arose as to why this was the case on what appeared to be identical soil and within 20 ft. of each other. The supervisor showed the party a soil pit which showed that the humus was approximately 8 to 9 inches deep and his explanation was that the natural seedlings did not grow very much until their roots reached the mineral soil; hence the check.

The party was not convinced by this explanation as it did not appear that the ordinary planting spade would in fact place the tree within reach of the mineral soil by an "L" notch, which was the method employed, and were inclined to think that the very heavy stocking of the natural regeneration was the cause of too much root competition. The next area we saw, however, convinced us all that the supervisor was right.

This area held a very heavy stocking of Norway spruce. So heavy in fact that the trees were touching and about 2 ft. high. Although it would have seemed the height of folly to plant this area with the same species such was the case. The whole area had been planted six years ago with the same species about 5 ft. x 5 ft. The planted trees stood out four or five feet above the regeneration and demonstrated clearly that the supervisor was quite right in his theories and that the mere fact of putting a planting spade into the soil and making an "L" notch was enough to give the little extra cultivation needed to start the trees. It seemed to the party that deep ploughing prior to a seed year would have ensured the natural regeneration a good start, but it seems that bulldozing and ploughing are by no means a standard practice in Denmark.

Self-sown European Larch

This area was self-sown about 1863; it is now about 90 ft. high and standing at 40 stems per acre. It is extremely fine larch. There is a third generation of European larch near this area which shows no promise at all being of bad form and cankered. There is also a useful understorey of Norway spruce, *Abies grandis* and Lawson cypress about 20 ft. high and providing a good ground cover.

12th September

Sorø Academy Forest District

Sorø Academy is an independent institution under the control of the Ministry of Education and the forest management has been under the supervision of N. B. Ulrich, Director of the State Forestry Service, since April 1st, 1948. The area is 6,400 acres of which 4,600 acres are forest. The forest area is divided into 12 forests around the town of Sorø. Since December, 1927, it has been managed by Superintendent F. Lorenzen.

The forest stands at approximately 100 ft. above sea level and about 20 miles from the sea. It is slightly undulating, hilly towards Sorø and rugged towards Susaa. The soil varies from a good mould on calcareous marl to heavier clay, and is physically good. The annual mean temperature is 45° F. and for the period of growth from May-September it averages approximately 57° F. The number of days in the year when frost occurs is high—approximately 100 days in all. Late spring frosts are severe and require special measures to combat them. The annual rainfall is 22 inches.

The principal species grown is beech which shows a good growth and the average mature height reaches 114 ft. The form of the beech is satisfactory. Beech in the old forest is not very satisfactory with regard to quality.

Vindelbro Skov*

130-year old Beech

This area of beech is about 130 years old and standing at about 80 to 100 stems per acre. During the summer of 1948 the area was fully cultivated by a Rotehoe for natural regeneration and after the mast fell the area was again cultivated with the same implement. In the summer of 1949 a stocktaking showed a stocking of 27 seedlings per sq. metre, (about 25 per square yard). It is proposed to remove the remainder of the mature beech over a period of 20 years depending largely on the demand for timber.

Beech Regenerated Twenty-five years ago

This area was regenerated naturally in 1925. A cleaning has been carried out three or four times in the pure beech areas and five or six times in the areas where the ash has appeared in groups. It is proposed to thin in favour of the ash which is good in form and shows no sign of canker. There is a crop now of about 4,000 stems per acre where as originally there were 400,000! The crop shows great promise.

140-year-old Beech

On an area of very fine beech 140 years old, the height measured in 1945 averaged 117 ft. It has been thinned six times between 1910 and 1950 and at present there stands 6,800 cu. ft. per acre. Natural regeneration of beech and ash is found over a considerable area.

This is the highest beech stand at Vindelbro and is a very fine crop but according to Prof. Grøn it has been underthinned and has smaller crowns than is considered desirable. In Prof. Grøn's opinion the aim of clean stem should be about 50 ft. and he stressed that half the total value of the tree is in the bottom 25 feet. Every effort should be made to encourage rapid girth so

*Skov is the usual Danish word for a wood.

he advised early and frequent thinning. He frequently stressed that beech is a necessity to Denmark both for shelter belts and soil improvement and also as public opinion demanded it. He also stressed that beech should only be grown where it will regenerate naturally and should *never be planted.*

The soil profile as taken from a sample pit showed 2 ft. of medium heavy loam, 1 to 6 ins. of marl and mainly chalky clay below 2 ft. 9 ins. In most people's opinion it was an ideal beech soil. Ash in places had grown well with the beech. In this forest the soil is generally heavier than Nodero and the forest floor corresponded more nearly to our own woodlands. Nettle and dogs mercury were abundant, but the party remarked on the almost total absence of brambles and briars.

Bromme Skov

Area approximately 741 acres; established on soil which was considered too poor for farming in the year 1800. During a hurricane in 1934 about 982,000 cu. ft. of timber fell in the course of 2 hours, and a similar amount fell as an aftermath of the storm in the following year. As a result of this a very large part of the area is covered with plantations 10 to 15 years old.

A soil pit was inspected and it was seen that the soil was light with 4 ins. humus, 18 in. sandy loam and below, sand. At one time it appears there was a sign of a plough pan but this did not appear on the soil profile and presumably was not a serious trouble. The frost danger was evident on this area and we were told that *Fomes annosus* was serious, as is generally the case in Denmark on old agricultural land.

Scots Pine Provenance Trial

This area of Scots pine was of various races. The Scottish strain (possibly from Gordon Castle) showed promise, but was by no means exceptional and was a fairly heavy branching strain. The Scots pine of German origin was very poor. It was stressed with these sample plots how necessary it is to duplicate your plots many times, as small differences in climatic conditions and soil temperatures give very varying results.

60-year-old Douglas Fir

A very fine crop. On this soil it is an extremely profitable tree to plant. The trees stood at 170 to the acre and it held approximately 4,400 cu. ft. to the acre. The annual increment is 212 cu. ft. per acre. The origin of this plot was possibly from Dunkeld seed. The average height is 90 ft. The professor stressed the difficulty of finding the correct strain of D.F. and said that in his opinion the Dartington strain was the best. A discussion followed as to the best tree to mix with Douglas. It was generally agreed that it was difficult to obtain mixtures of Douglas fir as it out-grew most other species. This particular plot was originally a mixture of Norway spruce and Douglas fir.

Vester Skov

Silver Fir

A stand of forty-year-old *Abies pectinata* was seen. This area was originally planted at 2,400 to the acre, but two-thirds became covered with *Chermes.* The *Chermes* was at its worst at 15 to 25 years old, but the stand survived the infestation and was thinned every year and then every 3rd year. It has 4,000 cu. ft. per acre approximately and the annual increment is 302 cu. ft. per acre. Some regeneration was seen but as the roe deer is very prevalent in these woods its chance of survival was slight. *Abies pectinata* is a great success on Jutland. It is fairly free from fomes and is wind-firm. It can be grown on a 90-year rotation and succeeds best where the rainfall is at about 20 ins. per annum.

Red Oak

Provenance experiments with red oak (Dutch) and common oak sown in 1910. A fine crop of *Q. rubra* 60 ft. high with a diameter of 8 inches at breast height. It had been thinned many times and fenced against roe deer. The stocking was approximately 2,000 cu. ft. per acre. The yearly increment is about 112 cu. ft. per acre. It was observed that the epicormics had persisted to a certain extent. On poor soil *Quercus rubra* had proved to be better than pedunculate oak.

September 13th
Bregentved Forest District

The owner of Bregentved is Count Christian Moltke who is Master of the Royal Hunt and the woods are managed by Conservator T. Jagd. The area is approximately 7,410 acres which is divided into 30 minor forests. Conservator Jagd has looked after these forests since 1919. The site is level and drainage is difficult. The whole area is subject to spring frosts. The annual rainfall is 23 inches. Soil is clay of varied character with a high water level. The top soil is thin with a thin humus layer overlying it. This all overlies a stiff clay. The annual increment for the district is estimated at about 105 cu. ft. per acre and the annual fellings at present are about 84 cu. ft. per acre.

Objects of Management

"The object is to build up a standing stock of biologically and economically well suited species so that a relatively large wood capital will stand accumulated in such a form that a reasonable annual yield may be expected. At the same time reserves will be in hand in an easily realizable form to meet any extraordinary demands."

Among the features characteristic of the silviculture at Bregentved may be mentioned the wide use of overhead cover, the permanent species of tree being established under old forest, or under a catch crop. This is done to obviate the damage due to spring frosts, the heavy growth of grass and the great tendency to stagnation of growth in entirely cleared areas.

Bregentved specializes in oak culture and the system favours a large number of stems per acre in its early stages followed by light thinnings at very frequent intervals, normally every two years. The practice of sowing direct is made simpler by the complete absence of squirrels and rabbits.

Grevinde Skov

Norway spruce under Beech

Norway spruce 16.8 acres, planted in 1925 under the shade of old beech with 2 + 2 plants spaced at 3 ft. 3 ins. × 4 ft. The old beech was felled successively from 1929 to 1935, and many Christmas trees have been removed from the area. The stocking is 7,000 cu. ft. per acre and the quality is very fine. It now stands at 2,000 stems per acre. It was stated by our guide that Norway spruce can stand more shade than grass, and it is advisable to keep a fairly heavy shade to keep down the grass; the beech cover was originally 90 ft. high.

Oak sown under Beech

Oak sown in 1944 with acorns from Bregentved. The method of cultivation and development of crop was typical of this forest. The old beech forest was thinned to give sufficient light. This entailed thinning the cover crop to 150 stems per acre. The cover crop, incidentally, was of a very fine quality and about 90 ft. high. Following the removal of some of the cover crop the ground was fully worked with a disc harrow drawn by a horse and the drills made by hand with a pronged hoe with 4 ft. between the drills. Acorns were sown at a rate of 446 lb. per acre, and the ground between the drills was harrowed for the first

4 years. The stocking was dense and the growth good but not exceptional, being about 5 ft. high. When we saw this area the stems of cover crop had been thinned down to 60 to 70 per acre and we were told the rest would be removed next year on the high ground. The cover crop will not be removed from the frost hollows for another three or four years. Oak mildew was prevalent on the crop, but we were told that the oak tortrix is not prevalent in Denmark generally. It was proposed to thin this area at a height of 15 ft. which the crop should attain at an age of about 15 or 16 years from the time of sowing.

Removal of old Beech from Areas Underplanted with Norway Spruce

This was an interesting area of Norway spruce planted in 1942 with 2 plus 2 plants under the shade of old beech. The over-storey of beech was in the process of being felled and it was quite amazing the slight damage that was done. Each tree averaged 130 cu. ft. and was felled towards the most open part, or with the butt towards line of extraction. This done, a winch tractor pulled the tree out whole without any lopping being done at all and the trimming was done on the ride. We saw very little evidence of damage caused either by felling or tushing.

Beech under Norway Spruce

A beech plantation established under the shade of 40 year old Norway spruce. It was planted by putting 1 to 3 plants in hoed plots in 1928 at every 16 ft. and the provenance was Czechoslovakia. The shade trees were cut over the years 1940-47 and the beech thinned at the age of 15 years old in 1943 and thereafter every 2 years to date. Again no sign of damage was seen as the result of extracting the N.S. In Denmark the Czechoslovakian beech is extremely highly thought of, and many fine plots of this provenance were seen. It was noticed that beech of this provenance has the branches at a large angle to the leader and that old branches died out well, and very few trees were rough.

Ny Skov

Abies Grandis plot

A very impressive stand of *Abies grandis* planted in 1926 with 2 plus 2 plants spaced at 4 ft. × 4 ft. with 50% interplanting of Norway spruce. The latter, however, have now been removed entirely in thinnings. Height 60 ft. Stems per acre 350. Q.G.B.H.=6½ ins. Stocking is 3,400 cu. ft. per acre, and the annual increment during the last 6 years is 448 cu. ft. per acre. The stems have been pruned up to 30 ft. on account of the ready sale of foliage in Copenhagen, and also because the timber will ultimately be used for veneer.

It was noticed some of the stems showed signs of cracking in a lengthwise direction. Conservator Jagd said that this was due to the drought of 1947 and was not due to frost as it occurred during the summer.

14th September
Excursion to the Odsherred District

The Odsherred State Forest District is the last remaining of the Royal "Rytter". These estates were crown lands that for about 100 years from 1660 were set aside for the maintenance of national cavalry regiments. The District has been an administrative unit since 1661. During the period 1780-1820 the forests were segregated from agricultural land and dedicated to silviculture. Some of the areas, particularly in the western forests were not, however, planted until about 1840.

The total area of the district is 4,325 acres, about 3,900 of which are wooded. It consists of 10 forests, the smallest of 95 acres and the largest 727 acres. The climate of the region is very dry and windy, with an annual rainfall of 19½ in. All the forests are located near the coast and there is little spring or night frost. The leader of the tour round this forest was Skovrider E. Bentzen. He said that, on account of the low rainfall, root competition in underplanted areas is very great. In this forest it is possible to clear fell and regenerate by planting and sowing. The normal method is the strip method.

Cattle Grazing in Conifer Plantation

This area had had a novel treatment as far as most of the party were concerned and therefore provided substance for a great deal of discussion. The crop is a mixture of D.F. and E.L., but it was not so much in the crop in which the interest lay but in the treatment from the first year. Cattle were let in to the plantation when the plants were 2 to 2½ ft. high, and allowed to crop the grass which was profuse in this area. We were told by Mr. Bentzen that as long as there is plenty of grass there is absolutely no fear of the cattle eating the trees, and a cleaning is effectively carried out with no expense and to the benefit of the cattle. The growth on the trees was excellent, the height being 12 ft. The grazing must be watched very closely.

Old Oak

This stand of oak at 165 years old was probably the most magnificent and inspiring seen on the whole of the tour. The trees were standing at approximately 20 per acre with an average Q.G.B.H. of 28 in. It was estimated that the crop stood at 1,800 cu. ft. per acre of more. The height averaged 84 ft. and the stems were beautifully clean and straight. An understorey of beech had regenerated itself and stood about 30 ft. high, with some ash.

Stokkebjerg Forest

Beech Sample Plots

This area was of the most magnificent beech and consisted of two sample plots which have been measured since 1852. The volume per acre now stands in one plot "M" at 5,600 cu. ft. per acre and in the other plot "X" 6,440 cu. ft. per acre. The yearly increment measured since 1852 has averaged 174 cu. ft. per acre. Plot "M" has a B.H.Q.G. of 21.7 inches and averages 113 ft. high, the other plot "X", 112 ft. high. These plots are managed by the Research Branch and the form of the trees is truly magnificent. It is proposed to graft from these trees for the purpose of establishing seed gardens. The trees stand at about 50 per acre. (See Photos 3 and 4).

Annebjerg Forest

"Park Beech"

The party was taken to this particular spot for the purpose of seeing what are called "park" beech. It was not at all what is known by a "park" area in this country. The beech were magnificent and the view we saw will be remembered by most of us for evermore. We stood at the top of a slight rise in the ground and looked towards the sea, a distance of perhaps a quarter of a mile. The beech overhead to left and right were 107 ft. high with a Q.G.B.H. of 21 ins. and standing at 4,600 cu. ft. per acre. To the left and right were small lakes and the sea was visible through the trees in the distance. It was a beautiful day and it illustrated very well how a beech wood can be both practical and of extreme beauty.

September 15th

The State Deer Park, Copenhagen

This park is the largest in Denmark and is governed by a Committee of which the Director of State Forests, Mr. Ulrich, is a member. The area of the park is 2,400 acres and contains therein many fine old oak and beech. Some of the beech are known to be 250-300 years old and some of the oak up to 800. Within the precincts of the park no cars are allowed, but people are allowed to walk through, take bicycles or drive in a horse and trap or ride. The committee very kindly allowed the buses of the touring party to go through; we were the first vehicles through the park for several years. In spite of the great age of the oak and beech there were many fine trees to delight the forester.

There was one particularly fine stand of beech covering some five or six acres. The many open spaces in the park were covered sparsely with old hawthorns and there was a fine growth of green grass.

The Park was first fenced in 1675 and now contains approximately 1,700 fallow deer and 300 red deer, as well as an unstated number of roe and Sika or Japanese deer. Each year 700 deer are shot, and some fine heads have been recorded from the red deer; some 22 pointers are among the herd.

General Observations

Beech Silviculture

Although near the northern limit of beech some very fine stands were seen. Generally throughout Denmark beech is planted as the public demands it, and the results leave little to be desired. It is the policy to plant beech at a much closer spacing than is the custom in this country, and to thin earlier and more often. Also sowing beech direct is practised with good results. Great stress is laid on the origin of the plants, and this applied to other species as well. The normal spacing for planting appears to be about one foot apart with 4 ft. between the rows. One year seedlings are commonly planted, but we never saw beech planted without overhead cover of some sort. Normally it is the natural crop to succeed oak, and in its early years it is nearly always a second storey to oak. It is commonly the practice to intersperse larch among the beech stands, or sometimes ash on suitable soils, and some magnificent larch were seen growing under these conditions. The rate of growth does not appear to be greater than in this country. Rabbits are non-existent and squirrels scarce, so the establishment by natural regeneration or by planting is much simpler. Also the absence of fences when the crop reaches the underplanting stage and the removal of overhead shade make the process simpler and cheaper. In some areas planting is greatly preferred to natural regeneration methods, and plantations were seen which demonstrated clearly that the planted areas were of better growth and form than the naturally regenerated.

Oak Silviculture

It was commonly the practice to sow oak direct with the object of a very heavy stocking for the first few years. Usually thinnings were started at 15 years or when the crop had attained a height of 15 ft. thinned every two years for 20 to 30 years and then three-yearly depending very largely on the development of the crop.

The practice of maintaining two storeys of oak from the same crop I should think is unique. Leaving suppressed trees to form ground cover and to assist in eliminating epicormic growth is very noticeable in the Danish oak woods and at first sight detracts from the appearance of the stands. The principles laid down for good oak culture were:—

1. Start thinnings early from a heavy stocking
2. Thin when 15 ft. high
3. Thin every 2 or 3 years
4. Develop large crowns
5. Maintain understorey and do not cut suppressed trees

The Danes manage to establish extremely fine plantations of oak from what we would consider not very promising conditions. The soil is generally lighter than is considered ideal, and the rainfall is very light. They have the advantage of several hundred years of forest conditions, and have evolved a technique most suitable to their climate and soil.

Miscellaneous

It is nowhere the practice to prune conifers unless they are wanted for very special purposes. The establishment of seed gardens seems to me to be a great step towards first class stands. The failure of the Scots pine was rather a surprise to me and no plantations were seen of any great worth. European larch and Japanese larch both do well in Denmark and so does Douglas fir; considering the low rainfall this is surprising.

Roe deer are a pest in Denmark and the only fences seen in the woods were occasional ones erected to exclude these animals. *Fomes annosus* is fairly common but mainly we were told on land which had at some time been under the plough. It was not common in the old forests. Larch canker is not bad in the European larch plantations and generally European larch can be said to be a success in Denmark, provided it is from a good strain. Several people remarked on the lack of bird life in the woods; buzzards were seen on two occasions and magpies and jays often. Hooded crows are common and also jackdaws and rooks. Mallard were seen on occasions on the ponds.

The extent to which the Danes use every small piece of usable ground was very pronounced. On the train journey from Esbjerg to Copenhagen there seemed to be hardly an acre wasted. The small woods of sometimes an acre or so were planted with Norway spruce, or larch. The cows grazed the fields to the roadside and except in parts of Jutland hardly a hedge or fence was seen. The farms are small and one of the most striking things is the absence of machinery. Horses are used much more than they are here and the dun-coloured Danish horses and red cows are a feature of the countryside. Very few tractors were seen and only two combines were seen at work though harvest work was still in progress.

The kindness and hospitality of the Danish people was exceptional and every facility was given the party to see as much of their country as was possible.

DENMARK DIARY

By. J. A. B. MACDONALD

Silviculturist, Research Branch

The visit actually began on 18th June, 1951, when the car left Copenhagen airport. It was a memorable drive, my first for a long time on the right hand side. The rain was torrential and as we got into the city there was a perfect welter of neon lights and reflections. All the time, Dr. Syrach Larsen kept up a flow of most stimulating talk about forest genetics in Sweden and Denmark, but I was altogether too dazzled and unfortunately cannot now recollect much of it.

19th June:

The Danish State Forest Seed Centre

In the morning the day began by visiting the seed centre for Danish State Forests at Humleback. This completely new Institute is under the direction of a young man, named Barner. He was chosen by Syrach Larsen when still a very promising pupil at Hørsholm and his job is to supply the State Forests with seed of the best possible quality for each particular district. District Officers notify their requirements annually in kilos per species, and also send preliminary reports to the Director of the Seed Station forecasting probable seed supplies in their district. Later on in the season a team of young men from the Station make a survey of seed stands and form a closer estimate of the amounts likely to be forthcoming.

In due course the seed centre makes, or at any rate assists in the seed harvest. They are equipped with jeeps and special ladders and climbing appliances. All progeny testing is carried out in the nursery which surrounds the Station.

Forest seed control is not yet as highly organised as in some other countries, but it is rapidly improving. Seed stands have been labelled "A" where trees are of very good form and type and in addition have been proved to yield progeny of extra-normal quality. In a "B" stand, the only other grade recorded, the form of the parent trees may be very good or excellent but progeny not sufficiently satisfactory. I was shown an efficient little stand description form.

The Station itself is equipped with two very up-to-date seed extraction kilns, both supplied with warm air from a car-type hot water radiator, and circulation is maintained by a rotary fan. The smaller of the two kilns is for very special small seed lots. This small kiln cost 8,000 Danish crowns (£400) and the larger one a little more.

Seed extracted works out at two shillings per hektolitre (or 9d. per bushel) of Norway spruce cones. Before being kilned the cones are air-dried in a well ventilated loft. Extracted seed is dressed and cleaned very much as usual, but storage is given very special attention.

A neat little refrigeration plant in the main cellar maintains the low temperatures necessary in each of four storage chambers, each chamber being separately controlled by a thermostat.

For "easy" conifers, which include pines and Norway spruce, temperature was maintained at four to six degrees centigrade. Barner said they were satisfied that complete uniformity of temperature over the year is very important, and certainly more important than actual temperature. Common silver fir is one of the difficult species both to dry and to store. They are at present drying it down to 12% humidity and storing it at – 4°C. All other seeds are dried to 8% humidity before storing. Seed drying is done very simply by packing the bags of seeds into the kiln and blowing air through at 25 to 40 degrees C. Each refrigeration chamber has a fan to keep air moving therein. So far as I could gather the whole cold storage equipment cost £1,000, but costs of running the plant seem to be exceedingly small.

Of the four cold chambers three are approximately 3 metres x 2 metres x 2 metres and one is 2 metres x 2 metres x 2 metres—in all about 1,500 cubic feet.

For storing the seed, Barner pointed out the shocking amount of space left when round bottles are used; something square must be found. In addition to storing State Forest Service seed, storage space is provided for seed merchants at 3 crowns per kilo (1/4d. per lb.) for the first year and 2 crowns per kilo p.a. (10d. per lb.) thereafter.

There was no time to inspect much of the progeny testing ground in the nursery which surrounds the Station, but Larsen did take me to see one seed plantation near the entrance where grafted European larch of specially good strain are planted line about with good Japanese larch in order to supply high quality hybrid larch seed.

Hørsholm Arboretum

Dr. Larsen took me straight from the Seed Station with its progeny testing grounds to this Arboretum which is an extension of the original, famous, but rather restricted Arboretum at Charllottenlund near Copenhagen.

Items of particular interest were:

1. Scots pine grafted in 1937 now about 15 ft. high and producing a heavy crop of cones almost annually.

2. Sitka spruce x white spruce crosses growing vigorously, but not likely to be so good as pure Sitka spruce.

3. A very good Sudeten European larch x Japanese larch cross.

4. Polish larch grafted in 1946 on Siberian larch stocks which were 5 to 7 years old, the grafting having been carried out 5 ft. above the ground.

5. Trees raised by grafting from the finest Japanese larch in Denmark with a beautiful light branching habit.

6. A triploid European larch.

7. Grafts from a famous mother tree, the "Thinghus" larch, considered one of the best in Denmark.

8. Grafts from a fine comb-type Norway spruce, the parent tree being 150 years old.

9. A 1934 cutting of a snake type Norway spruce now over 12 feet high—an ugly thing, but growing vigorously.

10. Lovely Douglas fir from a fine 30 year old tree in Professor Grōn's forest in Jutland "Linsa Vesterskov" No. V661. This tree is believed to be *Phaeocryptopus*-immune. Branches are particularly densely needled and the needles of a fine blue green shade.

11. Plants raised from controlled, self-pollinated Scots pine seed had produced poor small trees compared with very good cross-bred plants alongside.

12. Norway spruce V49 mother tree x different fathers, alongside self-pollinated V49—all 1946 seedlings. Plants from one cross are 3 ft. high, from another cross 2 ft. high while the self-pollinated trees are only 1 foot high.

13. Vigorous triploid alder 28 ft. high alongside grafting off a tetraploid alder of very bad type.

14. The famous larch crossing series was then inspected. It was a little difficult to see this properly on account of the luxuriant growth.

15. I then saw oak graftings and

16. immediately afterwards took two photographs of a small plantation of Norway spruce raised from cuttings which are all shooting *exactly* together. This was a most remarkable sight as normally a Norway spruce plantation shows shoots at all stages of development.

17. I tried to find out whether the form of propagation (i.e. cutting or graft) was likely to have any permanent effect on the form of the tree. To begin with, cuttings seemed to be much finer and far more symmetrical while grafts are definitely asymmetrical and of extraordinary vigorous growth with heavy needles. Neilson pointed out that the cutting was struggling against an insufficient root system while the graft was living on an abnormally good one; he felt sure that there would be much less difference obvious within a few years.

18. The difficulty in making *Abies* species grow into a proper tree form, from grafts and cuttings, was mentioned. I had heard of this long ago at Royal Botanic Garden, Edinburgh.

19. I took a photograph of the wide range of progeny from one self-pollinated hybrid larch tree. All sorts of forms and shapes from the European to the Japanese appeared to be present. This is a famous experiment.

20. The 1937 larch crossings were then examined. These are now most impressive, being up to 50 ft. high. The cross European larch x *L. gmelinii* and the ordinary hybrid larch are biggest and best. It was interesting to note that the pure Japanese is the smallest in height of the series but that pure European larch are tall nice trees being offspring of one of the best larches in Denmark. The *L. gmelinii* x Japanese larch cross when self-pollinated produced very small progeny.

21. A hybrid between European larch x Western American larch (*L. occidentalis*) which is a triploid, produced seed, but only one seed out of 500 lived. It produced a very fine tree with big, open scaled cones.

22. Progeny of a very fine single stemmed clone of *Thuja* (with short horizontal branches) propagated in 1942/43 was seen alongside very much less upright types.

The Forest Nurseries

On leaving the Arboretum, but before leaving Hørsholm, we went first to have a rapid run through what must be the most extensive Forestry Museum in the world. It is actually a permanent Hunting and Forestry Exhibition and is housed in two enormous, beautifully timbered buildings. These were built in the spacious times as riding school, stables, coach house and barn. From the way in which Syrach Larsen knew about everything it was not difficult to see that he had been one of, if not *the*, prime moving forestry spirits. Actually the Exhibition booklet which I got is written by him. What interested me most were the ancient ploughs and other massive machines, some of which had been used to form the earliest heath plantations in Jutland.

The Old Botanic Garden

It was a fitting climax to a memorable day to walk leisurely among the specimens in the old Botanic Garden and to hear from Syrach Larsen's own lips the stories of many of the classic examples of conifer propagation. Frequently there were most interesting little broods of progeny beside an old parent to illustrate the story. I think what took my fancy most of all were two European larches of queer forms which for many years had grown only horizontally across the ground. These he had produced many years ago from the curious, more or less horizontal tip of an oldish tree when one authority had put the phenomenon down (as most of us would) merely to exposure above the normal level of shelter. Larsen's father had voiced doubts and his son had quietly put the matter to test.

20th June:

Jutland, Ranpboel Forest

Arrived at Vejle in Jutland about 9 p.m. and went to see Ranpboel Forest. The area, which is on light soil, lies some fifteen miles north west of the town and has a mean annual rainfall of 15 inches. The forest contains a great deal of very large old spruce and common silver fir. One excellent tall stand of silver fir was 67 years old and contained 430 cubic metres per hektare, the increment being about 15 cubic metres per annum. Spruce and silver fir regeneration was everywhere, but it was admitted that this was by no means generally utilised for the next crop. The forest officer complained that Douglas fir was difficult to raise because of *Phaeocryptopus* attacks. It was almost night when we left the forest.

21st June:

Vejle Town Forest

In the morning we first passed through Vejle Town Forest—a large one—where there is some very fine beech. I thought that it would be well worthwhile trying seed from these trees in north east Scotland.

Before reaching the heaths I asked about *Fomes*, (it had been so bad when I was in Jutland twenty years ago). Apparently the disease did not continue to increase at the rate anticipated. Løfting feared, however, that there was a good deal of evidence to show that *Fomes* was worst in Norway spruce after full ploughing and complete deep cultivation had been given. Under these circumstances he was afraid that about 30% were attacked. He thought the best final results with spruce were obtained with much less intensive cultivation, that is to say when the modern double mouldboard plough is used with a subsoiler attached to plough furrows about five feet apart, and no further discing etc. follows. Under these circumstances he thought that the *Fomes* attack came down to something between 5% and 10%. Planting distances are at about four feet within the furrows.

Forests on the Jutland Heaths

Near North Snede at a little private forest which has a Danish name meaning Dog's Head, we entered the true heathlands and inspected the first plantations. In this region the heaths are on a very poor deep glacial sand. I had already noticed the white spruce hedges separating the fields, and also hedges of *Sorbus intermedia* which have increased in popularity since 1930. Furthermore, the plantations had a white spruce shelter belt surround. Without this belt it is fairly certain that Norway spruce at any rate would have been blasted badly and might even have failed.

The first plantation had been planted in plough furrows in 1930 and was an unusual mixture of Japanese larch, Sitka spruce, Norway spruce and erect mountain pine. The Japanese larch immediately caught the eye because of its remarkable health and vigour. The mixture, which was complex and intimate, not in bands or groups, had obviously been given some attention but not a great deal, nevertheless almost every species was generally doing well. Only in one or two spots was it observed that the Japanese larch had disappeared. The exact reason is not known but obviously local conditions had been more difficult; possibly it was wetter, more peaty or the *Calluna* had invaded more rapidly. In these more difficult spots only the mountain pine had developed, although it too had suffered a certain amount of failure. Although the large block of pure Norway spruce nearby had gone into a very severe state of check during a period of drought years, it was remarkably interesting to find that the Japanese larch, Norway spruce, Sitka spruce and mountain pine mixture had escaped damage from the same drought. Løfting feels sure that the beneficial effects of Japanese larch on the soil conditions are provided earlier than any benefit from mountain pine.

Nearby I saw Sitka spruce which had grown splendidly—far better than Norway spruce—for twenty years, now being suddenly and heavily attacked by *Hylesinus mecans*. The typical damage reminded me at once of the curious resinous flow from the bark which I have seen before on Sitka spruce butts at Cumlongon and elsewhere in Scotland. I had never heard it suggested, however, that this or any other beetle had anything to do with the resin flow there. Løfting believes that when a very vigorous tree is attacked the resin flows strongly enough to exclude the beetles, but when most trees are attacked in this dry region the beetles soon get the upper hand; apparently they entirely ring the tree which subsequently dies. Where Sitka is dying out as a result of

H. mecans it is being replanted by Japanese larch in deep screefs and is to some extent supplemented by Sitka spruce regeneration. I took a colour photograph showing *H. mecans* damage.

A 32-year old mountain pine/Norway spruce plantation alongside, showed the Norway spruce to be doing very well indeed. There is some doubt as to the exact form of the original cultivation, which may well have been more intensive than was given to the four-species mixture mentioned above. In a block nearby were some very coarse coastal *Pinus contorta* with extremely long branches. Looking beyond the mountain pine/Sitka spruce shelter belt on the windward side of the plantations was a medium quality *Calluna* heath. Some hundred yards away appeared to be a young Norway spruce planting looking remarkably yellow, but among it there could be seen a few double rows of good healthy *Pinus contorta;* in addition there was a vigorous Japanese larch/spruce plantation behind.

Further along the road I was interested to see fine vigorous roadside belts of pure Japanese larch partly used no doubt as firebelts. Beyond were considerable blocks of pure Norway spruce which were yellow and not at all vigorous. Some of these plantations had been underplanted with *Prunus serotina* and *Amelanchier florida*; the latter was doing well. Løfting believed that some of these shrubs and also a small shrub which he had seen in Holland, were capable of improving the soil under Scots pine.

Palsgaard Forest

Just before noon we reached this famous heathland forest which I had visited previously in 1930; it has been managed by Mr. Kirkgaard since before that time and owes much to his care. On the outskirts we saw beech, oak and silver fir strips which are more than shelter belts, and which Kirkgaard established not only to provide a windfirm edge but to ensure longevity along his boundaries. Sometimes he begins the process by primarily introducing silver fir into quite small gaps within the original plantations (these gaps probably being formed by *Fomes*). In holes blown out of the plantations by wind, Kirkgaard immediately plants Japanese larch, birch or Norway spruce to get quick growth, his primary object being to keep the wind from drying out the surrounding forest. I remember well the stress Bornebusch put on this need for keeping out drying winds, during my previous visit. We noticed that silver fir was growing best on the slightly raised parts of the heath and not on the bottoms where there is frost. A common form of replanting (probably after a precrop of mountain pine) was first row Norway spruce with silver fir and second row Norway spruce with beech.

I could not quite understand the desire to grow common European silver fir, a species which never seemed to look particularly healthy though it grows tall, since it comes from such an extremely different climatic region from Jutland with its 28 inches rainfall. However Jutland foresters are very keen on it and seem to prefer it and *Abies nordmanniana* to Norway spruce wherever possible. The worst difficulty, Løfting explained, was to preserve it from frost damage in youth. He thought, however, that it suffers drought better than Norway spruce—possibly it is deeper rooted.

Further along we came to strongly growing mountain pine 25-28 feet in height. These and some of a Pyrenees strain nearby which were fully 30 feet tall deserved to be called *trees* more than any mountain pine I had previously seen. A Japanese larch/Douglas fir mixture which had followed after a mountain pine pre-crop was growing well, but the Douglas fir was of an inferior type. Løfting prefers this mixture to a pure plantation of either species. Nearby however, there was a Douglas fir plot of first class type which had as usual been planted after mountain pine. *Abies grandis* was outstandingly good in this compartment.

We returned to Palsgaard after lunch to inspect more areas which had been pre-cropped with pure mountain pine. 20 years ago mountain pine in this forest and throughout the heaths was dying off heavily with *Lophodermium*. Later it was discovered that when very heavily thinned it recovered.

On the side of the main road through Glusted we saw areas of heathland which had been broken up and planted 6 to 10 years ago for the first time, chiefly with a Norway spruce/mountain pine mixture. The Norway spruce were planted one metre apart in a 2:1 ratio with mountain pine in furrows spaced approximately at 5 feet intervals. On one side the plantation had been re-cultivated using the double mouldboard plough, with the result that the Norway spruce had grown very much better—in fact on one side mountain pine is dominant and on the other Norway spruce. In one Glusted compartment a Japanese larch/Norway spruce mixture had been established alongside one of mountain pine/Norway spruce. The Japanese larch averaged 6½ ft. high, whereas the mountain pine were only 4 ft. This Japanese larch was from an inferior collection and had suffered some damage from both frost and *Nematus*.

In some of the older Palsgaard woods there had been a curious ground ridging system carried out a century or more ago. The soil was heaped with the ridges 25 yards apart, rather like the old rig system in Scotland, but piled much higher. Where spruce had been planted growth was excellent on the sides of the ridges, but had failed both on the ridge tops and in the intervening hollows. We then inspected a very fine Sitka spruce sample plot aged about 60 years, planted after a mountain pine pre-crop. The Sitka had been placed on the ridges between the original mountain pine furrows. The bark was of a peculiar scaly type, the scales being about 2 to 3 inches square. The trees were over 70 ft. high, about 12 inches diameter at breast height, and the branches were particularly fine. It is said that this spruce was not damaged at all in severe winters since it was quite young, when it suffered a lot from frost. The soil here is probably of a fairly good heath type, but nevertheless Norway spruce alongside was not more than 45 ft. high.

I feel that the whole heath here is generally better than many of our poorest heaths; maybe not inherently better, but being lighter it is capable of amelioration much more readily than some of our heavier heath soils. I would class it as a *Calluna*/grass type of heath rather like the best we have in upper Speyside (sands and gravels). There are, however, very difficult patches, for instance where *Cladonia* appears, but even the worst parts can be made to produce useful timber.

22nd June:
Kompedal Forest

On the way to Kompedal forest next morning I was intrigued to see large scale peat digging in what were either arable or ley fields. Apparently certain fields on old boglands are set aside once every few years for the removal of a layer of peat in much the same way—if in miniature—as we work opencast coal in Britain. The road took us through a valley where sessile oak is the native species.

During discussions on Sitka spruce, Løfting thought a 50 year rotation to be suitable for Jutland, possibly making use of regeneration over quite a long period. He was quite certain that every effort must be made to prevent the reinvasion of *Calluna*, i.e. to maintain the existing *forest* vegetation type.

We next visited an area where there were considerable plantings of the Heath Society. White spruce, oak, *Sorbus intermedia* and contorta pine were all very much in evidence. Kompedal forest is of some 4,500 acres and has been formed very much by the old, slow but sure method of planting a preliminary crop of mountain pine on ploughed heath and later introducing other conifers—mainly Norway spruce. We turned into the forester's headquarters and were met by a very bright young foreman. He took us first to see the nursery which was the best I had seen on the Continent. Line sowing was common, lath covers were used and there were frequent white spruce hedges for shelter. They had used hopwaste compost though unfortunately not in a new nursery. Serodella with adequate NPK fertiliser is used as a greencrop.

In the yard at the Forestry buildings I saw another double mouldboard plough with a big hook type subsoiler. In the spring there had been a very big fire in the area which destroyed 2,500 to 2,800 acres. Over 200 acres of this area were being ploughed for P.52. To do the job two big wheeled tractors fitted with huge spuds and an enormous hydraulic-coupled single furrow plough are used to turn out a furrow 16 inches deep by 18 inches wide. The plough which is aptly named "Goliath", has been developed in Jutland, but is said to have Norwegian and Scottish ancestors! The cost of ploughing is about £3 per acre and the two tractors with their huge spudded wheels are most essential when roots are encountered. The double mouldboard-subsoiler ploughs is only used for the species and mixture trials at this forest after the roots of the previous crop have been removed by hand.

We next inspected a most impressive fire belt, planted after full cultivation in 1949 with what was believed to be Japanese larch, but seemed to include many hybrids. Mixed within the larch are a large number of other species including: *Prunus serotina*, *Alnus incana*, *Alnus glutinosa*, various oaks, birch, some beech, robinia, sand willow and some *Amelanchier*. The whole area was rotovated between the lines of plants in 1950 and again in 1951. We then inspected the planting machine which had been used to plant this fire-belt and other considerable areas. The machine is employed in fully cultivated ground—in fact two machines are pulled behind one tractor and four men can insert 25,000 plants per day, i.e. 10 times as many as can be done by hand. The point was made that it is essential to have all the plants ready and very well arranged and that this took a great deal of planning and preparation in advance—much more so than when hand planting is employed. On leaving the forest we passed through Kongenshus (King's House) where there are some excellent Japanese larch on an elevated and exposed site by the roadside. These trees are in great demand for seed. Banks pine looked rather unhappy in this exposed site—and not very encouraging anywhere in Jutland. There were very good hawthorn and *Sorbus* hedges at Kongenshus.

Felbord Forest

In the afternoon we visited Felbord State Forest. This forest employs the double mouldboard plough and subsoiler only, additional cultivation even on new heaths is not used. The ploughing is carried out in the summer before planting and approximately 2,800 plants per acre are put in at a spacing of about 5 ft. x 3 ft. 5 ins. Passing down a long road towards the south were very tall mountain pine trees on one side. These were 45 years old and thinning and introduction of Norway spruce began 7 years ago. The Norway spruce is now growing fast.

23rd June

We paid a brief visit to Løfting's own little forest which had been taken in from the heath by his father—also a forester. There I saw the biggest *Pinus contorta* I have ever seen and Sitka spruce also which were very large for Jutland. Unfortunately the Sitka are now being attacked by *H. mecans*. Norway spruce is growing quite well, but the area has a very low rainfall and is sandy and porous. Probably as a result of the sandy condition common spruce is much attacked by *Fomes*, and Løfting is having to replace it. The natural vegetation is heather with some Juniper. Douglas fir has done very well and Scots pine is quite good. Discussing the *Fomes* troubles we agreed that an introduction of more varied species was the soundest hope and once again that a good interior type Douglas fir which would be at home in low rainfall areas must be sought. We also need a good line of Corsican pine which will suffer a dry northern climate.

In the evening we left Jutland and drove back again across Fünen and Zeeland to Roshilde near Copenhagen.

24th June

Returned by air from Copenhagen to Prestwick. Fairly thick cloud over Jutland spoilt my view of that intriguing country ; the next land I sighted was the Pentland Hills.

NOTES ON A TOUR OF SOUTH AND CENTRAL SWEDEN

By J. D. MATTHEWS

Geneticist, Research Branch

It is recorded that over fifty per cent of the land area of Sweden is covered with forest. The impression left on one's mind by the almost endless pattern of small fields, lakes, rivers and forest is in keeping with the importance of the forest industry to that country. Our twelve-day visit made during June, 1951, was remarkable for the opportunities which arose to see forest practice on very large and very small estates; to discuss the work of the Forest Tree Breeding Association, and to compare the growth and characteristics of Scots pine, Norway spruce, birch, beech and other species with that encountered in Britain. Professor Lindquist, Director of the Botanic Garden at Gothenburg, arranged the tour and led the party which consisted of Messrs. M. V. Laurie, J. A. B. Macdonald and J. D. Matthews.

Notes on General Silviculture

The tour commenced at Malmö at the southern tip of Sweden, and it soon became evident that the pattern of forestry and agriculture in the province of Skane (Latitude 56° N., the same as Edinburgh) is very similar to that of a large part of lowland Britain. Forestry is subordinate to agriculture and has an important shelter function. The natural forest of Skane, which probably included mixed deciduous forest on the better soils, has largely disappeared, having been exploited for 400 to 500 years. Planting commenced in Sweden before 1600, when a small amount of Scots pine was planted on the east coast just south of Stockholm, and there has been a great deal of reafforestation with spruce and pine of German origin in Skåne. Remnants of the natural coniferous forest were first encountered near Hässleholm, fifty miles north of Malmö. This consisted of derelict woodland in urgent need of improvement, a task which is the responsibility of the Regional Forestry Boards. The well managed woodlands in South Sweden are almost all on the large private estates, whose owners can afford to manage their plantations correctly. The smaller "farm forests" or peasant estates, consisting of fifty acres of arable land and 250 acres of forest, have relied on exploitation of the best trees for their forest revenue, with consequent progressive loss in production and quality of the forest.

Two large private estates were visited, the first being the Rössjoholm Estate owned by Baron Rosenörn-Lehn, which has been managed for over 80 years. The owner's mansion looks across a wide lake to the plantations which cover a long ridge and appear most impressive. Here we saw a magnificent stand of Norway spruce of German (Hartz Mountains) origin. The mean height was 120 feet and the age 83 years. This corresponds to the Quality Class I of the Forestry Commission Yield Tables. A little later we were able to make a detailed comparison of the growth of Norway and Sitka spruce at 50 years of age. The mean heights were respectively 75 feet and 77 feet, while the standing volume was 3,913 cubic feet per acre for the Norway spruce as against 4,943 cubic feet per acre for the Sitka spruce. Up to seven years of age, at Rössjoholm, the Sitka spruce is rather slower than Norway spruce, but is subsequently much faster. The latitude 56° 5′ N. is the same as Stirling and the rainfall is twenty-five to twenty-eight inches a year.

Other exotics growing on this very fine estate include Japanese, Kurile and Korean larch. The Kurile larch (*Larix gmelini* var. *japonica* Pilger) has not been planted under forest conditions in Britiain, and is rarely encountered in Europe. It closely resembles Japanese larch in appearance, and has similar rather strongly developed horizontal branches, but the young shoots although red are downy and the cones are small. Growth is satisfactory at Rössjoholm, the stand having a mean height of fifty-nine feet at forty years, and a standing volume of 2,098 cubic feet per acre. This approximates to Quality Class II of our revised yield tables for Japanese larch. The progeny of this stand was seen nearby and at seven years of age was growing extremely well on a moderate site.

An eleven year old stand of the Korean larch (*Larix gmelini*) also looked promising. It is reputed to be a hardy tree in Sweden and has been used as far north as Norrland (approx. latitude 62° N.) This species has the best growth form of the *Larix gmelini* group.

The Japanese larch stand at Rössjoholm was planted about 1920, and is equal to the best growing in Britain. Thinnings have been annual from 1946 to 1950, about 850 to 900 cubic feet being removed on each occasion from approximately ten acres. The stand had obviously benefitted from such careful tending and was especially notable for the high proportion of straight stems.

The younger Scots pine plantations were said to be of Central Swedish origin, and were of superior quality to the very bad plantations formed from seed of German origin which were seen in some parts of Skane. The poor quality of the so called "Darmstadt" pine has often been referred to in Swedish forest literature, and provides an example of the dangers of indiscriminate use of seed from foreign sources.

Count Palmstierna's estate at Maltesholm was memorable for the very fine beech growing on fertile brown forest soils. The ground flora included masses of garlic. Three stands were visited, the first being forty-five years old and of very good quality; the second was ninety years of age and had attained a mean height of eighty-five to ninety feet with a standing volume of 3,814 cubic feet per acre; the third was a 220 year old woodland which was being very successfully regenerated under the uniform system. The regeneration contained a high proportion of trees with straight stems, which persist well into the crown.

The most notable features of the older Swedish beech woods were the low stocking, the long clean stems and the well developed crowns of the trees. Very close stocking is maintained in youth until the dominant trees have forty feet of clear stem. The thinnings then become progressively heavier until at eighty to ninety years the crop consists of fifty to one hundred dominants per acre, with massive crowns and correspondingly high girth increment. An understorey of subdominants may or may not be left to cover the soil; the practice varies from place to place. Natural regeneration is used to restock the ground as far as possible and the generally accepted rotation is 100 to 120 years.

Red oak (*Quercus borealis*) is a popular tree in Sweden, and Count Palmstierna is converting part of a mixed stand of spruce and pine to a beech-red oak mixture, and also making a direct comparison with conversion to pure beech on the same ground. The red oak is a useful tree on heathy soils. At forty-five to fifty years the growth falls off considerably and Professor Lindquist advocates underplanting with *Tsuga heterophylla* or *Thuja plicata* at this stage. *Quercus borealis* looks and behaves like sweet chestnut, but can tolerate poorer soils than the latter species.

A fine stand of ninety-year-old European larch reputed to be of Scottish origin was inspected at Maltesholm. Larch is known as "English spruce" in some parts of Sweden, and was imported from Scotland seventy to one hundred years ago at a time when there were trade connections with Britain—principally through iron-mining. Schotte, the Swedish monographer of larch, thought very highly of the Scottish larch used in Sweden, and the Maltesholm stand is indeed a fine example of good larch. Possible parallels in Britain are the trees at Erchless Castle, Inverness-shire and at Tintern Forest, Monmouth.

Count Palmstierna runs a large sawmill to convert the produce from his forests. His estate is a model of good management and his generous hospitality leaves us greatly indebted to him.

Three days after leaving Malmö we reached the town of Halmstad and made our first acquaintance with the work of the Regional Forestry Boards. Mr. Bergstrom is in charge of forest operations in the county of Halland; his beat consists of some 30,000 acres of *Calluna* heath and 42,000 acres of derelict and semi-derelict pine, spruce and birch woodland belonging to peasant owners of varying degrees of awareness and ability as foresters. His job is to prevent further deterioration of the existing forest, and to reafforest bare areas by a process of education of, and assistance to, the owners.

Our party first studied the establishment of Norway spruce on heather land at Attavara. Where rowan and juniper are present they are left, and the two-plus-two-spruce plants come away quite nicely. Where there is no shrub layer the plants need assistance to get above the heather and this is given in several ways:—

1. The heather is cut leaving a clean patch about a yard square around the plant.
2. The heather is killed locally or extensively with sodium chlorate.
3. The heather is burnt, but this is no help on peats.
4. A nurse species is used to suppress the heather and give shelter and also some assistance to the roots of the spruce. The nurse can be a pine or even Japanese larch on the better land. The experiments seen at Attavara included *Pinus montana* as nurse.

FERTILITY IN FOREST SOILS

By J. M. B. BROWN
Ecologist, Research Branch

The most matter of fact forester must sometimes marvel at the way in which bountiful Nature provides for the well-being of her subjects. In a recent number of *Soil Science*, a South African investigator, G. Ingham, brought forward evidence that the drip from trees and other plants is enriched with some essential plant nutrients and specially with ammonium compounds. It has, of course, long been known that rain-drops, particularly the rain-drops of thunderstorms, may contain measureable amounts of nitrate: but Ingham analysed the drip from previously cleansed plant parts and the rain water itself under otherwise identical conditions, and found very significant differences in content of ammonium, phosphorus and calcium. Moreover this property of withdrawing some of the very small amounts of inorganic materials lodged in the air is possessed, it seems, not only by the leaves and stems of plants, but by any freely exposed cellulosic material.

When I first read a report of this work I was faced with the task of restoring to health and fertility a much abused and neglected garden, from much of which the invaluable top soil had been removed, buried, or otherwise done away with. I had decided that the first need was to get something growing on every square yard as soon as possible, thus promoting the opening-up and weathering of the clay sub-soil, increasing organic matter, either directly, or via the compost heap, and protecting such structure as the surface soil had from the damaging effect of rainfall. To this end beans, spinach, peas, beet and lettuces were sown regardless of expected needs and potatoes were drilled or dibbled in at various places, while other plots were plugged, after a generous dressing of Buriton chalk, with plants of the cabbage group. On areas that could not be green-cropped by orthodox methods, the grass *Poa trivialis*, which usually appeared sooner or later, was given every encouragement. It was no small satisfaction to learn that these methods had yet another support from scientific research and that a direct enrichment with inorganic plant foods could be expected to follow from every successful crop, even were this only a sward of meadow grass.

Other notions were, however, suggested by Ingham's results. The experienced forester then stationed at Alice Holt mentioned that he dealt with the local intractable clay soils by spreading compost on the surface and, without other ground preparation, planting direct through the compost. He now appears in the guise of a prophet, because the surface compost dressing will doubtless fix ammonium and other nutrients. On the wet ground of this locality one is reluctant, because of the damage to soil structure, to clean up the herbaceous border after the autumn rains have begun. Why not leave the plant stems over the winter to protect the soil, shield against frost and maybe add their quota to fertility? They can easily be cut down when growth starts in spring and severe frosts are over. The sacks or newspapers used as frost screens, or those irritating dead leaves from the neighbour's poplars, can all contribute to the maintenance of fertility. The humble scare-crow too, whether or not wearing Savile Row clothes, may have a positive contribution to make to production, apart from his legendary function in preventing loss.

Nurserymen in the Forestry Commission will doubtless weigh these considerations when discussing the manner of compost application, or the pros and cons of green-cropping and bare fallowing. I wish now to draw attention to the application of Ingham's results in afforestation work on difficult sites. Foresters will often have observed that, it may be after many years of check, a plantation, once it begins to form canopy, is well set for normal growth. The plantation which, a few years before, inspired doubt and well-nigh despair, rapidly closes its ranks and calls out for brashing. Several factors are at work here. In the first place, the suppression of the competing natural flora is very influential, particularly where this is largely of heather or heaths. Secondly, there is an improvement in the microclimate, when the young trees shield one another from the wind and maintain a relative humidity generally above that of the open moor or down. Thirdly, the needle or leaf fall, even where, as on acid soils, the break-down is slow, provides a moist layer, relatively rich in nutrients, which forms an attractive medium for the fine rootlets of the trees. May it not be, however, that an important cause of the often abrupt increase in vigour once the trees begin to form canopy is the gradually improving fertility of the soil as a by-product of the drip from the ever mounting quantity of foliage and shoots? The more the trees manufacture in this incidental way, the more raw material have they for fresh shoot production in the following season. Verily, he that hath to him shall be given.

NATURAL REGENERATION OF OLD CALEDONIAN SCOTS PINE AT RANNOCH

By A. WHAYMAN

Forester, East Scotland

When one considers that the Black Wood is a natural woodland, it is difficult to understand the reason for the absence of young, naturally regenerated trees, especially as the area was pretty well churned up during war-time fellings. These dragging operations, one would have thought, should have provided an adequate seed-bed for natural seedlings. As a matter of fact the only places where natural regeneration has, to any extent, taken place is in areas outwith the Black Wood proper, where no forest operations have taken place. Why then this failure?

I am certain, from the outset, that lack of seed has nothing to do with the failure, nor has grazing, although I did at first think that grazing was a contributory cause.

Very few rabbits, a few roe deer and an occasional sheep may be found in the Black Wood, but as a rule they avoid the place. Deer were plentiful before the 1939-45 war, but have not returned since they were driven out by the operations of the troops, who used the Black Wood and the surrounding district as a training area.

The area is now fenced along the south march, and very few deer are ever seen in the area. Rabbits, especially along the lochside, are increasing, but have not so far spread through the wood. This latter danger will be removed when fencing is completed.

If lack of seed, or grazing, is not the reason for lack of natural regeneration then the fault must be with the seed-bed.

In order to examine the seed-bed, vegetation types must be be considered. The Black Wood area can be roughly divided into four types of vegetation areas. They are:—

1. *Calluna—Vaccinium*
2. *Calluna—Vaccinium* and Bracken
3. *Mollinia—Juncus* and *Scirpus*
4. Pure *Calluna*

In groups 1 and 2, especially on the knolls, some natural regeneration does take place; but seedlings grow very slowly and very often die during periods of drought. This is because germination has taken place in the moss layer, and the roots of the seedlings are not able to reach the mineral soil beneath. In these same groups, many seedlings which were growing on drag roads have died, especially those in the centre where the mineral soil had been exposed. The few remaining ones are found at the side, where all the richer top layer of soil had been deposited. It has been borne out in most natural regeneration experiments, and it is a general principle, that preparation of ground must only be such as to make available to the plant a soil layer in which decayed and decaying vegetative matter is available.

It is on the knolls, which now show a vigorous growth of young heather rather than old rank heather, that natural regeneration is to be found. It can, I think, be safely assumed that these knolls, before the trees were cut, were heavily shaded, and that the heather had been nearly killed out. With the removal of the trees and the shade, the heather started to grow again, and natural regeneration of the Scots pine took place on a comparatively moss-free seed-bed.

Group 3 consists of peat flats and flushes where one would not normally expect natural regeneration without a great deal of costly preparation. The annual vegetation growth is in most cases sufficient to stifle any seedlings which may have germinated, unless they are on upturned roots, and the expectation of life of seedlings, especially those which have germinated in spoil from drains, is not very high. Drought and rank vegetation cause their deaths.

Little if any, successful regeneration of the peat flats and flushes could be undertaken without extensive preparation, and the suggestion that soil improving species should be first planted in these areas is sound.

It is evident from the profile of the soil that more extensive burning took place within the Black Wood than is recorded and the conditions obtaining when the trees growing in these flats and flushes first germinated must have been very different to those of today.

It is significant that whilst groups 1 and 2 have a dense mat of moss covering the forest floor together with rank heather growth, group 4 (pure *Calluna*) has very little moss, and the heather is not rank. This moss layer has a bearing on the success or otherwise of natural regeneration. It is in the last type of ground that most natural regeneration has taken place, and this area has in the past been burnt over at regular intervals for grouse management.

Before any noticeable increase of natural seedlings can take place within the Black Wood, the seed-bed must be improved; and any birch which may spring up on this seed-bed must be dealt with ruthlessly. I have seen no evidence of Scots pine regenerating itself in birch areas, even when the birch has been removed and Scots pine mother trees left.

Another point which has a marked effect on the success of natural regeneration, quite apart from the seed supply or seed-bed, is the time of year at which the seed-fall takes place. This is controlled by the weather, and very often the first decent spell of dry warm weather is not until late June or July and may even be August.

This late seed fall means late seedlings. I have seen seedlings still with their "seed-cap" on in the month of September. These same seedlings when again viewed in December after some frost have shown signs of frost lift and did not survive the winter.

THE DISPERSAL OF HARDWOOD SEEDS BY VOLES AND MICE

By R. J. JENNINGS
Forester, North Wales

In the late autumn of 1950 some 4,000 lb. of red oak, *Quercus rubra,* were put into an acorn store to remain there until required for sowing in the nursery in the following spring.

The acorn shed, which is a "lean-to" type constructed of larch poles thatched with birch and spruce brash, was carefully and completely enclosed on all four sides and roof with mouseproof netting, but owing to a shortage of netting it was not possible to cover the floor. The earth however was excavated to the subsoil and trodden down hard. As the seed store was at the bottom of my garden, forty yards from the house, it was able to get the personal attention that hardwood seed storage invariably demands, and turning took place at regular intervals.

In a few days time it became obvious that the acorns had been discovered by mice, and close investigation showed that they were gaining entry to the store through the floor, using not only their own underground runs but also the runs of several voles which it has since been found run beneath the store to a pond in the wood.

During the next five months, box and breakback traps set in the seed store accounted for forty-six-long-tailed field mice (*Apodemus sylvaticus sylvaticus*), six short-tailed voles (*Microtus agrestis hirtus*), and one water vole, (*Arvicola amphibius amphibius*). Poison was also laid in the store continuously, and it is probable that many more mice than this were destroyed.

In the summer of 1951 my vegetable and flower garden adjoining the acorn shed produced a dozen or so red oak seedlings, and later in the year whilst weeding an adjoining common oak plantation planted in 1949 the workmen drew my attention to several red oak seedlings that were growing in the grass at distances up to fifty yards from the seed store. There is little doubt that these seedlings sprang from acorns carried by mice from the store along their underground runs, and then forgotten or abandoned, possibly because they had been sprayed with a noxious fluid to discourage their attention.

Most of us can call to mind small groups or single seedlings of naturally-regenerated oak or beech growing in rough grass sometimes at considerable distances from a possible parent tree. The opinion is frequently expressed that this regeneration has resulted from occasional seeds dropped by squirrels or birds, but my own observations lead me to believe that they are much more likely to have been carried there by mice.

Pigeons, pheasants and jays are probably the three birds that devour most acorns and beech mast, but they swallow it where they find it either on the ground or in the tree tops, and it is doubtful to my mind whether either of the first two birds carry much of anything in their beak to eat elsewhere. The magpie and the carrion crow have a liking for acorns on occasion, but their main diet is generally insects or carrion.

Both mice and voles have extensive networks of runs in all types of herbage, particularly in rough grass, as anyone who closely examines a *Molinia* bog at ground level can see for himself. *Juncus* and *Scirpus* bogs, too, are very often honeycombed with a maze of runs.

Although the harm they do outweighs any small point in their favour, it is interesting to note thay by the dispersal of heavy seeds even the humble mouse may play a minor part in the natural regeneration of our woodlands.

REHABILITATION AT PLYM FOREST, DEVON

By R. S. WHALE

Forester, South-West England

Since the start of rehabilitation work in old woodlands at Plym Forest we have dealt with about 45 acres in 1950 and 1951. At the beginning of the operation some of us thought that it was probably almost a waste of time trying to get and make a reasonable crop from what on first inspection looked just another block of scrub coppice.

The forty-five acres taken in hand during the past two years consist of twelve different blocks, in different parts of the forest; the sizes of the blocks ranges from one up to seven acres.

To give a picture of the mixtures concerned, details of the four main blocks, along with a table of heights, quarter girths, etc. are given below:—

Block No. 1. The main species in one acre of this two-acre block is oak with a slight mixture of sycamore, ash and sweet chestnut. In the remaining area part of the main species is ash with a mixture of sycamore and sweet chestnut.

Block No. 2. Seven acres in all; two acres of ash with a slight mixture of oak and sycamore; two acres mainly sycamore, with a few ash and oak to complete the crop; the remainder of the area contained each species in almost equal numbers.

Block No. 3. A fairly even crop of oak, ash, sycamore, and chestnut, covering an area of three acres.

Block No. 4. Consists of two acres with birch as the main crop, and an even mixture of oak, ash, sycamore and chestnut.

Treatment

To get a clear picture of what each block contained it was decided to mark all the best trees with paint, taking into consideration the following points:—

1. Species, height, and whether coppice or seedling tree, giving preference to the latter.
2. Making sure that crown development was not overlooked.

All the trees and scrub not marked were cut and the tops stacked in heaps, taking care to see that the trees left were kept clear for future thinning and selection, and also to assist rabbit extermination, as all the blocks are breaking up conifer planting.

No doubt you may think that to cut all the scrub, which was mainly hazel, was too costly, but it was considered necessary to reduce root competition for the remaining standards, and also to assist in the extraction of the produce cut out in the cleaning-thinning operation.

The cost of the above operation by direct labour was from £8 to £10 per acre, but on all the areas treated, except where it was purely a cleaning operation, the produce prepared *i.e.* stakes, posts and firewood, covered the costs involved. Subsequently a contractor was found to undertake this type of work and pay at the rate of £3 to £5 per acre for the produce.

The result of this cleaning/thinning operation has been to leave a fair hardwood crop of about twenty-five to thirty-five years with future possibilities.

Further Treatment

A further marking will now be carried out, selecting the best trees of any species to give an even spacing over the area of about 130 to the acre. Future thinnings will be directed to assist crown development, as in most cases the crowns of coppice trees are small unless space has been given them at an early stage. In areas where there are a large number of oak, pruning will be carried out to a height of about twenty feet. As the cost of this can be very heavy it will be limited to the best stems.

Certain parts of the area are not suitable for this treatment; these will be restocked by underplanting, which should give good results as the fertility of the soil has been retained.

DETAILS OF STOCKING

Block No.	Acres	Species	Quarter-girth at breast-height, in inches From	To
1	2	Oak	4	8
		Ash	2½	5
		Sycamore	3	5
		Sw. Ch.	4½	6½
2	3	Oak	3½	5
		Ash	2½	4½
		Sycamore	3	5
		Sw. Ch.	4	7
3	7	Oak	7½	8
		Ash	2½	5
		Sycamore	2½	4½
		Sw. Ch.	3	7
4	2	Oak	3	4½
		Ash	2½	4
		Birch	3½	7
		Sycamore	3½	5
		Chestnut	4½	6½

Note: (1) The height of the crop ranged from 20 to 25 feet.
(2) The age of the crop lies between 25 to 35 years except in the case of the oak in Block No. 1 which was 30 to 35 years.

THE FIELD OFFICER AND THE CHOICE OF SPECIES

By W. H. GUILLEBAUD

Deputy Director General

The choice of species for a given planting site is one of the most responsible, and at the same time one of the most fascinating duties of the forest officer in the field. Depending on the correctness of his choice the outcome may be a fine block of productive forest or a scruffy lot of sickly-looking trees needing endless patching up—usually with that panacea for most silvicultural disorders the humble Scots pine—and never looking anything but a mess. This is putting an extreme case, no doubt, and in practice the contrast is seldom likely to be so sharp.

We have now more than thirty years of experience—for the early years trial and error is perhaps the better term—and as a result should be reasonably conversant with the silvicultural peculiarities of our major forest trees, though the oldest among us would be the first to admit that we have still much to learn. But it is well to remember those "other conifers" and "other hardwoods" which ten years or so ago represented only one or two per cent of our total planting but which in recent years have come much more into the foreground.

Judging from the seed demands received at Headquarters such "minor" species as *Pinus contorta*, *Tsuga*, *Abies grandis*, and red oak, may well join the ranks of the major species in the near future, and there can be few of the Commission's officers who would care to say that they know the precise niche which each of the above species should occupy in our planting framework.

It is considerations such as these which prompt the reflection that there must be occasions when there is a certain element of doubt in the mind of the field officer as to which of two—or possibly more—species to employ on a given planting site. Granted that the doubt exists, what does he do about it? If the land is due for planting in the next planting season, he must make up his mind quickly one way or the other, fortifying himself, no doubt, in appropriate cases, by reference to higher authority. The decision once taken, the requisite number of plants of the selected species must be allocated to the area in question and the land duly planted. If they grow, well and good; if they do badly or fail, the plantation will have to be patched up in due course. In either case it is fairly safe to say that in a few years time all concerned will have completely forgotten that there was originally a doubt as to which of two, or even more, species should be used.

Obviously if the problem is on a big enough scale, and more particularly if it relates to doubtfully plantable land, it should be referred to the Research Branch, but there are limits to the resources of that Branch, and in practice only the outstanding cases can be dealt with in this way.

The field officer may then say, why not carry out a local experiment? But our experience of such experiments has not been happy, to put it mildly. Almost invariably corner posts decay, labels become illegible, and records lost, and when, as may well happen, the responsible officer or forester leaves the district the whole project lapses into oblivion. But apart altogether from such considerations it is open to question whether the conventional type of rectangular plot in which each of the species to be compared is usually planted in a pure block does really give this species the best chance of showing their mettle. Much will depend on whether, for the site in question, the species are what Lord Robinson has termed "pioneer species", or whether they belong to his alternative group of the "successor species". The classic example is Sitka spruce, which on good *Molinia* flush peat in the Borders behaves as a typical pioneer, and can be planted pure without suffering any appreciable check, whereas on a tight *Calluna*-covered morainic knoll it may check almost indefinitely if planted pure, but may succeed in establishing itself quite happily with the aid of canopy of an unqualified pioneer species such as Scots pine or Japanese larch.

Among the conifers the only true pioneer species we have are the pines and the larches, which are all strong light demanders (incidentally that is one of the chief reasons why they behave as pioneers), and consequently low in the scale of volume production. Our remaining species, the spruces, Douglas fir, *Tsuga* and the like behave as pioneer species only on the sites which are really favourable to them, and elsewhere require the more or less complete canopy and shelter provided by some less exacting species which can behave as a pioneer on the site in question.

This is, of course, common knowledge already in the case of Sitka spruce on the more heathery soil types of our western and northern moorlands, where the mixing of pine and spruce by alternate pairs of rows has become a fairly standard practice on such sites. Where the site conditions are not too unfavourable for the spruce or other successor species this method functions admirably; but in limiting conditions the pine rows may be too far apart to establish early canopy, and by the time they have done so the trees may be so tall and bushy that the spruce has either to be rescued by a costly and unprofitable operation, or given up to the more or less inevitable fate of ultimate suppression.

On the other hand in our experimental areas on the upland *Calluna* soils there are numerous examples of a striking improvement in the growth of the outermost three or four rows of Sitka spruce adjoining a pure plot of a pine or of Japanese larch which has established canopy. Root excavations have invariably shown that the improved growth of the spruce trees is associated with the development of strong lateral roots running under the canopy of the pioneer stand. This illustrates the advantage, in the case of successor species, of growing them in close proximity to a stand which is likely to get quickly into canopy, and suggests that a convenient way of testing such species would be to plant them in the form of narrow strips running through a block of the species selected as the most suitable choice for the site in question.

We have digressed somewhat from the problem we started out to discuss, namely that of the field officer who is in genuine doubt as to which species to plant on a certain site and who would like to give his second choice (or choices) a chance to show their mettle. Bearing in mind the criticisms, already made in this article, of local field experiments in general, is it possible to devise a method which will meet the more serious at least of these objections? The ideal method should: (1) give the species on trial the best available growing conditions, (2) be sufficiently flexible to enable several species to be tried out alongside each other without seriously complicating matters, (3) be simple to lay out, record and supervise, and (4) occupy only a relatively small proportion of the planting area so that the consequence of a failure will not be a permanent gap in the plantation.

I suggest that some at least of these desiderata could be achieved by adopting a system of narrow, but widely separated, experimental strips running the whole length of the block in question. The optimum width for the experimental strip will be discussed later, but for the moment it is assumed to be a strip three rows wide. The interval between the strips should be such that they do not form more than 10 per cent at most of the whole area.

As a simple illustration take the case of a rectangular 5 acre block of uniform ground with sides of 10 chains by 5 chains, and assume that it is dryish *Calluna* ground in a locality with a rainfall of about 35 inches per annum and that it is reasonably sheltered. The first choice for such a site is likely to be Scots pine, but the field officer may feel that the soil conditions are such that Douglas fir might stand a possible chance of succeeding. In a block of the above dimensions there will be about 132 rows of trees (at 5 feet spacing) running at right angles to the long side of the block, and of these 10 per cent, or 13 rows, could be reserved for the trial species, the remainder being planted pure with Scots pine. Thus there will be room for not more than 4 experimental strips, each 3 rows in width and 5 chains long. If the two end strips start 10 rows in from the outside of the pine block, there will be belts of 33 or 34 rows of pine between each pair of experimental strips. See Fig. 1 opposite.

There would seem no need to mark permanently the position of the experimental strips. Provided the local staff know the way the strips run and have a record of the species it should be easy to pick them up on the ground.

This form of narrow experimental strip would lend itself to a fairly flexible arrangement of species within the strip. For example on low quality peat land where *Pinus contorta* was considered the only reasonably safe choice for the main species, the experimental strips could be composed either of pure Sitka spruce, or of a mixture of alternate plants, or pairs of plants, of Scots pine and Sitka. Such a mixture in the strip would be a further insurance against

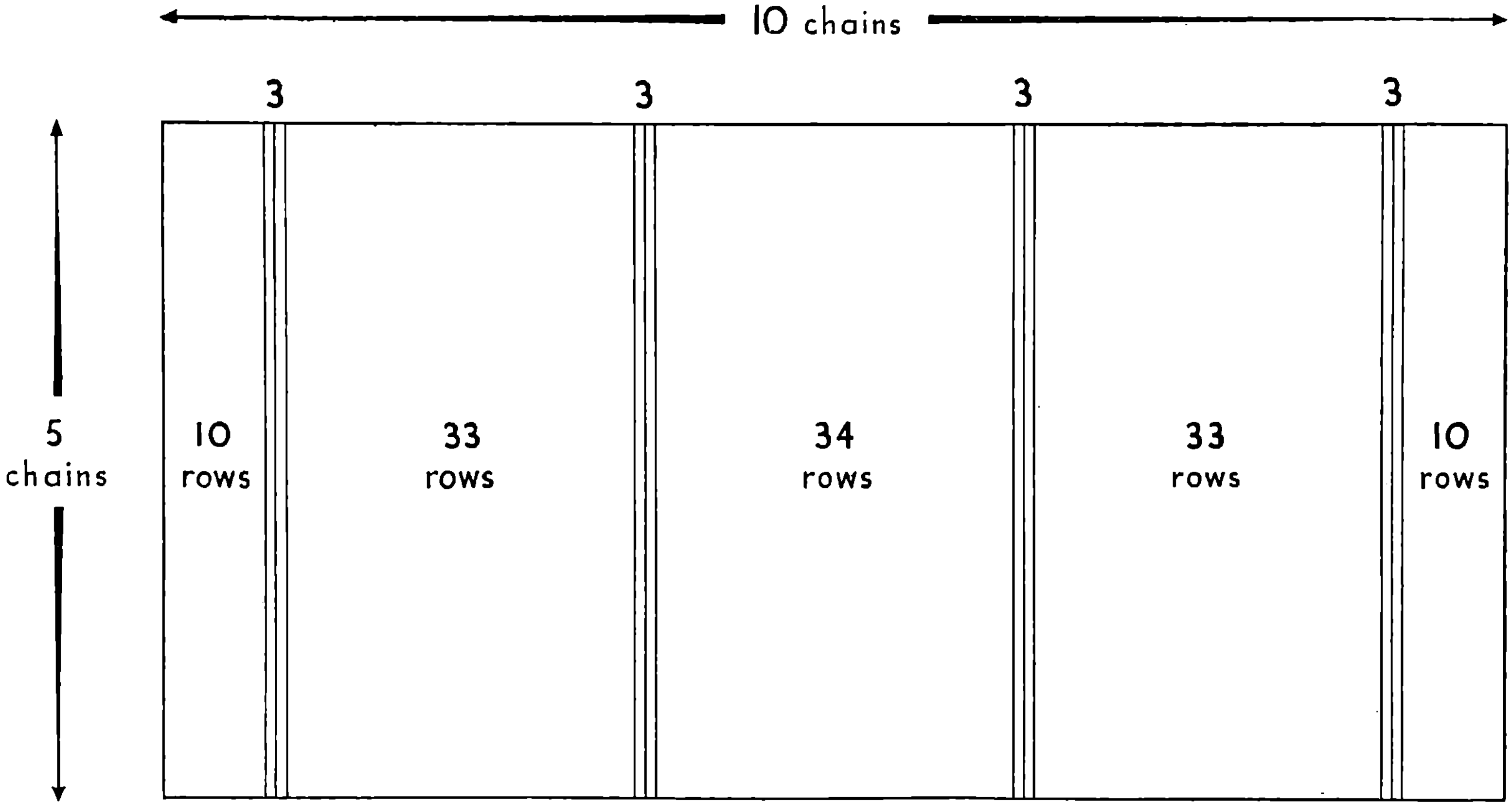

Fig 1. Arrangement of trial species in a matrix of the main species selected.

a total failure of the Sitka and would also provide evidence as to the potential development of Scots pine when sheltered by the *P. contorta* stand.

On somewhat better land, but still marginal as regards any other species than pine, the main crop species might be Scots pine and possible trial species, Sitka spruce, *Tsuga* and *Abies nobilis*. Those three species could be planted in successive blocks of 9 plants each (3 x 3) along the length of the experimental strips.

Another example is the case of a block of good bracken ground where the choice might lie between Japanese larch, Douglas fir, Norway spruce, or any of the minor shade-bearing species which happened to be available. Whichever species was decided upon for the main block, the alternative species could be planted in 3 × 3 groups in the trial strips or in any other form of mixture preferred.

Sometimes the choice between Sitka spruce and Norway spruce on a given site is quite debatable. Whichever was the selected species it would often be of interest to plant trial strips of the alternative species for future information and guidance.

No mention has hitherto been made of the broadleaved species, but there would seem to be scope for the method on typical beech sites but where there is some speculation as to the possibilities of growing oak or ash. Trial strips of oak, or ash as the case might be, could be run through the beech matrix. If the chances of ash succeeding were rated very low, the trial strips could include some admixture of beech as an insurance against total failure.

Optimum width of trial strips

This is not altogether an easy problem. A width of three rows is almost certainly the minimum, anything less would make the strip difficult to locate on the ground, and if the trial species proved slow to establish itself it would be all too quickly overgrown. On the other hand a four row belt would involve a gap of 25 feet in the main crop which would take a lot of bridging over if the trial species failed. Further, the broader the belt the less intensive will be the sheltering and other beneficial effects provided by the main crop species; also, the broader the belt the more conspicuous it will be in the landscape.

The main objection that can be advanced against a three row strip is that it will need constant attention to prevent the outer rows from being overgrown by the main species. But this will only be the case where the trial species is very slow in starting, and in that event, whatever the width of strip within reason, attention will still be necessary. On the better sites and where differences in the colour of the foliage or winter branches are small, *e.g.* with Norway spruce or Sitka spruce comparisons, it may well be feasible to widen the trial strips to, say, five rows. But where conditions are more or less difficult for the trial species my own view is that a three row strip is wide enough.

Amenity Aspects

An inevitable drawback of the strip form of planting advocated in this paper is the ugly striped appearance given to the plantation from a distance. Much will depend naturally on the species used, but where colour contrasts are bound to be striking the rows should be sited across the slopes and not up and down.

Beating-up

This is always a troublesome factor in species trials. If there are appreciable failures in the year of planting and these are beaten up in the usual way with plants of the same species in the following year, the odds are that the beat-up plants will be of a different indentification number and the results may be disconcerting. A simple precaution to take is to keep back and reline a substantial number of plants of the same batches as were used in the trial strips and use these for any necessary beating-up in the following year. Any further major failure should be beaten up with the main crop species.

General Remarks

Before concluding this article there are two points I wish to stress. The first is that these suggested experimental strips are not intended in any way to replace the systematic experimental work of the Research Branch. Wherever extensive areas occur of doubtfully plantable land, the problem of choice of species and trial of method of soil preparation, manuring, and so on, should be remitted to the Research Branch which will be responsible for carrying out and recording the necessary experiments. The cases I have envisaged are when the land is *a priori* plantable, but where there is a niggling doubt at the back of the field officer's mind as to whether he has chosen the right species, and he would like to do something about it.

The second point is that this is not a State Forest Memorandum and should not be construed as an open invitation to all and sundry to produce a *stripe* of zebras in the Commission's future plantations. Conservators will use their own discretion as to the extent to which it is desirable to experiment along the lines suggested.

THE CHOICE OF TREE SPECIES IN SCOTLAND

Lecture delivered in Aberdeen 13th September, 1950, to the British Council Course on Forestry in Scotland

By JAMES MACDONALD
Director of Research and Education

In considering the problems involved in the choice of species there are various possible methods of approach, but I wish, to-day, to begin by regarding the subject against the background of our recent forest history. I believe that by so doing, I shall give you a more complete picture, while, at the same time, I shall be making it easier for you to follow the processes by means of which this section of our silviculture has been developed.

It would, however, be as well if I were to tell you, in a very general way, what species we have in Scotland to-day, and what areas they cover, because I feel that, by doing so, I shall be giving you a point of departure from which you may set out on your survey of the subject.

You have already been told that our indigenous forest flora is poor in tree species, with only one conifer and with only a handful of broadleaved trees to its credit, and that in the course of rather more than two centuries we have been able to embellish our poorly furnished forests with a variety of species from other countries, some of which have thriven in a most remarkable manner under the skies of Scotland. That knowledge will help to explain some of the figures which I am about to place before you.

There were in Scotland, in 1947, about 570,000 acres of High Forest. Of this area, just over 200,000 acres were Scots pine, 85,000 acres Sitka spruce, 70,000 acres Norway spruce, 48,000 acres European larch, 47,000 acres beech and 45,000 acres oak; these six species therefore accounted for 80 per cent of the total high forest. The remaining 20 per cent is made up of a large number of other species, both broadleaved and coniferous: there are eighteen other species which are represented by more than 100 acres of plantation as well as a considerable number more which occur in smaller patches. Some of them, like Japanese larch and Douglas fir, are of the highest importance; others we may regard merely as curiosities.

You will note that approximately 20 per cent of the high forest is broadleaved, but this does not quite give a true picture of Scottish woodlands as a whole; because in addition to high forest, we have a quarter of a million acres of scrub, of which all but 10,000 acres is composed of broadleaved species. If we take this into account, we find that about half the existing woodland (high forest and scrub together) is broadleaved and half coniferous, and to put things in this way will perhaps give a more adequate picture of Scottish forest conditions.

Nevertheless, it is true to say that silviculture in Scotland to-day is predominantly coniferous. Most of the broadleaved high forest is old, and little of it is under systematic management, while the scrub areas have no future as broadleaved forest and must either be left as they are or be converted to conifers. Let us now consider how this situation has arisen.

In the middle ages, Scotland was generally reported by foreign travellers to be a country almost destitute of trees, and this impression is strengthened by the numerous Acts of different Scottish governments which were aimed at the conservation of timber and the encouragement of planting. It must be realised, however, that all this applies only to the lowlands of Scotland because the Highlands, which were rarely visited and, in those days, scarcely known, contained large areas of pine, birch and oak forest. Although Scotland was one kingdom, it was really two countries.

It was in the sixteenth century that we first begin to find references to the planting of trees, planting around houses and buildings for shelter, and it is curious to note that this planting was carried out with broadleaved trees, among which the sycamore was prominent. This is interesting because sycamore is an exotic and it is probably the first foreign tree to have been planted in Scotland; indeed the general view now is that it was introduced into Scotland before it reached England, another unusual feature. The relatively more settled times of the seventeenth century led to an extension of planting although it was still confined, in the main, to shelter and ornamental planting, and for the most part broadleaved trees were still used. Among those mentioned, in addition to the sycamore, were the ash, alder, elm, beech and birch. It is in the seventeenth century too, that we first hear of the use of Scots pine for planting in the lowlands, while towards the end of that century we begin to read of the introduction of other European conifers, the Norway spruce, the common silver fir (*Abies alba*) and the maritime pine (*P. pinaster*). The last mentioned had a burst of popularity early in the eighteenth century; this was short lived and the tree is rarely seen now.

Forestry proper did not begin until the eighteenth century when some of the great landowners like the Earl of Haddington and the Duke of Argyll began to form plantations in the lowland districts of Scotland, in which hardwoods were extensively used, but with a mixture of Scots pine, mainly raised from Highland seed, and later and more sparingly, of Silver fir and Norway spruce. These plantations were made, as a rule, on reasonably fertile ground but we do read that in 1740 the Duke of Argyll attempted to afforest a deep peat bog on the borders of Midlothian and Peebles-shire, an attempt which ended in failure. This was one of the first of many such ventures. Although the conifers of Eastern North America began to be known in the middle of the eighteenth century, they had little influence over silvicultural practice; the same cannot be said of the European larch, the planting of which by the Dukes of Atholl caused a profound and revolutionary change in Scottish Forestry. Meanwhile the old Highland Forests were rapidly disappearing to meet industrial needs and before fire, sheep and deer. We have to-day only relics of these once extensive woodlands.

The nineteenth century was important for exotic conifers which were introduced in large numbers from all over the world and particularly from Western North America. The taste of early Victorian times ran to conifers, and very few estates between 1830 and 1860 were without their pinetums. These were established mainly because of their ornamental value, but they had an important influence on subsequent silvicultural practice as they served as trial grounds, helping to sort out the likely successes from the certain failures. They had, however, a curious effect on the development, as forest trees, of two of our most important conifers, the Douglas fir and the Sitka spruce, which were introduced within two years of each other, the former in 1827 and the latter in 1829. The Douglas fir was being planted as a forest tree at Murthly soon after 1840, and at other places soon after the middle of the century, but it was not until the eighteen-eighties that Sitka spruce was first used as a forest tree at Durris. Stirling-Maxwell explains this, I think correctly, by stating that the Douglas fir was a good arboretum tree whereas Sitka spruce, which even at its best is a shabby looking tree, was neglected because of its appearance.

Although the recent exotics were cultivated with great enthusiasm in pinetums throughout the nineteenth century, it is surprising, on looking back, to find how little they were used in forestry, for the foresters of that time had three staple species, the Scots pine, the European larch and the Norway spruce which they planted pure, or, more often in mixture, all over the country.

The twentieth century showed an increasing feeling for the more recent exotic conifers, but the most important changes were the first large scale attempts to afforest the peat lands of the Borders and of the west of Scotland, in which Sitka spruce was extensively used, and the discovery of the Hybrid larch at Dunkeld. The first, for which the Duke of Buccleugh's Moorburnhead plantation in Dumfries-shire, Sir John Stirling Maxwell's forest at Corrour in Inverness-shire and the Crown Wood of Inverliever in Argyll are celebrated, paved the way for all the subsequent developments in the afforestation of peat, while the second gave us an entirely new tree with distinct possibilities.

In 1914, one of the great turning points of history, Scotland had considerable areas of conifers, mainly Scots pine but with substantial quantities of European larch and Norway spruce and much smaller but increasing acreages of species such as Douglas fir, Japanese larch and Sitka spruce. There was also a fairly large area of ageing hardwoods and extensive stretches of oak and birch scrub in the Highlands. At that time, Scottish foresters, when they were planting them at all, were still using the same broadleaved species as their predecessors had used in the seventeenth century, but with conifers it was quite different. The coniferous flora had been enriched out of all recognition and, in developing the use of new species in forestry, Scottish foresters and Scottish explorers and collectors had played a leading part. The effect of the War which began in 1914 was two-fold; it led to very heavy fellings in the coniferous forest and to the lack of balance among our age-classes which is now a feature of our woodlands; it also led to the intervention of the State in forestry and the beginning of the great schemes of afforestation with which you are familiar.

So far as species are concerned, 1919 ushered in the age of exotic conifers. Never before had they been used on such a scale. As an example, out of the 85,000 acres of Sitka spruce which we had in 1947, only 3,000 acres were more than thirty years old.

I would like now to look more closely at the factors affecting the choice of species other than those historical changes and historical accidents, but in dealing with this subject I do not propose to go into any great detail. Broadly speaking, the two principal factors involved in choice of species are climate and soil. Except in the central Highlands, our climate is not severe, as most of the land is within no great distance of the sea. It is characterised by cool summers and mild winters, but it has three factors which are of particular importance for exotic trees. The country has occasional winters of exceptional severity, it is subject to repeated frosts in the spring and early summer, and it is constantly exposed to strong winds.

The low summer temperatures are probably responsible for the poverty of our forests in broadleaved species. Trees like the horse chestnut, the lime, and the sweet chestnut grow very much more slowly than they do in the south of England, while species such as the plane and the *Liriodendron*, which reach a large size in the south, are rarely seen here.

The climate, fortunately, corresponds sufficiently to that of the Pacific Coast of North America to make it possible for us to use most of the important conifers of that region in our forests here and, by a happy chance, the climate has proved highly suitable for the Japanese larch from the mountains of Japan, but many of the species which grow naturally in continental climates, with hard winters and fairly definite, well marked seasons, suffer severely in our irregular climate from late frosts in spring and early summer. The larches of northern Asia, for example, fail badly with us, likewise the Balsam fir of Eastern North America and some of the spruces from the same region.

Late spring frosts affect our choice of species locally to a considerable extent, and we have often to adjust our planting plans in order to keep a frost-tender species which would otherwise be suitable, out of a site which is subject to frost. Thus we have often to replace Sitka spruce by Norway spruce or even by Scots pine, or we may plant the tender species in mixture with a hardy species in the expectation that the latter will grow and give enough protection to allow the tender species to develop.

There is a strip of country along our western sea-board which is generally free from frost, and there one may see growing a variety of species, eucalypts and so on, which are normally tender trees in this country. It might have been possible to establish in those districts a number of unusual trees and so enrich our forest flora further were it not for the occasional severe winter which is apt to play havoc with young trees of this character. Nevertheless a visit to either the south-west or west of Scotland will well repay anyone who is interested in the growth of exotic trees in Europe.

The severe exposure to which most of the country is subjected materially affects the choice of species for planting, because trees which are susceptible to damage from exposure must be placed in sheltered situations. Exposure also affects the rate of growth, and it is not common to find on exposed sites rates of growth better than the third quality class in conifers. Altogether, exposure is a factor to which foresters in Scotland must pay very close attention.

Rainfall is generally adequate though there is a very wide range between our wettest areas in the west and our drier eastern districts; but, owing to its distribution over the whole year, it is probably adequate for most of our trees, both native and exotic. But on free-draining soils in some of our districts of low rainfall we must be careful in our choice of species.

The recent serious losses in some of our larch plantations due to what is known as "die-back" illustrates in a most interesting way the effect of local climate on a species which is suitable for our climatic conditions as a whole.

This "die-back", with which a number of insects and fungi are associated, is undoubtedly associated with frost damage, and it is usually most pronounced in frosty localities. But we have found that there are considerable variations in susceptibility to "die-back" between lots of European larch of different provenances. Some of the Swiss lots are particularly susceptible; others like Silesian larch and larch from old Scottish stocks are relatively resistant. This has brought home to us forcibly that although a foreign tree may be generally suitable for use in this country, much may depend on its actual origin, from what point in its natural range it was derived. The provenance of seed is a matter to which we are now devoting much attention. The differences between one lot and another are interesting to the botanist and taxonomist; they are even more interesting to the forester who has to fit his trees to special conditions of climate and soil.

Within the last thirty years, our schemes of afforestation have drawn us more and more on to land which had not been dealt with in any systematic way, or to any great extent, by earlier generations of foresters; the attention of present day silviculturists is taken up largely with adapting species to the soils of the peat moorlands and the upland heaths and hill slopes. This is work in which important progress has been made in Scotland. Here it would be as well to review what has been done earlier in the way of adapting species to soil. A survey of woodlands, carried out during the first World War, threw much light on some of the practices of nineteenth century foresters. So far as soils are concerned it appeared that Scots pine was planted on the lighter soils, soils then classified as sands and sandy loams, that Norway spruce was favoured on the heavier soils, clay loams and clays, while European larch, though grown on a very wide range of soils, was more frequent on soils of medium texture. This rough classification does not take us very far but it gives some idea of the way in which the forester's choice was exercised in the nineteenth century.

Before the 1914-18 war, there had grown up a practice, which was greatly developed later, of selecting species for planting according to the type of vegetation on the ground. This was not applied in lowland districts so much as in upland areas, where it was usual for foresters to plant Scots pine on *Calluna* ground, European larch in bracken or on grassy slopes without peat, and Norway spruce among coarse grasses and *Juncus* where the soil was moister. Gradually as peat planting developed, a system was worked out of allocating species for planting according to the vegetation on the ground. Thus the better peats, with coarse grasses, *Juncus* and various herbs in the vegetation would get Norway spruce, bracken peat or thin heather peat would get Japanese larch, peat covered with *Molinia coerulea* would be planted with Sitka spruce; as conditions became more difficult, and *Calluna* appeared mixed with the *Molinia*, a mixture of pine with the spruce was indicated, and at still lower levels of fertility where *Scirpus caespitosus* was present *Pinus contorta* would be used. Beyond that, where the vegetation consisted of *Scirpus* with rather stunted *Calluna*, no attempt would be made to afforest what was and still is regarded as an unplantable subject.

This account of the selection of species by vegetation types has been deliberately simplified, but I hope the general drift of the idea has been made clear to you. The use of vegetation as a guide to choice of species is simple and convenient, and although it has proved to be relatively successful it has certain dangers. In the first place, most of the land which we plant has been under a rough form of management for sheep raising; it has been heavily grazed and heavily burnt, and when it is taken in hand for planting it is not always easy to determine whether the vegetation on the ground is a temporary phase or is relatively permanent. It has occasionally happened that spruces have been planted on what appeared to be a suitable herbage but which changed after a few years enclosure and protection into a sward of *Calluna* which caused the spruces to go promptly into check. The other risk is that although the vegetation may be a good enough guide for the establishment of a species, it may not be a good indication of its probable development in the future.

Simultaneously, there were going on attempts to modify or improve the sites and the soils so that they would either give more rapid growth of the species normally planted on them or allow of the planting of a more valuable and more exacting species. The most important of them are:

(*a*) **Turf planting and intensive drainage**
These have greatly improved the rate of establishment on peat and have enabled us to extend the range of some of the most valuable species.

(*b*) **Manuring**
The use of phosphatic manures on difficult peats and on the poorer *Calluna* moorlands has made it possible to establish high-yielding species such as spruce in conditions which otherwise would not have allowed them to develop.

(*c*) **Deep ploughing**
The practice of deep ploughing, which has been made much more effective during the last twenty years, has had important consequences on many of the podsolized moorland soils, particularly in the north-east of Scotland. By deep ploughing it has been possible to increase the effective depth of the soil and improve the drainage, with the result that the establishment of many more species can now be reasonably expected.

Although, by ploughing, we are deepening some of our soils, it must be remembered that we have many soils, in the west and north especially, which are very shallow. Some of these are literally shallow, in that there is no great depth of soil above the under-lying rock; many of the deeper peats, on the other hand, are shallow in the sense that only a relatively thin upper layer is sufficiently well-drained and aerated to sustain root growth. These soils have recently been attracting the attention of W.R. Day of Oxford, in connection with certain pathological symptoms which have made an appearance in some of our plantations. It is too early to say whether these shallow soils in certain circumstances are likely to lead to the appearance of pathological conditions, and the matter must obviously be investigated fully, but these shallow soils may well cause us trouble of another kind in the future when the trees have grown larger. They are the soils on which damage from gales may be severe.

The first half of the twentieth century has been a time when pure plantations of conifers have been the vogue in this country. Now it looks as though the fashion were changing and that foresters were going back to the ways of earlier generations. Mixtures are being more and more discussed and planted. There are many reasons for this change, some of them extremely good, but the subject is complex and I can do no more than mention it in passing.

Hitherto, I have been speaking mainly of conifers but I cannot conclude this lecture without some reference to the broadleaved species which in one form or another occupy such a prominent place in the Scottish scene.

The interesting thing about the broadleaved High Forest is the extraordinary distribution of the age-classes. Taking the country as a whole, we have the astonishing situation that only 3 per cent of the broadleaved High Forest is less than 30 years and only 9 per cent less than 60 years of age. Most of the standing broadleaved High Forest was in fact planted before 1880.

Thus, to set off against the relatively large area of mature and even over-mature broadleaved timber we have only a small area of young plantations. There has been little planting of broadleaved species during this century. For this there are two reasons. The first is that the increasing uncertainty attached to the possession of land has made private owners reluctant to sink capital in such a long-term project as the cultivation of broadleaved trees; the second is that the Forestry Commission has been able to acquire very little land suitable for the production of hardwood timber. This is unfortunate because some of the Scottish hardwood timbers have a high reputation and it would be a misfortune if their cultivation were not maintained. It is possible that the difficulties of growing these trees have been exaggerated, for by forming a suitable mixture with conifers, it should be possible for the planter to provide intermediate yields in the form of saleable thinnings while the final crop, though its realisation may be deferred, gives a very much higher return in money than the most productive conifer.

The most important broadleaved trees in Scotland are the beech, the oak, the sycamore, the wych elm, the ash and the birch. How do they grow? A certain amount of information on their rate of growth was obtained during the survey of fellings carried out while the 1939-45 war was in progress, and although this information is fragmentary, it does tell us a little more than we knew before.

In High Forest, beech and oak are the principal species, with beech slightly more frequent, and in some districts, much more frequent. If you look around the Aberdeen district, for example, you cannot but be struck by the scarcity of oak and by the relative abundance of planted beech. Beech is not a native of Scotland. All the trees you see are either planted trees or the descendants of planted trees.

The usual rate of growth of beech in the south of Scotland corresponds to Schwappach's Quality Class 3, while in the north-east, as evidenced by plantations in Angus and Kincardine, it is one Quality Class lower. This is not rapid growth, but in view of our climate and our latitude it is not unsatisfactory. Beech seems to grow more rapidly in diameter than oak, ash or elm and in this respect is equalled only by sycamore, and thus it is usual to find in mixed hardwood stands, that the largest trees are usually sycamore and beech. Beech is tolerant of a wide range of soils and appears to be able to grow on any of the mineral soils in Scotland, provided that there is reasonable depth and good drainage. It has also the advantage of being more resistant to exposure than most other broadleaved species; it is for this reason that in an old mixed plantation one often finds the beech standing up several feet above the level of the other species.

Oak has a wide distribution as a native tree in this country; it is also to be found everywhere as a planted tree. Both species—pedunculate and sessile—are present, but owing to the long-continued plantings, the two trees occur indiscriminately over most of the country.

The rate of growth of oak appears to be slightly faster in the south of Scotland than in the east and north. Generally, it corresponds to the third quality class of Gehrhardt's tables for oak in Germany; but on deep soils, for example in the Tay Valley of Perthshire and in parts of south-west Scotland, Quality Class II may be found. As an example of the better type of growth I give you the measurements of three trees felled during the 1939-45 war at Meikleour, on the River Tay, between Dunkeld and Perth. They were 172 years old.

Total Height feet	Timber or Merchantable Height, feet	Mid quarter girth, inches	Volume
95	74	21½	237.5
90	76	20	211.1
91	64	23	235.1

On the other hand, oak, growing near the shores of Loch Ness, in woodland which conformed in character to the Highland Oak Woods described by Tansley, showed a rate of growth well below Gehrhardt's fourth Quality Class, while in the South of Scotland, in districts where the usual rate of growth corresponds to Quality Classes II and III, there is a drop to Quality Class IV on sites where the soil is podsolised or slightly podsolised and where acid-forming plants such as *Vaccinium myrtillus* occur in the vegetation. These types of woodland are at, or are just below, the limit of cultivation of oak as a forest crop; on the other hand, on the deeper and richer soils in the lowland districts the oak has considerable prospects of succeeding.

Sycamore, which in Great Britain seems to flourish best in the south of Scotland and the north of England, is a tree which is well adapted to our conditions in the lowland districts. In the south of Scotland, it is found to vary considerably in rate of growth, from 70 to less than 40 feet in height at 50 years of age. To some extent, this is a reflection of the quality of the various soils, but generally speaking the rate of height growth seems to be influenced far more by exposure. Sycamore gives a valuable timber, and it seems to reach a large size more quickly than any other broadleaved species save beech.

The wych elm (*Ulmus montana*), is not uncommon in the south and centre of Scotland where it often forms a constituent of the mixed plantations. It yields a valuable timber and is therefore worth preserving, but the elm disease, which is present in the Tweed Valley in the south-east of the country, may cause some difficulty. It grows relatively fast and, up to 70 years of age, appears to increase in height at the rate of one foot per annum. Unfortunately, it seems to be subject to butt-rot when it passes 80 years of age, and this butt-rot is frequently very severe.

The ash, which you will find as a planted tree all over the country and in self-sown groups in many parts of our river valleys, is most prominent in the south-western counties where it occupies a large part of the broadleaved and mixed woodland. In that district it grows at a rate which corresponds to Quality Classes II and III of Wimmenauer's Yield Tables; but although this growth-rate is better than one might have expected, it is not fast enough to yield ash of the highest quality. Nevertheless, sound ash can be produced, good enough for all but the most exacting requirements.

I have mentioned five of these species in some detail, because I feel there is a place for them in our Scottish silviculture, although they have been sadly neglected in recent years. On the deeper mineral soils of the south, the midlands and the east of Scotland, there is no reason why they should not be cultivated again. But, if this is attempted, it would be advisable to follow the practice of earlier generations of foresters and plant conifers with them, both to nurse them and to give intermediate returns; it would be as well to mix the hardwoods also, as was generally done in earlier times. There are disadvantages, for example, in growing a pure crop of beech in our cool climate where the fallen leaves do not decompose rapidly.

Because the country is windswept, and because plantations cannot be large on good soil which has a high value for agriculture, it is unlikely that broadleaved trees will grow to the height they would reach in larger blocks or in better sheltered sites, but they will yield substantial quantities of useful timber which can find a use in Scottish industries.

I have left to the end the consideration of birch, of which there are about 7,000 acres in Scotland in the form of High Forest; mainly because one cannot discuss this species in High Forest, without dealing with it as scrub, in which form it occupies nearly 200,000 acres of woodland. We feel in Scotland that we ought to be able to grow good birch; we must admit that we have very little birch anywhere which we can show to a visitor as good examples of the species. Very little birch appears to have been planted and in this respect birch differs from most other trees in Scotland. It is all the more puzzling, therefore, that there should be such enormous differences in the habit and growth of this tree in the Highlands. It has been suggested that the Highland birch is neither *Betula verrucosa* nor *B. pubescens* but another species, and it is clear that botanical work on this tree is urgently required. Most of these birchwoods, with their stunted, misshapen trees, have been classified in our forest Census as "scrub", and the only way of dealing with them silviculturally is by converting them to conifers unless modern genetical work can give us a birch tree which will be capable of growing satisfactorily under these conditions in the Highland valleys and hillsides. The area of birch which can be classified as High Forest is not large, as you have learned; there are occasional patches of good growth but, over all, the quality of the crops is poor.

It is obvious that until the botanical and genetical aspects of the Scottish birches are cleared there is little prospect of improving our birch woods, and unless this is done the birch will yearly occupy a smaller and smaller area of our forest land.

The other main constituent of our scrub woodlands is the oak and these scrub oak crops are fairly near the natural type of forest in the Highland valleys where they occur. The growth is poor. I have already given some information about the rate of growth of oak in one of the better stands near Loch Ness, which was, in fact, good enough to be classified as High Forest. That was of poor quality, but in the typical scrub areas the oak is very much poorer. The policy which is being followed, where those woods have to be dealt with, of converting them to crops of shade-bearing conifers like Norway spruce, Douglas fir, *Abies grandis* etc., is the correct one as every forester will agree; but it causes some annoyance to botanists to see those interesting specimens of woodland disappear, although numerous areas are likely to remain undisturbed as shelter for live-stock. The method of conversion which was extensively used at one time—the girdling of the oak trees which were left standing after they had died—also caused some resentment on account of the unsightly appearance of the dead trees.

This brings me to my last point. There is one other consideration which a forester in this country must keep in mind and that is the problem of amenity, a subject to which the public is highly sensitive. It is a consideration which weighs more heavily with foresters in State service than with those in private employment because the operations of the Forestry Commission are carried out on a much larger scale, and also because a department of government is a natural target for critics. But even private owners do not escape this form of criticism and the day has passed when they could ignore a public outcry.

The typical English landscape, as we know and admire it to-day, is really a creation of the eighteenth century, when the great landowners carried out their immense schemes of improvement with which the names of landscape builders like Lancelot Brown, William Kent and Humphrey Repton are associated.

In Scotland the movement also went on, but with a subtle difference; nevertheless of our lowland districts it may be said too that the eighteenth century created most of the scenery, the fields, the hedgerows, the woods, the parks and the policies, which give the characteristic flavour to the rural scene.

Then there came the Industrial Revolution and the enormous expansion of industry which went on throughout the nineteenth century, leaving behind it a dreadful legacy of quarried hillsides, smoke-blackened lands, slag heaps and all the other accompaniments of fierce industrial activity. I have often thought that it was not until the industrial supremacy of this country was passing into other hands that people began to think seriously of the effect of industry on the landscape, began to question the need for ruthless methods of working, began to scutinise closely any activities which affected the appearance of the countryside. At the same time it must be remembered that most of the people in Great Britain live in towns, and to the town dweller the country is a place for recreation and enjoyment; the people of the towns do not look upon the countryside as the greatest and most important of their factories, and they are apt to resent and be puzzled by any striking change in its appearance.

The anxiety to preserve the beauties of the countryside is a genuine feeling promoted by the highest motives, but like all such things it carries within its fabric not a few streaks of irrational thinking.

About some of its repercussions on forestry I do not need to speak at length here. There is, for example, the objection to the felling of timber. There is nothing new about this. A century and a half ago, William Wordsworth wrote a famous sonnet about the felling of the trees round Neidpath Castle, near Peebles, by the then owner, the Duke of Queensberry.

"Degenerate Douglas—O the unworthy lord
Whom mere despite of heart could so far please,
And love of havoc, (for with such disease
Fame taxes him) that he could send forth word
To level with the dust a noble horde
A brotherhood of venerable trees,
Leaving an ancient dome and towers like these
Beggared and outraged . . . "

The feelings which stirred Wordsworth have been roused in countless men and women since.

"While the earth remaineth", says the Book of Genesis, "seed time and harvest, and cold and heat, and summer and winter, and day and night, shall not cease". Some people forget that harvest must come in the forest as well as seed time, just as much as in the ploughed fields.

The choice of species by the planter is sometimes affected in parts of England, where there is an objection by the public to the use of conifers on the grounds that they look unnatural in an English setting, where the native type of forest growth is either oakwood in one or other of its variants, or beech forest.

The kind of objection which is raised by a modern poet:

"How vivid nature is—but rash
To leave design in holly and ash
To the wind's caprice, or to accident
Of the way an evening chaffinch went—
For see, advancing are invaders,
The dark determined conifers,
And into the careless sylvan dance
Quivers an implacable lance.
O soldiers lean with efficiency,
I have loved the idiosyncrasy
Of random individual things!"

This criticism has some validity in many parts of the lowlands of England, but it has been extended to the mountainous districts of North Wales and Cumberland where it would appear to have little validity at all; because in those regions conifers can be made to blend with the landscape and improve the scenery in a remarkable manner, while the natural woodlands have either disappeared or have been reduced to elements of indifferent scrub.

In those districts it seems to me that the real complaint is not about conifers but about change.

I have mentioned amenity at some length because this is one of the things in which there is an important difference between England and Scotland. In Scotland there is no antipathy to conifers as such partly because people are used to them, partly because they understand the value of forests in a way the English do not, and partly because conifers accommodate themselves to the Scottish landscape in a most admirable manner. Although there are one or two places, familiar to generations of tourists and holiday makers, where drastic change would be resented, Scottish foresters are not troubled by problems of amenity to the same degree as their English colleagues. But they keep those things in mind and much careful work has been done in planning for long-term effects where these are necessary.

The system of selecting species according to vegetation types has had one result which was probably not intended. Much of the beauty of our hill country lies in the subtle changes in shade and colour caused by local variations in the herbage, and the attractiveness is enhanced by sunlight and the rapidly moving shadows of the clouds. In many places, the forester, by fitting his trees to the vegetation, has preserved this characteristic and has even improved it, particularly in the winter, where the varied greens of the pines and spruces are diversified by the larches with their bare yellow and red twigs.

EXTENSION OF NURSERY EXPERIMENTS INTO RADNOR FOREST

By R. D. PINCHIN,

Assistant Silviculturist, Research Branch

This article is intended to form a sequel to part of the experimental work in nursery practice undertaken by the Forestry Commission's Research Officers during the years 1920 to 1929. An account of the nursery side of this work has already been published in Forestry Commission Bulletin No. 11, *Nursery Investigations* by H. M. Steven, 1928.

All the main aspects of nursery practice, as applied to the major coniferous species, were dealt with in the course of these investigations. It was decided, in the year 1928, to extend, into the forest, certain of the experiments which had formed part of the work carried out in the nursery stage, in order to test the long term effect of the various treatments applied in the nursery. The following subjects were selected for special study:

Method and Density of Sowing (four experiments)
Grading of Seedlings (six experiments)
Spacing of Transplants (six experiments).

Forest Site; General Description

Situation. The site selected for planting these experiments was in Radnor Forest, which is situated in the Welsh Marches, at a distance of about six miles to the west of Presteigne and three miles to the north of New Radnor.

The forest area occupies the northern and eastern spurs of the old Radnor Forest massif, sloping away from the central heather-capped plateau, and was, for the most part, formerly grouse moor and sheep-grazing land of poor quality. The total area of the forest is 3,870 acres.

Topography. The topography of the surrounding country is mountainous, consisting of a compact mass of broad, smooth hills intersected by narrow, blind valleys. To the east the land falls away gently towards the flat country of Herefordshire; while to the west lies the mountainous country of the upper Wye Valley and the Plynlimon Range (2,468 feet). The Radnor Forest massif is the highest block of hills in the locality, reaching a height of nearly 2,200 feet. The intersecting valleys are mostly steep-sided, but at the upper levels of the plateaux the gradient gradually diminishes to flat or undulating moorland. The hills are smooth in outline and the ground is generally unbroken, there being a marked absence of any rock outcrops. The planted area of the forest lies within a range of elevation of 900 to 1,900 feet, occupying, for the most part, the slopes of hills.

Exposure. Much of the forest, particularly the plateaux and extreme upper slopes of the hills and ground at the head of the valleys, is subject to severe exposure which, in many places, forms a serious check to tree growth. There are very few standing belts of old trees on the higher ground to provide shelter in any form. The only shelter the forest receives is by virtue of its aspect, which, being mainly N., N.E., and S.E. shelters it from the direct force of the prevailing south-west wind.

Climate. In general the climate of the region is fairly mild, but during the early months of the year heavy snowfalls may be frequent. Severe damage was caused to Douglas fir and European larch plantations by a glazed frost in January, 1940. Late spring frosts are common in the valley bottoms and have damaged young trees, mainly Sitka spruce and European larch. Exposure, particularly at the higher elevations of the forest, is, however, the main cause of injury from climatic sources. The mean annual rainfall of the region is in the neighbourhood of forty-five inches.

Geology. The geology of the area consists of Ludlow sandstones, shales and limestones of the Silurian formation, the uppermost strata in the locality being bedded shales which disintegrate readily.

Soil. The mineral soil is generally a type of brown earth, with no sign of podsolisation except on the heather-capped hilltops. The depth of the soil varies considerably with elevation and situation, and it is characterised by a thin layer of raw humus which is most strongly developed under bilberry (*Vaccinium myrtillus*). The soils can be classified broadly into three types:

(*a*) *Bracken* (*Pteridium aquilinum*) or grasses dominant as natural ground cover.

3 ins. decaying vegetable matter and humus
6 ins. dark brown loam (region of bracken remains)
8 ins. lighter brown heavy loam with shale fragments, on heavy shaly loam.

(*b*) *Bilberry—Grass—Mosses.*

6 ins. plant remains and raw humus
6 ins. brown loam, lighter in colour than in same horizon in type (*a*)
12 ins. yellow brown loam, heavy, with some shale, on a heavy shaly loam.

(*c*) *Heather (Calluna vulgaris) dominated slopes*
General soil type similar to (*b*) with the exception that a thin layer of heather-bilberry peat 1 to 1½ inches thick is found. Podsolization also becomes more evident with increasing elevation. On the tops of the plateaux the peat layer overlying the mineral soil may be up to 18 inches thick.

Types (*a*) and (*b*) occur generally on the lower and middle slopes and type (*c*) on the higher, more severely exposed ground.

Vegetation. The dominant natural vegetation of the area under afforestation is of three main types according to topographical position:

(i) *Lower slopes and valley bottoms.*

The vegetation of the lower ground is of the grass-herb type. Bracken may often be abundant and luxuriant locally but in general the grasses *Agrostis* spp. *Festuca ovina, Deschampsia flexuosa, Anthoxanthum odoratum,* and *Holcus lanatus* form the dominant ground cover. Bramble (*Rubus fruticosus*), raspberry (*Rubus idaeus*) and willow-herb (*Chamaenerium angustifolium*) are frequent, growing vigorously in damp situations.

(ii) *Middle slopes of hills.*

Grasses and bracken form the dominant vegetation, the associated grasses being *Agrostis* spp., *Anthoxanthum odoratum, Festuca ovina, Deschampsia flexuosa,* and *Holcus lanatus.* The vegetation differs from type (i) in the frequent local occurence of *Calluna, Vaccinium, Erica, Carex* and *Juncus* species. Gorse (*Ulex europaeus*), also, is common on many slopes. On the deeper and more fertile soils the bracken covering is often very tall and dense.

(iii) *Upper slopes of hills and tops of plateaux.*

The general type is *Calluna* moorland with *Vaccinium myrtillus* and *V. vitis-idaea* common and generally distributed, occuring sometimes in large pure patches. Of the grasses *Deschampsia flexuosa* may be abundant locally while *Holcus* and *Agrostis* frequently occur. Bracken is frequent, often locally abundant. Other commonly occurring species are: *Potentilla erecta, Empetrum nigrum, Cladonia* and *Blechnum spicant.* There is a general abundance of mosses, while sedges, *Eriophorum* and *Juncus* are locally abundant in flushes and damp hollows. In many places the heather is dense and luxuriant.

Forest Tree Species. On types (i) and (ii) Norway spruce, Sitka spruce, Douglas fir, Japanese larch and small lots of *Abies grandis* have been planted successfully. European larch has not been very successful as it has suffered considerably from frost and die-back in valley bottoms and from severe exposure at higher altitudes. Further, stocks of Alpine provenances used in the early plantings were entirely unsuited to the conditions prevailing in the locality, as shown by the greatly superior performance of plantations of Scottish seed origin.

Douglas fir has succeeded only in sheltered positions at the lower levels and the general altitude of the forest is considered too great for large scale use of this species. The effect is seen chiefly in poor stem form.

The higher-lying ground (type (iii)) has been successfully afforested with Sitka spruce, both pure and in mixture with pines. Norway spruce has also been widely used at all elevations but grows best on heather-free, sheltered ground.

Experimental Areas

Of the sixteen nursery experiments extended into Radnor Forest thirteen were laid down in one large block at Ednol Hill in 1928, two in Cwm y Gerwyn in 1929, and one at Rhiw Lawr in 1930.

Ednol Hill

This area occupies a part of the middle north-easterly slopes of Bach Hill (2,002 ft.) which forms the most easterly spur of Radnor Forest. The experimental plots are situated within a range of elevation of 1,250 to 1,450 feet, on a relatively gentle and uniform slope which rises moderately steeply to the summit, one mile distant to the south-west. To the north and north-east, the ground falls steeply to 925 feet in the valley below.

The aspect varies from south-east to north and the area is slightly sheltered from the south and west by the rising ground behind. Over most of the area, however, the general exposure is moderately severe on account of its high relative elevation.

In some places the curve of the slope is concave and plots on some parts of the area have suffered frost injury from time to time. The severe ice-storm (or glazed frost) of January 1940 broke off the tops and branches of many trees, particularly the largest ones, resulting in damage to some of the plots, particularly to Douglas fir, European larch and Sitka spruce in that order. Very little damage to Norway spruce was recorded.

The natural ground vegetation within the experimental plots is type (ii). Bracken and grass occur in a continous series from almost pure dense bracken three feet high to a grass—*Vaccinium* type.

Soil type (*a*) occurs fairly uniformly throughout.

Cwm y Gerwyn

Two experiments (Nos. 21, 22, Norway spruce: Grading of Seedlings: Spacing of Transplants) were planted in 1929 in the Cwm y Gerwyn valley near the north-western edge of the forest. The ground occupies the shoulder of a north-east facing slope, with a moderate and even gradient, at an elevation of about 1,200 feet. There is moderate shelter in all directions but the north-east.

A mixed bracken-grass vegetation forms the natural ground cover with frequent distribution of *Agrostis* and *Deschampsia*. *Vaccinium myrtillus* and *Festuca ovina* occur in patches. At the time of planting the ground was rough grazing but had been cultivated in earlier years.

The soil is type (*a*) as at Ednol Hill.

Rhiw Lawr

A single experiment (No. 8, European larch: Method and Density of Sowing) was laid down in the Rhiw Lawr Valley, one and a half miles to the north-west of Ednol Hill in 1930.

The site is at an elevation of approximately 1,100 feet, with a northerly aspect and it occupies part of a steep, narrow-sided valley with a bracken-grass type of vegetation, with *Calluna*.

The general features of the soil are similar to those found at Ednol Hill, but the larch here receives a much greater degree of shelter from exposure.

General Note on Sites and Species

A high degree of uniformity characterises the individual sites on which these experiments were laid down and although local variations occur, notably the presence of a thicker raw humus layer under *Vaccinium*, the soils are all reasonably uniform for experimental purposes. In addition, the fourfold replication provided in the layout of each experiment considerably minimizes any local site differences which might have influenced the growth.

The effects of wind exposure have been very noticeable on European larch at Ednol Hill in three experiments situated on the south-west side of the area where stem form is poor and most of the tree, have a pronounced lean. It is apparent that the altitude and situation are unsuited to the normal growth of the provenance used (Austrian Alps, Ident. No. 25/10, altitude 3,280 ft.), a type which is of doubtful value in Britain except on good quality sites.

The Douglas fir plots (Ident. No. 25/6, Washington Coast, B.C.) suffered less from the wind than those of European larch but form and stocking are poor and this species is not now considered satisfactory at this elevation.

Growth was more normal in the case of Norway spruce (Ident. No. 25/18, Vintschgau, Italian Tyrol, 2,600-3,100 ft.) and Sitka spruce (Ident. No. 25/16, Queen Charlotte Islands, B.C.) and losses were, on the whole, small. These species appear well suited to the site.

On the Cwm y Gerwyn and Rhiw Lawr sites the degree of exposure is much less than at Ednol Hill and no marked ill effects have been recorded.

Assessment and Analysis of Results

Periodical assessments of these experiments were carried out in the forest until the eighth growing season, while the most important were statistically analysed to test the significance of any considerable differences in growth and in losses due to the various treatments applied at the nursery stage, or to the effect of grading into good plants and culls at the time of planting.

The main results of these analyses appear in Tables IV and V and are discussed under the various objects of experiment.

Assessment data for losses per cent in the first year and the mean heights in October, 1935, are shown in Tables 1, 2 and 3. (See pages 60 to 62.)

1. Method and Density of Sowing

Nursery Side

A series of four experiments whose object was a trial of broadcast and drill sowing of seed at four commonly used densities was carried out at Bagley Nursery, Oxford (Bagley, Nursery Experiment No. 4, 1925 and 1927) using seed of Douglas fir, European larch (two experiments) and Sitka spruce.

The different densities at which the seed was sown were:

Square feet of seed-bed per lb. of seed:

	Broad-cast sown	*Drill sown*
Douglas fir .... / European larch	300, 150, 100, 50.	450, 300, 200, 100
Sitka spruce	600, 450, 300, 150.	900, 600, 400, 200

After two years in the beds the seedlings in each plot were lifted and assessed for the numbers of seedlings produced per lb. of seed and per square foot of seed-bed, and at the same time graded into the following three grades:

Grade 1 Seedlings with shoots over 4½ inches (over 6 inches in the case of Douglas fir).

Grade 2 Seedlings with shoots 4½ inches and under (under 6 inches in the case of Douglas fir).

Grade 3 Culls, namely, suppressed, drawn, forked, damaged, diseased and badly rooted seedlings, also those with unripened lammas shoots.

The seedlings of each grade from each method and density were lined out at Kennington Nursery at a spacing of 10 inches by 1½ inches in the case of European larch and Douglas fir and 10 inches by 2 inches in the case of Sitka spruce, using a layout with four replications.

After one year in the lines an assessment was made of the losses, through deaths and culls, in each of the three grades from each treatment.

The complete nursery data relating to three of these experiments are published in Forestry Commission Bulletin No. 11, pp. 67-76, Experiments No. 41, 42 and 44, 1925. The data for the second experiment with European larch, laid down in 1927, do not appear.

Conclusions. The main conclusions arrived at by Steven as a result of an analysis of these experiments were:

1. Drill sowing was beneficial to Sitka spruce and Douglas fir, inducing better growth and a larger production of seedlings per lb. of seed. Broadcast sowing was recommended for European larch.

2. The thinner sowing densities gave a larger production of seedlings per lb. of seed and better growth in both the broadcast and drill sown treatments for all three species.

3. In all three species losses in the transplant lines through deaths and culls combined were much higher in Grades II and III than in Grade I of each density. It is therefore important to choose a method and density of sowing which gives the highest percentage of Grade I seedlings.

4. Sowing densities recommended for these three species were, in square ft. per lb. of seed:

	Broadcast sown	*Drill sown*
Douglas fir	300 (405)	400 to 450 (540)
European larch	300 (495)	— (585)
Sitka spruce	600 (765)	800 to 900 (1,035)

Note: The figures in brackets indicate the standard sowing densities based on a standard germination capacity for these species in general use in the Forestry Commission's nurseries in 1950. It will be noted that these densities are much thinner than those recommended by Steven in 1928. This is accounted for by improved methods of nursery practice, particularly in the preparation, covering and after care of seedbeds, which have been developed since the original investigations were carried out. Present day methods permit of a larger out-turn of usable plants for a given quantity of seed than formerly.

The plants were lifted after one year in the transplant lines and regraded into good plants and culls (Tables 6 to 8). This concluded the nursery side of the investigation. (See pages 65 to 67.)

Forest side

As two-year-one transplants the plants were taken to Radnor Forest and planted out, keeping the eight different treatments separate.

A randomised block layout with four replications was adopted, each unit plot consisting of good plants and culls of one particular treatment. The following experiments are included in the series:

Radnor Forest Experiment No. 1, Ednol Hill, 1928 (Douglas fir)
,, ,, ,, No. 2, ,, ,, ,, (European larch)
,, ,, ,, No. 3, ,, ,, ,, (Sitka spruce)
,, ,, ,, No. 8, Rhiw Lawr, 1930 (European larch)

Conclusions. The following conclusions are arrived at from an analysis of the assessment data for these experiments (Tables 4 and 5, pages 63 and 64):

Losses on Establishment. In none of these experiments were any significant differences shown in percentage of losses on establishment due to the effect of the different sowing densities, nor between the broadcast and drill sown treatments.

Comparing the losses of culls and good plants, however, it is interesting to note that in all three experiments at Ednol Hill (Expt. 1, Douglas fir; Expt. 2, European larch; Expt. 3, Sitka spruce) the losses of culls were significantly greater at the one per cent level of probability. Combining all species and treatments, overall losses of culls were 30.3 per cent compared with 16.7 per cent for the good plants by the end of the third season. In the case of Sitka spruce, however, the losses of culls amounted to only 4 per cent.

Losses among the good plants were, on the whole, slight except in the case of Douglas fir which averaged 27 per cent.

Height growth. An assessment of height growth at the end of the eighth growing season showed that there were no significant differences whatsoever in mean height resulting from the different densities or methods of sowing at the nursery stage.

In all four experiments however, the culling is seen to have produced marked differences in height growth. The good plants were 10 inches to 24 inches taller than the culls at the end of the eighth season, differences which are significant statistically at the one per cent level of probability.

Combining all species and treatments the mean height of the good plants was 69 inches and the culls 53 inches.

2. Grading of Seedlings

Nursery side

Six experiments on the grading of seedlings were carried out in Kennington Nursery, Oxford (Kennington, Nursery Experiment No. 19, 1926-1928 and 1927-1929) using Douglas fir, European larch, Sitka spruce (two experiments) and Norway spruce (two experiments).

The object of this series of experiments was to study what influence, if any, the grading of seedlings according to size and quality had on losses and growth in the transplant lines and also on losses and development in the field.

Two-year-old seedlings of typical growth, lifted straight from the seedbeds, were used. On lifting from the beds the seedlings were placed into the following three grades:

Grade 1 Seedlings one half the maximum shoot length, with the exceptions noted in Grade 3. In determining the maximum shoot length the few exceptionally large seedlings were not considered.

Grade 2 Seedlings less than one half the maximum shoot length, with the exceptions noted in Grade 3.

Grade 3 Culls, namely, badly rooted, suppressed, drawn, weakly, damaged and diseased seedlings.

The three foregoing classes of seedlings were studied with, in addition, a further class combining Grades 1 and 2 and including all plants with the exception of the culls.

Lining out was done using the open trench method, with boards, at a spacing of two inches by ten inches between the rows. The plots were laid out in a Latin square, with four replications, each unit plot consisting entirely of plants of one class.

Conclusions. The principal conclusions arrived at by Steven were as follows:

1. Grade 1 seedlings gave the best results in the transplant lines for all species. The aim of seedling production should therefore be to increase the percentage out-turn of this grade.
2. The culls suffered notably higher losses than any other grade in all species. For this reason they should be destroyed.

3. The division of good seedlings into two grades, based on size, did not reduce losses in the transplant lines sufficiently to justify its general recommendation. When transplants normally remain two years in the transplant lines it may, however, be advantageous to grade by size, as the Grade 1 plants might possibly be lifted at the end of the first year.

Forest Side

Three experiments were lifted as 2+1 and three as 2+2 and the plants within each class were again graded into good plants and culls in the normal way (Tables 6 to 8). The Grade 3 plants (culls) of the first grading were thus further divided into those which had improved in quality during one year in the transplant lines and those which had not.

They were then taken to Radnor Forest and planted out, using a Latin square layout with four replications of each of the four treatments. This gave a total of sixteen unit plots of irregular size, within each of which the good plants and culls of the final grading were planted separately for each treatment.

This series comprises the following experiments:—

Radnor Forest, Experiment No. 4, Ednol Hill, 1928 (Sitka spruce)
,, ,, ,, No. 5, ,, ,, ,, (Norway spruce)
,, ,, ,, No. 9, ,, ,, ,, (European larch)
,, ,, ,, No. 10, ,, ,, ,, (Douglas fir)
,, ,, ,, No. 11, ,, ,, ,, (Sitka spruce)
,, ,, ,, No. 21, Cwm-y-Gerwyn, 1929 (Norway spruce)

Conclusions. An analysis of the assessment data obtained from these experiments (Tables 4 and 5) points to the following conclusions:

Losses on Establishment. In the four experiments using Sitka and Norway spruces, losses in the first year were negligible, but in the two experiments using Douglas fir and European larch the overall mean losses (all treatments, good plants and culls) were 38.6 and 14.3 per cent respectively. By the end of the third season the losses had increased to 45.1 and 22.8 per cent. These losses would appear to reflect the unsuitability of the site for the two latter species.

Variation in the percentage losses between the four different seedling grades during the first three years did not reach significant proportions, though losses in Grade 3 tended to be higher than in the better grades. There is thus no evidence to indicate that the grading of seedlings at the time of lifting from the beds for transplanting has any bearing on the proportion of losses sustained when they are subsequently planted out in the forest.

The final grading into good plants and culls such as is normally carried out in nursery practice on lifting from the transplant lines, has, however, provided conclusive results. In the Douglas fir and European larch experiments, in which losses were appreciable, the overall losses among the culls were 50 and 23 per cent respectively as compared with only 37 and 13 per cent losses among the good plants in the first year. The differences are significant at the one per cent level of probability. The losses of culls did not exceed 4 per cent in the case of Sitka spruce and 10 per cent in the case of Norway spruce in the first year. By the end of the third season overall cull losses in three of the four spruce experiments also (Nos. 4, 5 and 11) were significantly greater than losses among the good plants at the five per cent level of probability.

Height Growth. One of the outstanding results of this series of experiments is the fact that only very small and insignificant differences in height were shown by the plants in their eighth year as a result of the nursery grading at the time of lifting from the seedbeds, although the average in Grade 1 was in all cases higher than in Grade 3.

On the other hand it is remarkable that in all six experiments the final forest grading, i.e. into good plants and culls at the time of lifting from the transplant lines, produced conclusive results. Reference to Table 2 will show that the good plants in each experiment had a mean height of from 5 to 20 inches greater than the culls at the end of the eighth season. These differences greatly exceed the one per cent level of probability in all cases.

Combining all species and treatments the mean height of the good plants was 61 inches compared with only 48 inches for the culls, a difference of 13 inches.

The results of these grading experiments point to the conclusion that the seedling stage in the nursery is not a reliable criterion of the ultimate behaviour and development of the plant under forest conditions. Later, at the time of planting out in the forest, a simple grading into good plants and culls will more consistently conform to the growth and general behaviour which one might expect from the two categories.

3. Spacing of Transplants

Nursery Side

In 1926 and 1927 an extensive investigation was carried out at Kennington Nursery, Oxford, with the object of studying the influence of spacing in the transplant lines on losses, on the growth of shoot and root, and on subsequent losses and development in the field. Six of these experiments were selected for extension in Radnor Forest and included the species Norway spruce (two experiments), Sitka spruce (two experiments), European larch and Douglas fir.

The following spacings in the lines were studied, in inches:

1, 1½, 2, 3.

The distance between the lines was 10 inches. Only two-year seedlings of typical growth and size were used, culls and exceptionally large seedlings having been eliminated. Lining-out was done by the open trench and board method.

Conclusions. The following main conclusions were arrived at by Steven as a result of these experiments:

1. Wider spacings have given no advantage in better quality of transplant or in lower losses either in the transplant lines or subsequently after planting out, except in the case of the spruces.
2. The recommended spacing distances in the transplant lines are:—

	9 or 10 inches between the rows by;
European larch, above 15 inches average size	1½ inches
European larch, below 15 inches average size	1 inch
Douglas fir, all sizes, large or small	1½ inches
Norway spruce, if good growth and remaining two years in the lines	2 inches
Sitka spruce, if good growth and remaining two years in the lines	2 inches

Forest Side

The transplants were lifted after two years in the lines in the case of three experiments and one year in the case of the other three experiments. They were graded into good plants and culls (Tables 6 to 8), taken to Radnor Forest

RADNOR FOREST

Table 1

METHOD AND DENSITY OF SOWING

(Extension of Bagley Nursery Experiment No. 4, 1925 and 1927)

Experiment Number	Species and Planting grade	Year of planting	Losses per cent in First year									Mean height (inches), October, 1935								
			(Sowing densities in sq. ft. per lb.)								Mean	(Sowing densities in sq. ft. per lb.)								Mean
			Broadcast sown				Drill sown					Broadcast sown				Drill sown				
			300	150	100	50	450	300	200	100		300	150	100	50	450	300	200	100	
1 Ednol Hill	Douglas fir	1928																		
	Good plants		26	30	29	36	19	22	31	29	27	61	60	75	60	60	67	60	58	62
	Culls		39	42	52	64	59	32	48	44	45	56	57	60	49	47	54	54	51	55
2 Ednol Hill	European larch	1928																		
	Good plants		12	10	15	12	12	9	13	9	11	85	84	88	85	83	88	87	82	86
	Culls		32	28	50	33	36	50	33	41	38	66	65	62	59	59	62	63	51	62
8 Rhiw Lawr	European larch	1930																		
	Good plants		—	—	—	1	1	1	—	—	—	47	43	49	51	50	47	52	54	50
	Culls		5	7	1	—	—	2	—	2	2	40	37	37	37	46	39	39	42	39
			(Sowing densities in sq. ft. per lb.)									(Sowing densities in sq. ft. per lb.)								
			600	450	300	150	900	600	400	200		600	450	300	150	900	600	400	200	
3 Ednol Hill	Sitka spruce	1928																		
	Good plants		—	—	—	1	—	—	1	—	—	63	66	65	71	73	63	68	69	67
	Culls		1	—	5	5	1	5	5	3	4	54	61	58	55	61	54	59	58	57

Table 2

GRADING OF SEEDLINGS

(Extension of Kennington Nursery Expt. No. 19, 1926–1928 and 1927-1929)

Experiment Number	Species and Transplant grade	Year of planting	Losses per cent in First year: Seedling grades (1) Over half maximum shoot length	Losses: (2) Under half maximum shoot length	Losses: (1) and (2) combined	Losses: (3) Culls	Losses: Mean	Mean height (inches), October, 1935: Seedling grades (1) Over half maximum shoot length	Height: (2) Under half maximum shoot length	Height: (1) and (2) combined	Height: (3) Culls	Height: Mean
4 Ednol Hill	Sitka spruce	1928										
	Good plants		2	2	3	2	2	65	66	60	58	61
	Culls		2	4	4	4	4	53	41	55	47	49
5 Ednol Hill	Norway spruce	1928										
	Good plants		—	—	—	—	—	55	50	47	51	51
	Culls		—	3	2	1	1	41	43	40	42	42
9 Ednol Hill	European larch	1928										
	Good plants		12	12	15	17	13	92	95	79	87	89
	Culls		21	45	17	21	23	75	69	62	73	70
10 Ednol Hill	Douglas fir	1928										
	Good plants		41	33	31	43	37	70	75	69	62	70
	Culls		36	54	48	53	50	53	55	53	55	50
11 Ednol Hill	Sitka spruce	1928										
	Good plants		—	—	—	1	—	74	61	60	61	64
	Culls		5	—	—	4	3	68	54	56	53	55
21 Cwm y Gerwyn	Norway spruce	1929										
	Good plants		5	5	3	4	4	30	29	26	24	27
	Culls		1	16	5	18	10	26	21	21	20	22

RADNOR FOREST

SPACING OF TRANSPLANTS

(Extension of Kennington Nursery Experiment No. 18, 1926-1928 and 1927-1929)

Table 3

Experiment Number	Species and Transplant grade	Year of planting	Losses per cent in First year: Spacing distances in transplant lines 10″ × 1″	10″ × 1½″	10″ × 2″	10″ × 3″	Mean	Mean height (inches), October, 1935: Spacing distances in transplant lines 10″ × 1″	10″ × 1½″	10″ × 2″	10″ × 3″	Mean
6 Ednol Hill	Norway spruce	1928										
	Good plants		1	1	—	—	—	57	54	59	63	57
	Culls		2	—	—	—	—	41	45	50	48	44
7 Ednol Hill	Sitka spruce	1928										
	Good plants		3	3	1	1	2	72	81	72	74	74
	Culls		5	6	10	18	7	56	59	51	65	56
12 Ednol Hill	European larch	1928										
	Good plants		30	18	15	15	22	84	87	79	92	85
	Culls		37	26	29	40	33	69	64	68	68	67
13 Ednol Hill	Douglas fir	1928										
	Good plants		17	14	14	21	16	110	104	100	109	106
	Culls		35	38	29	27	34	87	85	85	90	87
14 Ednol Hill	Sitka spruce	1928										
	Good plants		—	—	—	—	—	77	78	73	72	76
	Culls		—	2	2	2	1	63	65	64	61	63
22 Cwm y Gerwyn	Norway spruce	1929										
	Good plants		7	4	6	2	5	33	35	38	34	35
	Culls		26	20	24	2	20	21	24	22	28	24

RADNOR FOREST
Table 4

ANALYSIS OF LOSSES PER CENT OF GOOD PLANTS AND CULLS IN THE FIRST YEAR; ALL TREATMENTS COMBINED

Experiment Number	Species	Year of planting	Mean losses per cent: Good plants	Mean losses per cent: Culls	Mean difference	Approximate standard error	Diff. required for significance at P=.01	REMARKS
Method and Density of Sowing								
1	Douglas fir	1928	27	47	20**	±2.9	8.1	
2	European larch	,,	11	38	27**	±2.7	7.6	
8	European larch	1930	—	2	2*	± .9	2.5	Very small losses
3	Sitka spruce	1928	—	4	4**	± .5	1.5	,, ,, ,,
Grading of Seedlings								
4	Sitka spruce	1928	2	4	2	±.8	2.6	,, ,, ,,
5	Norway spruce	,,	—	1	1	±.7	2.4	,, ,, ,,
9	European larch	,,	13	25	12**	±3.2	9.7	
10	Douglas fir	,,	37	50	13**	±3.3	10.1	
11	Sitka spruce	,,	—	3	3	—	—	,, ,, ,,
21	Norway spruce	1929	4	10	6	±3.0	9.2	
Spacing of Transplants								
6	Norway spruce	1928	—	1	1	—	—	,, ,, ,,
7	Sitka spruce	,,	2	7	5	±3.3	10.1	
12	European larch	,,	22	33	11**	±3.3	10.2	
13	Douglas fir	,,	16	34	18**	±2.4	7.2	
14	Sitka spruce	,,	—	1	1	± .7	2.3	,, ,, ,,
22	Norway spruce	1929	5	20	15**	±3.9	12.0	

* Difference significant at 5 per cent level of probability ** Difference significant at 1 per cent level of probability

RADNOR FOREST
Table 5

ANALYSIS OF HEIGHT GROWTH OF GOOD PLANTS AND CULLS, OCTOBER, 1935: ALL TREATMENTS COMBINED

Experiment Number	Species	Year of planting	Mean height in inches		Mean difference	Approximate standard error	Diff. required for significance at P=.01
			Good plants	Culls			
Method and Density of Sowing							
1	Douglas fir	1928	62	55	7**	±2.1	5.9
2	European larch	,,	86	62	24**	±2.8	8.0
8	European larch	1930	50	39	11**	±1.6	4.4
3	Sitka spruce	1928	67	57	10**	±1.1	3.2
Grading of Seedlings							
4	Sitka spruce	1928	61	49	12**	±1.2	3.6
5	Norway spruce	,,	51	42	9**	±1.5	4.5
9	European larch	,,	89	70	19**	±3.8	11.5
10	Douglas fir	,,	70	50	20**	±3.1	9.5
11	Sitka spruce	,,	64	55	9**	±1.8	5.3
21	Norway spruce	1929	27	22	5**	± .8	2.3
Spacing of Transplants							
6	Norway spruce	1928	57	44	13**	±1.24	3.8
7	Sitka spruce	,,	74	56	18**	±1.9	5.9
12	European larch	,,	85	67	18**	±3.3	10.0
13	Douglas fir	,,	106	87	19**	±3.7	11.3
14	Sitka spruce	,,	76	63	13**	±2.0	6.1
22	Norway spruce	1929	35	24	11**	±1.9	5.8

** Difference significant at 1 per cent level of probability

Table 6

NUMBERS OF GOOD PLANTS AND CULLS PLANTED IN RADNOR FOREST
METHOD AND DENSITY OF SOWING

Experiment Number	Species and Transplant grade	Year of planting	Sowing Densities (Sq. ft. per lb. of seed)										TOTAL
			Broadcast Sown					Drill Sown					
			300	150	100	50	Total	450	300	200	100	Total	
1 Ednol Hill	Douglas fir	1928											
	Good Plants		956	935	753	635	3,279	906	946	906	808	3,566	6,845
	Culls		167	116	182	198	663	80	120	153	195	1,611	2,274
2 Ednol Hill	European larch	1928											
	Good plants		768	769	735	568	2,837	772	803	732	591	2,898	5,735
	Culls		80	89	70	81	320	81	121	102	78	382	702
8 Rhiw Lawr	European larch	1930											
	Good plants		180	440	680	680	1,980	180	320	480	640	1,620	3,600
	Culls		20	40	80	80	220	20	40	40	80	180	400
			600	450	300	150		900	600	400	200		
3 Ednol Hill	Sitka spruce	1928											
	Good plants		924	841	839	635	3,239	991	922	892	682	3,487	6,726
	Culls		74	110	114	186	484	68	113	124	115	420	904

Table 7

NUMBERS OF GOOD PLANTS AND CULLS PLANTED IN RADNOR FOREST
GRADING OF SEEDLINGS

Experiment Number	Species and Transplant grade	Year of Planting	SEEDLING GRADES				
			(1) Over Half Maximum Shoot Length	(2) Under Half Maximum Shoot Length	(1) and (2) Combined	(3) Culls	TOTAL
4 Ednol Hill	Sitka spruce	1928					
	Good plants		656	571	530	256	2,013
	Culls		41	80	123	229	473
5 Ednol Hill	Norway spruce	1928					
	Good plants		563	564	528	367	2,022
	Culls		62	73	106	153	394
9 Ednol Hill	European larch	1928					
	Good plants		1,010	708	560	283	2,561
	Culls		57	40	80	120	297
10 Ednol Hill	Douglas fir	1928					
	Good plants		1,023	908	849	512	3,292
	Culls		59	112	144	232	547
11 Ednol Hill	Sitka spruce	1928					
	Good plants		963	990	957	587	3,497
	Culls		39	83	76	266	464

Table 8

NUMBERS OF GOOD PLANTS AND CULLS PLANTED IN RADNOR FOREST
SPACING OF TRANSPLANTS

Experiment Number	Species and Transplant grade	Year of planting	SPACING DISTANCES IN TRANSPLANT LINES 10″ × 1″	10″ × 1½″	10″ × 2″	10″ × 3″	TOTAL
6 Ednol Hill	Norway spruce	1928					
	Good plants		1,155	758	586	400	2,899
	Culls		124	55	46	19	244
7 Ednol Hill	Sitka spruce	1928					
	Good plants		1,090	801	602	405	2,898
	Culls		193	80	40	22	335
12 Ednol Hill	European larch	1928					
	Good plants		1,536	974	886	546	3,942
	Culls		163	120	79	40	402
13 Ednol Hill	Douglas fir	1928					
	Good plants		997	717	553	326	2,573
	Culls		184	87	61	37	369
14 Ednol Hill	Sitka spruce	1928					
	Good plants		1,763	1,163	894	636	4,456
	Culls		206	121	79	40	446
22 Cwm y Gerwyn	Norway spruce	1929					
	Good plants		1,555	1,271	922	660	4,408
	Culls		82	84	42	40	248

and planted out in unit plots of irregular size with a Latin square layout. Four replications of the four different spacings thus gave sixteen plots in all. Within each plot the good plants and culls were planted separately.

This series comprises the following experiments:—

Radnor Forest, Experiment No. 6, Ednol Hill, 1928 (Norway spruce)
,, ,, ,, No. 7, ,, ,, ,, (Sitka spruce)
,, ,, ,, No. 12, ,, ,, ,, (European larch)
,, ,, ,, No. 13 ,, ,, ,, (Douglas fir)
,, ,, ,, No. 14, ,, ,, ,, (Sitka spruce)
,, ,, ,, No. 22, Cwm-y-Gerwyn, 1929 (Norway spruce)

Conclusions. Analysis of assessment data obtained from these experiments (Tables 4 and 5) points to the following conclusions:

Losses on Establishment. In this series of experiments, as in the grading experiments, losses among the spruce during the first year were slight, whereas the losses of European larch and Douglas fir were considerable (losses of good plants 22% and 16%, culls 33% and 34% respectively). By the end of the third season these losses had increased by about fifty per cent.

Comparing the effect of the different spacings on losses among the good plants in the first three years it is noted that the narrower spacings tended to produce a higher percentage of deaths than the wide spacings (Experiments No. 12, European larch; and No. 22, Norway spruce). The differences, however, were not significant statistically.

Losses among the culls in this series, as also in the Method and Density of Sowing, and Grading experiments, were again high compared with the losses of good plants. In three of the experiments (Nos. 12, European larch; 13, Douglas fir; and 22, Norway spruce) the overall losses of culls in the first year were 29.9% while losses of good plants were only 13.8%, a difference significant at the one per cent level of probability. The losses of Sitka spruce culls were, however, again low, not exceeding 7 per cent.

Height Growth. The spacing experiments have emphasised rather strongly the lack of response in height growth to the use of different spacing distances in the nursery transplant lines. On the whole the height differences recorded at the end of the eighth season are small and insignificant throughout the whole series.

It is again brought out however, that the good plants possess a greater general vigour than the culls. From the height assessment data in Table 3 it will be seen that in each of the six spacing experiments the mean height of the good plants exceeded that of the culls by from 11 to 19 inches, differences which, in all cases, greatly exceed the one per cent level of probability. Combining all species and treatments the mean height of the good plants over the whole series was 72.2 inches compared with 56.9 inches for the culls.

Summary

1. Nursery investigations to test the effect of different methods and densities of sowing, grading of seedlings and the use of different spacing distances in the transplant lines were carried out at Bagley and Kennington Nurseries, Oxford during the years 1920 to 1929. These investigations form the "Nursery Side" discussed in the present paper.
2. The investigations were concerned with coniferous species only.
3. Four experiments dealing with methods and density of sowing, six with grading of seedlings, and six with spacing of transplants were extended into Radnor Forest during the years 1928 to 1930 to study the long-term effect, if any, of the nursery treatments. These experiments form the "Forest Side" of this paper.

4. **Method and Density of Sowing.** (Douglas fir, European larch and Sitka spruce):

Nursery Side. Drill sowing was beneficial to Sitka spruce and Douglas fir both as regards size and quantity of seedlings produced per lb. of seed, whereas broadcast sowing was recommended for European larch. The thinner sowing densities resulted in larger seedlings and better production per lb. of seed for all species, both broadcast and drill sown.

Forest Side. In the forest neither losses on establishment nor height growth at the end of the eighth season were influenced significantly by the different methods or densities of sowing applied at the nursery stage.

The good plants suffered a lower percentage of losses and grew faster than the culls, the differences in nearly all cases exceeding the one per cent level of probability.

5. **Grading of Seedlings.** (Douglas fir, European larch, Sitka spruce and Norway spruce).

Nursery Side. Of three grades of seedlings studied Grade 1 gave the best and Grade 3 (culls) the poorest results in the transplant lines. Grading according to size alone does not merit recommendation.

Forest Side. There is no evidence that the grading of seedlings before lining-out has any significant effect on the percentage of losses on establishment or on subsequent height growth.

On the other hand a simple grading of transplants into good plants and culls at the time of planting out in the forest is shown to be effective. The good plants of this grading showed a lower percentage of losses and faster growth than the culls, the differences being significant statistically in nearly all cases.

6. **Spacing of Transplants.** (Douglas fir, European larch, Sitka spruce and Norway spruce).

Nursery Side. Wider spacing distances in the transplant lines gave no advantage in better quality of transplants or in lower losses except in the case of the spruces.

Forest Side. After planting out in the forest the different spacing distances used in the transplant lines did not have any significant effect on losses or on subsequent height growth up to the end of the eighth season.

Where losses were appreciable the losses of good plants were significantly lower than the culls. The height growth of the good plants at the end of the eighth season was in all cases higher than that of the culls, the differences greatly exceeding the one per cent level of probability.

PLANTING BEECH AT WEST WOODS WITH AND WITHOUT COVER

By H. DYER

Forester, South-West England

During F.Y.50 some pure beech planting was carried out both with overhead cover and without cover. The elevation of the site ranged from 600 to 700 feet. The cover left took the form of hardwood coppice, mainly birch, spaced at about 20 ft. × 20 ft. where available. This had the effect of throwing a dappled shade. The beech were spaced at 5 feet by 5 feet and, where the spacing required it, they were planted close up to the coppice cover; in the past it has been usual to keep a certain distance away from the coppice. On inspecting the two areas in the following year, the plants without overhead cover, rather surprisingly, appeared to have given the better result. I think, however, that this is due to the ploughing done in the July preceding planting when a "stump-jump" plough was used. Planting was commenced in November, by which time the weathering of the ploughed area had given conditions which were just about ideal for planting. The planting was completed before the end of the year.

On comparing the two treatments, I am of the opinion, however, that the best results will usually be obtained where planting is carried out leaving, where possible, enough cover to give a dappled shade. There are various disadvantages in planting without cover, including probabilities of frost damage in the low lying places. Also, when weeding in areas without cover, there is sometimes a serious risk of the plants being scorched by sun, unless weeding is delayed until late in the season; but by delaying weeding one has to face very prolific weed growth in this area of heavy bracken, under which plants make only a small amount of growth. Further by suddenly opening up the plants late in the year, they are given very little time to harden off before being exposed to winter conditions, with the possibility of severe frosts. In the type of planting where cover was available, it was possible to weed with safety at any time when necessary during the summer months, and generally the weed growth was not so heavy as in the area without cover; one weeding during the summer season was usually sufficient. Frost danger, too, was practically negligible. I consider this form of leaving a dappled shade wherever possible is ideal for beech.

In my experience it is desirable to commence planting as early as practicable, and to complete it if possible before the end of the year or at the latest by February, according to weather conditions. Planting after February is usually a gamble.

ECCENTRIC GROWTH

By W. F. STODDART
Forester, Education Branch

On the Cademuir section of Glentress Forest there is a shelter-belt, measuring 200 yards by 40 yards, containing a mature crop of mixed conifers and hardwoods, 180 stems in all. This shelter-belt is subject to a prevailing wind of considerable force from the south-west on most days of the year, and it is interesting to note that all the trees are elliptical in cross-section, the greatest diameter being in the direction of the prevailing wind.

This unusual growth is termed "hyponasty" and is thought to be caused by the growing tissue on the windward side of the tree being in a state of tension and that on the leeward side in a state of compression. I measured the breast height diameters of a number of trees as follows; all measurements being in inches:

Scots pine	22 × 17
European larch	16½ × 14
Norway spruce	12 × 9
Ash	24 × 20
Beech	25 × 18
Oak	18 × 13
Elm	13 × 11

A P.22 Douglas fir in Glentress Forest was found with mid-height diameters of 5¾ × 3¼ inches.

EUROPEAN LARCH RACES

Review of Articles by N. P. Tulstrup in the
Dansk Skovforenings Tidsskrift—December, 1950

By W. H. GUILLEBAUD
Deputy Director-General

This paper gives provisional data on a number of European larch provenance experiments in Denmark 12 and 13 years old.

The following is the height of one series of plots at 13 years of age:

Plot No.	*Height (feet)*	*Origin*	*Region*
116	25.6	Ruda (special collection)	Sudeten
117	25.6	Erbersdorf	Sudeten
118	25.3	Ruda (State Forest)	Sudeten
122	25.0	Vysoke Tatry (4,300 ft.)	Carpathians
119	24.3	Jaromeric	Carpathians
120	23.0	Liptovska Teplicka (3,600 ft.)....	Carpathians
121	22.0	High Tatra (2,300 —3,600 ft.)	Carpathians
129	21.6	South Mahren, Vorkloster (1,300 ft.)....	Lower Austria
132	19.4	Wiesmath (Wiener Neustadt)	Lower Austria
130	19.0	Lackenbach	Lower Austria
131	19.0	Wechsel (Wiener Neustadt)	Lower Austria
125	17.1	Kematen-Inzing (2,300 ft.)	Tyrol
128	16.7	Fleinstal (3,900 ft.)	Tyrol
126	15.8	Obermieming (3,300 ft.)	Tyrol
127	15.8	Martelltal (3,900 ft.)	Tyrol

Perhaps the most significant feature of the above list is the uniformity of the height growth within a given regional provenance.

There is a difference of from 8 to 10 feet between the heights of the best (Sudeten) and the worst (Tyrolese Alps) origins. The Carpathian larch is little inferior to the Sudeten.

Other series of foreign provenance plots included three separate origins of Polish larch, Scottish larch from Kirkhill, Aberdeenshire, and larch from the Swiss Alps.

The Polish larch from Skarzysko in the South of Poland were the best of the series, outstripping even the Sudeten, and equalling Japanese larch in rate of growth; the poorest were the larch from the Swiss Alps. The Kirkhill origin was intermediate in height growth.

Form. The Scottish larch from Kirkhill were exceptionally well formed, but the Polish larch from Skarzysko and two of the three Sudeten lots, as well as a number of the Danish origins were also good. The only lot of really bad form, curiously enough was of Polish origin (Gora Chelmowa), but this seed came from old trees of coarse habit.

Canker. The plots showed very variable resistance to canker. Polish larch from Skarzysko was virtually immune; other resistant origins included the other Polish larch races, the Sudeten larch and those from the High Tatra. The worst lots were those from Switzerland, which were heavily cankered, some of the plots containing numerous dead trees. The Lower Austrian provenances were rather less badly attacked than the Swiss.

Summary. The writer concludes that the results point clearly to the superiority of the Polish, Sudeten, and Carpathian seed origins, as well as some of the Danish origins tested.

The Swiss and West Alpine larch should be ruled out for planting in Denmark.

The Scottish larch though outstanding as regards form was not specially vigorous or resistant to canker.

Of the Polish origins Skarzysko and Zagnansk were the best.

A REPORT OF WORK ON POPLARS AND POPLAR CULTIVATION IN GREAT BRITAIN—1951

By

T. P. PEACE, *Pathologist*

and J. JOBLING, *Assistant Silviculturist*

Research Branch

(This Report was presented to the Sixth Session of the International Poplar Commission, 1952)

Varietal Trials

The only new area started since 1950 is at Stenton in East Lothian, in the south of Scotland, where the bed of an abandoned reservoir is being planted. No assessments have been made during the year on any of the trials.

The main collection contained 223 clones in November 1950, and cuttings or plants of a further 60 clones have been received since then. Many of these are only of botanical interest, and some have done so badly in the nursery that they will not be used in trial plantations, but it is hoped eventually to extend the trials to include all really promising clones.

Negotiations are in progress for an area of about 25 acres of land to be used as a National Populetum. If these negotiations are successful planting will be started next winter. It is intended to plant initially three trees of all the principal species and hybrids, of which one will be retained to reach its full growth.

Progress has been made towards finding a suitable site for a wind exposure trial of different varieties. Lengths of very exposed roads in the Cambridgeshire fens have been selected, and negotiations for the use of the road margins for the poplars are in progress.

A large number of clones have been planted very close to the base of a high wall at Alice Holt Research Station. It is hoped, by this means, to discover which are geotropic (like *P. robusta*) and which are phototropic (like *P. serotina*).

Silvicultural Experiments

New silvicultural work on poplar started during the current forest year can be divided conveniently into two phases; namely, work in the nursery on the propagation of poplar from cuttings and the raising of plants suitable for planting out in the field, and work in the field concerning the successful establishment of poplar plantations on differing sites. In some cases the two phases are dealt with separately in that experiments laid down in the field are not always dependent on plants raised experimentally in the nursery, but generally speaking experiments are so designed that the plants produced during the nursery experiments are subsequently transferred to the field and the results in both places correlated.

All the nursery experiments, with one exception, are being carried out at the Forestry Commission Research Nursery at Kennington, Oxford. The most extensive of these is based on the wide spacing of cuttings, in conjunction with root pruning during the peak growing period. Three different spacings and two separate times of root pruning are being examined—making nine treatments in all—and the resulting plants are to be transferred to the field in the following season to study the effects of the treatments. A preliminary experiment of a similar nature has already disclosed that by wide spacing and root pruning of cuttings, plants are produced in one year which are comparable with stumped and transplanted stock in rigidity and shoot height growth and, in addition, possess what is thought to be a most desirable fibrous root system. For this year's experiment, 378 cuttings of each of the varieties *P. serotina*, *P. serotina* narrow crowned variety, *P. gelrica* and *P. robusta* are being used.

A second nursery experiment at Kennington is devoted to testing the effect that length of cutting has on survival and on the growth of the shoot during the first season. Six different cutting lengths are under examination, ranging from 4 ins. to 9 ins., and, as in normal practice, the whole length of the cutting is being inserted in the soil. Only cuttings of *P. robusta* are being tested, 120 for each of the six lengths. Previous work of this sort has shown that certain varieties under optimum conditions of soil moisture will produce a satisfactory shoot and root system from a cutting less than the normal length of 8 to 9 ins.

The third experiment at Kennington is one on a small scale, devoted to the examination of the shoot growth and survival of cuttings taken from different parts of one-year shoots. Three different types of cuttings are under trial: the first type is taken from the base of the shoot. The buds on them usually sprouted during the summer, and they now bear scars where the resulting shoots were removed. This type of cutting is thicker than normal. Growth takes place from adventitious buds produced around the pruning wounds. The second type is taken from the middle of the shoot. They bear a moderate number of normal buds. The third type is taken from the upper part, but not from the extreme tip, of the shoot. They bear rather more buds than the second type, but have a greater proportion of pith and are thinner and more pliable.

The fourth silvicultural nursery experiment is being carried out in one of the Forestry Commission Research Station's nurseries at Alice Holt Lodge, Farnham. This is a small scale project to examine the shoot and root growth from cuttings of *P. robusta* inserted in soils of varying acidity and alkalinity. Lime, in the form of calcium hydroxide ($Ca(OH)_2$), has been applied to small three foot square plots of acid soil, in which four cuttings have subsequently been inserted, in amounts ranging from ¼ lb. to 4 lb. An extended pH range has resulted, and it is expected that a fairly accurate determination can be made of the soil pH producing optimum growth and the range of pH in which poplar can be propagated from cuttings.

Silvicultural experiments in the field are mainly concerned with determining the means of establishing poplar plantations satisfactorily from the point of view of obtaining the maximum number of healthy and vigorous trees and the minimum number of deaths. Poplar experiments have been laid down on three widely different sites during the present season, although two of these can be considered as supplements to those laid down last year.

The first of these is on basic fen peat at Harling, in Thetford Chase Forest, where three planting treatments are under observation. Past work on the establishment of poplar has indicated that the raising of a mound of soil around the base of the plant is very similar in its effect, in producing more vigorous trees, to spreading a thick mulch of cut grass or other vegetation on the ground surface around the plant to a diameter of about four feet. In order to study the nature of the effects of mounding and mulching more closely, cultivation of the ground around the plant has also been included in the current experiments, and it is intended that this third treatment should eliminate altogether the weed growth, which is likely to be found in the vicinity of the plant during the growing season.

Comparable in detail, a second experiment has been laid down at Drayton, in Rockingham Forest, on heavy Northants boulder clay bearing a thick grass vegetation. The planting of poplar on this type of site has proved difficult, in that growth during the first two or three seasons after planting has been slow, while often there has been die-back of the leading shoot and, sometimes, death. It is expected, however, that this experiment will clearly show that cultivation, and either mounding or mulching or both, will enable the trees to exhibit greater vigour than has hitherto been the case with plantings on this and similar sites.

The varieties planted are *P. serotina* at Harling and *P. robusta* at Drayton.

The third establishment experiment is laid down on ground not normally considered suitable for poplar. This is a very acid site (pH = 3.8 to 4.5) in the New Forest, where the soil is a medium to sandy loam which is acutely deficient in lime and phosphate and markedly deficient in potash. Lime has been applied to half the plots in sufficient quantity to raise the pH to above 6.0, and next season, the second after planting, a nitrogen, phosphate and potash fertiliser will be added to stimulate growth in both limed and unlimed plots. Two varieties are being used in this experiment, *P. trichocarpa* and *P. serotina* narrow crowned variety, and it is expected that information will become available in due course on the relative reaction of Balsam and Black hybrid poplars to acid soil conditions.

The fourth field experiment is at Harling and is an extension of a nursery experiment, on the wide spacing and root pruning of cuttings, laid down and completed last season at Kennington Nursery. It is designed to compare the differences in behaviour in the field of plants raised from normally spaced and wide spaced cuttings, with and without root pruning. Mention has already been made of the preliminary results of this type of experiment, the plants used are all rooted one year cuttings of *P. serotina* and *P. robusta*.

The silvicultural experiments in the field have been statistically designed to give the maximum information on the reactions of the trees to different treatments, and assessments will be for survival, die-back, health and height growth. In addition, pictorial records will be maintained by photographing sample trees of each treatment.

During the past growing season assessments were carried out on three establishment experiments and four manurial experiments, all originally planted during February, 1951. Assessments were for survival, health, leading shoot, die-back and increase in height during the growing season. As the results are for the first season in the field only, they cannot be considered final or necessarily indicative of the future behaviour of the trees. In addition, since the experiments and analyses in themselves are intensely complicated and require detailed explanation for a full understanding, it is only intended here to give a brief summary of the preliminary results.

Each one of the establishment experiments, laid out on three different sites, included four varieties, four age/types of plant, three levels of a phosphate-potash fertiliser and two planting treatments, making in all 48 separate treatments for each variety. As was anticipated, it has not been possible to produce statistically sound evidence for any differences in behaviour between the varieties—*P. serotina*, *P. serotina* narrow crowned variety, *P. gelrica* and

Photo 1. Long-leaf pine forest tapped for resin in Alabama, U.S.A.

Photo 2. Worthless oak scrub which springs up when the long-leaf pine is clear felled.

(Photos by C. A. Connell)

Photo 3. Members of the Royal Forestry Society of England and Wales inspecting beech sample plots, 130 years old, at Odsherred, Denmark.

Photo 4. The finest beech in the Odsherred sample plots; note the fine branches in the crown.

(Photos by J. T. Wildash)

Photo 5. In the Beechwoods of Charlton Forest, Sussex. An informal photo taken during a staff outing from the South-East England Conservancy Office.

(*Photo by J. B. S. Hodge*)

P. robusta—such differences as did occur can be attributed in the main to variations of the site, differences in soil moisture content at the times of planting the variety blocks and, possibly, the different handling treatments each variety received. As regards age/type of plant, stumped one-year cuttings lined in the nursery for one year gave the highest survival figures, were the healthiest plants, and produced the greatest increase in height on all sites. Rooted one-year cuttings were generally less vigorous, but were superior to unrooted sets and stumped one-year cuttings lined for two years, both of which gave low survival figures, and proved the least healthy plants and produced smaller increases in height. The applications of fertiliser had no significant effects on the percentages of deaths or die-back, but on surviving plants, which did not die-back, the presence of fertiliser very slightly increased height growth and improved health. As already mentioned, the effects of mounding and mulching were very similar, though in some cases, particularly in the percentages of deaths, the former treatment gave slightly better results. It is interesting to note that a combination of mounding and mulching did not give significantly better results than either treatment alone.

Each of the manurial experiments included the four varieties named above, and involved the application of one of three levels of a nitrogen fertiliser during the summer, a phosphate and potash fertiliser, separately or in combinations, at the time of planting, and one class of plant, namely stumped one-year cuttings lined in the nursery for one year. The experiments were factorialised, and each variety was given 27 separate treatments. For all four varieties, and on each of the sites except one, nitrogen, either alone or in combinations with the other fertilisers, increased the number of healthy plants and their height growth. Because there were very few deaths in any treatment, it was impossible to draw any conclusions regarding survival. On two sites, both in Thetford Chase Forest, all three fertilisers, considered separately, produced nearly significant effects on health and height, whilst in Alice Holt Forest only nitrogen had a significant effect. On the fourth site, in Rockingham Forest, the overall effects were so small that they could not be analysed with any degree of exactitude. On one Thetford Chase site, interactions were observed and, although the result was not statistically significant, nitrogen was most beneficial in the presence of potash.

Similar assessments and analyses will be made at the end of the present season, and it is hoped that after two years growth in the field the reactions to different treatments will be more obvious and easier to differentiate.

Pathology

Inoculations with bacterial slime resulted in *P. tremula* x *tremuloides* being added to the list of canker-susceptible varieties. Eighty per cent of the trees of this hybrid inoculated, developed canker. It is possible of course, since a mixed population of seedlings was used, that the others may have been resistant clones.

Steps are now being taken to bring all the poplar nurseries into line with the recommendations made by the Committee on the Transmission of Poplar Diseases. This will involve the discontinuance this summer of all outdoor work on bacterial canker at the Research Station at Alice Holt. In future, inoculations will be carried out at a special nursery at Mundford, Norfolk. This year, work with slime inoculations at this new nursery will be made on freshly rooted long cuttings, a method found quite satisfactory by Sabet at Cambridge.

Two acres of heavily cankered *P. candicans* suckers at Parlington Park in Yorkshire are being used as a test area for other clones. The plants were put in gaps cut among the suckers and it is hoped that this may provide the natural infection that failed or nearly failed to develop when alternate rows of cankered sets and test trees were planted at the Research Station at Alice Holt.

Melampsora attack was again heavy, and more data were collected on varietal resistance.

Dothichiza attack was severe on large three-year-old poplars used for planting in some of the trials. The plants were particularly large owing to the favourable growing season of 1950, and the fungus gained entry through the pruning wounds made by the removal of some of the side branches at the time of lifting. In 1951 most of the pruning required on the larger plants was carried out during August, instead of at the time of lifting. It is hoped, since wounds then made had started to heal by the end of the growing season, that *Dothichiza* attack will be less serious. Attack by this fungus was one of the factors militating against the S-2 plants in the age and type experiments.

A portion of the canker testing area at the Research Station was severely attacked by *Phyllosticta populina*. Considerable efforts were made to eradicate this outbreak. The same fungus also occurred in company with *Marssonina castagnei* on dead shoots and leaves on a few poplars in Fen Row nursery, Rendlesham.

Systematy

Mr. P. G. Beak has continued his studies, and has again provided invaluable help to the Forestry Commission Research Branch by his willing identification of poplar material.

P. szechuanica and its supposed variety *P. szechuanica tibetica* have been located in a number of collections. They are being studied by Mr. Beak. It would appear probable that they are not in fact at all closely related.

Distribution of Cuttings

As in past years a "List of Poplars in the Possession of the Forestry Commission Research Branch" has been widely circulated, and among the requests for cuttings were some for varieties of which little is known except their behaviour in the nursery.

As was anticipated, the visit of the International Poplar Commission to Great Britain earlier in the year aroused interest in a number of varieties being cultivated in this country, and many requests were made for cuttings of these, as well as for cuttings of the numerous new clones now under trial in Forestry Commission nurseries and plantations. In all, 589 cuttings have been despatched to persons overseas during the current season, to Belgium, Canada, France, Germany, Holland, Lebanon and South Africa. Of these over a quarter were cuttings of clones of *Populus eugenei*. Catkin material has also been sent to Belgium. Interest in poplars in Great Britain has increased, and during this season 612 cuttings of varieties for trial have been distributed to persons in different parts of the country.

For the fourth successive season, cuttings of four certified poplar varieties have been supplied to private estates, trade nurseries and Forestry Commission nurseries. The numbers distributed are shown below with comparative figures for 1951 Forest Year in brackets.

	P. serotina	*P. serotina* n.c.v.	*P. gelrica*	*P. robusta*
Forestry Commission	1590 (1735)	1450 (1610)	1500 (1610)	1450 (705)
Estates and Nurserymen	2259 (3820)	1597 (3275)	1647 (2310)	2607 (4655)
Total....	3849 (5555)	3047 (4885)	3147 (3920)	4057 (5360)

The numbers supplied this year have dropped below the 1951 figure but are still above the average for the past three seasons. The reduction can be attributed in the main to nurseries having built up their stocks from past distributions, as was the intention when the scheme came into operation.

In addition over 4,000 cuttings have been sent to Eire and Northern Ireland to enable the respective Forestry Departments to lay down stool beds.

ASPEN POPLARS IN GREAT BRITAIN

By T. R. PEACE, *Pathologist*, and
J. JOBLING, *Assistant Silviculturist, Research Branch*

(A report presented to the Sixth Session of the International Poplar Commission, 1952)

The European aspen, *Populus tremula*, is a native tree in Great Britain and occurs in most parts of the country on a wide variety of soils. It is found most frequently as one constituent of mixed scrub hardwoods, but occasionally occurs nearly pure over small areas of an acre or less. It shows considerable variation in form, bark colour, etc. from place to place, but in any one wood the aspens are often of a single type and sex, suggesting that they all arose originally from one plant by suckering. Certainly quite large areas can be colonized quickly by the suckers from a single tree. Despite its wide distribution and comparatively common occurrence, aspen trees of merchantable size are rarely met with. On most sites, and particularly on the heavy clays, where it is very common, it has a tendency to die, or to suffer from root decay and blow down, when it is only some 5 to 6 inches in diameter.

From the forestry point of view it has normally been regarded as a weed species, and little effort has been made to treat it silviculturally. In a few places, however, groups of aspen suckers have been thinned and pruned, but none of these are yet old enough to judge whether they will be successful commercially. The planting of native aspen has not, as far as we know, been attempted, and, in view of its general failure to reach economic size, could hardly be recommended.

In a few areas aspen has proved an indirect source of damage to Scots pine, because it acts as alternate host to the rust fungus *Melampsora pinitorqua* which is capable of doing considerable damage to its coniferous host. Fortunately *Pinus laricio* and *Pinus pinaster* are resistant to this *Melampsora* and can be used for planting in places where aspen occurs among the coppice.

The only large-scale plantings of *P. tremula* that have been made in Great Britain were done by Bryant and May Ltd. (Match Manufacturers) about fourteen to twenty years ago in two areas, one at Ballochyle, near Dunoon in Argyll, Scotland, and the other at Lakenheath in Suffolk on the edge of the East Anglian fens. At Lakenheath, on a poor alkaline peat, the trees grew very badly and have shown no improvement with time. In Argyll they grew somewhat better, but over the last nine or ten years they have been attacked by a cankerous die-back, the real cause of which has remained, until recently, obscure. Generally only the fungus *Fusarium* was found on the dead twigs and cankers. Eventually however, K. A. Sabet, working at Cambridge University, confirmed the presence of *Pseudomonas syringae* forma *populae* on material from these trees, and it now appears that the *Fusarium* is a rapid invader of the tissues already damaged by the bacterium. This finding has been confirmed by the spontaneous appearance of *Fusarium* on cankers initiated by inoculation with bacterial slime on *P. tremula* x *tremuloides* hybrids at Alice Holt. The aspen planted by Bryant and May were all raised from seed collected in Poland and Russia, or were brought over from there as seedlings. They show, as would be expected, considerable variation. Although the results have been unsuccessful commercially, the trees have done rather better in Argyll than is usually the case with native aspen on similar sites.

At Raby Castle in Northumberland some seedlings supplied by Bryant and May were planted in 1938, and these have done considerably better, having reached an average height of 29 feet in the first eleven years. When last examined they were still disease free. Other aspen from the same source were planted on sand over chalk at Lingheath, Brandon. On such a dry site they have inevitably done poorly and are now developing bacterial cankers, with the usual secondary *Fusarium*. Apart from Ballochyle and Brandon, bacterial canker has not been recorded elsewhere on aspen in Great Britain. This may, in part, be the result of insufficient observation, but is is certainly not common. In the two cases where it was recorded, cankered Black or Balsam poplars were growing in the vicinity.

As far as is known, the American aspens *P. tremuloides* and *P. grandidentata* are confined to arboreta, and nothing is known of their forest potentialities. Plants of two aspen or semi-aspen hybrids, *P. tremula* x *tremuloides* and *P. alba* x *tremula* have recently been introduced from Denmark. The latter does not appear at all promising, so far, in the Forestry Commission trials. They have both proved hard to establish, but a commercial planting of the first named has made fairly rapid growth on a good site in Norfolk, though it is still too early to judge its real possibilities. On inoculation with bacterial slime, *P. tremula* x *tremuloides* has proved extremely susceptible. Though of course this does not necessarily postulate that it will be attacked in the field, it does raise doubts as to the advisability of large scale planting.

In the immediate future, research work on aspens is likely to be confined to further trials of *P. tremula* x *tremuloides* on a variety of sites.

AN AUDIBLE FIRE WARNING SYSTEM AT THETFORD CHASE

By G. H. CLARK
Chief Clerk, East England

Shortly after the war forty-one new houses for forest workers and supervisory staff were erected on a site adjoining the existing village of Santon Downham. Concurrently with this substantial extension of the village, arrangements were in hand for improving the fire protection and warning system for Thetford Chase Forest, the central control point of which is at the Santon Downham District Office. An important effect of the new housing scheme was the greatly increased availability of man-power for turning out to fires occurring outside working hours, but for this labour force to be fully effective there must be some easy and speedy means of summons.

With this in view the Conservator decided upon a warning siren similar to the type used for air raids during the war, with one control point in the District Office and a second in the Senior Fire Warden's house, which is located in the old village.

The principal problems to be solved in putting into effect this apparently simple project were:

1. The only electricity supply available at the time was 110 volts D.C. (generated by Forestry Commission). On the other hand a mains supply of 230 volts A.C. to the village was expected within a year or two, and the expense necessary to replace the siren later, or have it re-wired, would be wasteful and must be avoided if possible.
2. The siren must be powerful enough to be heard throughout the new and old sections of the village and yet not be sufficiently loud to be heard in Brandon (one mile distant), where it might be confused with that of the County Brigade. It must not cause undue disturbance or annoyance to the residents of Santon Downham.

Obviously a certain amount of disturbance in the immediate neighbourhood would be inevitable whenever the alarm was sounded, but the siting must be chosen so as to avoid the risk of possible serious shock to the nerves of very young children or elderly persons in the houses near by.

These considerations entirely ruled out the Home Office type of siren as used by Local Authorities. This type is extremely powerful and furthermore requires a 400 volts, 3 phase electricity supply. Its use (if this supply were available) would not only confuse the inhabitants of Brandon but in all probability would also cause some of the inhabitants of Santon Downham much nervous distress.

As a first step various patterns of siren were examined and discussed, but we were unable to obtain the loan of any apparatus for trial. Deliveries were subject to delays of up to six months and a further possible delaying factor in our case was the need to wire the selected model for a non-standard voltage of 110.

In the absence of trial, a decision had to be made on purely theoretical considerations. One difficulty in arriving at a choice lay in the difference between "audible range" and "alarm range". A siren may be heard in still air for a considerable distance, but its effective alarm range is limited to a much shorter distance. The choice was ultimately reduced to alternative models having respectively audible ranges of one and a half miles and three quarters of a mile. The first would be audible in Brandon to quite a considerable extent with a favourable wind. The second would have barely sufficient alarm range for the purpose intended. In the end the smaller model was ordered, with the intention of supplementing it with a second of the same type if found to be necessary later.

The order for the siren was placed in the Spring of 1948, and while delivery was awaited plans were drawn up for routing the overhead lines required from power source to control points and to the apparatus. In order to save wiring costs the closing of the main circuit was to be by relay switch remotely controlled by push buttons at the two selected points mentioned earlier. This enabled much lighter cable to be used for the switch lines. Voltage drop in the main cables had to be calculated and an approximate site arrived at for the siren. A further matter to be considered was provision of some indication at each control point in the event of power failure from blown fuses, cable fault or other cause. It would undermine the whole system if the operator pressed the button and assumed that the alarm had been sounded when in fact the peace of the village remained as tranquil as before. To avoid this kind of anti-climax a low consumption indicator lamp above each push button was decided upon. If the light went out, this would signify a circuit or power fault.

The approximate site of the siren was provisionally plotted on a large scale map of the village and its environs, and a circle representing an assumed alarm range of a quarter of a mile was drawn. The area enclosed included practically all that was required but the effects of reflection of sound from buildings, its absorption by neighbouring woods and competing sounds, such as radio sets, were incalculable, particularly as regards the fringe areas.

The siren was delivered in the late summer of 1948, and with the aid of a forester's van and eight motor vehicle batteries, tests were made at various points. It was found that in the open air, even with an unfavourable light breeze blowing, the effective alarm range was much greater than the quarter mile assumed. On the other hand, indoors, with windows closed and radio operating at normal volume, it was inaudible at two hundred and fifty yards. Also difficulty was experienced in hearing it on the leeward side when trees intervened. Even when allowance was made for the fact that the apparatus was being sounded from the floor of a van and not from the top of a pole it was evident that either a larger siren or a second of the same size would be necessary. It was decided to order a second model of the same type. In the light of the experiments conducted it was now possible to calculate the combined alarm range. The positions for the two sirens three hundred yards apart were marked on the plan and assuming a safe indoor alarm range under all normal conditions of two hundred yards radius, the boundary of the alarm range was plotted. The area of highest concentration for indoor audibility then appeared on the map as an ellipse (taken in so to speak at the waist) whose longitudinal axis was five hundred yards.

At this stage it was realised that the use of two small sirens instead of one large one had many advantages:—

(*a*) The expense of re-wiring later would be avoided. With a 110v. supply the two would be wired in parallel; with 230v. supply they would be wired in series, the change-over being both simple and inexpensive.

(*b*) The second siren, while increasing the alarm range as required, could be sited on the side of the village remotest from Brandon.

(*c*) Since the two sirens would be some distance apart, the applied voltage at the terminals of each, while working in parallel, would differ (that remotest from the supply being 6 to 7 volts lower); hence the aural frequency of the one would be slightly lower than that of the other. Over a certain area the dissonance thus caused would intensify the alarm effect, since a discord impinges on the hearing with more penetration than does a pure note.

(*d*) Residents nearest each instrument would not suffer from the same concentration of sound at close quarters as they would if near an instrument twice the size.

These advantages must be offset by a 20 per cent increase in cost.

The second siren was delivered early in 1949, but hopes of having the installation ready for use during the fire danger season of that year rapidly faded. Materials, particularly copper, were still scarce and there was considerable difficulty in finding a supplier who could produce a relay switch of the required type. Later in the year activity commenced in bringing the mains supply to the village and plans were then altered to have the installation working on the 230 volt A.C. mains in time for the following fire danger season, which would commence in February, 1950. Well before that, the overhead lines (suspended on locally grown larch poles) and the sirens were in position, and by February, 1950 all that remained to be done was the wiring to the control switches and linking to the mains. By March all was ready for test and by the end of that month the new audible warning system was integrated into Thetford Chase fire plan.

Its effectiveness may be judged from an incident that occurred some time later. The relay switch temporarily obtained was far from ideal and it was the intention to replace it when supplies improved. Its fault was hypersensitivity. One morning at 1 a.m. the sirens suddently sounded; despite falling rain and pitch darkness, the duty crew turned out from their beds—a tribute both to their devotion to duty and the efficiency of the system. What they said when the summons proved to be a false alarm is best left unrecorded.

The cause was never ascertained from proved facts, but the following theory is generally accepted:—

> The indicator lamps are wired across the push switches—thus a minute current flows continuously through the operating coil of the relay switch. When either button is pressed the lamp connected to it is temporarily by-passed and full current is supplied to the coil closing the switch contacts and operating the sirens. At that time power cuts were quite common and the day-time reductions in voltage were liable to be followed by night-time surges. It is thought that an unusually high surge occurred on that occasion, increasing the coil current sufficiently to close the contacts and hold them closed for perhaps a minute or so.

Following this incident the indicator lamps were removed from the circuit as it was felt that the temporary disadvantage of having no indication of fault in the system was preferable to having the crew turn out to a false alarm. The lamps were replaced as soon as a more suitable relay had been obtained.

GALE WARNING!
WINDBLOW IN WESTERN SPRUCE PLANTATIONS

By S. M. PETRIE

District Officer, West Scotland

"The modern extensive use of spruce in forestry in Great Britain is probably justified from a utilisation standpoint; but it does raise the danger of overthrow by strong winds, and demands that special consideration shall be given to this in appropriate circumstances". This sentence from an article entitled "The Soil Conditions which Determine Windthrow in Forests" by W. R. Day (*Forestry* Vol. XXIII No. 2) has very special significance for any forester concerned with West of Scotland forests, and may be regarded as a warning to him in the establishment of future plantations. Such districts, without a doubt, present circumstances wherein special consideration should be given to the dangers of windthrow. Preventive measures are possible and can be put into effect simply and at no great expense; remedial measures are difficult, very often ineffective and almost invariably extremely costly.

A brief examination of the causes of windthrow, of measures which may be taken to prevent it and of corrective action when it has occurred would not appear to be out of place even at this late date in the Government's vast afforestation scheme; it is now, when the Forestry Commission's early spruce plantings in West Highland districts are at the thinning stage, that wind effects are beginning to show themselves, and that dimly remembered warnings about the dangers of extensive blocks of pure, even-aged spruce, near the western seaboard, are coming back to mind. The unsightly gap caused by a gale in a spruce plantation, twenty years of age and receiving its first thinning, gives one a feeling of foreboding; if this is to happen to a stand of 30-foot high trees, some 800 to 900 to the acre after a first thinning, one is afraid to contemplate what may happen from the 30 to the 70-foot stage of growth, when numbers per acre are smaller, and where the block extends for miles without a change of species, a windbreak or natural shelter, any irregularity or even a marked difference in height. Vast acres of spruce on soft ground, growing rapidly, subject to heavy rains and frequent storms, with no shelter other than the undependable protection such trees afford each other, are unstable and unnatural communities, and windblow in the ensuing years may quite possibly be disastrous. The fall of one tree leads to the fall of its neighbour; as each tree or group of trees goes down, those in the vicinity become less stable, and a small initial or neglected gap may result in the entire heart being eaten out of the plantation by successive gales or even by "fresh" winds. Western districts are subject to a continuous succession of gales, summer and winter, and the country as a whole is shaken periodically by a really memorable puff such as occurred in 1898, 1926, and only recently in December, 1949. The last shook the writer as much as the woods when he had grasped the full extent of the damage, and had thereby been given cause to speculate on what might happen to the extensive spruce areas in his neighbourhood in the years to come.

Factors leading to Wind damage

The principal factors which either together or individually lead to the collapse of single trees, groups of trees or even whole stands are chiefly as follows:—

(*a*) Exposure of the site to strong prevailing winds.
(*b*) Incidence of a strong wind from an unusual direction.
(*c*) Shallow soils and lie of the rock formation.
(*d*) Heavy rainfall or snowfall.
(*e*) The drainage system.
(*f*) Concentration of the crown to the upper stem.

These may be briefly dealt with in turn.

(*a*) **Exposure of the site** of the plantation to a strong prevailing wind is an obvious contributory factor to windblow. Trees on an exposed hill face are obviously in much greater danger from wind than are those on a sheltered site. Such trees are, however, acclimatised from early youth to the prevailing wind and they develop through life a resistance to it both in crown and root to such an extent that, if margins are carefully handled, and if thinning is begun early and done often, damage from the wind normally experienced seldom or possibly never results. Very much greater damage may be expected from the mishandling of a plantation on an exposed site than of one on a sheltered site.

(*b*) **Incidence of a strong wind** from an unusual direction generally plays much greater havoc in plantations than do the prevailing winds, and in the establishment of plantations this factor has to be guarded against with as much care as have winds from the exposed side. Sudden gusts from the opposite direction to that of the prevailing wind catch trees "on the hop"; they are not acclimatised to force from that side; their energies all through life have been directed towards pressure coming the other way, and in consequence they are readily bowled over when hit by wind from an unexpected quarter. In almost all cases of severe windthrow in woods, it will be noted that trees have fallen with their crowns towards the direction of the prevailing wind, clearly indicating their lack of resistance to wind coming the other way. On the steep slopes of narrow glens where, whatever the wind direction, it blows either "up" or "down" the glen, it is not uncommon to find a blown group of trees at one spot pointing in one direction and at another spot, perhaps some hundred yards away, a group pointing in the opposite direction. Such blows are generally caused by the rebound of the gale from the side of the glen opposite to that of the plantation; where tributary funnels lead from the side glens, the direction of the rebounding wind is altered according to the lie of these tributary glens or corries, with the result that at some points on the plantation side, the wind strikes in a "down-glen" direction and at others in an "up-glen" direction. These rebounding gusts may be at right angles, or in an exactly opposite direction to that of the main gale, and they have been the cause of severe windfalls in plantations in hilly terrain.

(*c*) **Shallow Soils** and the lie of the parent rock material have an important bearing on the possibility of windthrow. It is upon the soil that the tree relies for anchorage, and if the soil be shallow, due to the presence near to the surface of a hard infertile sub-soil, pan formation or parent rock, root penetration downwards is impossible and an insecure footing only is obtained. Spruces are shallow rooters even in the most favourable of sites, but where soil fertility is confined to the shallow surface layer only, root spread is almost entirely horizontal; it is not uncommon to see blown spruce on some sites after twenty to thirty years of growth, with a downward root penetration of no more than six inches. The horizontal spread is considerable, and where orthodox spacing of the trees has been adopted, the root competition and the linking up of root systems of neighbouring trees are very considerable, so that very unstable conditions obtain and the crop has little resistance to offer to the first strong wind that blows.

The "lie" of the rock too is important. Where bedded rock outcrops at right angles to the floor of the plantation, roots are able to penetrate into and between the layers of the beds, and to secure a very firm grip beneath the soil; they are thereby able to withstand a much greater degree of exposure. This possibly applies less to spruces than to Douglas fir, pines and larch, which are more commonly to be found on such sites. Where the rock is flat under a shallow soil, or where the slope of the beds is in a downhill direction, no such anchorage can be obtained by the roots, and conditions very favourable to windblow ensue. On such sites, in heavy rainfall areas, where the water cannot percolate downwards but must ooze slowly along between the soil layer and the rock, gale damage may be expected. Examples have been seen where an entire group of trees, root, stem and canopy plus the soil layer, have been blown smoothly off the rock face, leaving it bare and exposed.

(*d*) **Heavy rainfall or snowfall** localities where extensive conifer blocks have reached the closed canopy and thinning stages provide optimum conditions for severe windblow, particularly in western districts or where strong winds are frequent. Gale damage in woods reaches its peak when thoroughly saturated soil conditions and the occurrence of a storm happen to coincide, and it is unfortunate that in this island a period of very heavy rainfall is very often immediately followed by a wind of gale force. It is surprising how often the cessation of the rain marks the beginning of the storm, and in the very wet summer of 1950 in Argyll, there was a steady sequence of days of continuous downpour lasting until the early evening, after which a south-westerly gale would immediately spring up and blow till midnight. The root systems of conifers were so loosened by the semi-liquid state of the soil that the trees, with their heavy wet crowns, were in perpetual danger of windthrow; where gaps from previous blows existed or where margins had been recently disturbed, toll was taken of the stands at intervals throughout the whole year. On saturated soils, uprooting and not stem-break is the rule, and even the most windfirm of broadleaved trees is not immune.

The rapid thaw of a snowfall has an even more saturating effect than heavy rain, as there is little or no rapid run-off of water to the drains, and a gale in conjunction with a thaw of snow can be very serious. In the wet soil conditions which prevail, the roots of trees lose all grip and are no longer able to hold together the mass of soil which should counter-balance the pressure of wind on the crowns; as a consequence, uprooting readily ensures. Should a fall of snow at the same time be lying on the canopy of the crop, windbreak may readily occur. Windbreak may happen by itself in hard weather conditions, or in conjunction with uprooting, should there be a partial thaw with a resulting saturated soil.

(*e*) **The drainage system,** both natural and artificial, has of course a great bearing on the stability of trees. The more rapidly superfluous water can be conducted from the soil of the forest area, the more will the drying out of the upper layers of the soil be speeded up and as a result the hold of the roots of the trees on the soil improved. Windthrow is very infrequent on a naturally well-drained slope, even after fairly heavy thinning; windbreak may occur, particularly if thinning has been so long delayed that the crowns of trees are confined to the topmost portion of the stem, but up-rooting is uncommon. It is of most frequent occurrence on wet flats where the run-off is slow, and on shallow soil areas where seepage down the slope is constant, due to the near presence of rock. Similar conditions prevail where the artificial drainage is insufficient, or is out of repair and water is unable to find its way along the prepared channels. The blocking of contour drains on slopes in wet districts is very liable to lead to the formation of a local marsh with resultant unstable conditions, and even the choking of a leader running more or less downhill may create a spongy area between the point of diversion of the water and the point where it finds again its own or another channel. Drainside trees are especially liable to blow, as the root spread of shallow rooting trees like the spruces becomes one-sided and the repair work done on drains tends to destroy any attempted root growth to that side.

Many of the Commission's plantations in western districts occupy a broad belt of the lower hill slope only, generally from sea level to about the 800 feet contour line, leaving in most cases, a very much larger area of bare hill between the tree planting limit and the summit of the watershed. While the plantation area itself may be adequately and efficiently drained, it is not sufficiently realised that an extensive undrained tract of country lying immediately above and forming a huge catchment area must dispose of its water via the planted ground before that water can find its way by the burns and rivers to the sea. Moreover, while the crowns of the trees reduce the impact of heavy rain upon the soil and trap part of it, which will evaporate from the canopy, the impact and quantity falling on the bare ground above is lessened in no such way, and a very quick run-off may follow, producing a volume of water with which all the forest drains may be unable to cope. The undrained unplantable ground can place a very heavy burden on the drains of the lesser planted area.

(*f*) **Concentration of the canopy** to the upper stem is an unfavourable factor in protection against wind. This point cannot be separated from thinning, and it is the timing of the first thinning and the length of the period between thinnings which determine the depth of canopy on the individual stem. A too long delayed first thinning, or too long an interval between thinnings, tends to "draw" the trees, whereby the lower branches of the crowns are suppressed and killed off, and the foliage is confined to the upper stem only, which is the only part of the tree having access to the light supply. The more thinning is delayed, the higher on the stem is the length of living crown, and the smaller becomes the percentage of crown length to total length. As a consequence, the more is the pressure of wind confined to the top of the tree and the stronger is the leverage effect upon the root.

Preventive Measures

In discussing the measures which may be the means of reducing or preventing the extent of windblow in extensive spruce plantations, it will be advisable to take in turn the headings as briefly outlined above. The causes of trouble lead to preventive devices which may be possible of adoption. As regards the depth of the soil and the rainfall there is little that can be done apart from the selection of the most suitable species. There are, however, some precautions which can be taken under the other heads and these may be examined briefly.

Exposure of Site

Exposure is a large subject and its consideration begins with the acquisition officer who makes it one of his cardinal points in assessing the value of an area for afforestation; the degree of exposure of any area determines the extent, species and treatment of any plantation which may subsequently be formed. While all sites are exposed to a certain extent, good quality soil localities have occasionally to be discarded because of the severity of exposure. Between such and the most sheltered localities, there are intermediate types which demand a modification of method on account of wind. The basic rule is to retain any existing natural shelter if the site should be so fortunate as to possess it and, should it not, to provide, as early as possible, shelter from trees especially planted for this purpose.

Natural shelter usually consists of solid or scattered scrub already growing on the ground, artificially created groups or belts of trees, or the remnants of a natural wood or plantation, It is now elementary procedure in the afforestation of an exposed site to make full use of these forms of protection, which are the best that can be afforded to young trees; they are enduring and they do not cause draughts. Their retention, in whole or in part, not only provides a guard against wind damage from the cleaning stage onwards, but also assists in the establishment of the crop. It is not intended here to discuss methods of dealing with scrub or old woodland, but fear of wind in handling spruce makes it imperative to ensure that marginal shelter is retained permanently and that, where conditions allow, the tree or scrub shelter available should be treated so as to break up the extent of pure conifers as much as required; the greater the exposure, the more scrub is retained or the more frequent are the patches or belts of old acclimatised trees left throughout the area. Marginal shelter is most important. It is generally on margins that initial windblow occurs and a large and unstable area of conifers may frequently be kept on its feet solely by the prevention of marginal gaps.

Where the area to be afforested is entirely bare, or where the existing crop is sparse or of local occurrence only, measures will require to be taken to stabilise a large spruce area by forming, at the earliest possible stage, belts or groups of more wind-resisting species, of a hardy type, sited so as to be of greatest service to the less secure species. Were economic and administrative conditions to allow it, it would be silviculturally desirable on an exposed site to establish marginal and internal belts of wind-resisting species some years before the planting of the main crop of spruce, with the object of having a certain amount of shelter from these belts in readiness, and of having them ever in advance of the spruce in growth. This is, however, not a practical proposition, and moreover the rate of growth of spruce in most western districts is generally sufficiently fast to outgrow other species even although these have the advantage of earlier establishment. The prescription to be stressed is that spruce areas should be frequently interrupted by belts of windfirm species such as Scots pine, *Pinus contorta*, Corsican pine, *Abies nobilis*, or Japanese larch as soil conditions permit in order to avoid too great an extent of pure spruce. The greater the exposure, the more frequent should these belts or clumps be interspersed, and while the majority should be placed at right angles to the prevailing wind, a few may be established in different directions as a guard against the unusual gale. The margins, as the weakest parts, must always be so safe-guarded by an alternative species, and if soil conditions and elevation allow, a hardwood margin is much to be preferred. Adverse soil conditions for the conifer species mentioned above should not be allowed to weigh too heavily against their use, as a change of species alone is a helpful measure; even a weak and stunted belt or group of larch in a spruce area may check the run of a windfall.

In this connection, it is advisable too to have spruce planted in mixture with another species wherever possible. Locality factors do not often permit of a suitable associate species; much of the ground in western districts is entirely a spruce type where pines, larches, silver firs and even Douglas fir cannot compete in growth with this species. It is noticeable, however, that where mixing has been done, and even where the secondary species has badly lagged behind in growth, the spruce are more windfirm and have a superior crown development. The hanging back and gradual die-off of such a secondary species as larch or pine have had much the same effect as a moderate cleaning or first thinning, with the added advantage that the process has been gradual. Should the original mixture have been one of plant by plant, the spruce have, early in the pole stage or about the first thinning stage, double the growing space, which they would occupy had the planting been pure. The result is that on removal of the pine or larch at cleaning there remains a firm crop of spruce with well developed crowns, gradually acclimatised to more open growth and in most cases windfirm. All round development is much better and such trees have a considerably larger volume than have spruce of the same age in pure plantations. An advantage of this type of planting, from the management aspect, is that it may be possible to delay or entirely avoid the first thinning which is not always a profitable operation. The cutting out of the associate species may leave the spruce well enough spaced to carry on to a size at which it would normally be receiving its second or third thinning.

Drainage

One of the chief forms of protection against windblow in spruce forests on soft ground, in western regions, is undoubtedly the formation of an efficient drainage system at the time of planting, and the maintenance of that system in good repair during the whole period of the life of the plantation. Many of our earliest plantings of spruce were done on ground which was not sufficiently intensively drained; this is obvious now in the cleaning of drains after a thinning. Further, in many cases on these early afforested areas, the arrangement of the drainage system was far from satisfactory. Too large a proportion of the drains are running in the direction of the hill slope, like ninety per cent of sheep drains in the West of Scotland, and they are actually draining a negligible area of ground. These drains, as the years have passed, have frequently become much bigger than their original size, the rush of water after a downpour having widened and deepened them appreciably, and this erosion has often led to the collapse of trees near the drain edges, a common initial stage of a larger gap.

On most spruce areas, efficient draining should provide that the majority of drains cross the hill slope and thereby trap water. Drains running with the slope must be restricted to as few as possible; fullest advantage should be taken of existing burns, and necessary leaders running down slope should be cut off to burns or natural water channels as frequently as possible, to prevent erosion of the sides and bottoms of drains with resulting danger of collapse to neighbouring trees. The cross drains, trap and feeder drains, should be of a satisfactory depth, depending on the site conditions, as it is their purpose to catch the water and dry the soil; the leaders running downhill directly or at an angle to the nearest water channel should be made shallow, as the volume of water passing along them will keep them of the requisite depth. The steeper the slope, the more shallow should be these drains. In some cases where steepness is very marked, erosion can be avoided by using depressions in the ground as leaders; the vegetation on the sides and bottoms of such depressions prevents any denudation and maintains the channels at their original size.

Normally, typical spruce ground in the West of Scotland requires twenty-five to thirty chains of drains per acre, but the correct positioning of the drains is considerably more important than the total chainage. There seems to be a general lack of deep trap drains on the upper parts of ground depressions, and at the foot of steep slopes. Mention was made earlier of the extensive flow in of water to plantations from large unplantable tracts of higher ground; deep trap drains on the upper margin of spruce plantations are almost essential and these can frequently be led to natural water channels without trouble. Such drains should leave no passage for water between the bare ground and the plantation, and if a fall for them is difficult to obtain, they can be led off at their lowest points to the nearest burn or stream.

An important point of detail is that such trap drains, or indeed any marginal drain to a plantation, particularly if on the exposed side, should be opened at some distance from the first line of trees. This allows of root spread in an outward direction. If the marginal drain is too close to the trees, root spread is permitted towards the plantation side only, and the outside trees, which should be the most windfirm, are given only half a chance to become so. The best protection to a spruce area is a strong margin, the greatest danger, a weak one.

Having formed an efficient drainage system, the fear of windblow makes it necessary to keep the system functioning satisfactorily at all stages in the growth of the crop. In the moist, mild conditions which prevail in western districts, the growth of vegetation is extremely rapid, particularly when an area previously grazed has been closed to animals and some shelter is provided by the planted trees. The sides and bottoms of drains quickly produce a growth of grass and moss which impedes the flow of water and reduces the depth of the drain. The higher the trees grow, the greater become the shelter and the more rapid the growth in drains, until such time as the canopy closes and further growth of ground vegetation is stopped. It will generally be found that on such areas, drains require repairing twice between establishment of the crop and closing of the canopy, after which a repair is necessary following each operation of cleaning and subsequent thinning. Mechanically ploughed drains are not so long-lasting as hand-made ones.

It is possible, after closing of the canopy with a resultant partial drying-out of the soil by the crop, that all the original drains do not require to be kept open and, at discretion, some of the feeders may be discarded; but it is generally a mistake to do so before the pole stage has been reached. In the repair of drains, particular attention should be paid to keeping marginal and trap drains at the requisite depth, feeders free of blocks and running freely to the leaders and of a depth great enough to allow for the usual deposit of dead needles and twigs. Leaders running with the slope should get a slight scouring only to avoid erosion, and provided they are steep enough to run freely, a growth of grass on their sides and bottoms should be rather encouraged than otherwise.

A common prelude to windblow is the collapse of trees which have been standing too near the sides of drains. The root spread of such trees is generally one-sided, and the spade work in drain repairs further weakens them by destroying any root growth which is attempting to gain the far side of the drain. In planting, no tree should be placed nearer than two feet from a drain edge; widely spaced trees are in little danger of blow if they are acclimatised to the spacing from early youth, and it is better to reduce the number of trees per acre than to have unstable members among the community. Turf-planted trees are less stable than those flat-planted, and the system of planting trees on furrows ploughed at five or six feet spacing, with a consequent drain between each row of plants, may lead to a most precarious stand of trees. Where every tree in the crop is a drain-side tree great danger from wind may follow.

The lay-out and maintenance of the artificial drainage system to fit in with the natural one is of prime importance in preserving spruce from windblow; its object is to prevent water from entering the plantation area, and to convey surplus water from this area as rapidly and with as little disturbance as possible. It is the presence of surplus water in the upper soil layers which so loosens the hold of tree roots on the soil that they become a prey to strong wind pressure on the crown whereby uprooting follows. The loss of one tree allows the wind more play on the crowns of its neighbours, which in turn are in danger of a similar fate; in this way gaps can become of ever-increasing size. The fall or leaning over of a single tree should always be attended to at once, as its weight upon the next one assists the wind in following up with a further collapse. The blown tree must be felled and snedded as soon as possible.

Treatment of Plantations

Once trees have been established the only further treatment which the forester can give them, apart from brashing and pruning, is to cut them down; and it is the intensity with which he cuts them down, either singly or in groups, that has the greatest effect on the size or depth of the crowns of the individual trees or of the canopy of the crop as a whole. The cleaning of a plantation has usually little if any effect upon the canopy; thinning "from above", which is the usual type in force, is done solely with the object of affecting the canopy and therefore plays an important part in regulating possibilities of damage by wind.

Spruce trees in western districts, particularly Sitka spruce, are fast-growing and stand upon the surface of the ground like ninepins bearing a heavy crown of foliage in the upper parts of the stem. They are not windfirm trees at the best of times, even in open stance, and in plantation form, where root and crown competition is so intense, their instability is greatly magnified. In early youth, and through growth until canopy is formed, they are fairly secure; it is when height is reached and lower branching is lost that the danger period begins; the greater the height attained and the more the crown is forced to the growing point of the stem, the greater becomes the danger from wind. The greater the length of the crown on the individual stem, the greater is the protection against wind, and crown development can be influenced only by thinning. Thinning of the marginal row is essential to obtain windfirm marginal trees, and it is good practice to thin margins even earlier than the general stand within, in order to secure edge trees with well-formed crowns on all sides and over the whole length of stem. Planting of a few of the marginal rows at wider spacing than the main crop might assist in the same connection. It is probably advantageous to keep the marginal trees green-branched to the ground, as this prevents the entry of the wind into the rest of the plantation.

It cannot be stressed too strongly that it is from the margins of spruce plantations that the greatest trouble from wind is most prevalent. A secure margin will protect an insecure crop; a broken margin will generally lead to trouble. Edge trees are acclimatised to wind; those on their lee side are not, and it is sound forestry to protect and maintain the original edge trees at all costs. The removal of these trees for such purposes as roads, hydro-electric cables, fire lines, etc., should be avoided wherever possible, for where it occurs some collapse almost invariably results. It would be good policy if all swaths to be cut through spruce areas for road or electric cable purposes could be attended to at the very earliest age in order to give the new marginal trees some time and opportunity to acclimatise themselves for the better protection of their neighbours inside.

As mentioned earlier in this article, the establishment of edge belts of a different species, where soil conditions permit, is one of the safest devices which can be adopted against windblow, and such species as pines, larches, *Abies nobilis* and the common hardwoods can be most useful. The hardwoods are only possible of use on low sites of a moderate fertility. Although they are perhaps slower of growth than conifers, their use is well worth while because of their windfirm qualities and their loss of canopy in winter. They may only attain half the height of the spruce but their protective value is still considerable, and once established they may endure for two or even three rotations of the softwood. Their use as a fire break is also advantageous.

Just as it is essential to preserve all the strong and windfirm trees in the thinning of the stand, so it is also of prime importance to get rid as quickly as possible of all the weaklings; in the first thinning, trees not likely to remain firm, trees with "sprung" roots, and trees too close to drain edges should be removed. A tree swaying in the wind and loosening the soil in its vicinity has an ill effect upon its neighbours, and is better out of the way. Thinning too, should, if possible, be done with a view to making the stand as irregular or of as uneven-sized units as can be attained, with due respect to sound marking; this provides for better canopy development, as too even a crop is more to be feared in times of storm than is an irregular one. An individual spruce too should, in the interests of wind protection, often be marked for removal to preserve a hardwood tree, or a conifer of some alternative species, for the slightest break in the regularity, or any alteration in wind-resisting capacity of the exposed trees, may check the gradual collapse through a pure spruce area.

Dealing with Windblows

Once a blow has occurred, what can be done about it? The forester immediately casts around for some way of re-stocking the blank and of preventing its spread, but apart from replanting right away, there is very little he can do. The opening of additional drains in a plantation already once thinned does more harm than good. The edge of the gap is insecure and it is now too late to attempt to strengthen it by thinning. The more trees now which can be kept standing on the newly exposed edges, the better for all concerned; even leaning or partially blown trees in the gap, provided they are not in actual contact with other trees, must be retained. A little protection is better than none.

The replanting of such a gap, be it small or large, is not always crowned with great success. The selection of a fast-growing species is not easy, and the ground may suit spruce only. The forester is anxious to get cover and protection established as early as possible to shield these bare unsightly edges, yet formation of the new crop seems much slower and more difficult than was the establishment of the original plantation. Pine weevil begin to play around the small re-planting. It becomes the gathering ground for all the deer and vermin in the surrounding neighbourhood and fencing it off may eventually have to be resorted to. Meanwhile each gale that blows makes the area to be dealt with a little larger, and sleepless nights become the forester's portion when the gales blow. There is little we can suggest to help him. Replanting with strong, large transplants of such species as sycamore, alder and birch, or with cuttings of fast growing poplars is the best that I can recommend. They are at least weevil-proof and, once established, their rate of growth is rapid. They are not easy of acquisition for this purpose, and it may be a useful practice to retain a small stock of such trees in some of the nurseries. Filling up the gaps in spruce areas with four to five foot high hardy broadleaved transplants or cuttings, fenced off temporarily if necessary, would probably help to some extent, and these species have the merit of being long-lived and windfirm; hence they might survive to assist the second crop of spruce.

It may be worth while considering the idea, where the area affected by windblow is still small or where the gap is still occupied by a few somewhat loosened trees, of roping or wiring edge or gap trees to more stable ones within the stand. It is the gradual increase in the gap's size with the occurence of every strong wind that is so much to be feared, and in countryside where spells of calm weather are of short duration, the partially disturbed trees of the gap or of its edges do not obtain sufficient opportunity of gaining a fresh grip, even during the growing season. Given a sufficiently long time to get a fresh root-hold on the soil and to acclimatise themselves to the new, more open condition, they may in time become firm enough to shelter their fellows and to stop the extension of the blank. By roping such trees to stable trees inside and in different directions, or by guying them to the ground, it may be possible to hold them upright and sufficiently secure for a period long enough to enable them to regain more or less their original stability and thereby to prevent further encroachment by the wind which the first opening of a gap encourages. This roping-back of these trees would also prevent the leaning of the crowns of half-blown trees upon their neighbours, a feature which makes them still more vulnerable to wind.

To conclude, there is with wind damage as with fire, little remedial action that can be taken and that not of a very convincing nature. Natural or artificial barriers are all that can be relied upon with any certainty to bring to a stop encroachment by wind through spruce woods. It is at the time of establishment that arrangements about shelter have to be made, and it is all through the life of the plantation that attention to the crop and soil condition has to be given if protection against the expected winds and storms of the locality is to be adequate and enduring. Against the periodic hurricane which is sent across these islands, we can do nought but watch and pray.

A TREE SHIELD TO PREVENT INJURY WHEN TUSHING LOGS

Most foresters who have ever worked on the extraction of big timber are familiar with the serious damage that can be done to the bases of standing trees by the cables used to haul or "tush" felled logs to the nearest loading point. This damage is generally most frequent during the later thinnings or selection fellings, and on natural regeneration areas—wherever some large trees have to be left standing and other large stems removed. It is most severe where tractors and wire cables are employed, but any rope may do harm if it rubs against the base of a tree trunk and similar damage is often done by the moving logs themselves. Once the bark is rubbed off an open wound remains, which may take several years to heal over; meanwhile fungal pests may enter and attack the wood.

From America comes news of an effective shield to protect tree trunks from such injuries. It is made from an oil drum, of a suitable dimension (a 55 gallon drum is suggested), by removing the top and the bottom and cutting the cylindrical surface longitudinally into two half-cylinders, using an oxy-acetylene torch. These pieces are again cut across, giving four shields from one drum. Each is strengthened by having steel rods of half-an-inch diameter welded to the straight edges; these rods are prolonged for about 6 inches beyond one edge of the shield, so as to form "legs" which can be stuck in the ground to hold the shield in place. Finally a hand-hold is cut near the top of the shield, for ease in lifting. (See Fig. 2).

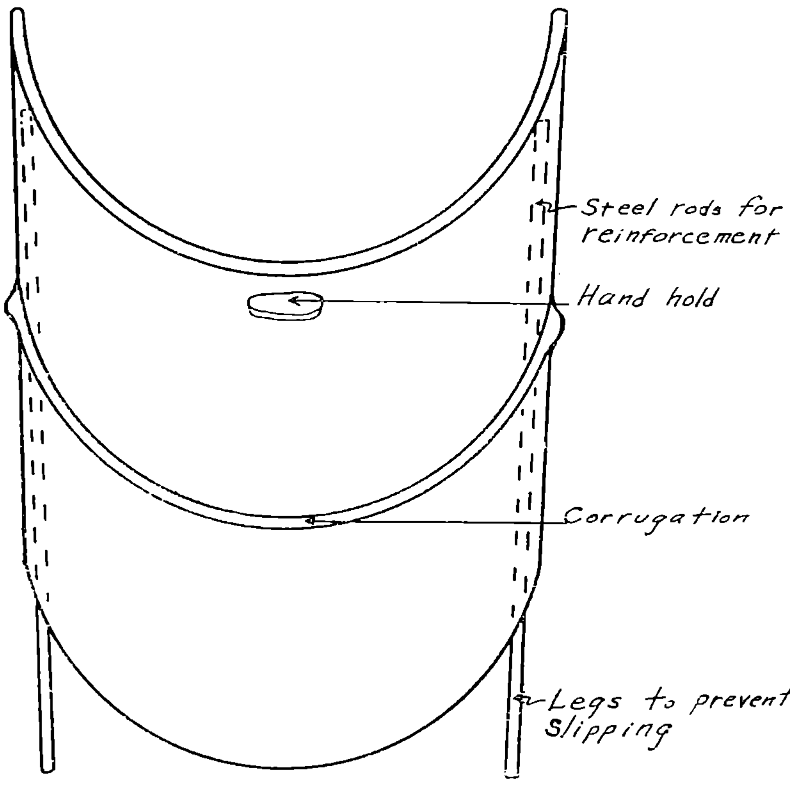

Fig. 2. The tree shield.

Shields of this type have several advantages. They are light in weight, easily carried or transported, and can be compactly nested to take little space. A shield is set at the base of each tree likely to be damaged by hauling operations, being moved on when these are over.

This device is described by Elmer W. Shaw in the *Journal of Forestry*, January 1951, p.45; and we are indebted to the Society of American Foresters for permission to reproduce these details.

DAMAGE BY STARLINGS TO TREES AT SLEBECH FOREST, SOUTH WALES

By F. A. SLATTER
Forester, South Wales

Shortly before Christmas, 1950, a flock of thousands of starlings descended on Pickle Wood, Slebech Forest, in Pembrokeshire, to roost for the night. A keen east wind was blowing at the time, and the birds concentrated on a patch of scrub woodland in a sheltered valley.

On passing this valley next morning, I was astounded at the extent of the damage caused. The combined weight of the birds had torn boughs from small oak and beech trees over an area of an acre or so, while some rhododendron bushes were nearly flattened.

I made enquiries locally to see if any similar occurrences had been recorded, but could not find word of any. Had the starlings roosted on an established plantation, very serious damage would have been caused.

AN EARLY PROPOSAL FOR STATE CONTROL OF WOODLANDS

(We are indebted to Mr. L. T. Vowles, of Ashleworth, Gloucester, for bringing this interesting extract to our notice.—*Editor*)

AN EXTRACT FROM THE GENERAL VIEW OF THE AGRICULTURE OF THE COUNTY OF GLOUCESTER. BY THOMAS RUDGE, B.D., 1807

Timber being confessedly in a state of progressive diminution, (in this county at least), it is an object well worthy the attention of the Legislature, to endeavour to secure a proper supply of that necessary article. Might not each owner of land be obliged to satisfy the overseer or constable of the hamlet or district, that, when he is cutting down a timber-tree, he is also supplying the loss, by planting, preserving, and raising a young one of the same kind, on some part of his estate? So that a yearly return might be made to the Quarter Sessions, and filed among the records of the county. If the general principle were adopted, provisos and exceptions might be introduced, to meet many cases, where the complete adoption of the plan might be improper, or even stand in the way of improvement. This measure is suggested with the hope, that another less exceptionable may be substituted in its room, or engrafted upon it; for, that some measure is expedient, cannot be questioned. The destruction of timber, owing to its high price, holds out an irresistible temptation to cut down, while the great expenses attached to landed property operate as a check upon planting: for, with the exception of a few public spirited gentlemen, plantations are scarce; but the notices for sale of timber are to be found, at the proper season of the year, in every provincial newspaper.

The vale of this county, it is true, abounds with young growing elms in every hedge-row; but for this, no thanks are due to the proprietor: it fortunately happens, that not only the stools of the trees which are cut down, but the roots themselves, which spread to a great distance, throw out new shoots in abundance, more than enough to replenish the loss; and, for the purpose of making good trees in a few years, it is only necessary to watch their growth, and prevent them from being destroyed by cattle, or stunted by numbers. The timber thus produced, is sometimes unsound, and particularly so, if the trees are permitted to grow too long after they come to a proper size for felling; but as the demand is urgent, and the sale certain, they seldom stand too long; and in this case, the timber is good for the several purposes to which this sort is usually applied.

But the great complaint is in the continual diminution of oak-trees: these require to be raised from the acorn, or transplanted and protected; but though they will re-produce themselves in the same way as elms, yet, growing slowly, the young shoots, or plants, seldom rise above the hedge-rows, so as to become trees, or if they do, are galled, knotty, and stunted. Besides, the little probability of any advantage in the life-time of the planter, from oak-trees, is another obstacle to the plantation of them: and therefore the Agricultural Societies have, with great judgment, and considerable success, promoted this valuable branch of husbandry, by honorary and pecuniary encouragement.

RIGHTS OF WAY

By W. J. RAVEN
Land Agent, North-West England

What do we mean by a right of way? I feel sure that many people do not appreciate the implication but the matter no doubt arises sooner or later at most forests, and in connection with our road construction programme it is certainly a subject of some importance. It will be my endeavour, within the space available, to give you something of the background of this matter.

The definition of a right of way in its most simple form is that it is a right of passing over someone else's property. It carries no interest whatever in the soil and the owner of the land is entitled to prevent the surface being used in any manner or for any purpose other than that of passing and re-passing. Rights of way can be classed under two headings, that is to say they can either be "Public" or "Private" and it is as well to deal with them separately because the principles are somewhat different.

A Public Right of Way is a highway and the common expression "The King's Highway" is to all intents and purposes a perpetual right of passage in the sovereign, for himself and his subjects, over another's land. The oldest existing highways are the Roman Watling Street which runs from Dover to London and from London to Chester, and the Fosse way which runs from Somerset to Lincoln. These rights of way and other lesser known ones have existed for centuries, but the first statute which organised the maintenance of roads was passed in 1555 and it laid a certain obligation on the part of the occupying inhabitants to contribute labour and materials to carry out the work. Nevertheless it is not only a main thoroughfare which can claim to be a right of way, a footpath which the general public are entitled to use, is just as much a highway as a wide by-pass road. Similarly you can have a carriageway, cartway, bridleway, footway, causeway, churchway and probably several other varieties, including an ordinary pavement. All of these "ways" fall within the definition of the Highway Act 1835 and they are in fact public rights of way which anybody may use for legitimate purposes. Now, don't go thinking you can drive your car on the pavement because that would not be a legitimate purpose, and the use of any particular highway depends upon its classification.

Classification is usually fairly well-defined although the extent of use of the various kinds of highway is largely a question of fact which a jury would decide in the event of a dispute. In general, the wider form of use will cover the lesser variety, for instance a carriageway, as the name implies, covers the right of passage for all wheeled traffic, you can also walk or ride on it; but you can only walk on a footpath. Some knotty problems do arise, in fact there has been a legal argument as to whether you can rightfully push a perambulator on a pavement, but in case your wife is becoming a trifle worried let me say that she is quite within her rights. Incidentally the passage of a corpse is commonly supposed to create a right of way, but this has no legal standing.

Public rights of way arise by one of two methods, they are either provided for by statute or by dedication. I do not think I need say very much about the former as it is simply a question of powers provided under an Act of Parliament. We have a modern example of this in the National Parks and Access to Countryside Act 1949, where the Minister is entitled to create new public rights of way. The establishment of a right of way by other means is not quite so simple and it is "dedication" which has to be proved, that is to say the question must be asked whether there has been some form of recognition that a particular "way" has been granted to the public, or possibly it might be more accurate to say that lack of any evidence to the contrary often provides its own justification. This is why you so often find some simple act undertaken by an owner such as the placing of a notice board or the locking of a gate on one or more days in a year so that there is in fact evidence to rebut any claim that a public right of way exists. The Rights of Way Act 1932 does give an owner protection in this way which is often sufficient to defeat a claim, but there are plenty of legal pitfalls which the Courts may be called upon to decide.

If a right of way is to be established by dedication it is necessary to prove use over a long period of time, but dedication by itself is not always conclusive evidence, and it has already been explained what measures may be taken by an owner to defeat such a claim. Dedication may be express or implied, the former is merely a question of fact that a landowner did give a right of way over his land to the public at large; an implied dedication may be more difficult to prove although I daresay there are plenty of people about who are willing to have a try. The Rights of Way Act 1932 provides that where uninterrupted use can be proved for a period of twenty years this will provide the necessary evidence and I think you can take it that there is some emphasis on the word "uninterrupted". It is really in effect the same principle as the Prescription Act of 1832 which governs private rights of way. The Rights of Way Act has recently been amended by Section 58 of the National Parks and Access to the Countryside Act 1949, but it does not alter anything I have said here. In case you are curious, it makes some change in respect of an extended time limit of forty years which it was previously necessary to prove for establishing a right of way where there was no person in possession capable of dedicating. This provision has now been deleted, so twenty years is the figure to work on for all purposes.

I am not going to dwell very long on a Private Right of Way but in general it is a right vested in some particular individual(s) and possibly for some specified purpose. It can only be created by grant, reservation or prescription and under the Prescription Act of 1832 a private right of way may be created by uninterrupted enjoyment for a period of twenty years over freehold land in absolute possession of the owner. It is really a privilege or easement granted by an owner of land and may be subject to such conditions as the owner wishes to impose.

This short article has no claim to be comprehensive of all the points involved in the law regarding rights of way, but it would be incomplete if the question of repairs was omitted. The common law ruling is that the inhabitants of each parish are responsible for surface repairs to rights of way, and it is a very ancient law founded on the theory of the right of the inhabitants to use all the public roads in the realm. However, the Highway Act of 1835 and other statutory law has since limited this liability, and the upkeep of roads is now the primary responsibility of the County Councils and the Ministry of Transport. There is nevertheless an interesting point in connection with the date of the 20th March, 1836, as a highway established before this date is known as an "ancient highway", and in such cases a Local Authority has no power to compel a frontager to pay the cost of making up, i.e. paving and sewering, etc. In a very general sense it can be stated that a public highway must be kept in such repair as to be safe and usable by the ordinary traffic of the district.

The liability to repair and replace stiles, gates, stepping stones on public highways (and including footpaths) rests on the same basis as the liability to repair the surface. It has been the practice of Parish Councils to assume responsibility in this direction under powers contained in Subsection (2) of Section 13 of the Local Government Act 1894. Parish Councils proceed by passing a resolution and going through certain formalities, and in considering where responsibility lies it should always be ascertained whether the Parish Council have in fact assumed responsibility under their powers. If not, then recourse should be made to the Rural District Council or the County Council.

The repair of bridges on public highways lies primarily upon the inhabitants of the County just as in the case of roadways it lies upon the inhabitants of the Parish. The making of bridges was not made part of the common duty of any public authority until 1888, when it was entrusted to the County Council. If a private person erects a bridge on a roadway over which the public have a right of passage, or acquire one, then the liability to repair it falls upon the Highway Authority.

Another duty of the Highway Authority is to erect direction posts or stones legibly inscribed with the name of the next market town or village to which the highway leads. While on this subject it is not without interest to note that if under Section 3 of the Rights of Way Act 1932 the owner of a private road erects a notice to the effect that it is private and it is torn down or defaced then he is not obliged to erect another one, but need only send formal notice to the Local Authority that the way is not dedicated to the public.

I hope this article will have been of interest, perhaps some of my legally minded colleagues will find cause to argue with me on one or two points as it is a subject on which there has been a fairly considerable amount of case law.

FUNDAMENTALS OF ROAD PLANNING

By E. R. HUGGARD

Planning Officer, Wales

Although the need for roads in our forests is now almost universally agreed, the question of when and where to construct them will remain controversial. Except on special locations where only shutes or ropeways will function (and even then over comparatively short distances and at a high cost) the fact is that the timber must be carried on or hauled by some form of mechanical vehicle. The question resolves itself into making a simple choice. Namely either to construct roads capable of carrying fast moving pneumatic tyred vehicles or else to make use of existing or improved tracks for tracked vehicles. There is a strong case for the roads.

The problem of getting the timber from the stump to the collecting point, whether it be tractor track or road, is the same in each case and need not be dealt with here.

In order to determine the most economical means of extraction it is necessary to have the true costs at hand for the different methods. Therefore with the following example I will show that the cost of construction of a road to within 150 yards of the growing trees is equivalent to little more than one penny per cubic foot over the whole crop.

Consider an area of 465 acres. In order that no tree shall be further than 150 yd. from a road the construction of four miles of roadway is necessary. The cost of road per mile would be £2,000 meaning £8,000 in all. This estimate is not conservative because I assume that there is no existing road in the area and this is seldom the case.

I assume the cropping figures to yield a volume of 600 cubic feet per acre after the fifteenth year followed by 600 cubic feet per acre every five years thereafter until the sixtieth year, which I take to be the rotation of the crop. Should these yield figures be disputed it will be an easy matter for the reader to substitute his own. A minor difference will not destroy the logic of the calculation.

Just prior to the first thinning at fifteen years, construct the road at a cost of £8,000.

Now, the first crop (600 × 465=279,000 cubic feet) is collected and we are at once able to reduce the debt by paying to the bank 2d. for every cubic foot sold=£2,325. That leaves a debt of £5,675. After a further five years the debt becomes £6,580 due to compound interest. Add to this £400 for getting the roads serviceable again for a further thinning. Thus the total debt is £6,980. Again, after the sale of the second thinnings, repay to the bank £2,325 leaving debt of £4,655. At the 25th year the debt has become £5,396 plus the £400 repair cost= £5,796. With a further thinning and a repayment of £2,325 the debt becomes £3,471. In a further five years the debt has become £4,023 plus £400=£4,423. After repayment of £2,325 again debt is reduced to £2,098. After the next thinning i.e. after the 35th year we are in the position to be able to complete paying off the whole debt. By then the debt had become £2,432 plus £400=£2,832. From then on our only outlay will be the £400 repair cost prior to each five yearly thinning.

Therefore after 60 years out total outlay has been:—

4 payments of £2,325	£9,290
1 payment of £2,832	£2,832
5 further payments for repair every five years of £400	£2,000
Total =	£14,122

$$\text{Overall cost of crop per cu. ft.} = \frac{14122 \times 240}{465 \times 6000} \text{ pence}$$

$$= 1.20 \text{ pence per cubic foot.}$$

Having thus arrived at a figure for cost of construction we are now in the position to make a comparison between road or tractor extraction. From figures supplied by the Mechanical Section it can be fairly assumed that tractor haul using trailer or sulky over the area mentioned above will not be under 3.5

pence per cubic foot, and indeed in most cases will be greater. On top of this charge may be the cost of constructing tractor tracks. Even assuming that tracks are already in existence, to get the timber out by road will only be 1.20 pence plus the cost of motor haul (say one penny)=2.20 pence per cubic foot compared with 3.5d. by tractor.

If we construct roads we get the following very definite advantages:—

(*a*) Timber is loaded as near stump as possible and does not have to be touched until reaching its destination, whereas with tractor haul the timber has to be reloaded into lorry at main road.

(*b*) Use of road for fire proptection.

(*c*) Use of road for speedy transport of labour and staff.

(*d*) The road, after sixty years, remains a heritage to the nation, its cost of construction having been covered.

I therefore maintain that to extract by road is a much more economical proposition than by tractor. The exception arises when the cost of the road would be high compared with the acreage of timber within its range. Before any road is constructed for extraction this road cost construction figure should be calculated. Where this has been done for a dozen forests in Wales, it has been found that only in a very few cases would it be uneconomical to build roads. Having planned a road system for a forest we can then go further and decide from calculations the correct direction of flow of timber and the economical positioning of dumps, loading ramps, etc. It is by co-operative study between silviculturist and engineer that the ideal forest extraction plan will materialise.

Having decided what to construct we must now decide when. Taking only extraction into account, then the best time is just prior to the first thinning. The road could then be left idle for five years, when it should be repaired ready for the next thinning. But as there are other considerations such as fire protection and labour movement, it may pay to construct at an earlier date and to keep the road repaired continuously. As these are matters not affecting extraction, the extra cost of earlier construction due to heavy compound interest and the cost of continual repair must be borne by these items and do not affect the figure of 1.20 pence arrived at earlier in this article. The decision when to construct can only be made on individual merit in each case, as the problems of fire danger and labour movement differ greatly from place to place. The saving which the provision of a road would make to the latter can also be calculated, but that of fire protection can only be considered as an insurance premium.

The conclusion to be drawn from this comparison should be that in almost every case it would be an economic proposition to construct roads within 150 yards of the growing timber. The difficulty arises because not only would it be impossible to construct all the roads as soon as they are required, but the necessary immense financial backing could not be forthcoming. But it can be stated that as roads are such a good proposition what money there is for extraction should be put into building them and that large sums should not be expended on extraction by tractor, where there is time and money to build a road.

Of the utmost importance, therefore, is where to put the road. Not only from a correct location point of view but also to decide, owing to the limited mileage capable of being constructed, which sites to choose for roads and which for tractor tracks. At this stage the other factors besides extraction purposes must be given due consideration. For although for extraction purposes it may not appear a priority to drive a road up a certain valley, the important matters of fire protection and labour movement may well weigh the balance in its favour.

Here again only liaison between silviculturist and engineer can decide. Efficient silvicultural attention soon follows along the borders of a new road, it being automatic on account of the accessibility. Conversely an area can be envisaged where the fire danger is small and the labour access question simple (say from a road on the ridge above a plantation) where tractor tracks would suffice.

It is the purpose of the Planning Office to locate the roads so that every advantage is taken of the topographical and geological conditions. To plan the roads giving access to the maximum of timber with the minimum of road. Which means constructing a carriageway just capable of bearing loaded timber waggons.

Among the points of importance in locating a forest road are the following:—

(*a*) Access to the maximum of timber with the minimum length of road.

(*b*) Avoidance of natural hazards as far as is possible, i.e. bogs, rivers, large rock outcrops, extensive excavation work, etc.

(*c*) Location of suitable local surfacing materials which would be used in the construction of the road.

(*d*) Good access for loaded timber waggons to main road.

(*e*) Suitable points of access to off-shoot valleys for other tracks or roads.

(*f*) Other possibly cheaper methods of extraction.

(*g*) Fire danger and labour conditions.

It is necessary to complete the planning of a whole block of forest before starting construction of any road, so that the part fits into the whole. Generally speaking it is wise to extract the thinnings along part or the whole of this road system rather than to use a temporary route for a local thinning operation. For although the outlay on the repair of the temporary route may appear small, the result is no nearer to achieving a completed extraction road network.

INCOME AND EXPENDITURE ACCOUNTS OR CASH ACCOUNTS?

By E. C. SHANKS

Assistant Accountant-General, Headquarters

It will be remembered that the Select Committee on Estimates (1) recommended that "an accounting system on commercial lines should be introduced in each Conservancy and the accounts of the Forestry Commission as a whole should be built up from these accounts".

The consequent starting of pilot schemes of Income & Expenditure Accounts at Bristol and Dumfries, has, no doubt, led to some speculation as to how exactly this form of accounting differs from our present accounts. The difference between these two types of accounts is fundamental and therefore can be expressed very simply, but to do justice to both some additional explanation is necessary.

Before describing one or the other there is that difficulty of terminology which arises when one applies precise meanings to words in everyday use (and tending to have different shades of meaning to different persons). The

(1) Sixteenth Report from the Select Committee on Estimates. Session 1948-49 H.M.S.O.

terms "Income and Expenditure Accounts" and "Cash Accounts" have come into use but each term is, within the correct use of words, capable of being applied to the other.

Commercial Accounts, Income and Expenditure Accounts, and Financial Accounts are here taken as synonymous terms as applying to the system of accounting in use in commercial and industrial concerns in this country and throughout the world—a technique which has been building up for the last 600 years. "Cash Accounts" is the term used to designate the system used in the Forestry Commission and in other government departments.

Accountancy and its Sub-divisions

Possibly the development of accounting skill is the distinguishing feature of the higher civilisations! but at any rate the Sumerians 5,000 years ago had well developed accounting records though on clay tablets (enclosed in excellent filing covers). The Egyptians and the Romans, too, had their accounting systems. The Incas had theirs, but on knotted cords!

It is understandable that when an organisation grows beyond the day to day oversight of one man, those in control have to rely more and more on figures to assist them in the management. Modern book-keeping dates from about 600 years ago when the Italian City States had already developed and codified a system of double-entry income and expenditure accounting. That knowledge has continually been added to, and the excellent modern tendency to accelerate the accumulation and codification of knowledge resulted in the formation of professional societies of accountants, first in Scotland and then in others of the Anglo-Celtic countries. As a result developments have been increasingly rapid and to-day there are hundreds of thousands of trained accountants (and probably millions of accounts assistants) keeping books on the income and expenditure basis in every country of the world. The professional societies in most countries are in constant liaison and incidentally Great Britain will have the honour of being host to the International Accounting Congress in London in 1952.

The purpose of accounts can be stated as, firstly, to check performance against plan, and secondly, to help to form policy for the future, both in its minor and major aspects. Properly designed accounts can therefore be of material use to both the functional management (e.g. State Forest Officer, Estate Officer) and to the general management (e.g. Conservator, Director). A very great deal can be read from accounts not the least of which are the comparisons afforded between different units at the same level and between different periods.

The accounting which has been found necessary to management has, in the building-up of a technique, been sub-divided; each sub-division has a specific purpose and it is essential that all be co-ordinated. The sub-divisions are:—

(1) Financial accounts

(2) Cost accounts

(3) Budget accounts

(4) Statistics

Most of the items in these can be expressed in more than one unit, e.g. "preparation of ground" can be expressed as either pounds spent or as acres prepared. For present purposes, however, our attention can be confined mainly to the money aspect, but with the proviso that "unit" or "quantity" records must be co-ordinated with money records.

"Financial Accounts" is the more widely recognised term for "Income and Expenditure Accounts" or "Commercial Accounts", though their use is by no means confined to commercial organisations. These accounts consist of the compilation of the true income and the true expenditure on individual items for a given period. Financial Accounts are, of necessity, historical, i.e. they are a record of payments or incurments of a past period.

Cost Accounts are mainly concerned with finding the cost per unit; they are built up from figures extracted from the accounting and other records. It is possible for them to show an incomplete picture, but well-designed financial accounts which necessarily show the total expenditure tend to anchor costings to fact. Though historical costs are still sometimes prepared, the preoccupation of modern cost accounting (and there are active and authoritative professional bodies of cost accountants here and in the U.S.A.) is to produce these costs as soon as possible after the operation, if not at the time of the operation. Modern cost accounting can therefore be said to be concerned with the "rate per unit" and with the present time.

Budget Accounts (or Budgetary Control Accounts) on the other hand aim to produce, for example, on January 1st., what are estimated to be the financial accounts for the year ending the following December 31st. They are worked out in considerable detail for each branch of the organisation, both in money and in quantities, with co-ordination at each stage. The result of this is that any snags are dealt with before they can occur. For example it would be disastrous for an organisation to embark on a manufacturing programme if the money to buy raw materials at a crucial time were not available (as might be the case if the working capital were insufficient or if book debts had not been collected). In operating Budgetary Control the main divisions of the organisation, say Production, Sales and Finance, would have agreed on a programme having regard to all factors e.g. available production capacity, available markets and selling facilities and available finance *at every stage.* Each section (and possibly each sub-section) of the organisation having details of its own necessary contribution to the common and agreed programme, the compilation of prompt "Budget Progress" figures enables effective action to be taken if the target for that section is not reached. If the target for one or more sections is not attained there are liable to be repercussions in other sections. Budget accounts are therefore concerned with planning a co-ordinated future programme with provision for a periodical comparing of actual achievement against the plan.

The fourth sub-division is Statistics which does in fact include Financial, Cost, and Budget accounts, but is used here for figures other than those in the three sub-divisions already described. In many cases they may be taken from those accounts, but not always.

In brief, therefore, financial accounts are concerned with the past, modern cost accounts with the present, and budget accounts with the future. It is highly desirable that all these be co-ordinated, and this means in effect that the cost and budget accounts should be co-ordinated with the financial accounts which are the only compilations of the three which are undoubtedly fact.

What are colloquially known as "Cash Accounts" (perhaps more correctly "Vote Accounts") are in effect compilations for reporting back to the body from whom the money came how actual spending (analysed under agreed heads) compares with the amounts advanced. It is widely used in government accounting, particularly by "spending" departments. Outside government and similar organisations however it is rarely used as a general form of accounting save in some of the smaller charitable organisations. On the other hand it is used to a minor degree in subsidiary procedures in commercial organisations. Firstly, the Petty Cashier is controlled on "Cash Accounting" lines especially where what is known as the "Imprest System" is in use. This analogy was, no doubt, the basis for a critic's dismissal of government accounts as "penny cash book accounts". Secondly, the Chief Accountant of an organisation normally has to prepare a budget (with dates) of the amounts which have to be available to meet planned commitments. His compilation, usually rough, of actual receipts and payments, usually with very few heads of analysis, to compare with his "Cash Budget", is on "Cash Accounting" lines.

The Cash Accounts compiled by the Forestry Commission are however a development from the framework of the cash accounts necessary for reporting back to higher authority, and this elaboration was obviously undertaken with a view to providing information of value to the management. Whereas only forty heads are necessary for reporting back, we have expanded these to over two hundred and seventy heads of analysis or "standard heads", as they are termed.

Compilation on a double entry basis is not a distinguishing feature of Income and Expenditure Accounts although almost without exception it is employed therein. The Forestry Commission Cash Accounts are compiled on a double entry basis and most of the mechanisms of commercial accounting are also used, e.g. posting by proof slip, self-balancing ledgers, monthly trial balances and summarisations for reporting to higher levels.

Income and Expenditure Accounts
(or "Financial Accounts" or "Commercial Accounts")

The distinguishing feature of this type of accounts is the constant endeavour to ascertain the true income and the true expenditure on a given object for a given period. It is usual to analyse the income and expenditure further into "subjects", e.g. wages, materials, individual operations and expense headings, but there is always a constant review to ensure truth in both description and composition. It is also usual to compile separate accounts for the different activities or "objects" of an organisation. For example the British Transport Commission prepares separate accounts for its several services, e.g. railways, road haulage, canals, etc.

Fixed assets are rarely "used up" in the normal period of accounts, say one year, and it is inequitable to charge the full expenditure to the period in which these were purchased. Therefore they are treated as "Capital" and not charged against revenue. In the case of wasting assets, however, it may be decided to charge a proportion against the income of a given period. The types of asset concerned range from those fixed and immovable, e.g. land, to those lasting a few years only, e.g. ploughs, and for the latter and similar "wearing out" types of asset there are accepted rules for charging proportions of initial cost against income. For example, the cost of motor vehicles is spread over the estimated life of the vehicle.

The true expenditure for a period includes that relating to goods, etc. received even if they are not paid for till after that period. Conversely sales should include credit sales in which the property in the goods has passed but for which the money had not been collected until after the period. The necessity to record these types of transaction implies careful recording not only of cash received and cash paid but of incurments, e.g. accounts payable, accounts receivable. At all times careful distinction has to be made between revenue and capital. Cumulative and separate accounts are compiled of capital items and it is usual (and in many cases essential) for detailed records of assets to be maintained and co-ordinated with the cumulative asset accounts. The main purposes of these detailed asset records are:—

1. To identify each asset comprised (the asset account in the Income and Expenditure books must include all assets of the type described by the name of the account and conversely must exclude items which have gone from our possession, e.g. by wearing out or by sale).
2. To enable losses in value, e.g. depreciation on buildings and machines, to be assessed and to indicate the appropriate income to which they are to be charged.
3. To enable the relative charges and other expenditure to be identified with the object to be charged (for example area records indicate the current occupation of land and buildings whether it be an outside tenant, silvicultural operations, nursery, research, etc. and thereby the accounts are indicated to which rent payable, rates, maintenance, etc. are to be charged).

Over all the records, financial and subsidiary, there is an unremitting check on accuracy of composition and description. The position can be materially strengthened where the various records of the organisation are closely co-ordinated, especially where one set of records is designed for as many users as is economical. Not only does this help to maintain accuracy, because one section's finding may have repercussions on the treatment by another, but it is far cheaper than one record per user. In other words the records are deliberately designed as a composite whole and not piecemeal.

For example, among the subsidiary procedures necessary for correct accounting is one to charge the use of a vehicle or machine to the operation or subject of expense. This is done by means of a log-book compiled by the driver and the usage recorded is charged out by a pro-rata charge which covers fuel, lubricants, maintenance, tyres, repairs, mobile servicing teams, depreciation and overheads. The totalling of logged time provides an arithmetical control on the compilation in general but also provides, in addition, a record of time in use and idle time—per unit and in total. Furthermore, the various causes of idle time can be easily analysed. The individual purchase prices of vehicles and machines are recorded and working lives assessed for calculation of depreciation. This provides a complete "Machinery or Plant Ledger" which supports the asset account in the income and expenditure books. Identification details, e.g. registration number, type, year of manufacture have to be recorded and the addition of a few others such as engine numbers, chassis numbers, provides on the same record the information usual in a "Machinery or Plant Register". The complete record per unit (machine or vehicle) constitutes a valuable reference and further enables comparisons between units, districts and periods to be made by the functional staffs.

The comparison of the total of each of the relative items, e.g. fuel or tyres, recorded in the income and expenditure accounts, with the total recorded in the log books provides a safeguard against errors. Other valuable by-products of the compilation are fuel consumption, cost per mile, per hour, these also being available for comparison between units, districts and periods.

Other subsidiary procedures are necessary to income and expenditure accounts such as mechanisms for inter-unit charges, for example of stores issued. Almost all of these procedures provide, as by-products, valuable information and records for other sections of the organisation.

Just one final note on Income and Expenditure Accounts. Over the past hundred years the Government has been increasingly concerned with the form of accounts kept by trading bodies mainly (1) from the aspect of equity to those investing in those concerns and (2) as a protection to the business community. The form of accounts stipulated by Government is that of Income and Expenditure Accounts.

Cash Accounts

Apart from a detailed analysis of salaries (which would probably be required whatever system of accounting were in use) we are now required, for official purposes, to analyse our payments and receipts into about forty "heads of account". In an endeavour to provide some of the information normally obtained from financial accounts, we have expanded these to over 270 "standard heads". Over the years certain rules as to compilation have been laid down, in essence, the Cash Accounts are an analysis of our Cash Book into these 270 standard heads. This form of analysis makes no provision for the following:—

(1) expenditure due but unpaid

(2) sales invoiced but unpaid

(3) depreciation, etc. on wasting assets employed

(4) expenditure paid in advance, e.g. rent, value of stocks on hand.

On the other hand expenditure relating to the purchase or construction of a capital asset is charged wholly against the income in the period in which it is paid for and conversely the sale of a capital asset is credited to the income of the period in which the money is received.

Cash Accounts being a record of payments and receipts, the allocation to a standard head has to be done at the time of or soon after payment or receipt. The account to be charged ultimately with the expenditure often cannot be known at the time of payment, e.g. stores purchased, so that additional accounts have to be opened to accommodate such items as POL (petrol, oil, lubricants), Stores. Some of these, e.g. POL, can be apportioned before the closing of the books but on a rough and ready basis, others, e.g. Stores, are not apportioned at all and remain in one total in the accounts. In other words a standard head will contain part only of the expenditure on the operation or subject concerned. For example, "Preparation of Ground" not only would exclude expenditure incurred but not yet paid but would exclude depreciation on machinery, etc. used (not charged at all), repairs, tyres, stores, hand and other tools, maintenance charges, etc. (all charged to the head "Stores") while POL is charged on an artificial basis; further the capital cost of vehicles and machines purchased for preparing ground would, in accounting terminology, be "written off" in the period of payment, and would be charged not to "Preparation of Ground" but to "Stores".

There are other anomalies and drawbacks in Cash Accounts, mainly arising from the basis on which they are prepared. Though Cash Accounts are broadly consistent from one year to another it cannot be known whether the incidence of capital and revenue remains the same nor whether the relative expenditures remain the same. For example, the increase over the years in the use of vehicles and machines tends to vitiate comparisons.

Conclusions

The two types of account, "Income and Expenditure" and "Cash" have quite different objects. Each account in Income and Expenditure Accounts sets out deliberately to ascertain the true expenditure (or income) on that subject. Each standard head in Cash Accounts merely provides the means of reporting back according to prescribed rules the progress of actual disbursements against totals originally allocated. While the designation of each individual Income and Expenditure Account accurately describes the items comprised (it is deliberately chosen) most of the standard heads in Cash Accounts require the addition of some such qualifying phrase as " . . . with the customary omissions" or " . . . certain items of which are unexpended" or both phrases.'

The Forestry Commission is a government department and must comply with the regulations applicable to all government departments. We are bound therefore to render each year our actual receipts and payments under certain specified heads of account. In other words we must render a Cash Account. But for this only some forty heads of account are needed in place of the 270 standard heads we are now operating.

Furthermore, the figures derived from those 270 standard heads of the present Cash Accounts do not in all cases fulfil their intended purpose, management accounting, because their basis is fundamentally different from that of the accounts found in a large commercial organisation, viz. income and expenditure accounts.

It is suggested that the solution of the problem is the production of normal management accounts, of which income and expenditure accounts are the basis, and the compilation as an *ad hoc* job of the cash account figures in the simple form required, i.e. forty heads only. It is on these lines that the pilot schemes of income and expenditure accounts have been instituted in two Conservancies to determine (*a*) the form, in detail, of the accounts and (*b*) the adjustments in records and procedures necessary for the introduction of income and expenditure accounting throughout the Commission.

The benefits ultimately to be derived may be summed up as follows:—

(1) *Economy of Effort:* the provision of basic figure records, compiled day by day, to meet the requirements both of the accounts and of the functional sections, is cheaper and much more effective than a number of unco-ordinated compilations for individual sections of the organisation.

(2) *Control of Expenditure;* expenditure is analysed and presented in such a way that it will provide much more effective means of controlling expenditure and of determining the efficiency of operations than cash accounting affords.

BRECKLAND BIRD STUDIES

By F. H. PRIDHAM and T. S. FLINT
Lynford Forester Training School

The following article constitutes a report upon the 1951 activities of Lynford School Bird Club, a body which was formed in 1947 with the general object of studying bird-life in the locality and with a particular interest in the Breckland nest-box experiment, this latter being part of the wider investigation into the control of forest insects by insectivorous birds.

It is not intended here to give a complete account of the activities of the Club since its inception or to present a full report on its four years' work on the Nest-box Experiment. In this connection, however, the authors wish to acknowledge that the current year's work is based on the efforts of the Club's former members and of members of the School's instructional staff.

The years activities may best be summarised under the following heads:—

1. *The Forestry Commission's Nest-box Experiment* (henceforward referred to as the "Official Experiment") carried out under the guidance of the Edward Grey Institute of Field Ornithology, the recognized centre of field ornithology in Britain.

   The object of this experiment is twofold:

   Initially, to increase as far as possible the tit population of plantations, and, secondly, to determine to what extent titmice are able to control forest insect pests. To this end bird-box areas have been established in Commission plantations at: Alice Holt, Gwydyr, Glentress, Benmore and Thetford Chase; in addition research on similar lines and with similar aims is conducted at Wytham in Oxfordshire.

2. *The Club's Nest-box Experiment.* This is complementary to the Official Experiment in so far as a high percentage of the boxes are situated in hardwood or hardwood-with-conifer localities. A source of contrast and comparison with the exclusively conifer areas of the Official Experiment is thus provided.

Visits of inspection are made to all boxes at least once a week during the breeding season which, generally speaking, extends from the beginning of April until the end of July. From these visits are obtained the following data fundamental to the investigation:

(i) The breeding population
(ii) The breeding season
(iii) Clutch size
(iv) Nesting success

3. Observation and recording of resident species, migrants and natural nests.

4. Participation in the British Trust for Ornithology Bird Ringing Scheme. This is a national scheme for marking wild birds with small aluminium leg rings, numbered for identification, which are affixed either to nestlings or to trapped birds. Recovery of birds thus ringed provides information about migration and length of life.

1. Official Experimental Areas

The position during the 1950 nesting season was that three hundred boxes were divided equally between two areas of pure Corsican pine and Scots pine, comparable in age (twenty-five years) and each some three miles from the School in opposite directions, at Cranwich and Mousehall respectively.

The Cranwich box area is surrounded by Corsican pine of the same age which acts as a "buffer" against the extensive tracts of Scots pine in the vicinity, it being most desirable that titmice breeding in the boxes at Cranwich may be demonstrated to subsist entirely on the insect population of a Corsican pine area. To the south is arable land.

The Mousehall area is surrounded on three sides by Scots pine planted at the same date, while to the east lies a tract of open Breckland, bracken-covered, interspersed with gorse, and its grass cropped close by the ubiquitous rabbit. Both the Corsican pine at Cranwich and the Scots pine at Mousehall have been thinned twice; in addition, selected stems have been high-pruned.

At the end of the 1950 nesting season all boxes were removed because of thinning operations; re-erection could not be completed until February 1951, when the box height was standardized at four feet six inches, previous variation in box height between two and ten feet having been abandoned because of its inconvenience and of its small value to the investigation. One hundred and fifty were erected in each area, at a density of two per acre, and sited systematically to ensure that no box was overlooked in inspection.

A further extension to the scheme was then made. One of the most striking features of the Official Experiment so far has been the difference in breeding dates of titmice at Cranwich and at Mousehall. This phenomenon was most marked in the 1950 season when Great Tits and Coal Tits in particular bred from nine to eleven days earlier at Mousehall than at Cranwich. An additional block of fifty boxes was therefore established this year in Scots pine at Cranwich to provide a comparison of breeding dates and nesting success with the Scots pine blocks at Mousehall. The best site available was a compartment of Scots pine separated from the Corsican pine by a mature hardwood belt. Owing to its insufficient area, twelve boxes had to be erected adjacent to this belt; proximity to hardwoods appears to account for the 60% occupation in these twelve boxes compared with the 16% in the remaining thirty-eight.

The boxes used are of the standard pattern—ten inches deep by five inches by six inches in area, with a hole of one and a quarter inches diameter and a hinged roof opening for inspection.

Species

Boxes were occupied by three species—Coal, Great and Blue Tit in the following proportions:—

	Coal	*Great*	*Blue*
Mousehall	47%	37%	16%
Cranwich	57%	33%	10%

Clutch Sizes

(i) *First Broods*

		Smallest	*Largest*	*Average*
Mousehall	Coal Tit	8	13	9.77
	Great ,,	8	11	9.0
	Blue ,,	5	12	9.2
Cranwich	Coal Tit	8	11	9.65
	Great ,,	4	10	7.87
	Blue ,,	9	10	9.5

(ii) *Second Broods*

		Smallest	*Largest*	*Average*
Mousehall	Great Tit	6	8	6.3

Comparison of Breeding Seasons—Mousehall and Cranwich

The dates are those on which the first eggs were laid:

Coal Tit

Area	*Extent of Season*	*Beginning*	*End*	*Number of Clutches*	*Comparison with* 1950
Mousehall	.... 16 days	22nd April	7th May	18	2-3 weeks later
Cranwich	.... 14 days	27th April	10th May	25	2 weeks later

Great Tit

Area	*Extent of Season*	*Beginning*	*End*	*Number of Clutches*	*Comparison with* 1950
Mousehall	.... 15 days	4th May	18th May	16	10 days later
Cranwich	.... 19 days	6th May	24th May	17	4-6 days later

Blue Tit

This species was again too scarce for any conclusions to be drawn, but generally speaking it bred a week or so later than in 1950.

It would appear, therefore, that, although the cold, wet spring delayed all species in both localities to some extent, the later-breeding species (Great Tit) was delayed to a lesser degree than the earlier-breeding species (Coal Tit). It can also be seen that both Coal and Great Tits commenced breeding slightly later in the Corsican pine at Cranwich than in the Scots pine at Mousehall, and continued breeding in the former a little longer. Insufficient data are available from the newly established experiment in Scots pine at Cranwich for inclusion.

Reduced Occupation

In both areas the occupation, which had steadily increased over the past three years, showed a marked decrease to below even the figure for 1949. Mousehall dropped to 28.6% whilst Cranwich, which had many deaths and desertions last year, recorded 30%. The new Scots pine area at Cranwich returned the best occupation figure of 32%, though this was due to the very high figure for the boxes alongside the hardwood belt. One factor that may have affected occupation is that the boxes were not in position for the whole of the autumn and winter, during which time the flocks of feeding Tits would normally become used to them, using them for roosting and returning to breed in the spring. This reduced occupation, particularly at Mousehall, is in direct contrast to the success of last season which suggested that the area would support at least a 50% occupation.

Desertions and Deaths

There was an unusually large number of desertions of eggs at Mousehall (five Coal and three Blue Tit boxes), though nothing was seen of a Sparrowhawk such as was probably responsible last year for similar losses at Cranwich. Both areas suffered considerable nestling mortality, confined almost entirely to Great Tits, about twenty broods of which were affected to some extent. It is very noticeable that desertions and deaths in the new Scots pine area at Cranwich were negligible, again probably due to its proximity to hardwoods. There has been no regularity over the past seasons in the death and desertion rate, for, whereas in 1949 heavy losses were suffered in both areas, in 1950 the mortality rate of young Coal Tits at Cranwich was very high, and at Mousehall, nil.

2. Club's Nest-box Experiment

Description of Areas

The immediate locality of the School has been divided into three areas, defined as follows:—

Area "A"—Is that area, of mainly pure Scots pine with some Douglas fir and hardwood, lying between the Mundford-Lynford Hall road and the river Wissey. Some eighty acres are occupied by thirty boxes. Scots pine, the dominant species in this area, varies between fifteen and twenty years, is of moderate growth and as yet unthinned.

Area "B"—Is that area of mixed Scots pine and oak with some pure Douglas fir and some mature hardwoods, to the south of the Mundford-Lynford Hall road and largely in the vicinity of the Lower lake. Practically all age classes are represented in the hardwood species, and the area contains thirty boxes, being about one hundred acres in extent.

Area "C"—Is that area of mainly mature hardwoods with occasional conifer species, comprising the School grounds and Arboretum, the Upper lake and Ash Carr. The nature of the hardwood mixture prevents exact classification the main species being ash, sycamore, elm and alder and the average height, sixty feet. In this area, which extends over a hundred acres, there are forty boxes.

Although the boxes on the School Areas do not give the same systematic coverage as those of the Official Experiment, a distance of at least fifty yards is maintained between each box and the one adjacent.

Many boxes were re-sited, mainly to avoid the attention of children who, last year, were responsible for losses of eggs and young particularly in Area "B". Broadly speaking, the breeding season corresponded with the Scots pine area at Mousehall. Whilst the overall occupation figure compared favourably with that of last season's, there was a marked change in the relative occupation by species, as shown in the following table:—

Occupation by Species

	Overall Occupation	*Coal Tit*	*Great Tit*	*Blue Tit*	*Other Species*
1950	69%	5%	62%	31%	2%
1951	61%	22%	59%	14%	5%

As in previous seasons the Coal Tit was absent from the pure hardwood localities where the Great Tit predominated. In addition the latter was present in quantity both in the pure conifer localities and in hardwood-conifer mixtures.

Clutch Sizes

	Smallest	*Largest*	*Average*
Coal Tit	7	11	8.85
Great Tit	4	11	7.44
Blue Tit	4	10	7.2

In two boxes, two species of tit laid eggs in the same box. In the first case, on Area "A", a Blue Tit added six eggs to a completed clutch of Great Tit's eggs, the box being then unfortunately deserted. In the second case, on Area "B", there was the further complication of two nest cups being constructed, in one of which a Blue Tit laid six eggs; four eggs which were not definitely indentified at the time, though adjudged to be those of a Coal Tit, were then added to the second nest cup. From this assortment, five Blue Tit and a Coal Tit were hatched, and flew. When the box was finally cleared, a further four eggs were found in the bottom of the box on what appeared to be yet another nest platform.

Other Species

This season saw two new species occupying the Club's boxes—Nuthatch and Wren; together with a Tree Creeper which successfully reared five young in a box on the Lower Lake; these made up our "Other Species".

Two boxes in the Arboretum received attention from a pair of Nuthatches which carried out extensive plastering to the first box visited, culminating in the sealing of the entrance hole. When this was cleared the birds twice again blocked it with mud. The situation evidently proved too much for the Nuthatches which turned their attentions to a second box. Comparatively little plastering was undertaken, and, on nesting material of tree bark (mainly Scots pine), four young were reared in spite of a theft of two eggs and the failure of one other to hatch.

The Wren built the usual domed type of nest in the box she selected, but her clutch of five eggs was unfortunately destroyed, presumably by vermin. The entrance hole coincided in size and position with the pophole of the Nest-box and was consequently larger than that normally made by a Wren nesting naturally.

3. Observations of Species and Natural Nests

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

13th October Fieldfare (at the other extreme of their season, a flock of 30 Fieldfare was observed at Harling on 30th April).

18th March	Wheatear	23rd April	Yellow Wagtail
3rd April	Chiff Chaff	24th ,,	Whitethroat
7th ,,	House Martin	25th ,,	Turtle Dove
8th ,,	Swallow	29th ,,	Sedge Warbler
13th ,,	Stone Curlew	30th ,,	Reed Bunting
14th ,,	Cuckoo	4th May	Swift
15th ,,	Willow Warbler	5th ,,	Garden Warbler
15th ,,	Tree Pipit	5th ,,	Nightjar
15th ,,	Blackcap	10th ,,	Wood Warbler
19th ,,	Sand Martin	23rd ,,	Red-backed Shrike
20th ,,	Nightingale	24th ,,	Spotted Flycatcher
22nd ,,	Pied Flycatcher		

The Cuckoo was recorded (heard only) by three observers on the 12th March, but in view of the exceptional date, the next date for this species is also given in the above list. The Pied Flycatcher was recorded for the first time in the locality, only a single male being observed on one day only. The Wood Warbler was heard in the School Grounds on three days only, all being in May. A pair of Shoveler Duck was observed continually on the lake from the beginning of April and were adjudged to have bred although their nest was not discovered. Red-backed Shrike and Woodcock were both plentiful in the vicinity of the Hall, but in contrast to last year, the Crossbill was not reported.

Total Number of Species Observed

The year's observations brings the total number of species observed locally in the past four years by members of the Club to one hundred and fourteen. Some of the less common species for the locality are listed below:

Hooded Crow	Whooper Swan
Crossbill	Wood Warbler
Lesser Redpoll	Grasshopper Warbler
Siskin	Hen Harrier
Black Tern	Gadwall
Roughlegged Buzzard	Red-backed Shrike
Hawfinch	Great Grey Shrike
Yellow Wagtail	Pied Flycatcher
Whinchat	Marsh Harrier
Redstart	Great Crested Grebe
Golden Pheasant	Lesser-spotted Woodpecker

Natural Nests

A fairly representative sample of natural nests was found by Club members, and Nest Record Cards compiled for submission to the British Trust for Ornithology. These are cards designed for the systematic recording of the progress of each nest under observation from building, through laying, incubation, hatching to the eventual flight of the nestlings. Their compilation on a national scale provides a mine of information from which the facts of distribution and reproduction may be drawn.

Details of the natural nests found are given below:—

Jay	1	Skylark	1	Nightjar	2
Song thrush	6	Hedge Sparrow	4	Woodpigeon	1
Blackbird	8	(1 with Cuckoo)		Stock Dove	1
Mistle Thrush	1	Tree Creeper	1	Woodcock	2
Robin	6	Long-tailed Tit	2	Lapwing	1
Nightingale	4	Blackcap	5	Moorhen	6
Chaffinch	3	Chiff Chaff	3	Coot	2
Linnet	5	Common Whitethroat	3	Little Grebe	2
Yellow Hammer	2	Wren	1	Mallard	2
		Tawny Owl	1	Mute Swan	1
				Total:	77

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

Coal Tit	69
Great Tit	82
Blue Tit	22
Tree Creeper	1
Nuthatch	1
Wren	1
	176

The total of two hundred and fifty three cards represents an increase of twenty-five over last year's figure.

Nesting Failures

One of the less pleasing features of the breeding season was the large number of natural nests destroyed and robbed by the formidable combination of Jays and Jackdaws, ground vermin and local children. Nightingales and Warblers in the immediate vicinity of the Hall suffered most severely.

4. Bird Ringing Scheme

The Club participated for the first time, although on a modest scale, in the Bird Ringing Scheme of the British Trust for Ornithology. By far the greatest number of birds ringed were Tit nestlings in the School Area boxes. It is hoped to extend this branch of the Club's activities next season, possibly to the Official Areas.

In all, forty-eight rings were used as follows:—

Great Tit	21	Nuthatch	4
Blue Tit	11	Jackdaw	1
Coal Tit	10	House Martin	1

5. Other Activities

By kind permission of the Norfolk Naturalists Trust, a party from the Club spent a very interesting day at the Bird Sanctuary on Hickling Broad. Among the rarer birds seen or heard were the Bittern, Osprey, Montagu Harrier and Marsh Harrier.

In the Spring Term the School was fortunate enough to be addressed by Dr. Lack on "Bird Migration" and in particular on the autumn passage through the passes of the Pyrenees. Instruments used on the Continent for mimicking bird-calls were also demonstrated by Dr. and Mrs. Lack; in conclusion records of bird song were played.

It is to Dr. Lack that a final acknowledgement must be made. Not only has he directed the Club's work on the Nest-box Experiment, but has constantly given it advice and guidance in its efforts at bird ringing and identification.

OLD BRECKS OR NEW FORESTS?

(The following article is reproduced from "*Bird Notes*", the Journal of the Royal Society for the Protection of Birds, by kind permission of that Society.)

A Protest to the Editor of "Bird Notes" from Thomas Titmouse Esq. and the Hon. Reg. Regulus (Thetford Chase, Norfolk)

O teacher, our teacher, sir, sir, sir!

Your Society is "for the protection of birds"—all birds, we had supposed, not merely some birds. We pipe our protest at the distorted picture of East Anglia by one of your members, who writes of the new Breckland forests "these huge geometrical tracts of conifers bring little but Jays and foxes in their train, and drive such native birds as the Stone Curlew before them". This view is widely shared. How often have we overheard your birdwatchers, hurrying past us to the next sandy breck, declare our coniferous habitations "birdless"—thus showing, incidentally, that *they* had not overheard *us*!

Is Isaiah forgotten? "The desert shall rejoice, the glory of Lebanon shall be given unto it", and again, "instead of the thorn shall come up the fir tree". We pass over the benefits to your own species of the conversion of barren brecks to fruitful forests; the benefits to us birds are equally great. In summer, these conifer plantations support at least three, and in winter at least thirty, times as many birds to the acre as the brecks and heaths. If you object that quality, not quantity, is the aim of your Society, we would point out that the heaths support only 18 regular breeding species, while the conifers, so far from bringing in "little but Jays" support 27 regular species—and the Jays form only one-hundreth of the total population. Further, most of we conifer birds are there throughout the year, not merely in summer like our heathland cousins. If your aim is to protect the beautiful, we claim that in colour, form, agility and grace we are more than a match for the Stone Curlews, whose chief asset is an uncouth rarity.

This leaves you, sir, with one final excuse, that you protect the brecks and hate the forests because the brecks are the natural habitat of the region. Sir, you are wrong. The brecks are areas cleared of natural vegetation by your species in order to grow crops, and then after some years abandoned. Your friends the Stone Curlews haunt these unnatural wastes, but when a respectable vegetation clothes them once more, the Stone Curlews depart. Indeed, if your ancestors had not introduced rabbits, the breckland would revert to forest. Yes, the new conifers are much closer to the natural vegetation of the region than are the brecks—they are rather more orderly, it is true, but yours, sir, is the last species that should accuse mere trees of regimentation!

Lest you should think us as biased in one direction as your correspondent in the other, we hasten to add that we highly approve your purchase of one or two brecks. And provided that you will run a tank or bulldozer over the ground every few years, you will damage the natural vegetation sufficiently to keep Stone Curlews happy. Live and let live, sir. We will tolerate a few Stone Curlews, even though they disturb us nightly with their low-frequency caterwaulings. But we do hope that your birdwatchers will stop calling our forests "birdless", and that they will reconsider why a few ungainly Stone Curlews are always to be preferred to many beautiful titmice.

P.S.—As we birds cannot count accurately, we got Dr. David Lack of the Edward Grey Institute to supply the figures quoted in this letter.

Regular Breeding Birds at Thetford Chase

Heath Birds	*Conifer Plantation*
Linnet	Chaffinch
Yellowhammer	Yellowhammer
Woodlark	Coal tit
Skylark	Goldcrest
Tree pipit	Chiffchaff
Meadow pipit	Willow warbler
Yellow wagtail	Blue tit
Wheatear	Great tit
Whinchat	Willow tit
Stonechat	Longtailed tit
Stone curlew	Tree Creeper
Cuckoo	Whitethroat
Lapwing	Song thrush
Ringed plover	Blackbird
Stock dove	Robin
Wren	Dunnock
Nightjar	Wren
Partridge	Greater spotted woodpecker
	Ring dove
	Jay
	Sparrowhawk
	Barn owl
	Lesser redpoll
	Woodcock
	Crossbill
	Golden Pheasant
	Common Pheasant

A FOREST HERBARIUM

By D. B. CRAWFORD
Forester, East Scotland

A collection of forest flora specimens was recently started at Tentsmuir Forest, Fife. It is hoped that the following note on this collection, may be of interest to others who are contemplating forming a forest herbarium.

The objects of the collection are threefold. Firstly, to provide for the forest a record of its present flora. Secondly, to provide data which may assist the forester of the future in his problems and research, and, finally, to assist the work of local and visiting naturalists.

Before starting the collection, the area was clearly defined, and only plants growing within the boundaries are included in the herbarium. It was also necessary to decide the actual scope or range of plants, and it was agreed that to begin with only flowers were to be included, unless the specimen be rare or otherwise of special interest. The question of frequency terms was settled by using, for a trial period, the following words:—

ABUNDANT—Common, more or less, throughout the forest.

COMMON, but in a more restricted sense than that understood by abundant i.e., found over a large section of the forest or on sites replicated throughout the area but limited in their extent; an example of the latter class being drain sides.

FREQUENT—A plant found throughout the forest but in relatively small numbers.

OCCASIONAL—A plant restricted in range. It is possible that a plant coming under "occasional" could be frequent in any given section of the forest.

RARE—Self-explanatory.

The field work was arranged so as to include periodic visits to all the more obvious site changes. Tentsmuir, like most forests, is subject to many influences affecting the flora; two sides are flanked by rivers and their estuaries, the eastern side borders a fine expanse of sandhills and sea shore, whilst the inland march touches both muir and agricultural land. The smaller sites are usually visited in the evenings and the larger or more complicated areas examined at the weekends.

The plants, on being found, are either placed in a specimen tin or slipped in between the pages of an old pocket magazine or book: notes on locality, frequency, etc., are made on the spot. Care is exercised to ensure that the collected specimen is actually typical of the particular species—lone individuals are treated with caution.

Later the plant is transferred to sheets of newspaper and pressed. The specimen is carefully arranged so as to show as many points of recognition as possible. The actual pressing is best learned the hard way and, for this reason, is only dealt with briefly here. The collector will find that incorrect drying may often lead to deterioration or even complete disintegration.

The question of identification now arises. In theory plants are best identified in the field, but this is not always possible though it is essential that the plant be named as soon as possible, otherwise points of recognition may be lost as the plant wilts. The identification of difficult flowers is usually managed by consulting local naturalists, whilst second opinions are often sought for doubtful common species. At Tentsmuir we found that the local naturalists are generous in their assistance, and their unstinting help has contributed greatly to the success of the forest herbarium.

The method of mounting specimens is very much a matter of personal choice. At Tentsmuir we use large sheets of white cartridge paper; the plant being fixed by transparent tape. This paper is in short supply so economy is necessary. We usually manage to mount four specimens per sheet. The actual order of mounting is "as collected" but it is not suggested that this is the best method: this order is simple, but other methods may be found to be more desirable elsewhere. For example, the one specimen per sheet is the ideal way provided one has plenty of room to store the plants, and paper unlimited. A further method is to mount plants of any one genus together on one or more sheets. However the first system is essentially simple and is to be recommended because two or three sheets together present a compact picture of the forest flora at any given period.

The data included with the specimens were made as concise as possible. This, because it is hoped that the forester of the future will continue to add to the collection, and any system complicated by idiosyncrasies might well defeat this aim. The notes were divided into (*a*) frequency and location, (*b*) time of flowering, that is, the general period—early flushers or late stragglers being ignored, and (*c*) general notes or exact position of the plant if the one under review is rare. An actual example is given below:—

No. 10 CORALROOT. *Corallorhiza innata*

(*a*) Rare. Winter Lakes and plantation edges around the forest boundaries.

(*b*) June.

(*c*) 1. Specimen found on low ground E. side of Compt. 50.

2. Eighteen plants found at this station.

3. This is one of the Tentsmuir "specials"—said to be found in only two counties in Great Britain.

To complete the herbarium a list is being prepared. It is based, provisionally, on the order of occurrence, but it will eventually be an alphabetical index. A key to aid identification is also being considered. The list and mounted specimens are stored in a cardboard box.

In conclusion it should perhaps be stated that whilst the collectors believe that the herbarium has a distinct utility its preparation is also a very enjoyable hobby. From this angle it is to be recommended, and should be particularly helpful to those who find it difficult to see the wood for the trees.

LITERATURE ON FORESTRY IN SCOTLAND

By JAMES MACDONALD
Director of Research and Education

In preparing this note I have had in mind the figure of a newly-appointed District Officer—an Englishman or a Welshman—posted to a charge in Scotland. Finding himself in unfamiliar surroundings, but anxious to learn as much as possible about the forests and forestry of his new country, where should he turn for reading?

Taking the history of Scottish forests first, probably the best general account of the disappearance of the original forest is given by Ritchie (1) in a book which deals primarily with animal life and which, incidentally, gives interesting accounts of the rabbit, the red squirrel and the capercaillie. Papers on historical aspects of Scottish silviculture to which reference can be made are those by Watt (2), Murray (3) and Anderson (4) while information on the introduction of exotic trees into Scotland is given in articles by Dunn (5) and Balfour (6). Balfour's article, the work of a great expert on the subject, should be carefully studied by all Scottish foresters.

Local history should not be neglected. Hunter's (7) book on Perthshire estates is worth reading although it does not say much about silviculture, while local histories, of which there are many, sometimes tell a surprisingly large amount about woodlands and plantations. A good example of this kind is Chamber's History of Peebles-shire (8). The Statistical Accounts, the Old (9) and the New (10), which are available in all the principal libraries, occasionally throw useful light on past forestry practice. These surveys were made, parish by parish, by the ministers, and they are naturally variable in quality. Some of them however give valuable accounts of forestry and woodlands.

On the ecology of Scottish Woodlands there is surprisingly little information which can readily be got at, but Tansley (11), Anderson (12), Watt (13 and 14), Guillebaud (15), Fenton, (16 and 17) and Matthews (18) may be consulted. On geology and soils, reference may be made to Anderson (19), Muir (20) and G. K. Fraser (21-24). Fraser's writings on Scottish soil problems should be read with the closest attention; he is also the author of a paper (21) which puts the case admirably for afforestation in the Highlands. In this connection, the Report on Hill Sheep Farming (25) should also be studied.

For writings on the problems of afforesting bare lands one may turn to Steven (26-28) while Macdonald (29) and Guillebaud (30) may be consulted for good accounts of experimental work in afforestation. How the problem of the scrub birch areas was being handled is described by Watt (31).

An attempt by Anderson (32) to show how the various coniferous quality classes are distributed over Scotland is a suggestive and interesting paper although some of his conclusions are open to dispute, while a work by Fraser (33) discusses variations in rate of growth as a result of soil changes within a limited area.

On species, Scott (34) is still worth reading on the subject of Douglas fir while one of the by-lanes of Scottish silviculture is described by Macdonald (35) in his account of Eucalyptus in Western Inverness-shire.

The methods of planting current in the late nineteen twenties are recalled by papers by McEwen (36) and Cowell-Smith (37-38) while two papers (39-40) in the *Journal of Animal Ecology* are useful reminders of the plagues of voles which did so much damage in south and west Scotland in the early thirties of this century.

Finally two references are given, one to the capercaillie by Taylor (41), and one to an interesting but not very important animal by Watt (42)—the wild goat.

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BRINGING FORESTY TO THE PUBLIC

By H. L. EDLIN

District Officer, Publications

(Lecture delivered to the Edinburgh University Forestry Society)

Sooner or later most foresters feel the need to tell the general public something about the forests they tend and their importance to the national economy. There are two main reasons for this. First, in most countries forestry is to a greater or less extent a State enterprise, and so dependent, in any democracy, on public support for its continued progress. Second, forests are so large that we cannot, even if we wished, keep the public out of them, and an uninstructed public can do very serious damage, particularly through carelessness which results in forest fires. The message which foresters seek to give will of course vary from time to time and from place to place, and my object here is not to discuss *what* the public should be told, but rather to outline the various means available for getting that message across.

In the first place, it is advisable to review the situation strategically before deciding on tactics. First decide whether you wish to reach the people in general, or some particular section, such as farmers or schoolchildren; then assess their numbers, and plan accordingly. Remember that the work, to be effective, must be continuous; there should be a recognised plan of campaign for each year, to refresh people's knowledge of, and interest in, the forests. Coming to the tactical methods, there is a wide variety of means of communication open, all of which, sooner or later, are likely to be required by the keen forest publicist. Keep in mind the great diversity of the audience that you seek to influence; it includes, besides the almost legendary "man in the street", his wife and his family, who probably have more leisure time available to stop, look and listen; in most overseas countries, and even to some extent in Britain, it includes people whose native tongue is not English, and who will have to be reached through some other language.

The Spoken Word

This, though the oldest, is still the most effective means of getting a story across. Given adequate personal qualifications on the part of the speaker, his main problem is to find a receptive audience. There are two ways to do this. The best is to invite a party to visit an actual forest. The second is to get in touch with some body which regularly meets for lectures or discussions, and is ready to include forestry in its syllabus. In either case, make use as far as possible of some existing organisation, which has the ground already prepared to receive your gospel. Such bodies include the Boy Scouts, Young Farmers Clubs, schools, and similar youth organisations, local natural history societies, literary or political clubs, and many other bodies who may appear, superficially, to have little or no concern with trees or country life.

The gifted speaker can, no doubt, rely on the spoken word alone; but most of us will find it better to supplement our talk with some kind of "lecture material", such as specimens, film strips, maps, pictures, or diagrams, or printed literature which can be distributed to the audience. Besides preparing his set talk, the lecturer should go prepared for questions—he will certainly get them!

By far the biggest audience, of course, is obtained by broadcasting, but time "on the air" is closely rationed, making it only an occasional, though highly valuable, channel of information.

The Printed Word

Printed matter, to use a comprehensive term, carries a message which is less personal than a spoken lecture, but which is at once more permanently available and more easily distributed. Foresters have, broadly speaking, two ways in which to use it; they may either write or publish themselves, or assist professional journalists to do so. Taking the latter course first, a very wide audience can be reached through the sympathetic reception of press reporters, free-lance journalists, and authors who are ready to devote time and editorial space to featuring forestry or some aspect thereof. It is well worth while to give them the facilities they need, and to accept the fact that they will tell the tale in their own way—seldom in just the manner that a professional forester would himself adopt. Local and technical papers will usually devote far more space to forestry than do the great national dailies, and it is often the little local week-end paper that really "gets home" to the family circle.

When foresters start to write and publish themselves, they should keep in mind the fact that the general public expects a rather special treatment. Most of our writing is done for the fellows of our craft, taking the form of technical expositions or research reports which are outwith the ready grasp of the untrained man. In writing for a larger field we cannot assume any pre-existing knowledge of forestry, though it is as well to assume a fairly wide "general" knowledge and a genuine desire to learn. Technical terms should be used very sparingly and Latin names, if used at all, must be accompanied by English translations. Such a phrase as "lining out *Pinus sylvestris*" is just double-Dutch to the ordinary general reader. Illustrations help enormously; in fact, it is not really worth while, nowadays, trying to approach the public without good photographs or drawings, which justify their cost many times over.

Printed matter—books or pamphlets, may either be put on sale or given away. Strange though it may seem, the "sale-price" publication usually travels farther and fares better, because in return for their share of the sale price booksellers all over the country, and indeed all over the world, will either stock it or at least obtain it on request; and it is only taken up by people who are really interested in its subject matter. The "free-of-charge" publication needs to be distributed, since it cannot pay its own passage; this requires organisation and costs money, and at the end of it one can never be sure whether the recipients really read it or not. Nevertheless, the free "hand-out" is a useful means of reaching people, such as schoolchildren and certain rural groups, who are not in the habit of spending hard cash on reading matter.

Pictures

Although in one sense a picture is independent of the spoken word, and although it can transcend all language barriers, it is nevertheless, in practice, dependent on speech or print to explain its meaning and purpose. So pictures must rank as auxiliaries to published work or spoken lectures. A possible exception is what is called a "picture-set", a connected series of pictures, described by captions, designed for wall display in schools or meeting rooms, which can be left to tell its own story.

Photographs suitable for publication in any particular context rarely come to hand by chance. Even an extensive and well-indexed photographic collection can seldom supply everything that is needed. As a rule they have to be taken specially, due allowance being made for the rejection of a proportion that fail to reach the desired standard. It is worth remembering that negatives are not usually needed for reproduction in the press; the best material is a large glossy, black-and-white print. Owing to the great depth of focus needed for most forest subjects, the old-fashioned plate camera on a tripod often gives a better picture than more modern high-speed equipment; miniature cameras often fail to do justice to the intricate detail of a forest scene, especially when enlargements are made from their very small negatives.

Just as the printed picture helps out the printed word, so does the projected picture assist the lecturer. Projected pictures include lantern slides, film strips, motion pictures, and illustrations projected by an epidiascope; they can be in monochrome or colour, for although colour-printing is a costly process, colour projection is quite simple. The old-fashioned lantern slide is still going strong, despite its drawbacks of high cost, weight, and fragility. A good set of slides is a valuable aid to anyone who lectures regularly, especially if he took them all himself and knows all about them; slides are best made from negatives. The modern successor of the slide is the film strip, which is cheap, light, and durable; copies are easily made and distributed, and it is customary to supply teaching notes with them, so that any lecturer can pose as an expert. Film strip pictures can be made from almost any photograph or drawing, and their only drawback is that the lecturer is more or less obliged to follow the set course of the strip. Film strip projectors are light and quite portable, and reasonable in price, and can be operated by the lecturer himself, without the help of an assistant. Epidiascopes are of course excellent for displaying printed pictures, but their high cost restricts their general use.

The moving picture is in a field of its own, and nowadays it is fairly easily made and displayed even by amateurs. But it goes so fast, and is so generally associated with light entertainment, that one may be allowed to doubt whether it is really as effective as a series of still pictures explained by an intelligent speaker.

Specimens

Even more useful than pictures, in certain circumstances, are actual specimens from the forest. They enable one to bring the right atmosphere and sense of reality into an urban lecture room far removed from the woods. Of course we cannot, like members of some professions, bring in our finished product—the hundred foot oak tree—but we *can* carry seedlings or transplants (the fresher the better), seeds, cones, and small wood specimens. It is surprising how much interest a small tree can arouse, especially if passed round an audience that rarely sees green things growing in their natural habitat.

Shows

A rather specialised field of publicity is the agricultural show or similar display, which brings together many lines of attack. A good exhibit involves specimens, pictures, literature, and personal contact between the public and really knowledgeable members of the forestry profession. It may also make good use of scale models, but these are expensive to construct and only worth while if they are portable, so that they can be used repeatedly at different points.

Visits to Forests

I have left to the end the forester's trump card—the actual living forest to which he devotes his life work. Once he can get a party on his home ground he can usually convince them of the soundness of his own point of view. Of course it all needs arrangement, and an appreciation of your visitors' viewpoint also. The visitors will seldom want to see the particular research plot that interests the forest officer most, and they may have little comprehension of the niceties of different thinning grades. Instead they will want to see a big tree being cut down and sawn up, and little trees being raised in the nursery or planted out in the forest; much that looks like ordinary everyday work to the expert will have immediate appeal to these casual visitors. The tour must be planned, for such an audience, on rather different lines to a visit by professional foresters. For example, a party from a town will not be able to walk long distances without fatigue, though they *will* want to stretch their legs after a long bus ride, and they *will* enjoy a walk that leads them away from the high road into the cool green depths of the woods. It is a good plan to let everyone know at the outset what they are going to see, and then to tell them once again, when they actually arrive at the selected points, what is going on and why. A little advance "stage management" is usually needed to get all the interesting jobs in progress at the same forest on the same day.

On such occasions, and indeed whenever one is dealing with the general public, it is seldom worth while to try to teach forestry in the really technical sense. The audience that appears has no intention of embarking on forestry as a profession; they are neither students nor trained foresters on a refresher course. Their line of approach is: "This looks interesting—tell us all about it!" If you can answer this plea, then no matter how brief the contact, you will win friends to the cause of forestry.

Comment by the Information Officer: In the foregoing article, addressed to foresters at large, H. L. Edlin gives a good outline of the technique of public relations. But it must be stressed that such projects should not be undertaken without sanction and consultation, through the proper channels, on the official policy regarding the various aspects of publicity. DENNIS HEALEY.

THE MERRICK CLIMBED

By M. J. PENISTAN

Divisional Officer, South Scotland

For a long time we had talked about climbing the Merrick, the highest point of the Glen Trool National Forest Park, and of Scotland south of the Highland Line. At last a District Officers' meeting at its foot gave us the chance to climb it on the previous day.

We crossed the rugged and beautiful road through the Clatteringshaws section of Cairn Edward Forest, still in its infancy of small trees on black turves, and new tractor ploughing, and went on past Kirroughtree, a pole forest on rocky knolls and hollows, with little patches of many species on rapidly changing ground. On crossing the Cree we had a new approach to the hills; the woods were largely oak coppices, the pastures rocky and with a touch of peat in them, until suddenly on a narrow grassy road across the Cree at Clauchaneasy we were in country as wild as Sutherland; rock, peat and birches, and the hills closing in about us, craggy hard hills—Lamachan, Curlywee, Muldonach, Eschonchan. The road became rough and climbed round the back of the Glentrool Lodge policies—a fine wood of pine and larch with the native oak large and thriving. Suddenly the glen head opened out. The loch lay below, with its well sited clumps of larch and pine, and the fine old oak woods, some trees sessile and very large, a natural shelter to the little farms of Buchan and Glenhead. The valley continued back into the rough hills, and from the north the streams poured down from the high valleys. That Earl of Galloway who built the Lodge and planted the woods about the loch with great taste, quite aptly had inscribed the Buchan Bridge with Scott's "Land of the Mountain and the Flood". Those of us new to the Glen saw it at its most impressive. The highest hills, our Merrick among them, were just topped with mist, and after a series of wet days the burns were all in full spate.

We drove as far as Glenhead, where the track becomes too narrow for four wheels, and climbed out through the sheep buchts on to a wet hill. It was not a cheerful mid-day, but it was not raining.

The going up the Gairland burn was hard. All this Galloway ground is ill-drained and much of it tufted with *Molinia* and *Scirpus*. The valley sides were steep and crag-lipped; the wind ruffling the long grass, all green and very moist, with a few pipits piping up, the occasional crow, and a few thin sheep grazing quietly. We strung out and climbed round the end of the Rig of the Jarkness, over a conical morainic hill, and there was Loch Valley, grey, clear, wind-ruffled. Skirting it on very wet rough ground with the sketchiest of sheep tracks (or were they deer tracks) we looked down to Loch Neldricken, irregular, granite-shored, but peaty and dirty, just as Loch Valley was clear. It was grey, there was mist about the Merrick, the hard granite faces of Craignaw and Craig Neldricken stood uncouth and shabby in a grim wilderness, it was after lunch time, we had not gone far, the going was bad—it might still rain. A photograph shows us at lunch in the heather under the wind by a little burn running from Loch Arron, looking cold and grim.

Before we started again there was a glimpse of sun, the mist rose and patches of blue showed in the sky. We set off, and soon the going improved as we came on the fire beaters and burned-out ground of the 10,000 acre hill fire that burned for three days in June. Walking was easy now to those of us who found the heather step a trial. There was sunshine and firm footing. The ground was rocky and broken, the view to the south opened grandly. A party of red deer moved along the slopes of the Merrick over the Rig of the Gloon, two hinds and a fawn. There was a party of three stags above us on the Rig of Loch Enoch, and suddenly there was the loch itself below us. A wildly indented loch, the granite shore with white sands and clear water in a shallow hollow between Merrick, Mullwharchar and the Dungeon Hill. The water shone in the sun, the blue waves were white-capped. Gulls cried round the famous Loch-in-Loch*, sailing in the wind. Between granite hills there were hints of distant prospects, and the nearer hills of the Rhinns of Kells seemed low. We felt twice as good as we had done at lunch, and turned our faces to the mountain.

It is very steep from the east, more so from the north, and soon we were strung out up the Red Stone Rig, struggling across the face first among craggy granite slabs, then on the hard clinkery stone of the upper slope, stepping breathlessly up. The prospect widened continuously across the long high bog of the heart of the Forest Park to Loch Riecawr, Loch Doon and the rough hills at the northern end, to the round hills of Changue, Polmaddie and Haggis.

The sun shone on the summit, a level, very windy ridge, which was just below the flying clouds, the top hanging over the sheer north face and the deep Black Gairy on the west. Beyond the ridges of the Forest Park rose the Rhinns of Kells, Cairnsmore of Dee and Cairnsmore of Fleet; beyond in the sunny mist were the shadowy outlines of Cumberland and Man. Ireland was hidden by cloud across the green low moor and meadow of Wigtown, and the silver of sunshine on Luce Bay and St. George's Channel. Over Ayrshire, Ailsa Craig stood out in the Clyde, with all Kintyre behind, and Knockdolian repeating his cone shape on the mainland. The long curve of Ayr Bay led to Prestwick. We could see the large hangars, and beyond, shadowy but quite definitely, Ben Lomond and perhaps Ben Ime in Argyll. Arran sloped gently from the south to the fine highland peaks of the north. The wind tore across the top as we picked out the places about us, and soon we were striding across the short firm turf of the Broads of the Merrick among many sheep, by the Lum of the Gutters, up which the wind roared to Benyellary, and over his south face, down the Braes of Milgarvie to the tussocky lower hill, plentiful with blaeberry, through bracken to the shepherd's empty house at Culsharg, a green valley bottom among crags again.

We had passed a shepherd and two walkers on Benyellary—no others; at the foot of the rough path down the leaping falls of Buchan to the main Glen of Trool were dozens of cars parked and scores of people picknicking, and we were suddenly in everyday Sunday again.

ROE DEER IN AUSTRIA

By C. T. WILDASH
Executive Officer, Headquarters

Before considering the methods of shooting roe-buck, you must first of all be able to find him; to do so needs a knowledge of the habits and habitat of a most interesting and attractive beast, which is widespread in the Austrian

*A lochan on an islet of Loch Enoch.

mountains and on the high plain of Lower Austria. One may find him from the edge of the tree-line on the foothills of the Karawanken mountains practically up to the gates of Vienna, from the conifers of Carinthia to the beeches of the lovely Vienna woods. Great toll of the roe was taken by Displaced Persons and others wishing to supplement an inadequate post-war meat diet, and cruel, illegal methods were often used to bring about its destruction, such as driving over tripwires—a method which disables without killing, which breaks limbs and fails to discriminate between buck, doe and kid. The use of automatic firearms, picked up by irresponsible people in the chaos following the end of the war, also accounted for the death of a large number of roe of all ages and both sexes. With the co-operation of the Allied authorities, however, the Austrians managed to gain control of the situation once more, and it now looks as if the roebuck population has achieved a certain stability.

On the principle of "Know your enemy", although one is bound to admit that it is extremely difficult to regard these beautiful little creatures as such, it is as well to take note of the conditions in which the roe flourishes. It is firstly essential that they should have good cover to protect them from their natural enemies, which include man, wild-cats, foxes, the larger birds of prey, and marauding dogs. For this they prefer plantations of young conifers, up to say six feet in height, or the type of underbrush prevalent in hardwood forests, normally within easy and safe distance of good grazing. In the summer months, especially after rutting, they seem to prefer the coolness and seclusion of high forest. This applies to the buck particularly, and they are extremely difficult to find at such times. While the roe are well able to take care of themselves when in good condition, heavy winters often take toll of them; their tiny hooves sink deeply into thick snow; the roe, unlike the red-stag who is not such a dainty feeder and can often dig for food, grows weak with hunger, and experiences difficulty in extracting itself from the deeper snow-drifts, thus making it an easy prey for its broader footed and broad winged enemies. Because of shortage of food they often leave their mountain fastnesses and descend to the valleys nearer to civilisation during the winter; here poacher, dog and hunting cat are able to dispose of them. Foresters in Austria therefore put down winter-feed for the roe in clearings in the forest, under a roof to keep the snow from covering it, and with a salt-lick close at hand. It may be mentioned here that in Austria the roe is seldom found where the red-stag appears in any numbers, and the latter can therefore be classed as a natural enemy to the roe, although Austrian foresters to whom the writer has spoken can give no reason for this apparent antipathy.

The roe has the habit of feeding at dawn and dusk, and to do so leaves the protective woodlands for the richer grass of the meadows, retiring once more when the sun becomes strong and the dew leaves the grass. On moonlight nights, grazing goes on throughout the night, and the roe retire to cover rather earlier in the day than is otherwise the case. Such nights therefore make for bad shooting, for it is difficult enough to see them in the half-light of dusk or dawn: to see them clearly enough to shoot in the moonlight is only possible to the highly experienced hunter. The buck is most often seen before, or particularly during, the rutting season; after this for several weeks he leads a hermit-like existence in the depths of the forest, and to go shooting then is seldom worth while. He is not monogamous, although he may mate with the same doe for several seasons; the Austrian gamekeeper normally tries to keep the balance of one buck to every five does in his beat. This job is made easier by the fact that, unlike his cousin the red-stag who is often a wanderer from as far off as the Carpathians, the roe is more inclined to stay in one district throughout its life. Rutting takes place for two to three weeks in the latter part of July or the beginning of August. There has recently been an attempt to associate the rutting urge of the roe with the appearance of ergot, but from enquiries made, it seems as if the German foresters at any rate are quite content to leave the matter unexplained. The rutting season is the most fascinating time of year to observe roe; the doe calls with a soft, piping note, and is highly flirtatious at first. For primitive beauty, the running of the buck with the doe, both of them oblivious to the onlooker, is a sight unexcelled in nature. The nose of the roe is better than its eyes; it will trust its powers of scent and will often stand gazing at you if it cannot wind you. It is a very inquisitive animal, and it is an old hunter's trick, if a buck is seen to be alarmed, to make a sudden noise; often the buck will stop in its tracks as if to see the source of the noise. Similarly, if not otherwise alarmed, it will not always make off immediately after being shot at, and sometimes offers the opportunity of a second, and perhaps more successful shot. The buck, in general, is, and has cause to be, more cautious than the doe, and an old buck shows considerably more discretion than a young one.

In thick brush and in the half-light it is not always easy to differentiate between the sexes, and the use of field glasses for this purpose is always to be recommended. It is not invariably easy to see the horns of the buck, which are sometimes malformed or undeveloped. This may be due to previous injury at the base of the horn, the weak physical condition of the animal, or, in the case of a "perruque" formation of the antlers, to an injury to the sex organs. Peculiarly enough, an injury to the right side of the body often affects the left horn, and vice verse. Generally speaking the strength of the buck is reflected in the strength of his head-dress, and a fit animal in the prime of life will have powerful horns, well "pearled" at the base, and set wide apart at the tips. As the buck grows old (say over five years) his horns become coated with a dark-brown wax-like substance, and the "pearling" becomes narrower and smoother. Older animals of both sexes often develop a grey muzzle after reaching the age of five years. An experienced hunter will often be able to tell buck from doe at a great distance by the stronger neck and thicker body of the former: the movements of the buck too are usually more alert and suspicious than those of the female. When the buck or doe barks a warning, it is usually too late to attempt a shot, but for academic purposes it is interesting to note that the voice of the lord and master is gruffer and sharper than that of his consort. It is the masterful buck rather than the gentle doe who has earned himself a bad reputation with British foresters by his habit of rubbing his horns on young trees, thus damaging the cambium, and often eventually killing the tree. In the self-regenerated forests of Austria, this is regarded as a venial sin, only committed by a worthy miscreant. The marks on the young trees and the "slots" of the buck, larger and impressed more deeply than those of the doe, tell the observant forester, moreover, that a buck has passed that way.

There are, broadly speaking, two methods of shooting buck with a sporting rifle—and any other method is severely censured in Austria. First and foremost there is stalking, and secondly there is the method of lying in wait for the roe to appear. Whilst stalking commends itself only to the most active and agile of us, it is the only method of obtaining real sport, in which the wits and instincts are pitted against a wily, wary opponent. If the hunter has an objection to getting up before dawn in the middle of summer, buck shooting can be done at dusk, although the lazy man who sits waiting for his buck only at dusk is not usually regarded by the "Jäger" (ghillie, in this case) as much of a "Waidmann" (a word meaning the sort of fellah who doesn't shoot a roostin' hen-pheasant after dark in the close season), and as often as not will be conducted to a place where the roe never appear. The "Jäger" sets a very high standard of "Waidmannship", to coin a phrase, and will track wounded game for hours at a stretch rather than let it suffer unduly. You are expected to behave accordingly.

Let us therefore pretend that you are active and agile, and of course potentially a good "Waidmann" as I am sure we all are at heart. Our "Jäger" calls at the mountain inn where we are staying at four o'clock on a summer's morning. There was no moon during the night; it is not even raining, and it is the rutting season. Everything points to a good morning's sport. We have a cup of coffee, and move off with our rifles, magazine loaded, telescopic sight (very necessary in the half-light), field-glasses, and one or two extra rounds of ammunition in the pockets, but so placed that they do not rattle together. Our boots are well studded to get a better grip on the steeper slopes, for there is nothing more annoying than to slip about, and nothing—except stalking down-wind—so likely to terrify the roe. Unbeknown to your "Jäger" you slip a flask of schnapps into your pocket, and if you have any sense, another into yourself to stiffen the upper-lip at this ungodly hour of the morning. Remember, you are supposed to be on holiday, and already feel like death after an evening of cognac, home-grown tobacco, and hunting-talk. Once in the woods, however, your gloom dispels, and you lead the way, treading softly, with your rifle at the alert. The "Jäger" has the field-glasses, and directs operations. All at once, in spite of your caution and the "Jäger's" sharp eyes, a roe goes away, barking like all the hounds of hell, and giving you the fright of your life; the "Jäger" gives a shrill whistle, and the roe stops in its tracks. It has seen a few things in it's life, but never anything quite so extraordinary as this; secretly you sympathize, peering at the beast through your telescopic sight, while the "Jäger" is doing the same through the field-glasses. Only a doe! tension relaxes as the doe, recollecting itself, disappears into the thick of the woods howling her disapproval. We carry on, looking cautiously over every fence, and approaching every clearing with even more deference. The wind is in our faces, otherwise we might just as well go along singing for all the roe we would have seen. Suddenly, from behind a thicket, a buck and a doe flash by at the end of your rifle. You do not shoot because, like me, you are a fool who is too interested to remember that you have a rifle in your hands for that very purpose. Anyway the "Jäger" thinks you are a fool, and as much as says so.

It is getting light, and almost too late for successful buck-shooting. The "Jäger" sits you down at the edge of a clearing with the rifle across your knees. You are smoking a cigarette both for personal satisfaction, and to test the direction of a rather fluky wind. The "Jäger" pulls a little piece of straw from his coat pocket and puts it in his mouth. "Gosh!" you think in your ignorance, "that's a damn funny breakfast, even for a "Jäger". These thoughts are soon dispelled when he makes the straw produce a piping, whistling noise, imitating the call of the doe to the buck. The straw is cut like the reed of a wind-instrument. You wait, while the "Jäger" repeats the piping from time to time. All at once you sense rather than see the presence of a buck—he is alert, waiting, watching and testing the wind with his nose, standing in the long brushwood at the other side of the clearing. You can see his head through your telescopic sight; his horns, set close together at the tips, are darkish brown stained, and the pearling at the base of them is very narrow. This, and the extreme caution of the animal, tell you that he is old and unfit. The fact that you take careful aim, and press the trigger, forgetting in your excitement that these sporting rifles have hair-triggers, does not figure in this account. Nor does the fact that, because of this, you missed the buck, gave yourself a black-eye on the telescopic-sight, and thus drew the "Jäger's" wrath on your defenceless head by your own stupidity. It does not even tell how you produced the flask of schnapps at the critical moment, and became, in spite of your obtuseness, a good "Waidmann" by popular acclaim. You earned your breakfast willy-nilly.

FORESTRY COMMISSION STAFF

At 31st December, 1951

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	FLOWERS, H. R.	Secretariat, Private Woodlands
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	MCKENZIE, S. M. O.	Finance
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TELEPHONE: KENSINGTON 9691

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ENGLAND, NORTH-WEST CONSERVANCY

Upton Grange,
Upton-by-Chester,
Cheshire

Telephone: Chester 4006-7

CONSERVATOR:	Ross, A. H. H.	
DIVISIONAL OFFICERS:	Barrington, C. A. J.	Chester (Private Woodlands
	Chard, J. S. R.	Chester (State Forests)
	Raven, W. J.	Chester (Estate)
DISTRICT OFFICER I:	Jackson, W. V.	Mansfield (State Forests)
DISTRICT OFFICERS II:	Begley, C. D.	Carlisle (State Forests)
	Bell, H. W.	Shifnal (Private Woodlands)
	Chard, R.	Chester (Utilisation)
	Christie, A. C.	Shifnal (State Forests)
	Crosland, J. V.	Ulverston (State Forests)
	Flynn, A. E. G.	Chester (Aquisitions)

	Lapage, C. J.	Chester (Acquisitions)
	McNamara, P. J.	Mansfield (State Forests)
	Moir, D. D.	Chester (Estate)
	Roberts, W. G.	Shifnal (State Forests)
CONSERVANCY ENGINEER:	Mester, R. R.	Chester
ASSISTANT ENGINEERS:	Carter, F. R. L. (Civil)	Carlisle
	Humphreys, E. G. A. (Civil)	Shifnal
	James, J. E. (Civil)	Chester
	Priestley, J. B. (Survey)	Carlisle
SENIOR EXECUTIVE OFFICER:	Eadie, T. L.	

FORESTERS

1.	Delamere:	Jones, H. W. (Head); Brandon, J. W. (II).
2.	Thornthwaite:	Walton, W. (I); Fuller, H. (II); Wells, H. (II).
3.	Cannock:	Tribe, W. (Head); Morgan, L. G. (I): Hall, D. (II).
4.	Mortimer:	Adams, I. (Head); Shelley, W. R. (I); Grant, W. (II); Lloyd, J. C. (II); McMillan, J. R. (II); Morris, J. (II); Stokoe, J. (II).
5.	Walcot:	Rees, T. J. R. (I).
6.	Clipstone:	Simpson, G. A. (Head); Arnott, W. (I); Day, J. (II); Garner, W. (II); Hall, W. (II); Rowlands, I. G. (II); Sarsby, O. R. (II); Thomas, D. R. (II).
7.	Ennerdale:	Nelson, D. (II); Close, F. (II), (Blengdale).
8.	Hope:	Morrill, W. (II).
9.	Bawtry:	Hodgson, C. A. (II).
10.	Sherwood:	Tucker, E. J. (I).
11.	Kershope:	Sharp, G. A. (I); Anderson, R. D. (II); Jones, E. (II); Olney, B. A. (II); Pemberton, F. (II) (Also at Spadeadam); Power, R. J. (II).
12.	Hardknott:	Murray, M. (II);
13.	Grizedale:	Morley, D. S. (I); Allcock, M. S. (II); Backhouse, C. H. (II); Francis, E. R. (II).
14.	Greystoke:	Guthrie, F. H. (II).
15.	Cotgrave:	Davis, P. P. (Foreman)
16.	Dalton:	Keens, D. W. (II).
17.	Kinver:	Stockley, G. H. (II).
18.	Gisburn:	Hughes, D. J. (II).
19.	Long Mynd:	Attenborough, T. J. (Foreman).
20.	Swynnerton:	Bennett, H. (Foreman).
21.	Bagot:	Wilson, W. J. (II).
22.	Longtown:	Parker, F. H. (I); Rose, J. D. (II).
23.	Spadeadam:	Pemberton, F. (II) (Also at Kershope).
24.	Charnwood:	(New Unit).
25.	Habberley:	(New Unit).
26.	Oakamoor:	(New Unit).
27.	Packington:	(New Unit).

Private Woodlands :

Beeston:	Gwilliam, G. T. S. (I).
Satterthwaite:	Small, J. R. (I).
Shifnal:	Walsh, D. H. (II).

ENGLAND, NORTH-EAST CONSERVANCY

Briar House,
Fulford Road,
York.
Telephone: York 4684

CONSERVATOR:	Connell, C. A.	
DIVISIONAL OFFICERS:	Garthwaite, P. F.	York (State Forests)
	Portlock, W. J. J.	York (Estate)
DISTRICT OFFICERS I:	Conder, E. M.	Pickering (State Forests)
	Haldane, W. D.	York (Private Woodlands)
	Maund, J. E.	York (Utilisation)
	Selby, B. C.	York (Acquisitions)
	Smith, W. T.	Hexham (Private Woodlands)
DISTRICT OFFICERS II:	Crowther, R. E.	Kielder (State Forests)
	Forrester, S.	Hexham (Private Woodlands)
	Langley, P. J.	Bellingham (State Forests)
	Macdonald, I. A. D.	York (Private Woodlands)
	Marshall, I. R. B.	York (Private Woodlands)
	Mitchell, T. C.	Widehaugh (State Forests)
	Piper, R. J.	York (Estate)
	Rowan, A. A.	Rothbury (State Forests)
	Wood, T. G.	York (State Forests)
CONSERVANCY ENGINEER:	Sargeant, T. J.	York
ASSISTANT ENGINEERS:	Perkins, J. S. (Civil)	Bellingham
	Preston, G. W. (Civil)	Pickering
	Wortley, A. (Mech.)	York
SENIOR EXECUTIVE OFFICER:	Chaplin, L. A.	

FORESTERS:

1. Chopwell:	Harbin, W. B. (I).
2. Allerston:	Anderson, T. E. (Head) (Also at Langdale); Kirby, C. (II) (Estate).
Dalby:	Snowdon, L. (I).
Wykeham:	Gough, W. R. (Head); Stanley, W. E. (II).
Bickley:	Bolam, T. W. B. (II).
Harwood Dale:	Yeomans, F. W. J. (II).
Staindale:	Martindale, J. M. (II).

3. Rothbury:	
Thrunton:	Gledson, J. G. (II).
Chillingham:	Telford, J. W. (II)
4. Selby:	Wood, W. (II).
5. Kielder:	Beasley, G. F. (Head).
Kielder:	Stokoe, G. (II); Turnbull, M. T. (II); Young, R. E. (II).
Whickhope:	Tait, J. (II).
Mounces:	Hislop, J. J. (I); Fox, T. F. (II); MacDonald, R. (II).
Tarset:	Scott, J. J. O. (II).
Chirdon:	Straughan, J. G. (II).
Plashetts:	Parker, G. W. (II).
Smales:	Simpson, C. N. (II).
6. Hamsterley:	Daglish, T. E. (I).
7. Ampleforth:	
Boltby:	Featherstone, C. (II).
Bylands:	Stephenson, F. (II).
Gilling:	Cumming, J. (II).
8. Rosedale:	
Cropton:	Frank, H. (I).
Pickering:	Bartlett, R. F. E. (II).
9. Harwood:	Baird, R. L. (II).
Ray:	Rayner, D. A. R. (II).
10. Slaley:	Scott, J. F. (I).
11. Arkengarthdale:	Hird, J. T. (Foreman).
12. Redesdale:	McCavish, W. L. (I); Salmond, M. P. (II).
13. Langdale:	Anderson, T. E. (Head) (Also at Allerston).
Langdale:	Marsh, E. W. (II).
Broxa:	Mennell, J. (II).
Broxa Nurseries:	Chisholm, J. D. (I).
14. Widehaugh:	Davy, J. H. (I).
15. Wark:	
Wark:	Brown, W. C. (I).
Pundershaw:	Marshall, J. A. (II); Woodcock, F. A. (II).
16. Scardale:	Woodward, F. G. (II).
17. York:	Terry, T. N. (II).
18. Cleveland:	Adams, G. (II).
19. Wharncliffe:	(New Unit).
20. Coquetdale:	(New Unit).
21. Knaresborough:	Ainsworth, P. H. (II).
22. Londesborough:	Fawcett, E. (II).
Private Woodlands;	
Wintringham:	Gilson, R. B. (I).
Slaley:	Bewick, T. (II).
Harwood:	Masson, R. H. (II).

ENGLAND, EAST CONSERVANCY

Brooklands Avenue,
Cambridge

Telephone: Cambridge 54495

CONSERVATOR: Backhouse, G. W.

DIVISIONAL OFFICERS:	Ballance, G. F.	Cambridge (State Forests)
	Good, F. G.	Cambridge (Estate)
	Paterson, A.	Cambridge (State Forests)
DISTRICT OFFICERS I:	Dent, T. V.	Lincoln (State Forests)
	Grant, D.	Princes Risborough (State Forests)
	Halton, K.	Cambridge (Acquisitions)
	Payne, S. R.	Cambridge (Private Woodlands)
DISTRICT OFFICERS II:	Anderson, J. W.	Cambridge (Utilisation)
	Brett, I.	Aylsham (State Forests)
	Chapman, E. S. B.	Princes Risborough (State (Forests)
	Davidson, J. L.	Santon Downham (State Forests)
	Harrison, J. C.	Santon Downham (Private Woodlands)
	Hobbs, W. F.	Cambridge (Estate)
	Kirton, I. W.	Santon Downham (State Forests)
	Lochrie, J. H.	Cambridge (Felling Licences)
	Mackay, D.	Bourne (Private Woodlands)
	Manning, P. H.	Cambridge (Estate)
	Osmaston, J. F.	Princes Risborough (Private Woodlands)
	Rogers, S. W.	Santon Downham (State Forests)
	Searle, H.	Santon Downham (State Forests)
CONSERVANCY ENGINEER:	Dufton, F. G.	Cambridge
ASSISTANT ENGINEER:	Cook, G. O. (Mech.)	Santon Downham
SENIOR EXECUTIVE OFFICER:	Clark, G. H.	

FORESTERS:

1. Hazelborough:	Hale, W. J. (Head); Liddington, G. (II).
2. Salcey:	Clark, J. F. (I).
3. Ampthill:	Ingram, L. D. (II).
4. Rendlesham:	Wellington, C. R. (Head) (Also at Dunwich and Tunstall); Bewick, R. (I).
5. Rockingham:	
Apethorpe:	Harker, A. (Foreman).
Fermyn:	Williams, J. (Head) (Also at Fineshade); Morris, A. M. (II).
Fineshade:	Williams, J. (Head) (Also at Fermyn): Bloor C. A. (II).
Bedford Purlieus	Acott, E. J. (II).
6. Swaffham:	Lawson, E. (I); Fields, H. C. (II).
7. Thetford:	
Cranwich:	Walton. R. (II)
Croxton:	Woodrow, R. B. (II).
Didlington and Buckenham:	McNamara, N. A. C. (II).

Downham:	Salisbury, E. J. (I).
Elveden:	Cameron, A. H. (I); Parker, J. W. (II).
Harling:	Steel, W. H. (I).
High Lodge:	Redford, C. W. (Head); Axten, G. B. (II); Reid, D. (II).
Hockham:	Anderson, J. T. (Head).
Lynford:	Deal, W. (II).
Methwold:	Gracie, A. (II).
Mildenhall:	Roberts, G. (II).
Roudham:	Pywell, A. C. (II).
Santon:	Birkitt, A. (I); Hinton, F. I. (II).
Brandon:	Button, G. H. (Head); Burnie, H. W. (II); Keeler, B. (II); Williams, J. H. (II).
West Tofts:	Davis, S. (II).
Stationed at Santon Downham:	Shinn, F. (II) (Seed Store and Fire Control).
8. Kesteven:	Wyatt, L. (I); Hendrie, J. A. (II); Ling, J. (II).
9. Laughton:	Adams, H. (I).
10. Swanton:	Jones, F. B. (II).
11. Dunwich:	Wellington, C. R. (Head) (Also at Rendlesham and Tunstall); Paulley, H. W. (II).
12. Yardley Chase:	Marston, W. H. (I).
13. Bardney:	Jones, G. (I); Eckton, J. A. (II).
14. The King's Forest:	Smith, J. J. (Head); Stott, W. S. (II).
15. Wigsley:	Hall, V. B. (I).
16. Willingham:	Marshall, D. F. (I).
17. Wendover:	Johnson, H. (II).
18. Hevingham:	King, S. G. (II).
19. Shouldham:	Woolard, R. P. C. (II).
20. Watlington:	Schofield, R. (Foreman).
21. Bramfield:	White, S. L. (II).
22. Burwell:	Hardy, R. B. (II).
23. Gaywood:	Smith, W. P. (II).
24. Tunstall:	Wellington, C. R. (Head) (Also at Rendlesham and Dunwich); Mortlock, R. F. (II).
25. Walden:	Moulden, D. J. (Foreman).
Private Woodlands;	
Santon Downham:	Pritchard, R. (I).
Kesteven:	Mitchell, A. L. (I).
Princes Risborough:	Heavener, C. H. (II).

ENGLAND, SOUTH-EAST CONSERVANCY

"Danesfield",
Grange Road,
Woking
Telephone: Woking 2270-1

CONSERVATOR:	Smith, R. H.	
DIVISIONAL OFFICERS:	Dixon, E. E.	Woking (Private Woodlands)
	Ross, J. M.	Woking (State Forests)
DISTRICT OFFICERS I:	Snook, K. R.	Woking (Estate)
	Wallington, A. W.	Woking (Utilisation)
	White, J.	Gravetye (State Forests)
	Wilson, J. F.	Woking (Acquisitions)

DISTRICT OFFICERS II:	Burton, E. S. V.	Winchester (State Forests)
	Coode, J.	Woking (Felling Licences)
	Keen, J. E. A.	Woking (Private Woodlands)
	Lindsay, F. W.	Alice Holt (State Forests)
	Mithen, D. A.	Woodchurch (State Forests)
	Skinner, J. R.	Woking (Felling Licences)
	Spencer, A. J.	Gravetye (State Forests)
	Sutton, A. R.	Woking (Private Woodlands)
	Troupe, L. C.	Alice Holt (State Forests)
ASSISTANT ENGINEER:	Crawford, P. C. R. (Mech.)	Woking
SENIOR EXECUTIVE OFFICER:	Gulliver, H. W.	

FORESTERS:

1. Alice Holt:	Cross, L. G. F. (II).
2. Bere:	Watts, F. C. (II).
3. Woolmer:	———
4. Bedgebury:	Nelmes, F. J. (Head): Cooper, J. H. (I); Awbery, P. P. (II).
5. Bramshill:	Lingwood, N. J. (Head); Vickery, F. J. (II).
6. Chiddingfold:	Francis, R. E. (I); Forrest, A. H. (II).
7. Lyminge:	Watkins, S. (I).
8. Friston:	Holter, G. E. (II).
9. Micheldever:	King, B. H. (Head).
10. Buriton:	Laney, H. (I) (Also at Westbury).
11. Westbury:	Laney, H. (I) (Also at Buriton).
12. Challock:	Aston, T. (I).
13. Charlton:	Harvey, K. B. (II).
14. Vinehall:	Barling, F. C. (II).
15. Gravetye:	Craft, J. H. (I).
16. Marden:	Ayman, A. G. (Foreman).
17. Arundel:	Middleton, W. F. C. (I).
18. Orleston:	Bashall, J. R. C. (II).
19. Alton:	Twallin, R. W. (II) (And at Basing).
20. Andover:	Offord, P. J. (II).
21. Southwater:	Cant, P. R. (Foreman).
22. Basing:	Twallin, R. W. (II) (And at Alton).
23. Bishopstoke:	(New Unit).
24. Abinger:	Shepherd, W. R. (II); Law, S. J. (II).
25. Shipbourne:	Hyett, S. (I).
26. Crawley:	Butcher, C. (Foreman)
27. Hemsted:	Moseley, J. (II).
28. Slindon:	Davies, G. S. (I).
29. Hursley:	Hann, F. G. (II).
30. Groombridge:	(New Unit).
31. Maresfield:	(New Unit).
32. Mildmay:	(New Unit).
33. Rogate:	Wilkinson, E. J. D. (II).
34. St. Leonards:	Barden, J. T. (II).

Private Woodlands;

Arundel:	Hollis, G. W. (Head).

ENGLAND, SOUTH-WEST CONSERVANCY

Flowers Hill,
Brislington,
Bristol, 4

Telephone: Bristol 78041-5

CONSERVATOR:	Popert, A. H.	
DIVISIONAL OFFICERS:	Stileman, D. F.	Bristol (Private Woodlands)
	Stocks, J. B.	Bristol (State Forests)
DISTRICT OFFICER I:	White, A. H.	,, (Estate)
DISTRICT OFFICERS II:	Carnell, R.	,, (Utilisation)
	Dickenson, M. E. S.	Uffculme (Private Woodlands)
	Drummond, J. A.	Bristol (Private Woodlands)
	Dyson, W. G.	Presteign (Private Woodlands)
	Hughson, T. A.	Bristol (Estate)
	Kellie, J.	Devizes (State Forests)
	MacIver, I. F.	Malvern (State Forests)
	Newton, J. P.	Exeter (State Forests)
	Purser, F. B. K.	Devizes (State Forests)
	Semple. R. M. G.	Launceston (State Forest)
	Williams, D. N.	Dunster (State Forests)
CONSERVANCY ENGINEER:	Gladwell, L. B.	Bristol
ASSISTANT ENGINEERS:	Bromley, A. R. (Civil).	,,
	Hughes, R. E. (Civil).	,,
	Inglis, E. J. (Mech.)	,,
	Martin, D. R. (Civil).	Launceston
	Shillito, P. E. (Civil)	Bristol
SENIOR EXECUTIVE OFFICER:	Matthews, A. W.	

FORESTERS:

1.	Dymock:	Beard, A. C. (II).
2.	Brendon:	Bowdler, T. C. (II); Burton, H. J. (II).
3.	Eggesford:	Kibble, E. C. (I).
4.	Haldon:	Scott, G. H. J. (II).
5.	Halwill:	Wilkinson, W. E. (I) (Also at Hartland); Ball, W. F. (II); Tackney, A. J. (II).
6.	Quantock:	Jenkinson, G. A. (I).
7.	Bodmin:	Bowman, P. (II).
8.	Haugh:	Milne, D. G. (Foreman).
9.	Wyre:	Fairman, E. (I).
10.	Wilsey:	Brain, R. G. (II).
11.	Bruton	Stannard, A. J. (II).
12.	Dartmoor:	Poll, E. A. (II).
13.	Herodsfoot:	Strong, T. G. (II).
14.	West Woods:	Dyer, H. C. (I).
15.	Lydford:	Jane, T. A. (II).
16.	Collingbourne:	Hammond, B. R. G. (II).

17.	Hartland:	Wilkinson, W. E. (I) (Also at Halwill).
18.	Mendip	Fowler, J. (II).
19.	Savernake:	Wildash, J. T. (I); Everitt, E. C. W. (II); Mills, E. W. (II).
20.	Stanway:	Bultitude, R. (II).
21.	Braydon:	Wills, K. G. (II).
22.	Okehampton:	Smale, E. R. (II).
23.	Neroche:	Law, H. G. (II).
24.	Culmhead:	Rayner, J. R. (II) (Also at Honiton)
25.	Plym:	Whale, R. S. (I).
26.	Wareham:	Parsons, F. F. G. (I).
	Puddletown:	Fulford, A. G. (II).
27.	Gardiner:	Lewis, C. J. (I).
28.	Charmouth:	Cox, D. J. (II).
29.	Purbeck:	Butchers, H. J. (II).
30.	Blandford:	Green, W. J. (II).
31.	Fernworthy:	Fife, R. G. (II).
32.	Glynn:	Everitt, F. W. (I).
33.	Poorstock:	Coles, L. H. (II).
34.	Stokeleigh:	Bulleid, J. F. (II).
35.	Erme:	(New Unit).
36.	Shepton:	(New Unit).
37.	Dunster:	Chapman, S. (II).
38.	Honiton:	Rayner, J. R. (II) (Also at Culmhead).
39.	St. Clement:	Hockaday, C. (Foreman).

Private Woodlands;
Dunster: Humphries, W. J. (I).

ENGLAND, NEW FOREST

The Queen's House,
Lyndhurst,
Hants.
Telephone: Lyndhurst 300

DEPUTY SURVEYOR:	Wynne-Jones, E.	Conservator
DIVISIONAL OFFICER:	de Uphaugh, F. E. B.	Lyndhurst (State Forests)
DISTRICT OFFICERS II:	Guile, A. W. L.	Isle of Wight (State Forests)
	Kendall, R. H.	Lyndhurst (State Forest)
	Simmonds, S. A.	,, (Estate)
	Winchester, P. L.	,, (State Forest)
	Winterflood, E. G.	,, (State Forest)
ASSISTANT ENGINEER:	Sandwell, A. C.	,,
CHIEF CLERK:	Watson, W. G.	

FORESTERS:

1.	New Forest:	Young, H. C. (Head).
	Rhinefield:	Williams, L. H. (I): Leutscher, E. H. (II).
	Stockley:	Adams, J. H. (I).
	Lyndhurst:	Liddell, J. (Head).
	Lodgehill:	Broomfield, G. B. (II); Hindley, N. H. (II); Palmer, C. H. (II); Skinner, F. C. (II); Wood, P. (II).
	Holmsley:	Cuff, E. W. (II); Sainsbury, B. H. (II).
	Holidays Hill:	Green, F. J. (I); Henderson, J. R. (II).

Burley:	James, H. B. S. (II); Meech, R. (II).
Shave Green:	Holloway, A. T. (II).
Roe:	James, A. L. (II).
2. Parkhurst:	Parry, A. A. (Head Forester for Isle of Wight Units)
3. Ringwood:	McNab, C. (Head) (Also at Ferndown); Brinsley, D. A. (II); Harvey, D. R. (II).
4. Ferndown:	McNab, C. (Head) (Also at Ringwood); Middleton, J. W. (II).
5. Brighstone:	Parry, A. A. (Head); Freeman, J. E. D. (II).
6. Combley:	Parry, A. A. (Head).
7. Osborne:	Parry, A. A. (Head).
8. Shalfleet:	Parry, A. A. (Head).

KEEPERS:

New Forest (North): Blake, W. G.
New Forest (South): Smith, B. B.

ENGLAND, DEAN FOREST

Whitemead Park,
Parkend,
Nr. Lydney, Glos.
Telephone: Whitecroft 305

DEPUTY SURVEYOR:	Williamson, J. Q.	Divisional Officer
DEPUTY GAVELLER, MINES:	Herdman, H. P.	
DISTRICT OFFICERS II:	Leslie, J. E.	Dean
	Taylor, G. J. N.	Dean
CHIEF CLERK:	Redd, F. C.	

FORESTERS:

1. Dean Forest:	Walker, A. E. (Head); Parry, H. M. (II).
North:	Lees, G. (I).
Lea Bailey:	Roberts, G. E. J. (II).
South:	Lewis, A. E. (II).
East:	Davies, D. J. (I).
West:	Daniels, P. R. (I).
Centre:	Lee, J. J. (II).
Nagshead:	Davies, C. H. (I).
Cockshoot:	Lloyd, F. O. (II).
Highmeadow:	Watson, F. (I); Russell, C. F. (II).
Serridge:	Phelps, S. E. (I).
Blakeney Hill:	Falconer, I. (II).
2. Tidenham Chase:	Jones, H. (II).

DIRECTORATE FOR SCOTLAND

OFFICE OF DIRECTOR: 25 Drumsheugh Gardens, Edinburgh
Telephone: Edinburgh 33561

Director;	Sir Henry Beresford-Pierse, bt.	
Conservators;	Mackie Whyte, J.P. (Estate)	
	Newton, L. A.	(Private Woodlands and Acquisitions).
	Thom, J. R.	(State Forests)
Divisional Officer;	Forrest, G.	(Acquisitions)
District Officer II;	Chrystall, J. G.	(Acquisitions)
	Legard, P. H.	(Acquisitions)
	McIntyre, P. F.	(Acquisitions)
	Watt, I. S.	(Acquisitions)

Directorate Engineer;	Packwood, R. H.
Planning Officer;	Crane, W. A.
Mechanical Engineer;	Blane, J. W.
Assistant Engineers;	Black, E. M. (Mech.)
	Johnstone, G. M. (Mech.) Blair Athol
Chief Clerk to Director;	Handford, F. C.
Senior Executive Officer;	Mackenzie, M. E. W.
Higher Executive Officers;	Brooks, Miss A.
	Geekie, J.
	Jones, N. R.
	McMillan, w.
Senior Temporary Assistant;	Ferens, J. R.

SCOTLAND, NORTH CONSERVANCY

60 Church Street,
Inverness

Telephone: Inverness 223, 608-9

CONSERVATOR:	Fraser, J.	
DIVISIONAL OFFICERS:	Crawford, A. R.	Inverness (Private Woodlands)
	Dickson, J. A.	Inverness (State Forests)
	Gascoigne, C. A. H.	Inverness (Estate)
DISTRICT OFFICERS I:	Drummond, R. O.	Fort Augustus (State Forests)
	Fraser, A. M.	Inverness (State Forests)
	Long, M.	Munlochy (State Forests)
DISTRICT OFFICERS II:	Cassels, K. A.	Inverness (Estate)
	Cotter-Craig, T. D.	Beauly (State Forests)
	Graham-Campbell, D.	Dingwall (State Forests)
	Hardcastle, E. J.	Fort William (State Forests)
	MacLean, J. D.	Fort William (State Forests)
	MacLeod, D.	Munlochy (Private Woodlands)
	MacNab, J. D.	Dornoch (State Forests)
	MacRae, F. M.	Inverness (State Forests)
	Savage, G. F.	Dornoch (State Forests)
	Seal, D. T.	Fort Augustus (State Forests)
CONSERVANCY ENGINEER:	Mullowney, V. L.	Inverness
ASSISTANT ENGINEERS:	Beattie, H. G. (Civil)	Fort William
	MacMahon, C. D. (Civil)	Inverness
	Ross, R. B. (Mech.)	Inverness
SENIOR EXECUTIVE OFFICER:	Nicolson, M.	

FORESTERS:

1. Borgie:	Phipps, N. (II).
2. Inchnacardoch:	Macdonald, D. (Head); Fraser, W. A. (II).
3. Portclair:	Officer, A. W. (I).
4. South Laggan:	Murray, R. (I).
5. Achnashellach:	Mackay, J. (II).
6. Ratagan:	Mackay, A. (I) (Also at Glen Shiel).
7. Slattadale:	Mackenzie, A. (II).

8. Glen Righ:	Murray, A. R. (I).
9. Glen Hurich:	MacClymont, W. (I); Lockhart, W. A. (II).
10. Glen Urquhart:	Munro, G. (I).
11. Culloden:	Mackay, W. (I).
12. Nevis:	Riddell, J. M. (Foreman); MacNaughton, A. (Foreman).
13. The Queen's Forest:	Fraser, J. (II); Robertson, D. D. C. (II).
14. Creag nan Eun:	Watt, D. (Foreman).
15. Craig Phadrig:	Murray, D. (II).
16. Glen Shiel:	Mackay, A. (I) (Also at Ratagan).
17. North Strome:	Black, D. F. D. (Foreman).
18. Salen:	Mackay, J. A. (I).
19. South Strome:	MacLeman, A. (I).
20. Findon:	Gordon, J. (I).
21. Glengarry:	Grant, J. D. (II).
22. Kessock:	Ross, D. M. (II).
23. Eilanreach:	Smith, D. R. (II).
24. Dornoch:	Gunn, J. (I).
25. Inverinate:	Mackintosh, C. O. (II).
26. Balblair (including Carbisdale):	Sutherland, R. A. R. (II).
27. Clunes:	Morison, A. W. (Foreman).
28. Lael:	Macrae, D. J. (I).
29. Fiunary:	Drysdale, A. (I).
30. Glen Loy:	Grant, A. (I).
31. Glen Brittle:	Macdonald, C. (I).
32. Longart:	Brown, R. S. (II).
33. Leanachan:	Campbell, R. W. (I).
34. Guisachan:	Macintosh, W. (I).
35. Ardross:	Mackay, K. (I).
36. Inshriach:	Thom, A. B. (II).
37. Millbuie:	Murray, W. (Head).
38. Assich:	MacRae, M. (II).
39. Morangie:	Small, G. (I).
40. Kilcoy:	Frater, J. R. A. (I).
41. Strath Nairn:	Park, H. C. B. (II).
42. Ferness:	Stobie, F. D. (II).
43. Strath Conon:	Mackenzie, J. (I).
44. Strath Dearn:	Sutherland, D. R. (II).
45. Farigaig:	MacLeod, D. M. (I).
46. Urray:	Fell, J. B. (II).
47. Battan:	Taylor, C. A. (II) (Also at Boblainy).
48. Rumster:	Morris, H. D. (II).
49. Laiken:	MacPherson, E. (II).
50. Clach Liath:	McAllan, F. M. (Foreman).
51. Shin:	Maclean, A. R. (Foreman).
52. Torrachilty:	Nicholson, W. J. (II).
53. Raasay:	Macrae, H. (II).
54. Boblainy:	Taylor, C. A. (II) (Also at Battan).
55. Ceannacroe:	Mackenzie, A. (I).
56. Struie:	(New Unit).
57. Glen Affric:	(New Unit).
58. Strathy:	(New Unit).
59. Craigs:	(New Unit).
60. Sunart:	(New Unit).

61. Aigas:	MacPherson, W. D. (Foreman).
62. Strath Mashie:	(New Unit).
63. Loch Ericht:	(New Unit).
64. Oykell:	(New Unit).

SCOTLAND, EAST CONSERVANCY

6 Queen's Gate,
Aberdeen
Telephone: Aberdeen 33361

CONSERVATOR:	Oliver, F. W. A.	
DIVISIONAL OFFICERS:	Bennett, A. P.	Aberdeen (Estate)
	Maxwell, H. A.	Aberdeen (State Forests)
	Woolridge, T. H.	Aberdeen (State Forests)
DISTRICT OFFICERS I:	Feaver, B. R.	Aberdeen(Private Woodlands)
	Fergusson, J. L. F.	Perth (Private Woodlands)
	Horne, R. J. G.	Fochabers (State Forests)
	Murray, G. K.	Speymouth (Estate)
DISTRICT OFFICERS II:	Cathie, R. G.	Fochabers (State Forests)
	Day, G. A.	Auchenblae (State Forests)
	Donald, J. F.	Aberdeen(Private Woodlands)
	French, W. F.	Kemnay (State Forests)
	Jackson, R. d' O.P.	Perth (State Forests)
	Kennedy, J. A. M.	Forres (State Forests)
	Rennie, J.	Perth (Estate)
	Shaw, R.	Dunkeld (State Forests)
	Williams, M. R. W.	Torphins (State Forests)
	Woodburn, D. A.	Perth (State Forests)
CONSERVANCY ENGINEER:	Blenkinsop, R. I. C.	Aberdeen
ASSISTANT ENGINEER:	Clarkson, W. H. (Civil)	Aberdeen
SENIOR EXECUTIVE OFFICER:	Lenman, J. P.	

FORESTERS:

1. Monaughty:	Watt, D. M. (Head); Duncan, A. J. (II); McLeod, E. (II).
2. Kirkhill:	Gilbert, G. (I).
3. Montreathmont:	McConnell, J. (I); Stewart, G. (II).
4. Culbin:	Milne, W. G. (Head); Linder, R. (II).
5. Edensmuir:	Allan, J. (I).
6. Tentsmuir:	McDonald, W. (I).
7. Drummond Hill:	Ross, W. L. (Head); Maxtone, J. R. (II).
8. Teindland:	Reid, J. G. M. (II).
9. The Bin:	Urquhart, D. J. (Head).
10. Speymouth:	Allison, R. A. (I); Clark, J. F. (II).
11. Blairadam:	Main-Ellen, R. (II).
12. Drumtochty:	McDonald, W. (I).
13. Kemnay:	Ewen, B. A. (Foreman).
14. Midmar:	Innes, G. C. (II).
15. Deer:	Thow, J. B. (II).

16.	Scootmore:	Murray, G. J. A. M. (I); Seaton, J. A. (II)
17.	Clashindarroch:	Kennedy J. M. (Head); Guild, J. (II).
18.	Roseisle:	Mason, W. (I).
19.	Blackcraig:	Pacey, R. H. (II).
20.	Carden:	Mitchell, F. M. (II).
21.	Inglismaldie:	Mackay, W. (I).
22.	Durris:	Paterson, S. H. A. (Head).
23.	Newton:	Lamb, J. A. (Head); Coull, G. F. (II).
24.	Newtyle:	Douglas, W. S. (II).
25.	Alltcailleach:	Marnoch, D. M. (II).
26.	Kinfauns:	Russell, J. C. (I).
27.	Whitehaugh:	Duguid, C. (II).
28.	Craig Vinean:	Corbett, J. (Head).
29.	Glen Devon:	Salmean, C. (Foreman).
30.	Lossie:	Scaife, C. (II).
31.	Keillour:	Reid, J. K. (II).
32.	Tilliefoure:	Anderson, F. (I).
33.	Blackhall:	Robbie, J. D. (Head).
34.	Rosarie:	Pennet, H. (I).
35.	Pitfichie:	McDowall, C. (I).
36.	Fetteresso:	Anderson, D. (I).
37.	Strathord:	Anderson, J. A. (II).
38.	Allean:	Reid, J. (I) (Also at Glen Errochty).
39.	Tornashean:	McMaster, A. J. (II).
40.	Dallas:	Stewart, E. A. (II).
41.	Countesswells:	Cassie, A. C. (II).
42.	Pitmedden:	Crawford, D. B. (II).
43.	Rannoch:	Garrow, P. J. (II).
44.	Tomintoul:	McRae, J. (II).
45.	Hallyburton:	Hepburn, N. R. (II).
46.	Corrennie:	Biggar, A. W. (II).
47.	Delgaty:	Skene, W. F. (II).
48.	Glen Isla:	Grigor, E. (II).
49.	Glen Doll:	Watt, W. J. (II).
50.	Glen Errochty:	Reid, J. (I) (Also at Allean).
51.	Ledmore:	Rose, A. (II).
52.	Glen Livet:	(New Unit).

Private Woodlands;
Aberdeen: Whayman, A. (I).

SCOTLAND, SOUTH CONSERVANCY

Greystone Park,
Moffat Road,
Dumfries

Telephone: Dumfries 1156

CONSERVATOR:	Macdonald, J. A. B.	
DIVISIONAL OFFICERS:	Fossey, R. E.	Dumfries (State Forests)
	Gibson, W. N.	Dumfries (State Forests)
	Penistan, M. J.	Dumfries (Private Woodlands)
DISTRICT OFFICERS I:	Donald, R. R.	Palnure (State Forests)
	Sutherland, W. B.	Moffat (Private Woodlands)

DISTRICT OFFICERS II:	Brown, N. M.	Walkerburn (State Forests)
	Devitt, J. G.	Auchencastle, (State Forests)
	Fergusson, W. S.	Dalbeattie (State Forests)
	Golding, R. A.	Palnure (State Forests)
	Grant, A. G.	Dumfries (Estate)
	Mayes, B. B.	Dumfries (Estate)
	Stewart, G. G.	Langholm (Private Woodlands)
	Wilson, K. W.	Dalry (State Forests)
CONSERVANCY ENGINEER:	Rodger, R.	Dumfries
ASSISTANT ENGINEERS:	Bowie, J. D. (Civil)	Dumfries
	Moncrieff, J. C. (Mech.)	Dumfries
SENIOR EXECUTIVE OFFICER:	McGeorge, T. H.	

FORESTERS:

1. Glentress:	Mackay, W. H. (I).
2. Cairn Edward:	
Bennan:	Parley, C. W. (I).
Clatteringshaws:	Towns, K. W. (II).
3. Newcastleton:	MacIntyre, J. F. (Head); Lloyd, S. (II).
4. Dalbeattie;	Watson, J. (Head); Thomson, A (II).
5. Forest of Ae:	Reid, J. M. (Head); Dick, C. R. (II).
6. Edgarhope:	Slater, J. (II).
7. Greskine:	Hunter, J. (I).
8. Auchenroddan:	Parkinson, J. W. (II) (Also at Brownmoor).
9. Kirroughtree:	MacMillan, H. (Head); Cannon, F. J. (II).
10. Fleet:	MacDonald, J. D. (I); Gallacher, J. (II).
11. Kilsture:	Robertson, D. (II).
12. Changue:	Clark, D. (II).
13. Dundeugh:	Craig, J. S. (II).
14. Tinnisburn:	Broll, J. L. (II).
15. Corriedoo:	Mowat, J. (II).
16. Garcrogo:	Patterson, B. (II).
17. Laurieston:	Kirk, D. M. (II).
18. Twiglees:	Robertson, W. J. (II).
19. Castle O'er:	Irving, R. H. (I).
20. Glen Trool:	MacRae, A. D. (Head).
21. Clauchrie:	Melville J. (II).
22. Shielswood:	———
23. Mabie:	Graham, A. (Head).
24. Wauchope:	McNicol, F. (I).
25. Carrick:	Chisholm, M. R. (I); Cumming, S. E. (II).
26. Elibank:	Urquhart, G. (II).
27. Glengap:	Carruthers, M. F. (II).
28. Craik:	Harkness, J. R. (I).
29. Cardrona:	Peddie, A. S. (I).
30. Craigieburn:	Brown, P. (I).
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No. 12. Income Tax and Death Duties on Woodlands.

No. 14. Phomopsis Disease of Conifers.

No. 16. Larch Canker.

No. 17. Chafer Beetles.

No. 18. Two Leaf-Cast Diseases of Douglas Fir. 6*d.* (7½*d.*)

No. 19. Elm Disease (Ceratostomella ulmi). 6*d.* (7½*d.*)

No. 20. Watermark Disease of the Cricket Bat Willow.

No. 21. Leaf Cast of Larch. 3*d.* (4½*d.*)

No. 23. Pit-Props.

No. 25. Replanting of Felled Coniferous Woodland in relation to Insect Pests. 6*d.* (7½*d.*)

No. 26. The Spruce Bark Beetle. 6*d.* (7½*d.*)

No. 27. Poplar Planting. 4*d.* (5½*d.*)

No. 28. Collection and Storage of Acorns and Beech Mast. 4*d.* (5½*d.*)

No. 29. Pissodes Weevils. 6*d.* (7½*d.*)

Binders for leaflets (71-8) are available price 1*s.* 3*d.* (1*s.* 4½*d.*)