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FORESTRY COMMISSION.

No. 9: APRIL, 1930.

Editing Committee:
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H. A. PRITCHARD,
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FRASER STORY.

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EDITORIAL.

The Commission.

THE second quinquennial period of office of the Commissioners ended on November 29th, 1929, when Lord Clinton and Major Price retired. The remaining members were reappointed, and two new members added. The personnel is now as follows : Sir John Stirling-Maxwell, Bt., K.T. (Chairman), Mr. R. L. Robinson, O.B.E. (Vice-Chairman), Rt. Hon. Sir Francis Acland, Bt., Mr. J. H. Alpass, M.P., Col. Sir George Courthope, Bt., M.C., M.P., Mr. D. R. Grenfell, M.P., Sir Hugh Murray, C.I.E., C.B.E., Mr. W. R. Smith, M.P., Col. W. Steuart-Fothringham.

The Commission has been unusually fortunate in its Chairmen ; in Lord Lovat, who organised the department and steered it through the early difficult days to relatively calm water ; in Lord Clinton, who consolidated the position and secured approval of the larger programme referred to below, and now in Sir John Stirling-Maxwell, who has been with the Commission since its inception and brings to the work a life-long and intimate knowledge of forestry.

Forest Policy.

The present Government on the recommendation of the Commissioners in September last, approved the provision of £9,000,000 of new money for the work of the Commission over the decade 1929-39. This sum, with the estimated receipts, will enable an average of well over £1,000,000 per annum to be devoted to afforestation and forest workers' holdings. The programmes involved are large, and will tax the energies of the department. It is proposed to afforest, on a gradually increasing scale, some 330,000 acres, in addition to replacing existing woodlands to the extent of about 25,000 acres, *i.e.*, to plant in all 355,000 acres in the next ten years. The number of forest workers' holdings to be formed is 3,000. In order to fulfil the planting programme, it will be necessary to acquire 60,000 acres of plantable land per annum.

Reorganisation Committee.

A Reorganisation Committee, consisting of Sir Francis Acland (Chairman), Messrs. R. L. Robinson, Walter Smith, Chadwick, Taylor, with Mr. Honywill as Secretary, investigated very carefully in the course of 1929 the work and organisation of the Commission. Their report is still under discussion with the Treasury.

Wages.

The Commissioners are at present engaged in investigating the wages of their workmen, more particularly in England and Wales, where minimum wages are fixed by the Agricultural Wages Board.

Work of the first Decade.

The tenth year ended on September 30th, 1929, with the close of P.29. The total area of plantable land acquired was 310,000 acres and about 138,000 acres were planted or replanted. Of forest workers' holdings 620 had been completed and 250 were in process of formation. Private individuals and local authorities working under grants for the Commissioners also planted or undertook to plant about 73,000 acres.

These figures represent a notable effort, although for reasons which need not be recapitulated here they fall short, on the afforestation side, of the Acland programme.

The first decade has in its records disappointments as well as achievements. If we do not start the second decade so full of enthusiasm, as at the beginning of the first, for certain types of land we have at least a much firmer grip on the whole subject and a knowledge of what not to touch. The fire season of 1929 brought us a new experience, or rather a common experience in over-full measure, the moral of which is also apparent. Now, midway between the two decades, we find that our technique of hardwood afforestation is unsatisfactory. The outstanding conclusion from our first decade's work is that the man who goes too far outside ordinary experience, or otherwise " chances his arm " is very apt to get caught. Sound forestry technique can only be built on sound foundations and the best foundation is that of observed facts.

Divisional Officers' Conference.

The second quinquennial Divisional Officers' Conference was held in the Forest of Dean early in September, 1929. A short summary appears on page 6 ; a more complete record of the proceedings can be obtained from the Library on application.

Forest Apprentices' Schools.

In view of the larger number of foremen and foresters required in connection with the Commission's expanding programme arrangements have been made for additional accommodation at the Schools. At the beginning of last session the Scottish School was transferred from Beaufort to Benmore in Argyllshire where Mr. H. Watson has been duly installed as Instructor with 24 students. The Mansion House has been equipped as a school and students' hostel, and rooms have been provided not only for a larger number of forest apprentices, but also for visiting students and members of scientific societies. Some 36,000 acres of afforestable land belonging to the Commission are available in the district for work and demonstration while the arboretum and gardens immediately surrounding the school extend to over 100 acres.

A scheme for the better accommodation of the apprentices in the Forest of Dean is also under consideration, and it is hoped that

improvements will be effected before next winter. There are at present 31 students at work under Mr. R. G. Broadwood the Instructor, and it is expected that this number will shortly be considerably increased.

The prospectus issued to candidates for forest apprenticeship has recently undergone revision, and a copy of this, for purposes of reference, is published in this number of the Journal (see page 78).

Contributions to the Journal.

Apart from reports, reviews and articles of general interest for publication in the Journal, the preparation of material will be entrusted in future to one or two Divisions each year. It is suggested that the Divisions selected should each appoint a Committee consisting of, say, a Divisional Officer, a District Officer and a Forester. Contributors are reminded that the Journal should appear annually in February and consequently material should reach the Editing Committee in London by the end of December each year.

The organisation indicated above has been given a trial in this number of the Journal, Mr. Sangar having been made responsible for the collection of contributions from Division II.

CONFERENCE OF DIVISIONAL OFFICERS, DEAN FOREST, 1929.

This conference, similar in character to that which took place in London five years ago, was held from August 31st to September 6th, and was presided over by the Technical Commissioner. The Assistant Commissioners, Deputy Surveyors and all Divisional Officers attended and Mr. Pearson and Major Cosgrove of the Forest Products Research Laboratory were present by invitation at two of the meetings.

Two sessions were held each day—in the morning from 9.30 to 1 p.m., and in the evening from about 8.30 to 11.30. In the afternoons excursions were made to places of forestry interest in the district and there was one whole-day excursion.

The following is a list of the papers which were read and discussed :—

" Planting." D. W. Young.
" Quality of Plants in Relation to Growth and to Nursery and Plantation Losses." A. P. Long.
" Some Important Aspects of Nursery Work." J. F. Annand.
" Time and Degree of Beating Up Coniferous Plantations as affected by Initial Spacing and Weeding Operations." O. J. Sangar.
" Turf-Planting and the Subsequent Attention to Turf-Planted Areas." J. M. Murray.
" Direct Sowing." C. O. Hanson.
" Oak Planting." L. S. Osmaston.
" Land Acquisition." W. L. Taylor.
" Forest Workers' Holdings (Scotland)." John Cameron.
" Preparation of Ground." A. D. Hopkinson.
" Weeding." A. L. Felton.
" Treatment of Scrub Areas in Planting." F. Scott.
" Experimental Data." Research Branch.
" Forest Fires Data." Finance Branch.

The main object of the Conference was to review " the experience of the last ten years in order to improve future procedure," and in particular to lay stress on " any methods which might cheapen the cost of establishing successful plantations." Attention was principally directed to the actual operations upon which the Divisional Officers have been engaged, and in each case a leading paper introduced the subject, and was followed by a discussion.

Mr. D. W. Young, in his paper on " Planting," and Mr. A. P. Long, on " Plants in Relation to Nursery and Plantation Losses," dealt at considerable length with the quality of plants as influenced by overcrowding, under-nourishment and other adverse factors. They contended that more regard should be paid to the production of strong plants, and the rejection of poor-quality material. This might lead to more severe " culling," especially of seedlings, but it was considered that the resulting vigour of growth obtained from the better plants would compensate for any initial loss in numbers and lead to economy in the long run owing to fewer losses in planting out, greater uniformity

of crop, reduction in weeding costs and more rapid production of timber. Planting methods were considered in some detail, particularly as to the merits of each as determined by the size of plant, form of root system and the type of land planted.

There was general agreement with the views expressed, it being considered that even at some sacrifice of weakly plants, resulting possibly, in certain years, in failure to reach the area prescribed in the planting programme, only nursery stock of good quality should be used.

Mr. Annand's paper discussed the more important aspects of nursery work. He said that technique was now better understood by the Commission's employees than was the case nine or ten years ago. He drew special attention to the methods of lifting and handling seedlings, the procedure commonly adopted being frequently faulty and capable of improvement.

Discussion of Mr. Sangar's paper on beating up, showed practically unanimous agreement with the view that it is unnecessary to obtain 100 per cent. stocking at the spacing originally selected, and it was considered that in most cases the attainment of an 85 or 90 per cent. stocking is sufficient, and results in considerable saving in the cost of formation.

Turf-planting was very carefully dealt with in an interesting paper by Mr. J. M. Murray, and the discussion showed that the officers were in full agreement as to the value of this method.

The divergence of opinion which exists as regards the merits of the direct sowing of conifer seed was demonstrated in the discussion of Mr. Hanson's paper, and most of the officers thought that for broad-leaved species the method could frequently be practised successfully, and that it was a desirable means of establishing plantations. In this connection it was pointed out that direct sowing was the nearest approach to natural regeneration and, therefore, where practicable, to be preferred to planting.

Mr. Osmaston advanced arguments in favour of the natural regeneration of oak, and discussed also several other methods of re-stocking felling areas. Incidentally, he expressed a preference for sessile oak as more suitable than pedunculate for the conditions obtaining in the New Forest.

In connection with land acquisition Mr. Taylor estimated that in England and Wales there were approximately two million acres of plantable land, and possibly about a similar area in Scotland. Forest land was difficult to acquire from a variety of causes, common rights and sporting interests being among the greatest obstacles. During the subsequent discussion it was evident that many Officers were doubtful if the requisite area of suitable land could be obtained without the extensive purchase of surplus assets. This was especially the case as regards land in Scotland, where the estates are very firmly held and present prices for sheep stock and acclimatisation values are high.

It was pointed out in the discussion on Forest Workers' Holdings that, if possible, holders should be granted further assistance in

effecting capital improvements, and in most cases it was necessary to give them full-time employment.

As will be seen from the above list of papers, attention was also given in the discussions to preparation of land for afforestation, weeding and the treatment of scrub areas.

The results of investigations conducted by the Research Branch into most of the subjects discussed were supplied by Mr. Guillebaud, and statistics relative to costings, &c., were made available by Mr. Chadwick.

The subject of fire control was given special consideration, and two sub-committees were appointed which drew up specific recommendations regarding the protective measures to be adopted. The proposals included the preparation of detailed plans, the steps to be taken in connection with fire lines, sites for storing fire-fighting appliances, staffing, the duties of patrols, systems of alarm signals, and many other matters relative to the organisation required.

Forests Visited during the Conference.

The first areas to be visited were Shobdon and Radnor Forests, where hill planting with conifers at various elevations up to about 1,500 ft. were inspected. In Dean Forest the plots of various species at Abbotswood were examined, and much interest was taken in the Cockshoot Wood, where there is excellent natural regeneration of oak as a result of recent treatment. An oak and beech wood was also visited, and particulars were given regarding the volume removed in thinnings and the amount of timber still remaining. In the Highmeadow Woods particular attention was paid to the vigorous growth of a pure oak plantation raised from seedlings and now 21 years of age. A case arising from the planting of ash among coppice, the latter now threatening to outgrow the ash was the subject of investigation and discussion.

At Tintern an opportunity was afforded of examining larch sample plots which had been thinned several times, and the results recorded during the last twenty years or so. An inspection was also made of oak standards among coppice which, in plots, had been treated in several different ways. Dymock was interesting principally on account of the oak seedlings which had sprung up from acorns sown in furrows and which had made a most promising start. Sample plots were also inspected, including examples of larch underplanted with various species, and an oak plantation where some of the young trees had been sprayed experimentally as a protection against mildew.

All agreed that the week's conference had been a complete success. The utmost good feeling prevailed, and the officers, who are usually widely separated from each other, and seldom meet, were able to discuss in private as well as collectively the many problems affecting their work.

YIELD FROM SEED OF EUROPEAN LARCH (1929 NURSERY SOWINGS).

By W. H. GUILLEBAUD.

In March, 1929, the Technical Commissioner requested the Assistant Commissioners to take special care to sow European larch seed only in nurseries, which had been proved by results to be suitable for raising larch, and asked that reports on each batch of seed should be provided at the end of the growing season.

In all 563 lbs. of seed were sown, of which 352 lbs. were of continental origin (mostly of the 1927–28 crop, *i.e.*, seed which had been stored for a year), and 211 lbs. of home seed, collected for the most part in Scotland. The latter was probably seed of low germinative capacity.

The average yields per lb. of seed sown were as follows :—

Continental seed	6,220 seedlings
Home collected seed	4,330 ,,

The average yields from the individual lots varied considerably, as may be seen from the following table :—

TABLE No. 1.

I. No.	Origin.	Laboratory germination.	Quantity sown.	Average yield.	Total yield.	Average size of seedling.
		Per cent.	lbs. ozs.	Per lb.		Inches.
28/30	Münstertal, Switzerland	44 + 3	330 0	5,900	1,953,000	2·7
28/67	Scotland (N. East) ...	—	67 0	3,800	263,000	3·0
29/27	Silesia (Sudeton) ...	44	16 0	11,200	179,000	2·6
29/79	Scotland (N. East) ...	—	5 0	1,800	9,000	1·3
29/80	,, (East) ... (Drummond Hill)	—	73 1	6,400	465,000	2·2
29/81	,, ,,	—	58 0	2,400	140,000	3·0
29/82	Scotland (West) ... (Barcaldine)	—	3 0	4,300	13,000	4·5
29/83	Tyrolese Alps	—	3 1	9,100	28,000	2·3
29/84	Swiss Alps	—	2 1	10,100	21,000	2·1
29/85	Western Alps	—	1 0	8,000	8,000	2·2
29/	Monymusk	—	0 12	2,700	2,000	2·5
29/	Teindland	—	0 8	8,000	4,000	3·0
28/	Hamsterley	—	3 8	4,900	17,000	3·5
			563 0	5,500	3,102,000	

The average yield from the Münstertal seed (Lot 28/30) was under 6,000 per lb., and thus slightly lower than the yield from 29/80, the best of the Scottish seed. It should be mentioned that the latter, although extracted in 1928–29, was seed of the previous year's crop, and thus of the same age as the Münstertal seed.

A yield of 6,000 1-year seedlings per lb. is about an average result for the past few years, and cannot be considered as unsatisfactory in view of the exceptionally difficult weather conditions during the 1929 growing season. The records show that most of the seed was got in in good time, that a thin sowing density was employed (average about 1 lb. to 300 sq. ft.), and that great care was taken in covering the seed. Unfortunately, in most districts no rain fell for many weeks after sowing, with the result that the covering soil caked badly in the heat, while in the drier nurseries the whole of the upper layers of the soil dried out, delaying, and in some cases virtually inhibiting, germination. Owing probably to the dry season there was no trouble from *Mcria* in any of the nurseries during the summer, but the great heat in July and August caused heavy losses from sun scorch in certain districts. Cutworms were also the cause of losses in some nurseries.

The following table summarises the results from the Münstertal seed, the only lot sown on a sufficiently large scale to provide comparable data.

TABLE NO. 2.—SEED FROM MÜNSTERTAL. I. NO. 28/30.

Nursery.	Quantity sown.	Yield per lb.	Average size.	Remarks.
	Lbs.	Th's'ds.	Inches.	
Eggesford ...	10	3·4	3	Good initial germination. Heavy losses during drought.
Quantocks ...	10	1·8	1	Germination poor owing to caking and drought.
Botany Bay ... (Tintern)	30	8·0	3	Special fine soil used for covering. Soil kept moist in spite of the drought. Beds not sheltered.
Whitelye ... (Tintern)	31	4·0	3	Treatment same as at Botany Bay but a drier soil. Losses due to drought and cutworms.
Rhinefield ... (New Forest)	32	5·9	2	Good germination but some losses from sun scorch. Very heavy losses from cutworm in August.
Nagshead ... (Forest of Dean)	18	4·0	6	Drill sown covered with sand. Beds protected with birch branches. Heavy losses from caking, drought and cutworm.
Do.	27	3·0	5	Broadcast covered with soil. Do.
Old Pale ... (Delamere)	85	6·8	3·5	Drought affected germination. Slight losses from cockchafer and leather-jackets.
Lyminge ...	2	9·0	3	Beds protected throughout summer. Some losses from chafer grubs.
Bramshill ...	30	5·2	1	Beds protected throughout summer. Drought very severe affecting germination and growth.
Dalby	10	10·7	2	Beds caked after sowing owing to drought.

TABLE No. 2—*continued.*

Nursery.	Quantity sown.	Yield per lb.	Average size.	Remarks.
	Lbs.	Th's'ds.	Inches.	
Chopwell ...	7·5	11·9	3	Drill sown. Germination affected by dry weather following sowing. D.O. thinks poor result in broadcast beds due to too thin covering and drought.
	7·5	5·3	2	Broadcast. Do.
Tulliallan ...	8	12·3	5	Drought followed sowing. Beds watered in dry weather during summer.
Seaton	5	5·0	2	Heavy rain shortly after sowing exposed seed and also caused caking. June was rainy, but July hot and dry, August warm and wet.
Craibstone ...	5	7·2	2	Losses due to hot weather in July.
Inchnacardoch ...	0·5	18·0	3·5	June and July very dry but sunless.
Ratagan... ...	9·5	2·6	0·5	Drill sown. A good tilth was obtained but soil was packed by continuous heavy rain before and during germination. Abnormal defoliation in autumn, probably due to *Meria.*
Benmore ...	1	3·7	1·5	Weather at time of sowing wet and cold. Severe caking in ensuing dry spell.
Glenfinart ...	1	10·1	1	Same as Benmore.

The second column of figures indicates the wide range in yield in individual nurseries. Neglecting the exceptional output at Inchnacardoch, which related to only ½ lb. of seed, the yield varied from a maximum of 12,300 plants per lb. at Tulliallan to a minimum of 1,800 at Quantocks with an average of 5,920 for the whole of the sowings. It would probably be unfair to condemn any of the nurseries on the present season's results, owing to the exceptionally severe weather conditions which are bound to have hit some nurseries harder than others. As already pointed out the results cannot be considered as bad when compared with a number of previous seasons, and it must not be forgotten that the seed, though of good germinative capacity, was not fresh seed. In some of the nurseries continental seed of the new crop was sown alongside the Münstertal seed, and gave considerably better results, see Table 3 below.

As regards quality of growth it will be observed from the last column of Table No. 1 that there is not much to choose between the size of the average plant from continental or home seed, if anything the latter gives a slightly larger plant. In Table No. 2, however, the difference in

TABLE NO. 3.

Nursery.	Origin of Seed.	Crop year.	Yield.
			Per lb.
Bramshill	Münstertal	1928	5·2
	Silesia	1929	11·4
Benmore ...	Münstertal ...	1928	3·7
	Silesia	1929	8·3
Tulliallan ...	Münstertal ...	1928	12·3
	Silesia	1929	12·0
Seaton	Münstertal	1928	5·0
	Western Alps (Rafn)	1929	8·0

the size of plants from seed of the same origin, but raised in different nurseries, is seen to be very marked. The smallest plants were those at Ratagan with an average height of only ½ in., while the tallest were raised in Nagshead Nursery, averaging 6 ins. in height. The minimum and maximum heights of the two lots are worthy of note. These are as follows: Ratagan, min., ⅜ in., max., 1¼ in.; Nagshead, min., 3 ins., max., 9 ins. The great difference in size was probably due, in part at least, to the delayed germination at Ratagan, owing to the unfavourable (wet and cold) weather conditions. The average size (2·7 ins.) of all the lots is about normal for larch, and seedlings of that size could be handled without much difficulty for lining out, if required.

It is not easy to pick out from the data in Table No. 2 any very definite guiding lines for future treatment. Caking after sowing has been an important factor in reducing the yield in many nurseries, but caking can be brought about either by drought baking the covering soil or by heavy rain which consolidates it. The use of specially-prepared covering soil rich in humus might reduce the losses from this cause. The parallel results in Nagshead and Chopwell nurseries with broadcast and drill sowing, drill sowing giving considerably higher yields, are interesting. It is possible that with the very thin sowing densities now in force some of the scattered seedlings in broadcast sown beds may be unable to get through the crust, while in the drills there is more chance of a group of seedlings pushing up together to break through.

In experimental nursery work the evidence has been in favour of broadcast as against drill sowing, and the two cases mentioned above may be only exceptions.

Many losses were undoubtedly caused by sun scorch during the hot, dry weather of the summer, but though some nurseries sheltered while others did not, there is no conclusive evidence from the data as to the effect of shelter. For example, Botany Bay nursery did not

shelter, but the beds were kept moist by a stream and the relatively good yield of 8,000 plants per lb. was obtained. Nagshead sheltered, but got only 3,000 to 4,000 plants. (Cutworm was a disturbing factor here.) The high yield at Tulliallan was probably due in part to their being able to water the beds during dry weather. It is fairly certain that in such a summer as 1929, and especially in the south and west of the country, shelter, where applied, must have been beneficial. The shelter, besides preventing sun scorch, reduces evaporation from the surface of the soil and so gives a chance of survival to late germinating seedlings.

In addition to the data already given, seed of I. Nos. 28/30 and 29/27 was sown experimentally in seven nurseries. The quantity sown in each nursery was $\frac{2}{3}$ lb. The experiment was designed for the study of different races of larch, and also to provide material for work on the relation between shoot frosting and *Meria laricia*. The seed was sown in drills on the 30th of April, and gave the following yields expressed in terms of 1 lb. of seed :—

TABLE No. 4.

Nursery.	Münstertal Seed. I. No. 28/30.	Silesian Seed. I. No. 29/27.
Royal Botanic Garden, Edinburgh ...	7,000	8,400
Barcaldine	10,700	13,900
Altonside	9,600	10,400
Drumtochty	15,400	16,700
Inchnacardoch	17,900	17,600
Ratagan	6,800	12,000
Nagshead	11,200	16,400
Kennington	4,200	6,200
Average yield ...	10,300	12,700

General Conclusions from the Divisional Sowings.—Proper care appears to have been taken in the handling of the seed, and the unfavourable season may fairly be blamed for the fact that the yields have not been higher. There have been no complete failures.

Improvements in technique may be sought in the following directions :—

(1) The use of specially-prepared covering soil to prevent caking.
(2) Shelter during and after germination in hot, dry weather.
(3) Control of soil grubs, especially cutworms and chafers.

HARDWOOD PLANTATIONS.

By W. H. Guillebaud.

The Technical Commissioner issued in May, 1929, a circular to Divisional Officers in England and Wales calling for reports on the plantations and sowings made in their Divisions with hardwood species. The following summary of these reports has been prepared.

Oak.

Area planted.—Approximately about 1,000 acres have either been sown or planted with oak during the past ten years.

Soils.—The soils on which oak has been grown range from deep sand in the Eastern Counties, through sandy loams and loams (Tintern and the Dean), gravelly clays (New Forest), to pure clays as at Apethorpe, Chiddingfold, etc. The average soil is either a clay loam or a clay.

Vegetation.—Usually rank, consisting largely of coarse grasses, brambles, briars and flowering herbs. Blackthorn is often abundant on the Northamptonshire clays and also at Alice Holt in Surrey.

Method of Formation.—The majority of the older plantations, *i.e.*, those planted more than four years ago, were formed in much the same way as any conifer plantation, the spacings were usually 4 ft. 6 ins. and frequently alternate lines were planted with pure larch giving a 50-50 mixture. Planting was usually by vertical notch, or L notch and both seedlings (one, two and three year) and transplants were used. Direct sowings on a considerable scale were, however, carried out in Rockingham Forest. The earliest sowings here were a failure owing to destruction of the acorns by birds—chiefly pheasants and wood pigeons—but by very deep sowing in ploughed furrows, the acorns being slitted in 4 to 6 ins. deep, this trouble was successfully overcome and a good take obtained. Deep sowing has certain disadvantages, the seedlings often do not show above ground until the late summer, they are very small, and are more subject to mildew attack. An experiment on depth of sowing carried out in the Forest of Dean in 1929 in which 2-inch and 5-inch sowing depths were compared gave results which so far are markedly in favour of the shallower sowing, the germination was better and the plants much stronger than in the deep sowing; it should be stated, however, that there was no trouble here from birds.

The quantities of seed used in direct sowing have varied considerably, there can be little doubt that the use of too little seed was an important factor in the failure of many of the earlier attempts at direct sowing. A sowing density of 15 to 20 acorns to the running yard—equivalent to about 3 to 4 cwts. of acorns per acre when sown in rows 4 ft. apart—appears to be a safe allowance for average conditions.

The principal change in planting methods within the past few years has been in the direction of closer planting and the use of seedlings in place of transplants, most of the planting is now done at 3 ft. × 2 ft.,

4 ft. × 1½ ft., or 4 ft. × 2 ft., one- or two-year seedlings being inserted in a vertical notch.

Failures.—In general, oak appears to be an easy tree to plant, failures during the first year rarely exceed 20 per cent. and are usually much lower. Frost, while stunting the growth, seldom kills the plants right out. and when heavy failures do occur, they are often found to be due to excessive root pruning followed by a dry spring. Experiments on grading have shown clearly that it is necessary when planting out seedlings to discard the weaker plants.

Rate of Growth.—The development of the young plantations has been very slow during the early years and there are few if any of the plantations formed during the past ten years which are really established in the sense that the majority of the plants are definitely above the weed growth and on the way to form canopy. At the age of 7 years the average height of the plantations is only 23 ins. ; it appears that it is somewhere between the 9th and the 14th years that the trees really begin to get away. The heavier the soil the more prolonged is this initial waiting period.

Evidence from the Data as to the Influence of Soil, Vegetation, and Methods of Formation upon Rate of Growth.—It was hoped that the data, when assembled and classified, might thrown some light on the above important points, but the evidence is altogether too scanty to enable any definite conclusions to be drawn. On the data under report it seems that whatever the soil and method of formation, whether the planting is done with seedlings, transplants, or by direct sowing, very little growth in height is put on during the first 4 to 6 years.

Evidence from experimental Work.—Experimental work only began in 1927 and very little can be expected in the way of results from only three years' growth. Various cultural methods have been employed in the hope of finding some way of stimulating growth and so getting the plants quickly out of the weeding stage, but so far with little success. There is some evidence of improved growth as a result of spraying against mildew during the third year after planting but this work is still only in the preliminary stage. As regards method of establishment, quantity of seed appears to be an important factor in the success of direct sowing. Birds may do as much damage to the sowings as mice and must be kept off by scaring where they are very numerous—pigeons and pheasants have been the chief offenders. One-year seedling oaks notch planted with as long a tap root as possible have so far given quite satisfactory results. Assessments of experiments in the Forest of Dean show that at the end of three years' growth the average height of the plants is from 9 to 12 ins. The height range is very considerable, there are many plants of under 6 ins. in height which have made no appreciable height growth, but there is usually a proportion of relatively large plants. It was found that the proportion of plants of 18 ins. in height and over varied from 1 to 5 per cent. With close planting, *e.g.*, 4 × 1½, the number of such tall plants may be sufficient to form quite a substantial nucleus in the crop.

In Alice Holt Forest the expense and difficulty of weeding the young oak plantations led to the introduction of a method of planting on an upturned ridge of turf. In this method, shallow trenches 8-ins. wide and not more than 3 ins. in depth were dug across the planting area in rows 4 ft. apart and the turf inverted at the side of the trench to form a continuous ridge. The plants were notched into the centre of the ridge, the roots usually extending well into the natural soil below the turf. The resulting shallow drains persist for several years in clay soils enabling the plant rows to be found without any difficulty and thus cheapening the cost of weeding to a very marked extent. Compared with direct planting, the ridge method does not give quite as good results, either in respect of growth or percentage of failures, and in exceptionally dry seasons there is evidently some risk of the plants drying out.

Summary.—There is general agreement as to the difficulties experienced in raising oak and also as to the desirability, especially in the east and south of England, of shelter. Divergent views are expressed as to methods of formation, Mr. Long and Mr. Story favour small transplants and the other Divisional Officers either direct sowing or the use of 1-year seedlings. Mr. Long would be content with 25 per cent. of oak associated with 75 per cent. of coniferous nurses and Mr. Story recommends planting either pure or with other hardwoods at 5 ft. apart. Stress is laid by other officers on the importance of close planting. The evidence as a whole appears to indicate that, exceptionally frosty localities apart, shelter, though desirable, is not essential, and that well-grown 1-year seedlings close planted either pure or in strips or groups among a coniferous nurse (preferably larch) will give satisfactory results at a reasonable cost. By close spacing is meant a distance apart of the oak in the lines of not less than 2 ft. and preferably 18 ins. The relative merits of sowing and planting remain at present an open question. Line sowing is preferable to spot sowing, especially where there is risk of damage from birds or mice ; in either case it is the poorest economy to be sparing with the seed. Less than 15 sound acorns to the yard run will rarely give a satisfactory crop and it always pays a float off the light seed before sowing. Spring sowing (March) is safer than winter sowing on stiff soils and in mice infested areas.

Weeding during the first two years can be greatly reduced by thoroughly screefing broad (15-ins.) strips preparatory to planting, although, as Mr. Long points out, different methods may have to be employed in the exceptionally frosty area of the Eastern Counties.

Ash.

Area planted.—Approximately 1,500 acres have been planted with ash during the past ten years.

Soils.—The soils are principally moist loams and clay loams on lower slopes and in valley bottoms, on flat low-lying ground, etc. Much of the land was formerly under broad-leaved trees, often with a more or less dense growth of coppice.

Vegetation.—Generally similar to that of the oak plantations, that is, consisting of coarse grasses, bramble briar, blackthorn and flowering plants.

Method of Formation.—Very seldom by pure planting, usually with alternate rows of larch, *i.e.*, a 50-50 mixture, the proportion of larch being sometimes reduced to 25 per cent. Other nurses used at times are beech, Norway spruce and poplar. Spacing usually 4 ft. by 4 ft., or 4½ ft. by 4½ ft. A large range of plants has been used including 1 + 1 + 1, 1 + 2, 2 + 0, 2 + 1, 2 + 1 + 1, 2 + 2, 3 + 1, 3 + 2, etc., the corresponding sizes ranged from 6 to 30 ins., the smaller sizes, 12 ins. and under, predominating. Planting method, notching with spade or mattock, except at Selby, where some of the earlier plantations were pitted. In the same forest ash seed was sown green in patches in P. 23, but the experiment was not successful.

Failures.—Losses in general have been low, rarely exceeding 20 per cent. Dying back of the shoots through frost has been a very common experience, but except on areas of very heavy weed growth the root stock usually remains alive.

Rate of Growth.—All the reports testify to the difficulty of establishing a satisfactory crop of ash ; they also bring out what appears to be one of its salient characteristics, namely, the great irregularity in development of the plants. This irregularity of growth is well seen in some of the older ash plantations in Highmeadow Woods. In one block in Compartments 77 and 78 the height ranges from 1 ft. to 16 ft. at 15 years of age and similar examples are reported from other compartments. In each of these cases the important factor is clearly the depth of soil over the limestone rock, the growth falling off at once on the shallower soils. The same irregularity in growth is to be seen in most of the younger plantations on all types of soils, individual trees and small groups making quite rapid growth while the majority of the plants remain obstinately in check. It is not suggested that depth of soil is necessarily or even usually responsible for this phenomenon, but it seems highly probable that it is a soil question. It would appear that really suitable soil conditions occur in a very local and patchy fashion seldom occupying more than a small fraction of the total area. Owing to this uneven development average figures for rate of growth do not convey much useful information, but it is clear from the records that the plants as a whole have put on little growth during the first five years.

Evidence from the Data as to Influence of Soil Vegetation, etc., upon Rate of Growth.—The effect of depth of soil upon growth has been referred to above. The only other factor for which any evidence appears to exist is the influence of shelter which has been noted at Westhay where plants raised among coppice were definitely taller than adjoining plants in the open.

Evidence from experimental Work.—None. Experiments are now being put in hand.

Summary.—Ash has been planted on a considerable range of soil and on bare ground as well as among coppice, but the results so far have not been very encouraging. The important factors to be considered appear to be (*a*) soil, (*b*) protection from frost, (*c*) size and quality of plant, (*d*) racial type of ash.

As regards the soil, it is quite possible that mistakes have been made in the past resulting in the selection of unsuitable sites. Ash does not seem to thrive on consolidated soils, such as so often result from the clear felling of coppice on clays or heavy loams. Anything that will help to keep the upper soil layers friable and well aerated is likely to promote the growth of ash, hence the importance of retaining as much soil cover as possible in the early stages of an ash plantation. The great sensitiveness of ash to late frost is another reason for making use of any shelter that may be available. Where no shelter exists and where there is much risk of frost damage, the establishment of an advance crop of such plants as grey or black alder may prove to be the cheapest and most satisfactory method in the long run.*

As regards size of plant, further investigation is clearly needed, but sturdy well-grown plants are advisable where there is much weed growth to contend with.

Lastly, as regards type, the fact has been established on the Continent that there is a considerable silvicultural difference between the "lime" ash, which grows naturally on chalk or limestone rocks and the "water ash" found growing on siliceous strata. The use of the wrong type leads to unsatisfactory results.

Beech.

Area planted.—Approximately 2,500 acres have been planted with beech during the past 10 years.

Soils.—Two main types of soil have been planted with beech as the principal species, (*a*) sand or loamy sand in the eastern counties of England, and (*b*) loam over chalk on the chalk downs of the South of England. In both cases the soils are liable to dry out rapidly in hot weather, while on the down soils there is the additional difficulty that the soil, which is usually very thin over the chalk, is so packed with flints as greatly to impede planting and firming.

In addition, beech has been planted fairly extensively as wind belts or fire belts and also for beating up conifers on all types of soil.

Vegetation.—On the sandy soils either fine grass or grass and heather, on the downs fine grasses—chiefly *Festuca ovina,* with brome grass, *Holcus, Brachypodium* and other coarse grasses, and the usual downland herbs. After enclosure, the vegetation grows rapidly to a height of 2 to 3 ft.

Method of Formation.—Almost all the beech has been planted in mixture with other species, usually larch, but in some areas Corsican pine, ash, sycamore and other hardwoods.

* See review of Swart's article on ash (page 87 of this Journal).

Notch planting has been the standard method of insertion and every type of plant has been used from 1-year seedlings to 2 + 2 and 3 + 4 transplants, but 1 + 1 has been the most generally used type.

Failures.—Losses have been very heavy averaging 50 per cent. over the whole of the planting. The causes of the failures are variously attributed to frost, drought, late planting and the use of unsuitable stock—too large in some cases, too small in others.

Rate of Growth.—Most of the larger plantations are too young for any substantial growth to have been put on.

The following data relate only to the Forest of Dean and Highmeadow Woods, where measurements of some of the older areas have been recorded :—

Compartment.	Age.	Pure or Mixed.	Rock.	Height.	Remarks.
	Years.			Feet.	
95	15	M.	Limestone ...	6–18	
355	15	M.	„ ...	12	
H.M. 55	14	M.	„ ...	16	
H.M. 14	12	M.	„ ...	9–16	
381	11	P.	O.R.S. ...	10–12	Rough nursery grown up.
376	7	P.	„ ...	1–3	Small group.

Height growth appears from the above data to average about a foot a year at 12—15 years of age, but the current rate of growth at that age is probably much greater. The group in C. 376 seems to indicate the same sort of check as is found elsewhere, but is not typical of growth conditions in the Dean as a whole.

Evidence from the Data as to the Influence of Soil, Vegetation and Methods of Formation upon the Proportion of Failures.—The beech plantations formed within the past five years are situate for the most part in the east and south of England, and it is precisely this part of the country which has experienced an exceptional succession of dry springs, late frosts and hot summers. The weather conditions have thus been very adverse, and it is impossible to say which of the three conditions mentioned above has been the chief cause of failure. A large range of plants has been tried but no particular deductions can be drawn from the data, although decided opinions have been expressed by certain of the reporting officers as to the type of plant likely to do best under their particular conditions. As to planting methods, notch planting has been the standard method, and there have been no comparative trials with pitting.

Evidence from experimental Work.—A small experiment on planting on ploughed furrows as compared with screefed patches was carried out at Friston. Up to the present no difference is discernible.

Summary.—On the evidence at present available it would seem that, with existing methods, attempts to establish beech on open ground in

frosty localities are almost foredoomed to failure. Experiments now under way are designed to investigate the following problems: (*a*) The possibility, by suitable cultural methods, of establishing beech successfully as a pioneer crop in the open. (*b*) The choice, methods of establishment, spacing, &c., of nurse species to be planted as an advance crop.

Other Hardwoods.

The more important remaining hardwoods are sycamore, Spanish chestnut, poplar and walnut.* These have been planted on a relatively small scale, and the main results can be briefly summarised below.

Sycamore.—Planted chiefly in Division 3 for boundary belts and in Division 5 at Clipstone and Laughton Forests. The plantations failed generally in Division 3 owing to unsuitable soil conditions. In Division 5 the initial losses, using 2 + 2 plants, have not been unduly high, but the late frosts are described as stunting and eventually killing the plants. At Elveden, where 1-year natural seedlings were planted in P. 27, a 75 per cent. failure resulted.

Spanish Chestnut.—The recent records for this species are confined to two forests, Clipstone in Lincolnshire and Rendlesham in Suffolk. In the former forest fairly extensive sowings and plantings have been made on a sandy soil with a heather and bracken herbage. In the sowings the surface was screefed, the soil broken up, and seed dibbled in at the rate of 40 to 48 lbs. per acre. The results were not satisfactory, crows and pheasants doing a great deal of damage and the percentage of stocked patches is only 10 to 15 per cent. Sowing was also tried in open furrows, and this method is considered better than the spot sowing. Thin sowing was undoubtedly one cause of the failure.

One and two year seedlings were used for the planted areas with quite good results as regards the initial take, but the development has been unsatisfactory owing to late frost which cut back the plants each year. In the spring of 1929 some of the shoots were pruned before flushing, and there is a more hopeful show than hitherto, though it seems doubtful if next year any of the shoots will be out of the frost zone.

At Rendlesham the growth is fair where there is little frost damage, and the plants are now 2 to 3 ft. high, but in most areas the plants are cut back every year by frost and little progress is made. Cleaning is still being carried out in areas planted as long ago as 1923. Beating up has been heavy in the past, but there is now a 95 per cent. crop.

Mr. Young gives details of three plantations in the Forest of Dean which are interesting on account of their rapid growth.

(1) Age 29. Ht., 38 ft., Q.G. 6 ins. Soil, heavy loam and clay on Coal Measures. Formation, sowing in patches at 4 ft. × 4 ft. with 4 seeds in each patch.

* This species will form the subject of a special report.

(2) Age 27. Ht. 35 to 38 ft., Q.G. 4 ins. Soil, loam on O.R.S. Formation. Seedlings from rough nurseries planted 4 ft.×4 ft.

(3) Age 15. Ht. 20 to 25 ft. Soil, sandy loam over Coal Measures. Formation, planted 4 ft.×4 ft. and 5 ft.× 5 ft., both pure and also 6 ft.×6 ft. with 25 per cent. beech. Of the three areas the 5 ft.×5 ft. planting is not quite as good as the other two. All the beech are alive in the 6 ft.×6 ft. area, but are under the chestnut and beginning to be suppressed.

Poplar.—Reports on this species refer to Rockingham, Rendlesham, Laughton and Selby Forests.

At Rockingham the plantations as a whole are considered satisfactory, although rapid growth is confined to scattered individuals some of which have grown 6 ft. since planting in P. 23. The more recently planted areas are slow in getting away, but deaths have not been heavy. In general 2 + 0 are considered the best plants, large plants such as are commonly used on the Continent have not proved a success.

At Rendlesham the most successful species so far is the Black Italian, but even these are badly frosted each year and usually do not come into leaf until late in the season. *P. trichocarpa* is a failure after the second or third year, except on the higher ground, and is no longer being planted. The P. 25–P. 29 plants were 1 + 1, 2 to 4 ft. in height, and planted at 11-ft. spacing. Failures about 20 per cent. The oldest trees were planted in P. 22, and are 17 to 18 ft. high, with about 12 ins. growth this season.

At Laughton wind appears to be the main adverse factor, causing the plants to die back.

At Selby, poplar, like all other species in the plantation, suffers severely from frost. Plants of varying size and age have been tried, and the large plants have done the best. The following data relate to poplar planted in this forest.

Planting Year.	Growth.
P. 21 and 22	Average height, 4 to 5 ft. Maximum height, 12 ft. Leading shoots up to 12 ins. Not many failures.
P. 23 and 24	Average height, 3 ft. 6 ins. Maximum height, 5 ft. Leading shoots, 4 to 9 ins.
P. 25	Average height, 3 ft. Leading shoots, 3 to 10 ins. Losses most among the very small plants, and amount to 20 per cent.

Several species of poplar have been tried at Selby, but of these the Black Italian is the most promising.

Summary.—Just as in the case of the major species, late frosts appear to be the main obstacle to success in planting sycamore, Spanish chestnut

and even poplar. Various methods have been suggested in the reports for mitigating the difficulty, such as the use of larger plants, pitting or mounding in place of notching, use of all available shelter, establishment of an advance crop, etc., and it is evident that all these lines deserve investigation. In the meantime careful handling of the plants, both when lifting and planting, avoidance of too late planting, rejection of weakly plants, and utilisation of every scrap of shelter available, are some obvious precautions to be taken.

NOTE ON PLANTING OF HARDWOODS.

By Fraser Story.

The use of 2 + 1 transplants planted in small pits is my suggestion for overcoming the hardwood planting difficulty. My reasons for this decided preference are given below. Let me deal first with the type of plant. Transplants of 2 + 1 have an advantage over other types because they are more hardy, less subject to shock on planting, easy to handle and cheap. Their one drawback, namely, their small size when planted, is nothing in comparison to these advantages.

The comparative hardiness of the 2 + 1 plant is due to several definite causes. The main one is that the epidermis is thicker than that of either a seedling or a 2 + 2 plant. After lining out in the nursery at 2 years old, scarcely any growth in height is made, but the root system develops—in other words, the plants get over most of their check in the nursery lines. The new shoot of a 2 + 1 plant is usually only an inch or two in height; all the rest of the little stem, which is often only 6 or 8 ins. in height, is "hardened off," *i.e.*, the bark becomes thicker.

If the plant is allowed a second year in the nursery lines a long shoot of relatively delicate tissue is produced, the thin bark is profusely provided with lenticels open and ready to transpire a large amount of moisture. This delicate growth is a real source of danger when the plant is transferred to the planting area, where it is suddenly exposed to air, sun and and wind before the roots have taken hold in the soil. The inevitable result is a severe check.

Transplants of 2 + 2 are also objectionable because of their greater height, which causes the plants to sway about in the wind as the 2 + 1 plant does not do. The swaying motion is harmful because the roots and rootlets, even if they are not broken, are constantly being disturbed in the soil. Moreover, much of the root system may actually be exposed, which, of course, is fatal. Plants which survive develop leaves at a considerable height above the ground, and consequently suffer further injury from the action of wind (*a*) in the roots from the swaying motion and (*b*) in the leaves from over-transpiration. The short, strong, 2 + 1 transplant escapes these dangers almost entirely.

As for the method of planting, I think that notching is entirely unsuitable for a hardwood transplant. Planting, I suggest, should be by means of a small "pit" or rather a small patch of cultivated soil. In my experience, it is only under exceptionally favourable circumstances that hardwood transplants will endure notching. Some form of pit planting is invariably advisable; in fact, essential, if the plants are to live and grow. Fortunately, owing to the small size and the compact root system of a 2 + 1 transplant, the pit need not be larger than about 9 in. × 9 in. and 8 in. deep. After screefing a patch of this size the soil should be hacked or stirred (but not removed) by means of a hoe or

" half mattock." With such an implement a man can easily make 400 pits in a day. The insertion of the plant follows and should be done by a small hand trowel or scoop—not a spade, which is cumbersome, and does not let the man get near enough to his job. With the trowel sufficient soil should be pulled to one side of the pit to enable the roots rapidly to be placed in position, and then the soil which has been dragged aside is pushed back and the whole made firm.

Owing to the screefing and cultivation of the soil on the 9 in. × 9 in. patch no weed growth, or extremely little, springs up immediately beside the plant in the first year. By the time weeds are becoming troublesome in the second year, the plant is well established and making considerable height growth, and it is only necessary to keep its head free of tall weeds. This operation requires attention principally in the second year, but sometimes in the first and third years also. It should never be necessary to weed more than four or five times in all, entailing an expenditure of, say, 30*s.* per acre. No unusual problem presents itself in regard to weeding hardwoods, but as the soil chosen for these is generally heavier or more fertile, and the situation better, than the average for conifers, weed growth is usually stronger. If the plants have been spaced at fairly regular intervals and in lines, the task of keeping the leading shoots clear is by no means difficult. It is not always necessary to employ a sharp instrument like a sickle, the proper use of merely the hand and foot in clearing the weeds is frequently quite as effective and less costly. In any case, weed growth is less troublesome where a form of pitting has been adopted and with 2 + 1 plants beating up may usually be dispensed with.

The cost of establishing hardwoods on the above lines must necessarily vary to some extent according to locality, but on an average (exclusive of fencing and draining), it should not amount to more than £7 8*s.* 0*d.* per acre as shown below :—

	£	s.	d.
Plants—1,800 plants (2 + 1) per acre at 33*s.* per 1,000 (delivered on planting area)	2	19	0
"*Pitting*" at 400 pits per man, per day, at 6*s.* per day	1	6	0
Insertion of plants at 500 per man, per day, at 6*s.* per day	1	2	0
Beating up—10 per cent. of planting costs.. ..	0	11	0
Weeding—5 times at 6*s.* per acre	1	10	0
	£7	8	0

Apart from occasional frost damage to beech and chestnut I cannot say that I have found hardwoods more difficult to establish than conifers.

NOTES ON FOREST ESTATE WORK.

By C. E. L. Fairchild.

Most of the Commission's officers are concerned in some way or other with one of the numerous branches of forest estate work. It begins immediately on the acquisition of a new area, and if this is large, probably for the first few years, there is more work on the side of the estate than on that of forestry.

To give an idea as to how estate work is carried out, perhaps the best plan will be to take a new acquisition, and show the way it is broken up to its final allocation of planting land and forest workers' holdings.

When handed over to the Divisional Office a large acquisition will consist of anything up to fifty or sixty farms, most of which are occupied, but others vacant, to the joy of the Divisional Office, especially in these days of extended planting programmes, and it is these latter that must be dealt with at the start.

The first thing to be done is an investigation of the acquisition, especially of the vacant farms and the adjoining areas. Of course, a good deal of information can be obtained from the acquisition report, but the detailed information, as to the utilisation of each field and piece of land, must be obtained on the ground, and a decision reached as to the use to which it will be put in the future.

There are roughly three divisions into which the land will fall. First in importance is the land to be set aside for planting; secondly, that to be used for forest workers' holdings purposes, or possibly, if the agricultural area is large, to be used for the establishment of a farm; and thirdly, there is the unplantable land which will be let off for grazing later.

When the utilization of the different classes of land has been decided, a schedule is drawn up and the land, as allocated, is marked out on the maps and areas plotted. If the proportion of agricultural land on the whole area is high, then one or more farms will be set aside to be treated as such, and agricultural land from adjacent farms may be allocated to these in order to enlarge them and make it possible for them to be run as farms, in later years, when the sheep walks have been taken for planting purposes. The remaining agricultural land is then divided into holdings and the boundaries fixed.

The existing farm houses, and such parts of the out-buildings as are deemed necessary for the requirements of the holding will lend themselves to the immediate establishment of the first forest workers' holdings, with which the land of adjoining projected holdings may be let as byetakes, until such time as dwelling houses can be built, and the remaining parts of the original farm buildings utilized.

There is nearly always some adjustment required in the allocation of the land; certain fields may be too isolated to be used to good effect for holdings, and may be more useful if planted for thickening up the planting area; or again, from their shape, the fencing out of such

fields may be of greater cost than is warranted by their agricultural value.

On the other hand, land which has been put down for planting may, from its position, be of use for improving the compactness of a holding and the shortening of its boundaries; or, again, it may be advisable to leave it unplanted from a protection (fire, etc.) point of view, and even if rough or poor, it can, as has been proved in many cases, be improved by gradual treatment.

The unplantable land has also to be dealt with, and though, with gradually extending knowledge and improved methods of planting, this class of land is yearly shrinking, yet there will always remain tracts of land which from their exposure or poverty will never be worth planting. This land is then allocated to the farms and holdings for grazing purposes. Sometimes, to save fencing out small portions, the whole of this area may be let to an established farm, with rights of grazing a specified number of sheep reserved to the neighbouring holdings.

When the general scheme has been laid out the actual details must be considered. Rents for each farm and holding must be worked out in accordance with the value of the land. In the case of a first letting, rents are often subject to negotiation with the chosen tenant, and these negotiations entail a good deal of time and bargaining.

During the time between the first appearance of one of the Commission's officers in the neighbourhood to the actual completion of the acquisition, many applications will have been made for the vacant farms and these must be sorted out. The majority of them will come from farmers who want farms complete with sheepwalks and who are not interested in holdings. This type of applicant is seldom of any use to the Commission. Other applications will be from men who are prepared to take anything offered to them. These must be interviewed individually after they have filled up a detailed application form, in order to find out their suitability for holdings and forest work. As a rule, applicants will have had some experience on farms, and from these the tenants of the first holdings established on the area, will be selected.

Having given some idea of the initial stages of the work on a newly acquired area, the different branches of estate work will now be considered. These, of course, apply to established forests as well as to the new areas just discussed.

Building work is, perhaps, one of the most important branches of estate work. Forests are made up of planted and to-be-planted land, farms under the original tenants, of which the Commission has not obtained possession, and forest workers' holdings, some in a completed state, and others in various stages of progress. As far as building work is concerned the farms and the holdings can be divided into four types.

1. *Completed Holdings.*—This class consists of the farms and holdings on the areas of which the Commission are the landlords, some of them still in the occupation of the undisturbed original tenants. These should

be the least troublesome as far as building work is concerned, but this is not always the case. Normal work consists of upkeep and gale damage repairs, but among other difficulties that arise, the tracing of damp, and the cure of smoky chimneys are two of the commonest problems to be solved, and the most difficult.

If the work is straightforward it can be undertaken by the forest estate workmen, should such exist, otherwise one must obtain builders' tenders, but in every case of repair, except, perhaps, urgent gale damage, specifications must be drawn up, and an estimate of the cost submitted. The specifications and estimates must be gone into carefully in each individual case. The utility and economy of the many different materials on the market need to be judged and their particular suitability for the work determined.

It is very important when repairs are taken in hand that the premises should be thoroughly examined, in order that all defects may be remedied at once, as it is greatly in the interests of economy to ensure that a further visit will not be necessary for some considerable time, and to this end specifications should be made as detailed as possible.

Estimates of costs are important as giving an idea of the amount of money required, and also as a check against over-expenditure, but it is useless trying to make estimates hard and fast where one is dealing with an old building. Few of the buildings are modern, it is impossible to tell exactly what will be met with ; for example, the lead of valleys, which often looks as though it only requires repairs in the parts seen, may be found on removal to be badly perished ; window and door frames, which one thinks can be pieced, have to be entirely replaced ; and interior walls covered sometimes with five or six thicknesses of paper, nearly always require more repair to the plaster beneath than is expected.

Additional work which may be mentioned in connection with existing holdings is outside painting and interior decoration. As a rule the latter is the tenant's liability but tenants are always changing and for a new tenant the Commission sometimes supplies the material, the tenant doing the work.

2. *Holdings which contain a Dwelling House but no Outbuildings.*— For these, outbuildings of various kinds will have to be provided sooner or later. Sometimes only a chicken house or a pigsty is required, other tenants on the larger holdings will want a complete set of buildings consisting of cowhouse, calf-pen, stable, pigsty, cart shed, storehouse and barn, but in the majority of cases combinations of buildings are asked for.

Plans must be drawn to meet the tenants' requirements and the locality. The tenants as a rule have to pay 6 per cent. interest on the cost of new buildings, so their requirements must be carefully considered, specifications drawn up and, if the work is to be done by direct labour, quantities must be worked out and the materials ordered. If not done by direct labour a contract is procured, such contract can either be for the whole job or only for the labour, the Commission supplying the material. When timber is obtainable from the forests arrangements are made for

its conversion to specified lengths and sizes, thus reducing the expenditure.

There are many types of buildings suitable for forest workers' holdings, these vary according to the locality, but there are certain points common to all which need consideration, and which will make them better adapted to the needs of holders. For example, the tenant of a forest worker's holding often works at some distance from his house, and does not return until the evening. This means that a good deal of the work must be done by his wife or children. When this is the case it is an advantage to have the storeshed and barn as near the cowhouse as possible, to obviate the necessity of women and children carrying heavy loads some distance. Another great convenience can be secured in the lay-out of the cowhouse by arranging, where possible, that a passage way be left in order that the stock be fed from the head, to prevent the woman or child having to make their way between the cows to fill the manger, in many counties this is essential.

3. *Holdings which contain Outbuildings but no Dwelling House.*—A house will have to be built on a suitable site, in the choice of which, considerations of light, dryness of site, nearness to outbuildings and water supply are of importance. If water can be piped into or near the house it adds greatly to the attractiveness of the holding. The actual building may, as in the foregoing, be by direct labour or contract. In Division II, where skilled labour is difficult to obtain, contractors' tenders often prove more economical and satisfactory, if and when they can be secured.

Plans for bungalows, suitable to the needs of the holders, can be obtained from the London Office, together with suitable specifications. It is sometimes found necessary to reverse the plan in order to get a better aspect for the living room, the specifications must also be amended to agree with the particular materials to be used for construction, which varies with the locality.

When possible several builders' tenders should be obtained, but this cannot always be arranged, as there are certain districts where even one reasonable contractor is difficult, or impossible, to find. When the tenders have been considered and the successful contractor selected he signs the R.I.B.A. form of contract. This form covers all points that may arise, and by its use eliminates any probability of dispute.

The work will require very careful supervision as contractors, like old soldiers, are adepts at "swinging the lead," and have many means of saving on their contract which need a vigilant eye to detect.

4. *Holdings which contain within their Boundaries a House or Building in ruins, or otherwise unsuitable for Occupation.*—The reconstruction of such buildings into satisfactory dwellings is often extremely difficult. The existing windows in these old places have an awkward fashion of being just where they are not wanted, and generally occur where one wants to put a partition wall, or staircase, whilst the best and largest window may turn out to be in the only part of the building that is suitable

for a pantry or dairy. Old walls which are perfectly sound if left alone are dangerous to pierce for new windows and doors, as, especially in Wales, they have been built of large rounded boulders with very little mortar. However, one has to get over these difficulties as best one can, and it is surprising how, with a little thought (and perhaps a little training in the way of solving jigsaw puzzles) they can be overcome.

Great care is necessary in the preparation of specifications for this type of work, as one does not start with a clear board, as in the case of a new building, but one has a certain amount of existing work and materials to fit in. It is advisable to draw up the specifications on the same lines as a standard copy, and to go through the items and rooms one by one, otherwise one will generally find that some important point has been overlooked, and as contingency items should be avoided if possible, one may find the money running woefully short and supplementary estimates necessary.

Having equipped the holding with house and buildings a few short notes on tenancy matters may be of interest. When the prospective tenant has been interviewed, and has agreed to the terms and conditions of the tenancy, a draft agreement is prepared, signed by the tenant and submitted for approval, after which the draft is kept for reference purposes in the Divisional Office, and the agreement proper, consisting of two copies of the draft, is drawn up. When the signatures of the Assistant Commissioner and the tenant have been obtained, one copy is kept at Headquarters and the other copy is sent to the tenant for his retention.

There are three forms of agreement in general use : (*a*) the ordinary Forest Worker's Holding Agreement, (*b*) the Farm Agreement for letting from year to year, and (*c*) a shortened form of agreement which is extremely useful for short-term lettings, for byetakes and other purposes. The procedure as outlined above is the same for each form. All need careful drawing up, as it is seldom that some amendment or addition to the printed form is not required.

The Forest Worker's Holding Agreement runs, as printed, for 364 days, and is generally the simplest to prepare. It will often require alteration in the period of the letting, as few first lettings commence on 1st October, whilst all must end on 29th September ; an additional clause, to cover the payment of interest on the costs of new buildings provided, will generally be required, in other cases the reservation of a right of way, or building, the responsibility for a fence, or some similar clause must be added, and often ingoer's liability for repayment of Tenant Right by instalments.

The Farm Agreement for letting from year to year is a very long document, consisting of some twenty pages, and covers everything fully. When negotiating for a tenancy of this kind one generally has to discuss the objections of the tenants clause by clause, but with patience and with certain concessions which are not very important from the Commissioners' point of view, it is seldom that agreement cannot be reached in the end.

The shortened form of agreement is extremely useful ; it is used for

short-term tenancies in which the full detail is not required, or for tenancies for land only. It can also be adapted to suit any other tenancies which do not come into the forest worker's holding or farm classes.

All agreements have a tracing attached showing the area, and also a schedule of the ordnance numbers of the land concerned, as taken from the 25-inch ordnance sheets. The schedule as a rule takes a considerable time to work out, as the old field-boundaries are often straightened for the new holdings and thus much of the area needs to be accurately re-measured. A detailed schedule is, however, well worth the time spent on its preparation, as it can be continually referred to for one purpose or another.

Rents for forest workers' holdings are generally payable monthly or quarterly and collected by the forester. Other tenants generally pay the Divisional Office direct every half year, the half-yearly days of payment depending on the custom of the district. When the tenants at a particular forest are many a rent audit is held twice a year at a convenient centre, to which the tenants come to pay their rents, and at which they air their grievances, and try to get as much out of the Commission as they think is possible. The matters brought up are very varied, mostly they consist of requests for fencing material and repairs to buildings, but requests for advice on quite private matters are also often received. Some tenants consider a landlord's responsibilities endless, and it is essential if a tenant's request is granted, to make him do something, however little, in exchange or towards the fulfilment of his request.

Other classes of work that are akin to tenancies are the letting of sporting and the granting of permissions. Sporting over an area is sometimes leased for a number of years, but often the letting rests on correspondence. If " leased," a proper legal document is required ; if " let " by correspondence, a letter of acceptance is sent with a covering letter, in which the terms and conditions of the letting are fully set out, if the prospective tenant agrees to the terms and conditions he signs and returns the letter of acceptance.

" Permissions " are generally dealt with by correspondence in the same way. Their variety is endless, and they range from the taking of photographs, or the gathering of moss, to the laying of pipe lines, or the making of bridges. The most important point to cover in the letter granting permission is, that the permissee accepts full liability for any damage that may arise from his enjoyment of the permission.

It is impossible in a short article to cover the many ramifications of estate work or to give any idea of the office work involved, the checking of current expenditure on building and other work, the keeping of records of capital expenditure for each farm and holding, the preparation of forest workers' holding schemes, a subsequent preparation of, and amendment to, forest workers' holding cards ; also, the endless correspondence with manufacturers, builders and tenants, the renewals of tenancies, and the miscellaneous matters (a large item) that have to be dealt with daily ; these are but a few of the further items that come under estate office work, whilst to the outdoor work may be added the super-

vision of a growing staff of estate workmen, for, like the forest work, estate work is steadily growing from year to year; it is run in close connection with the forest work, and it is hard to say where the one begins and the other ends. They depend the one on the other, the forest side establishing the trees, and the estate side establishing the labour, both sides work harmoniously towards the same end, the creation and perpetuity of the forest.

SALE OF CONIFER THINNINGS.

By G. W. Jones.

The Delamere Woods are very favourably placed for the sale of conifer thinnings, for Liverpool, Chester, Warrington, Manchester and other large industrial towns with considerable building developments lie within a radius of 30 miles. These notes thus really show what we do under almost ideal conditions as regards possible markets, but they may be of interest to foresters who are not so happily placed, and may suggest possibilities.

The Delamere plantations are, unfortunately for the sale of thinnings, almost entirely Scots and Corsican pines, and at the beginning of 1927 there were about 710 acres of such plantations unthinned and uncleaned, aged from 15 to 30 years, and mostly planted at 4 ft. or 4 ft. 6 ins. spacing. Cleaning and first thinning were urgent over a large area, and in that year some 60 acres of cleaning and first thinning were done, plus 60 acres of cleaning only, the whole at a loss of £123 (cost £214, revenue £91). To push things ahead it was decided to concentrate on bulk sales at popular prices, with delivery of the goods and satisfied customers, rather than small high-priced sales and unsatisfied customers. The difficulty, especially having only Scots and Corsican pines to sell, was to get any sort of bulk market to fit these requirements. After a certain amount of "commercial-travelling" (free on lorries taking plants and seedlings to other forests) a connection was built up and, estimating "probables" for this February and March, we shall have for the 12 months ending 31st March, 1930, receipts amounting to £800 against £600 costs, with cleaned plantations, ready for profitable exploitation in hand.

During the four years ending 31st March, 1930, a loss of over £120 per annum will have changed gradually into a profit of more than that amount annually, and there will have been cleaned and thinned 393 acres at a cost of £1,700 against a revenue of £1,750, *i.e.*, a profit of £50 over the whole period, and there will be about 50 acres of cleaned plantations in hand; if the weather turns bad more cleaning will be done, and will be in hand reducing the profit for the current year, to the benefit of the next.

What may be of interest is that under such conditions cleaning (by which is meant the brashing of the lower limbs and the cutting-out of weeds and dead poles) can be done and charged against the revenue without turning profit into loss, but it must be done piecework, and for this we now pay from 15*s.* to 20*s.* per acre according to conditions. The actual thinning is done daywork because nothing is felled till sold, and this means cutting special sizes in special places with different distances to carry to rides, and with trusted labour piecework probably would not bring any benefit to compare with the difficulty and labour of fixing rates.

If the plantations were of larch or spruce it would be much easier to sell the thinnings, which go almost entirely for rustic work on housing schemes, but other very useful markets have been found, especially amongst local nurserymen, who buy many thousands of fruit stakes in competition with imported bamboo at £4 10*s.* per thousand at ride-side ; these stakes are really like straight bean rods, bundled in fifties, and they will take dead ones ; nurserymen also buy similar, but slightly stouter and shorter stakes at £6 5*s.* per thousand, and basket rods fetch £5 15*s.* Everything too big for the foregoing is sold according to size and quality at prices varying from 2*s.* a score for the smallest thinnings, 6 ft. and up, through 6*s.* per score for Grade II (9 ft. minimum length, 2 to 3½ ins. butts) to 11*s.* per score for poles classed as Grade I, *i.e.*, 3½ to 5 ins. butts, 12 ft. and up, with wireless poles selling at 3*s.* 6*d.* or more apiece, and occasional larch thinnings at 50 per cent. or so advance on the foregoing. All these prices are at ride-side, but small customers will not generally fetch them so there is an arrangement with a local lorry owner, and when a lorry-load of orders has accumulated for (*e.g.*) the Altrincham district, he takes the lot and delivers to the various purchasers from each of whom an appropriate proportion of money for haulage is collected. A small stock of all kinds of produce is also kept outside the forester's lodge and serves to supply ready-cash purchasers of small quantities, who often drive off with their stuff in the back of their motor-cars, whilst it also allows the forester to show a bigger customer samples of produce without wasting time taking him to the woods for the purpose.

Sales are still increasing and the urgent first thinnings will soon be done, and it will be possible to raise prices, as we have done with birch brush from cleanings which sells, in the rough, unbundled for steeplechase jumps (including the Grand National) at 50*s.* per ton, and is running short. Soon, however, will come the second thinnings, bringing their fresh problems as to the sale of stuff of bigger size. However, small sales to date seem to show that this will sell at up to 25*s.* f.o.r. for the collieries and other purposes not yet discovered, and poles for electric transmission lines may take the better stuff and that from the third thinnings.

It is certain that, even given such a favourable district, it is only possible to sell so as to utilize so closely if you take care to satisfy every customer and never turn down the smallest order for the oddest class of stuff. The smallest man, if satisfied, may put you on directly or indirectly to a bigger one, and the strangest and most awkward new specification may be leading you to a new outlet for the produce. Another thing is to train your customers from the start that they must bring cash with order ; most of them soon get accustomed to it, especially after they have been sent back empty-handed once or twice, but all the same it is often awkward unless you spend 24 hours a day at the lodge, and still more awkward when they send a man complete with cash to fetch some poles, perhaps after coming 20 or 30 miles, at 7 o'clock on a wet and windy night. Above all, in the ordinary way,

do not fell anything till sold, or at least do not carry it to ride-side, because you may grade it wrong for a subsequent order, and have to turn it all over again to pick out what you want, for you must grade to suit your customers, and not try to fit your customers to your grades. When you get cash before delivery and before the stuff is even felled, it is awkward to keep your produce accounts right, but that is a matter for the accountants, and it's worth it.

Details for the 10 months ending 31st January, 1930, are as follows :—

Sales—		£
Scots and Corsican poles (all sizes) (33,000 poles)		517
Scots and Corsican rods and stakes (14,800 stakes)		72
Firewood, *i.e.*, dead poles ex thinnings (86 tons)		37
Christmas trees, *i.e.*, tops of Scots and Corsican pine thinnings (324 tops)		8
Pitwood and timber, *i.e.*, the larger thinnings (33 tons)		34
Miscellaneous (including bean rods)		16
Birch brushwood		51
		£735
Stocks unsold (cut to order)		27
		£762
Costs—	£	
Thinning	355	
Cleaning	75	
Extraction and delivery, etc.	143	
	—	573
Profit on 10 months		£189

A FEW TIPS TO YOUNG FORESTERS AND FOREMEN.

By G. H. Brown.

Before taking up duty under the Forestry Commission, I was employed in the south of England, on temporary work, under another Government Department. I had over 200 men in my charge, one-half of them being gipsies. I seemed to have given satisfaction, as I was complimented from Headquarters. Naturally, I thought I knew the last word in supervision. However, before I had been many hours in North Wales I discovered that my education was only commencing.

My present gang of men are really decent fellows, and they are the pick of this neighbourhood. As some of you young foresters or foremen may be appointed to one of the Endurance Stations amongst the Welsh mountains, I will try and give you a few hints of what you may expect. Most likely your men will live a long way from the scene of operations, and will be allowed walking time to a given point. They won't be late in the morning, but will approach the starting point at about 3 miles per hour. After that, speed is reduced to one mile in three hours. The only remedy is to fall in with them and lead them to work. This is where a ganger is useful.

Don't work in big gangs, as you will find that every watch in the gang is 15 or 20 minutes in front of yours in the afternoon.

Don't reprimand a man in front of his mates, as this tends to make him a hero in their eyes.

When finishing measuring up piecework, don't put too much faith in the stake you may drive in the ground. You must have a secret land-mark, as the wind has been known to blow these stakes 2 or 3 chains further back, and especially during planting operations you will find them up to all sorts of tricks, but you can always retaliate with something better. The workmen have no spite at you, but they think they are working for a wealthy firm, although, perhaps, you won't think so. Avoid the farmers as you would the plague, and put farmhouses out of bounds during working hours.

Don't envy other foresters down south, who can play tennis and catch butterflies, as you can have enough exercise here to keep you fit, viz., running after your hat, jumping over swollen brooks, and, last but not least, running after mountain-sheep that have strayed or been thrown into your plantations. There is some satisfaction in this last sport, because, if these sheep have gained 2 lbs. or more through grazing in the plantations, they lose more before they are turned out, as you have to run them to a standstill.

All these amusements will make you fit. The pure mountain air will give you a tremendous appetite, and you will soon apply to your Divisional Office for an increase of salary.

DIVISIONAL CORRESPONDENCE.

By W. E. Coggins.

In Divisional Office No. 3 (E. & W.) all letters are typed in triplicate, the two copies being dealt with thus: One copy is placed in its appropriate file and the other fastened to the second copy of other letters sent out on the same day. It is, therefore, a comparatively simple matter to summarise and tabulate the correspondence sent out during a given period.

A summary has been made for the period October 1st to December 31st, 1929, and the result, given below, may prove of interest to officers in the Department who have no actual experience of Divisional Office work.

In compiling the summary no account has been taken of the Annual Report, Stocktaking of Stores and Stocktaking of Produce, which were prepared and typed during the period under review. Also excluded from the summary are reminders for rents due, payment of bills for produce, and letters sent out with cheques in payment of accounts, rents, rates and taxes. Printed forms are used for these purposes, the relative details being inserted in manuscript. The work entailed in the preparation and typing of agreements and the monthly accounts has also been ignored. The summary is, therefore, strictly limited to the correspondence sent out of the office in letter form.

Subject.	To Headquarters.	To District Officers and Foresters.	To outside the Forestry Commission.	Total.
Plantations	27	31	5	63
Nurseries	22	33	—	55
Forest protection	14	12	6	32
Sales of produce	27	67	57	151
*Acquisitions	31	17	18	66
F.W.H. buildings and lettings ...	126	153	17	296
Other buildings and lettings	56	56	36	148
Accounts and estimates	35	61	14	110
Rates, tithes and taxes	33	6	96	135
Rents	11	14	19	44
Stores and stationery	69	62	2	133
Labour and accidents	28	42	9	79
Staff matters	22	73	2	97
Legal and Parliamentary	11	5	3	19
Tours	7	10	—	17
Grants and advisory	5	3	13	21
Miscellaneous	1	3	10	14
	525	648	307	1,480

In addition, 17 circulars, each of 28 copies, were sent out to District Officers and Foresters.

* Includes correspondence on existing acquisitions.

There were 72 working days covered by the period, and the correspondence, excluding circulars, averaged 21 letters per day.

It might also be mentioned that a good deal of correspondence with District Officers and Foresters is carried on in manuscript form when the typists are pressed for time, and as only one carbon copy of such correspondence is made it has been excluded from the summary. It is estimated that the average daily number of letters sent out in this form is 3, making the average daily output 24.

The three months chosen are considered to be average months, although during other months of the year the number of letters under the various sub-heads would vary.

The summary is of particular interest in showing the number of letters written about " Forestry " (301 under plantations—mostly about plant supplies—nurseries, protection and sales of produce), and the number (444) about buildings and lettings.

In connection with the above the District Officer (Mr. G. B. Ryle) has supplied the following summary and notes of his correspondence. His letters are all written in manuscript books, and as a complete summary of all correspondence would have taken up too much time, one operation (out of the 10 in his charge) has been taken and the whole of the letters written during the calendar year 1929 about this operation (Glangwilli) summarised, with the following result :—

Subject.	To Divisional Office.	To Forester.	To outside the Forestry Commission.	Total.
Forestry (plantations, &c.)	4	21	1	26
,, (nurseries)	—	6	2	8
Estate work (roads, &c.)	1	2	8	11
F.W.H. buildings and lettings ...	23	30	6	59
Other buildings and lettings	12	11	7	30
Acquisitions	7	2	3	12
Accounts and estimates	8	9	—	17
Stores and experiments	2	—	1	3
Produce and sales	1	1	2	4
Staff matters	2	3	—	5
	60	85	30	175

The extent of the Glangwilli operation is about 3,000 acres, and at the end of 1929 there were nine Forest Workers' Holdings, 5 Farm lettings and a new Forester's House ; in connection with which there were 8 repair contracts in progress. The burden of the office work on

these contracts is mostly over as soon as the specifications have been drawn up and tenders accepted.

Correspondence from the foresters is sent direct to the District Officer, except in special cases of emergency, routine and accounts matters. Progress Reports are all sent to the District Officer for scrutiny before being sent to the Divisional Officer.

A good deal of office work falls to the lot of the District Officer in connection with estimates, plant, allotments and lining-out programmes.

FOREST TELEPHONES.

By A. H. Popert.

Among the many factors which have to be considered in connection with the operations of the Forestry Commission, and more particularly having regard to the protection from fire of young plantations, are rapid and efficient means of communication. There are various ways of effecting communication, but only the use of telephones will be considered here.

Telephones may be either connected with the public exchange system, or private lines. The advantages of the public exchange are firstly, the definite known annual outlay as subscription, which includes maintenance, and secondly, unlimited range. Against these there are certain disadvantages. The subscription may be high for the amount of use to which the instrument is put, *e.g.*, if the stations are, as would be the case in many of the Commission's forests, several miles away from the nearest exchange there is an additional annual rental of 5*s.* per furlong over 2 miles. This means, in the case of a forest 6 miles from an exchange, a yearly charge of £15, plus calls. This charge, in many of the Scottish or Welsh forests, would be much higher still. There is also the possibilty of misuse of the telephone, which could be counteracted by a rigid system of entries and checking all calls in a book. In many rural districts, the service is only available during certain hours, and this limited use is obviously a great disadvantage.

A point in connection with the exchange system which is worth considering, is the party line, which enables several houses to be put on extensions on the same exchange line, at a cost of about 8*s.* per annum per instrument, plus the ordinary single-line rental.

With regard to private lines, that is, telephone systems erected on the Crown's own property, and which have no connection with a Post Office line, there are several points to discuss. For purely forest purposes, private lines have advantages over exchange lines in that they are cheaper to maintain, and that a temporary line can be run out and plugged into the main line at any time and any convenient point. Their erection is simple, and any one with an elementary knowledge of electricity and a certain amount of skill in using a soldering iron can do the work of erection and maintenance. One would probably find in each Division a man who has either been a R.E. signaller, or who has had similar experience who could maintain all the lines.

The chief disadvantage of a private line is that it cannot be plugged into an exchange line, and the transmission of a message from a point on the private line to an exchange line necessitates a third operator to carry the message between the instruments at the junction point. This may lead to misunderstandings, and gives rise to a chance of an error of the "reinforcements," being transmitted as "three and fourpence" type, but this instance may not frequently arise.

There are several methods of erecting the lines for a telephone of this type, either with insulated wires, or bare copper wire. There may be

one or two wires ; the former uses an earth return and the latter a wire return. Experience shows that there is no doubt that the two bare copper wires are by far the most satisfactory for a permanent line, and the cost of erection of two wires is only about £7 or £8 per mile more than the cost of a single wire, as the number of poles and heavy labour required is the same in each case.

Insulated telephone wires were much used during the war, and since then a covered wire of seven iron strands and one thin copper has been sold for garden and wireless aerial use ; this, however, makes a very poor permanent phone line. The iron wires have a high resistance, corrode quickly, and are hard to solder, and the insulation is very easily rubbed off, necessitating the use of insulators at each supporting point. This type of wire is useful for running out a temporary line, which can be rolled up again after use. The heavy blue and yellow type supplied by David Green and Co., Lytham, is the best.

Apart from the use of especially erected wires, there is the possibility of using wires in fences, which may in some cases run conveniently between points at which telephones are needed. This is not to be recommended for many reasons, the chief ones being the high resistance of the iron fencing wire, which means much loss of battery power in ringing and speaking ; the difficulty of maintaining efficient insulation, *e.g.*, a wet and rotten streak of wood down a post or a broken strand of wire brushing the conductor would cause a bad leakage ; and the necessity of soldering all joints in the conducting wire. The use of insulated wires, excepting heavy rubber-covered copper cable, which are expensive, is again a source of liability to break down for much the same reason.

From a point of view of cost, it is admitted that the first cost of erection of a system of telephones connected by cheap insulated wires or fencing wires, may be less than that of a line such as that described below. Electrical laws, however, cannot be disregarded with more impunity than other laws, and the almost certain result of dependence on a cheaply-erected system is that it will break down at a critical moment, and all the money spent in its erection will be wasted, together with a great deal more in the shape of young forests which might have been saved by an efficient telephonic service.

With regard to the telephone instruments themselves. A certain number of portable magneto ringing telephones are still procurable from dealers in disposals board materials, at a price of about 15*s.* each complete. This, of course, is far below cost of present price, and new instruments would cost £7 or £8 each.

In case there are any operations where it is proposed to instal telephonic communication, I append some details of the construction of one line that cost £23 10*s.* per mile to erect, and which functions very satisfactorily between a fire lookout and a lodge in the Dean Forest. The annual Post Office charge for this line, if it had been erected as an extension of the P.O. line to the lodge, would have been about £8, whereas

the present cost at 5 per cent. on outlay is £1 5*s*., with a probable maintenance of 10*s*. p.a. the outside.

The procedure to be adopted is as follows. The line should be first mapped out on a 6-inch map and carefuly gone over in the ground and any points of difficulty such as main roads, power lines, etc., noted. In the case of main roads, the requirements are that crossing wires must be at least 20 feet above the road and not within 5 feet (either above or below) of Post Office wires. It is as well to use insulated wire to cross a road, though it is not necessary, particularly if the proposed line passes under or over G.P.O. wires. Authority must be obtained from the County Council concerned, and the local Post Office engineers, which is usually done without difficulty. If any poles have to be placed in land not belonging to the Crown a way-leave, with a probable small annual payment, must be negotiated with the owner.

A point of increasing importance is the large number of electrical power lines now being erected all over the country; these must be erected with great care and the telephone line protected by at least three steel wires connected to earth plates at each end, erected over it as a guard, so that should the power line break, it will fall on to the earthed steel wires. Crossings should be made as near a power-line pole as possible.

Under average conditions the distance between the poles is 40 yards or 44 poles per mile and they carry two wires. Allowance must be made for extra poles at corners, road crossings, etc. If larger poles are used, the distance between poles may be increased up to 60 or 70 yards.

Assuming two wires are being used, the requisite amount of wire and insulators at 2 per pole should be ordered, with 10 per cent. extra for spares. In this case, the wire used was 18 gauge hand-drawn bare copper wire supplied by Edison Swan Cable Co., at 65*s*. per mile. The insulators were reel type, of 2-inch diameter, with a peripheral groove, and a central hole $\frac{5}{16}$ diameter. These were supplied with flat-headed 4-inch screws with a $\frac{7}{16}$-inch diameter top. Enough insulated wire, which may be of the blue type mentioned above, should be allowed for road crossings and down leads at both ends of the line. The poles were larch thinnings (not stripped) and charred and tarred at the butts for 5 feet from the bottom. The tops of the poles are cut to an inverted V shape, and pieces of zinc, 8 inches × 5 inches nailed on with galvanized 2-inch nails, to protect the top of the poles and to give a better finish to the job.

The length of the poles was 18 to 20 ft. (larch thinnings), running out to a top diameter of $3\frac{1}{2}$ ins. The tops and insulators were screwed on before erection, one of the latter on each side of the pole, under the ends of the zinc covering and one placed one foot below the other. The poles should be erected so that the positions of the insulators alternate either right or left on each successive pole. The changing of the wire from right to left or vice versa tends to stop induction, though on a short low-powered line this trouble is not likely to occur.

In addition to screwing on the insulators it is as well to wrap 2 or 3 yards of barbed wire round each pole at about 8 ft. from the ground, the ends of the wire being taken on to a point 3 ins. above the zinc coverings and the other buried in the ground at the foot of the pole.

The position of the line is marked out on the ground and pegs driven in to show the position of each pole, which can then be erected. The holes should be at least 4 ft. deep, *i.e.*, about one-fifth of the pole length. The next job is the erection of the wire. No straining beyond the tension obtainable by twisting the insulators with two turns of the wire round it is necessary, unless the line is erected in very cold weather, and care must be taken to allow the same amount of "sag" in each wire. At each insulator a piece of the bare copper wire about 10 ins. long is wrapped tightly round the backward end of the span and taken round the groove of the insulator in the opposite direction to the main wire—pulled tight and then wrapped round the forward end of the main wire. This obviates the necessity of cutting the wire at each insulator, which is correct Post Office practice, all joints being subsequently soldered. The idea is to save the whole line from slackening if it gets broken at one point.

The wire is paid out from the reel on which it is supplied by the works in quantities of a mile, by running the drum along the ground with a crowbar through the central hole. For extensive work it is worth while to make a simple framework with a central spindle to carry the drum horizontally. It is best to run out about 100 yards at a time and fix this to the poles. Great care must be taken to avoid kinks in the wire, and if one occurs it must be unwound, not pulled out, as this leaves a weak place in the line.

At any corners, on the line, the poles must be stayed, for which purpose two strands of heavy galvanized twisted together fencing wire can be used in the same way as a fence post is stayed, and, of course, the end pole must be stayed in the same way.

When the wire is being erected, any branches of trees, which might touch it in a gale or fall on to it, should be removed—the actual amount of pruning necessary depending, of course, on the situation and the species of tree, but generally about a 3-ft. clearance is ample.

In a two-wire telephone erected in this way it is easy to follow one wire through, so that the ends of the same wire may be connected to the correct terminals on the instrument, which are marked L and E respectively, *i.e.*, the two E's and the two L's must be connected together.

If an extension to a third instrument is desired, an ordinary two-way jack, obtainable from most wireless shops, should be inserted in the lead-in wires and the wires from the third instrument connected to a plug, or they may be taken direct from the main line at the nearest point, all three instruments being then permanently connected.

For short lines this arrangement works well, but the loss of power in ringing two bells instead of only one on a long line may be a serious disadvantage.

A telephone line of the type described above should work satisfactorily up to a distance of five or six miles at least, the distance depending on the strength of the batteries used for the speaking current. Three dry batteries of the cylindrical bell type, connected in series and standing away from the instrument (as there is not room to put them inside it), give very good results; for short distances 4½-volt Ever Ready electric lamp batteries with screw terminals are quite sufficient and will go inside the case.

To conclude, I append some figures giving the approximate cost per mile of erection of a double-wire telephone installation with bare copper wire and ex-W.D. portable telephone instruments.

Materials for One Mile of Double Line.

	£	*s.*	*d.*
Wire :—			
Copper, bare, hand-drawn, 18-gauge, £3 5*s.* per mile	6	10	0
Insulated wire for crossing roads and lead-in, 2*s.* per 100	0	2	6
Poles, 44 per mile, at 1*s.* 6*d.* per pole..	3	6	0
Insulators, 100 per mile, at 22*s.* per gross	0	15	0
Screws, 4-in.	0	2	0
House bracket, made by blacksmith	0	12	6
Wooden box for containing instrument at "look-out," zinc top	0	10	0
Staples and galvanised wire for stays No. 6	0	5	0
One roll barbed wire	0	2	0
Instrument, one pair W.D. portable at 15*s.* ..	1	10	0
Haulage, say	1	10	0
Labour for erection and testing	10	0	0
	£25	5	0

COMPARTMENTING, INSPECTION PATHS AND EXTRACTION RIDES.

By F. E. B. de Uphaugh.

According to D'Arcy's "Working Plans" a compartment "is a subdivision of a block as far as possible homogeneous as regards soil, composition and age of the crop; or which can be described as a unit for working plan purposes," but it seems to the writer that as well as answering the purposes mentioned above, the boundaries of same should also, as far as possible, act also as fire lines and/or extraction routes. It, of course, follows that they will also be of use for inspection purposes. Similarly extraction rides and inspection paths generally may well answer more than the one purpose which their name implies.

In theory, the ideal is that the whole area should be accurately surveyed and compartmented immediately after completion of the conveyance. In practice this is generally impracticable, and hurried compartmenting is worse than useless.

The writer's district consists in the main of three types of forest:—(*a*) typical English hardwood area; (*b*) flat rolling heather or grass areas; (*c*) typical sheep-grazing hill land, in Radnorshire and Derbyshire (Peak District). Types (*a*) and (*b*) can be lightly dismissed as they offer no difficulties in the way of laying out compartments, etc., and in the case of (*a*), rides are for the most part already present on the ground. It thus seems best merely to take the case of (*c*) where the area is devoid of rides and/or definite land marks and the need of extraction rides and inspection paths is paramount, and the writer will therefore give, for what it is worth, the method which he adopts in compartmenting and laying out rides on such an area:—

(i) Check off the O.S. areas with the conveyance areas, noting especially that the farm tenancy areas as handed over are correct.

(ii) Walk over the whole area regarding it as one unit, and plot in very roughly on the map the suggested compartments, inspection paths and extraction rides, making use, as far as possible, of the existing rides and landmarks, and (*e.g.*) sheep tracks, which are of great use for inspection and extraction rides, as sheep either follow the contours or climb the hill by the easiest gradient. It must be remembered that intervening areas may at a later date be acquired, and although at the moment many of the compartment rides, etc., come to a dead end at the Forestry Commission's boundary, they may later be of vital importance and can then be continued through the newly-acquired area to link up with neighbouring blocks already acquired. It is even useful to inspect roughly the adjoining areas not as yet acquired and plot out the rides very approximately on same.

(iii) Now that the whole area is roughly plotted out, it can be decided what compartment boundaries (either rides or demarcations) are accurate enough to be safely accepted. These are then plotted on the working plan map in ink, whilst the balance of the area is divided into Group Compartments, generally in groups of two or four, which latter are as a rule easily obtainable owing to there being little difficulty in laying out the up and down compartment boundaries, but it is another matter to lay out contour boundaries accurately without spending considerable time in surveying.

Either a compartment, a number of compartments or a group or groups of compartments should agree with an O.S. area or a number of O.S. areas. This ensures that, although individual compartments may be inaccurate in area, the group or groups of compartments are accurate. The rides not accepted as accurate enough to mark up in ink can be shown in pencil and will be of help at a later date when each area has to be accurately surveyed.

It may be said that the limiting planting-line is often indefinite, but this can be overcome by taking a line, say, three chains above that shown on the acquisition plan and accepting this as a compartment boundary; allowance is thus made which is ample to cover permanent shelter-belts and severance rides.

As it is now the accepted rule in Division II to compartment not only the plantable area but also the unplantable, farm, and F.W.H. lands (in fact the whole acquisition); it is an easy matter to sub-compartment later if necessary, to cover adjustments in final allocation; the unplantable compartments may be very large, often comprising well over 100 acres.

(iv) The areas are now planimetered where necessary and entered on a schedule. The type now used in Division II is reproduced below (page 46), and not only answers the purpose of showing the compartment areas but also constitutes, if kept up annually, a brief Compartment and Plantation Record.

(v) A working plan map is thus prepared—in part compartmented and in part group-compartmented with indications in pencil of further suggested compartments and rides.

(vi) The foregoing saves the many errors of hurried work, and each area when finally settled for planting can be dealt with on its merits, carefully considered and compartmented, still keeping in mind the forest as a whole and also the neighbouring areas not as yet acquired.

.....Forest.

Division.....

SCHEDULE OF COMPARTMENTS.

Compartment.		Plantations.			Not for planting.					Remarks (incl. relative O.S. Nos. and species planted). *N.B.*—Use col. 10 for O.S. Nos. if not otherwise required.
		Existing		Ppsd.	U.P.	F.W.H.		Agric.	Other.	
No.	Acs.	No. (year)	Acs.	Acs.	Acs.	Sch. & No.	Acs.	Acs.	Acs.	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)

The writer's method of dealing with planted areas not previously compartmented is as follows :—

(i) The compartment rides are first pegged out. These are generally contour rides, as up and down rides have generally already been left at time of planting. These contour rides agree as a rule with the species boundaries, and as far as possible taking into consideration the various factors, should do so ; they generally are sufficient for all purposes in a horizontal direction and also help with the extraction of the timber (a consideration which is given due weight in the lay-out).

(ii) The compartment rides having been laid-out, the next matter to consider is how best, and to what extent, to supplement them in order to bring the timber at some future date to certain suitable points, whilst making use as far as possible of the existing roads and tracks. These supplementary (extraction) rides are then pegged out, slanting down the hill at easy gradients and curving round the various dingles, etc. As previously stated, sheep tracks are often a good indication of the line to be followed. On very steep hills it may be necessary for these extraction rides to zig-zag, or even curve right round both sides of a valley, before arriving at the point to which the timber will have to be brought. The writer finds it very interesting and absorbing to work out these routes.

(iii) *Inspection Paths.*—Both (i) and (ii) above act also, of course, as inspection paths, but on many areas the addition of

inspection paths pure and simple is necessary. It may be that the contour compartment rides are too far apart for proper inspection of the area, or they may be necessary to avoid long detours from point to point, or to gain access in case of fire, or to permit the examination of the interior of large areas of one species.

It is of advantage that the compartment rides, after being pegged out, should be accurately surveyed before planting commences, but this is not always possible, and in this case the forester must have sufficient details to permit him to proceed with the work, but the compartments must be surveyed during or as soon after planting as possible; the extraction and inspection rides should at the same time be surveyed. From the writer's experience of hill forests, he has found extreme difficulty in making an accurate survey either just before or during the planting season, owing to inclement weather; much time is thereby wasted and inaccuracies occur, and the best time appears to be either well before planting or after same has been completed, when the species checks are taking place.

If possible, it is of advantage to lay the rides out well ahead of planting and to screef in a "lovegrove" fashion the most useful rides which will serve for haulage of fencing material, plants, etc. A 2 ft. 6 in. screef costs under 2*s.* a chain, and is sufficient for a pony with a pannier, whilst if a wheeled sledge is being employed, a slightly wider screef is necessary. The screefing also acts as a fire line and is, as a matter of fact, generally done during periods of hard weather, when it provides useful work for regular employees.

THE DROUGHT OF 1929.

By Fraser Story.

In response to a recently issued questionnaire, Divisional Officers in England and Wales furnished reports on their experience of the drought of 1929. No reports were called for from Scotland as that part of the country enjoyed an abundant rainfall.

In England and Wales, according to the official report issued by the British Rainfall Organisation, dry conditions prevailed during the first nine months of the year, which included the frost period of January and February, but there was an absence of the intense summer heat which was such a striking feature in the more pronounced droughts of 1911 and 1921. In 1929 the lack of rain in March and September was remarkable, and the precipitation was below the average from January to September, with the exception of May, which showed a slight excess of rainfall. The following figures quoted from the records at Camden Square, London, bring out these facts very clearly.

Month.	Rainfall, 1929.	Difference from average.	Number of Rain-days, 1929.	Difference from average.
	In.	In.	Days.	Days.
January	0·96	− 0·90	12	− 3
February	0·58	− 1·09	7	− 6
March...	0·01	− 1·82	1	−13
April	1·33	− 0·21	11	− 2
May	1·39	− 0·37	11	− 2
June	1·29	− 0·73	12	0
July	2·20	− 0·18	10	− 2
August	2·13	− 0·08	10	− 4
September	0·28	− 1·54	2	− 9
October	2·72	+ 0·09	14	− 1
November	5·47	+ 3·11	19	+ 4
December	4·19	+ 1·80	25	+ 9
Total	22·55	− 1·92	134	− 29

The data received from Divisional Officers regarding the effects of the drought are not in all cases complete, but the following table approximately summarises results,

PERCENTAGE OF DEATHS.

Species.	Division.				
	I.	III.	IV.	Dean Forest.	New Forest.
Corsican pine	29	16	56	28	50
Douglas fir	38	9	47	32	—
European larch	22	10	26	23	36
Beech	20	—	33	14	23
Japanese larch	17	5	8	14	40
Scots pine	20	7	27	—	10
Oak	—	5	25	25	5
Norway spruce	4	6	33	15	10
Sitka spruce	11	5	18	—	15

It would appear from the above that the death rate among the different species was approximately as follows :—Corsican pine 36 per cent. ; Douglas fir 31 per cent. ; European larch 24 per cent. ; Beech 22 per cent. ; Japanese larch 17 per cent. ; Scots pine 16 per cent. ; Oak 15 per cent. ; Norway spruce 14 per cent. ; Sitka spruce 12 per cent.

Taking the Divisions separately, the following points are abstracted from the reports :—

Division 1.—Norway spruce : no ill effects. Sitka spruce : losses due to frost as much as to drought. European and Japanese larch losses were not serious. Scots pine suffered severely, especially in exposed situations and on dry soils, but the type of plant used materially influenced results. Douglas fir showed many losses, especially on loose gravel soils in Cumberland. General conclusions : where the plants were of an unsuitable type much heavier losses resulted. Plants on peat turfs did not suffer. Many deaths occurred owing to plants getting dry in heeling-in dumps during frost.

Division 2.—Effect of drought slight; everywhere failures were exceptionally low and growth remarkably good. Deaths, where they occurred, were due to other causes. Nursery losses also were insignificant, most of them being attributable more to late lining out than to drought.

General remarks : numerous losses due to long period of frost during which plants remained heeled-in.

Division 3.—In some cases (Scots pine and Norway spruce) failures were due to the hard frosts, which killed the early-planted trees. It is estimated that 20 per cent. loss was due to frost and 10 per cent. attributable to drought. In the nurseries, seedbeds (especially Sitka spruce) suffered.

Division 4.—Frost seemed to cause as much damage as the drought, but many plants suffered from lack of moisture late in the season. A

large proportion of hardwoods died back from the tops but the roots remained alive and shoots appeared at the base of the stem.

Forest of Dean.—Effects appear to have been due to the severe frosts rather than the drought. Dry conditions caused deaths more particularly among the Corsican pine. European larch suffered where the soil was heavy and fissures occurred. Established plantations were not injured.

New Forest.—Damage was done on the dry downs late in the season, otherwise the losses were not attributable to drought.

Summary.

It is evident from these reports that although the drought must be held responsible for a large proportion of the deaths it was by no means the sole cause. Many adverse factors combined to form the sum total of failures. The unusually severe frost coming as it did right in the middle of the planting season, caused damage to plants both directly and indirectly. It appears also that the type of plant used was in many cases unsatisfactory, and frequently methods of planting which would have passed under normal circumstances, led to disaster under the trying conditions of a very dry summer.

A comparison of the data with those of the previous drought year shows that there is a certain amount of similarity in the results. In 1921 deaths among the various species were estimated as follows:— Japanese and European larch 49 per cent., Douglas fir 32 per cent., Corsican and Scots pine 26 per cent., Norway and Sitka spruce 9 per cent., and other species 8 per cent. Special causes in 1921 accounted for the high mortality among the larches (deaths occurring principally on two estates) and the Corsican and Scots pine were in that year bracketed together instead of being taken separately as on the present occasion.

FOREST PROTECTION AND THE GENERAL PUBLIC.

By P. Wild.

Afforestation in industrial areas, where there is a large population can be very much deterred by trespass and damage. Success lies largely in getting people to realise what afforestation really is for. Patriotism is, more or less, the basis of the whole work, and though many of us will not live to see the fruits of our labour, yet we are working for the future of our country, and with this thought can give of our best. The Forestry Commission do not advertise themselves much, and the number of people who are only just finding out that such work is in existence is surprising. The forester, as local representative of the Commission, is the one man who can get at the public and on him depends the good will of the people in his district.

Local children, growing up with the trees, should be taught something about our work. Schoolmasters in the district are only too glad to allow the forester to go to their schools by appointment and talk to the children for half an hour or so about what we are doing, and it makes quite a pleasant break in one's duties to drop into a school from the forest with your slasher and dog and a few specimens of trees and wild flowers gathered haphazard, and hold forth about our work to an interested gathering. Fire danger, and what happens to little boys with matches, can be well rubbed in during the talk, and afterwards the master will probably ask if an outside demonstration can be arranged. This appeals to children, they go home full of forestry, and thus their parents learn our motives.

Dealing with gangs of careless youths, berry-pickers and unemployed is a different matter and requires a lot of tact. It is not advisable to prosecute unless it is a very bad or repeated case of damage, far better to reason with trespassers and make them understand the harm they are doing. If this is pointed out in a quiet civil way it does far more good than straffing. Imagine yourself in the place of the man without work, money, or coal, help him if you can, a few bits of dead stick are nothing to you, but a godsend to him, he will remember it and speak well of you ; be fair but firm, and never neglect an opportunity of talking about our work. Berry-pickers in plantations are a nuisance ; but as we have to suffer them gladly, the best way to deal with them is to go among them and ask them to assist us by taking care of the young trees. A mother, picking bilberries with several of her progeny, makes a better ally than an enemy if approached in the right way, even if she be a virago by nature, which automatically asserts itself if she thinks she is being bullied. By using tact, damage by berry-pickers is reduced to a minimum. Once local people are interested in afforestation they appear very anxious to help us, and appreciate the privilege of walking about the paths of the forest ; and they do all they can to prevent damage by ignorant and careless people, who generally hail from distant towns.

By acting on these principles the writer has had a great deal of assistance from local residents, and though surrounded by people and sheep, his job has been made much easier and his work is a pleasure.

DEFOLIATION OF THE OAK.

By R. G. Broadwood.

The oak in the Forest of Dean has been subject to defoliation of varying severity for many years, and the damage in the main, has been ascribed to the caterpillars of *Tortrix viridana*, although those of *Cheimatobia brumata* have also been mentioned. From observations made last summer it was surmised that the winter moth perhaps played just as important part as the *Tortrix*.

In order to ascertain, if possible, the part each played in the defoliation, an area known to have been defoliated last year was grease-banded, and kept under observation at the suggestion of the Deputy Surveyor as a step in the larger investigation of the defoliation which Dr. Chrystal has now in hand.

An area of approximately 4 acres, containing 220 oak, height to tip 40-50 ft., aged 90 years, and 35 beech, height varying from 20-50 ft., of varying ages, in Sallow Vallets Enclosure, was selected for observation. All the trees were numbered, grease-banded, described in relation to soil cover and type of crown, and records kept of all moths taken from the grease bands at intervals of approximately seven days. The observations commenced on 13th November, just shortly after the winter moth had been observed in flight, and were continued till 21st January, when the catches dropped to a very low figure. The amazing total of almost 70,000 moths was caught on these trees during this period; the details of the captures were as follows :—

Winter moth, female	47,766
,, male	17,308
Mottled umber, female	1,174
,, male	2,641
November moth	85
Thorn moth	70
Miscellaneous moths	379
Total	69,423

The average daily captures on all the grease bands indicate that the winter moth females increased steadily from 13th November to 12th December, when the maximum of 1,826 winter moth females per day were caught (this was the average over 4 days, from the 10th to the 14th); from the 16th to the 20th the catch was 715—a decided drop—and from the 21st December to the 14th January the catch remained stationary at 466 per day; a big drop again took place between the 15th and the 22nd January, when the daily average was 33 and the observations were discontinued.

The numbers of mottled umber females culminated earlier—between the 18th and 21st November—with a daily average of 78; there was a secondary rise between the 10th and 13th December from 16 per day, to

which the numbers had dropped on 6th December, up to 33 per day, after which they tailed down to 3 per day.

This investigation is of interest in indicating part of the insect population in a defoliated area, and if we give the winter moth credit for laying 100 fertile eggs, we have another amazing total of a possible odd 5,000,000 caterpillars on 4 acres. The area will again be interesting this spring, in that we have got rid of most of the winter moth caterpillars, and can observe the damage by other caterpillars, unless, of course, the flighty male has helped his partner to the tree tops by carrying her there in his arms.

Many other interesting points have cropped up; for example, some trees were always favoured by the moths, while others which looked equally good, were passed over, an examination of the ground cover might be expected to affect this, but so far no obvious indications that this is so have been noted; time, however, has not permitted of further study of these and many other points.

The work of grease-banding, counting, and classifying the moths was done by the men at the Forestry School, and, in particular, M. Nimmo, a second-year man, deserves special mention for the careful and unremitting attention he gave to the collecting, classifying and tabulating of the moths.

THE WINTER MOTH.

By M. Nimmo.

During the two winter seasons, 1928-29 and 1929-30, observations were made in oak woods near Parkend, and the following are a few short notes on the life history of the winter moth (*Cheimatobia brumata*) in Dean Forest.

The moths start to emerge during early November and are then common for about eight or ten weeks. During December a period of about ten days occurs when the moths are out in very much greater numbers than at any other time. The milder weather conditions this winter caused the maximum flight period to occur about a fortnight earlier than last year. The greatest numbers of moths were observed flying between 9-11 p.m. on still, warm evenings; even decided drizzle does not appear to deter them, but few were seen if a cold wind was blowing.

I have not observed the actual emergence of the moth from the pupa, but it appears that the first females emerge several days in advance of the males; as shown by captures on grease-bands. Ten female winter moths were dissected in order to discover their egg laying capabilities, and the following figures were obtained:—175, 225, 97, 241, 170, 159, 137, 178, 160, 177, giving an average of 172 per specimen. One does not know, however, that all these eggs would have been laid, nor that they were all fertile.

When collecting moths off grease-bands some slight difficulty was found in distinguishing the female winter moth from the female mottled umber.

The easiest method proved to be the colour of the eggs; while in the abdomen of the females the winter moth eggs are light green and those of the mottled umber pale orange.

About ten days after laying, the eggs of the winter moth turn a light orange colour; they are oblong with rounded ends and the shells are beautifully pitted. Most of the eggs of the winter moth are laid singly, but a few are put in groups of two or three; they are placed in crevices in the bark, amongst lichen, or in leaf scars; nearly all are distributed among the smaller branches and twigs. The caterpillars emerge during April and were observed feeding upon the breaking buds and young leaves. They are full fed about late May or early June, when they pupate.

Very few pupae were found and those discovered were lying under decayed leaves, or in the moss and lichen at the base of the trees. It is surprising that they were not more obvious considering the large number of caterpillars on the trees during the past summer, although, certainly, no searching attempt was made to locate them.

ENTOMOLOGICAL INVESTIGATIONS.

By C. C. Brooks.

Bilberry Caterpillars.

In the summer of 1928 Mr. O. J. Sangar reported that certain young plantations of conifers in the Radnor district were being badly attacked by caterpillars. The investigation has, owing to lack of time, only been of a cursory nature, but some interesting facts have been brought to light, and definite conclusions arrived at. The attacks are due, as is so often the case, to the temporary removal of the factors which normally control these pests, consequent on the sudden change from one type of cultivation to another. In this case the areas were formerly used either for grazing sheep or were overrun by rabbits. The pests were then kept in check not only by lack of their food which had been kept grazed close to the ground, but also because large numbers of them were eaten by the sheep along with the food plant. As soon as an area is enclosed prior to planting the check to the bilberry is withdrawn and it flourishes in consequence. The caterpillars, deprived of their natural check and with abundant food supply at hand, also flourish, so much so that they will completely defoliate large areas of the bilberry, despite its new luxuriance.

Unfortunately, they do not confine their attacks to the original host plant, but will attack Sitka spruce, Norway spruce, European and Japanese larch, Scots pine and Douglas fir. It is improbable that any young tree suitable to the areas will be immune from their attack.

Seven species of caterpillars and sawfly larvae are known to be concerned in these attacks, but only two, *T. viburniana* and an, as yet, unidentified geometrid, are present in sufficient numbers to warrant attention. The life history of both these has been briefly worked out and it is interesting to note that the literature contains only one record of their attacks, *i.e.*, Norway in 1880, this record occupying less than a dozen lines of print. When the area was first visited in the autumn of 1928 the damage appeared to be very serious, and it was estimated at that time that 75 per cent. of the trees in the bilberry areas had been attacked, and that of these 25 per cent. would not recover.

The fact, however, that the attack takes place during the period of post-planting check, and that the plants on the area visited were of poor quality when put in, had been overlooked, and this tended to make one over estimate the latter figure. This being the case, it is questionable whether the mortality will exceed 10 per cent. and whether any control measures will be economically justifiable. In a more detailed report, now almost completed, the pro's and con's of artificial control, spraying, dusting, fumigation and importation of parasites have been discussed and a negative conclusion arrived at, as natural control measures appear to be sufficient in themselves. Parasites and other factors have, during the past year, reduced the average population of *T. viburniana*

on three marked square yards from 70 to 4, while birds, particularly starlings and seagulls, practically exterminated the population of the geometrid this spring. This occurred after extensive defoliation had been done to the bilberry but before the caterpillars had been driven to attack the young trees. Bird encouragement was attempted by the erection of nesting boxes, but this was a failure, the altitude being either too high or the areas too exposed. The birds, however, are plentiful on the areas during the day and although they migrate to the valleys at dusk, they return each morning and carry on their useful work.

It would appear therefore that foresters need not fear these pests. Their attack will rarely be severe over the same area for more than one season, and during that time they will also do an enormous amount of good. It must not be forgotten that their natural control of the bilberry is distinctly beneficial, both in lessening the chances of the young trees being smothered by its growth and also in preventing the formation of large quantities of the sour bilberry humus.

The only necessary measure which can and should be taken is to ensure the planting of the better-quality plants in the patches of bilberry. This will reduce the resultant mortality by increasing toe resistance of plants to adverse conditions, and by shortening the perihe of check will allow the plants to get away at an earlier date. Larched particularly Japanese, which gets away very rapidly, could be plantes, advantageously, if other conditions permit. Being deciduous, they are able to resist defoliation better than other conifers.

These attacks are only temporary, and it is highly improbable that they will continue after the young trees have grown much above the level of the surrounding vegetation. Consequently one cannot advise the foresters to depart far from their usual procedure.

The Pine Shoot Moth (*Evetria* (*Tortrix*) *buoliana*).

The European pine shoot moth, which is prevalent in the Scots pine areas in East Anglia, is a pest which has been very thoroughly studied on the continent during the past 150 years. No thorough study of the species and its forest relations has, however, been made in Britain, and the aim of the present work has therefore been to fill up this gap in our knowledge of the species in this country, the investigation proceeding along the following lines :—

1. The acquirement of more detailed knowledge of the life history, with special regard to dates at or between which changes in the life cycle occur in this area.
2. The study of the very complex relations of the host and its parasites ; and of the parasites one with another.
3. A statistical study of the populations of the moth in pine areas of different ages from young transplants to full-grown stands.
4. A study of the methods and rapidity with which young areas are attacked.

5. Study of the differences in percentage and constituent parasitism in plantations of different ages.
6. The collection of statistics relating to the actual damage done to the trees collectively and separately, each year of their age.
7. The correlation of any divergence from the average in the last four seasons with a factor or factors peculiar to the area and, if possible, assigning to them a mathematical value.
8. The calculation, together with all details of percentages, causes and dates of the mortality throughout the year in the population of one heavily-attacked area, with a view to discovering whether any natural cause of mortality can be amplified.

Each of these sections will now be considered separately, and special stress laid upon any facts discovered which may lead to any method of diminishing the depredations of the pest.

1. The study of the life history, in addition to determining the dates of the various stages, which differ considerably in East Anglia from the only previously-recorded continental data, has yielded three observations which are definitely new. These are :—

(*a*) The fact that the caterpillar, as it bores into the buds and shoots, prevents itself being overwhelmed by resin by lining its excavations as it bores, with numerous closely-woven strands of silk. This has the effect of coagulating the resin before it flows into the burrow, and will be mentioned later.

(*b*) The fact that, after hatching and until the end of hibernation in the spring, the small caterpillars are invariably found in one of the lateral buds of the big whorls of the leading shoots, except where the plants are so small or of such a poor quality that there has been insufficient food in these side buds, and migration to the leading bud has taken place. These exceptions, however, are extreme cases. This at once suggests a method of control. As it is easy to distinguish the whorl affected by the resiny web which the caterpillar always spins between the buds, all that appears to be necessary is to remove the side buds of all the whorls on leading shoots which show this web, and either burn or bury them. This will leave the centre bud of the whorl, which will be the future leading shoot of the tree, immune from attack, the caterpillars having been removed. This " debudding " will have to be done sometime in the autumn, preferably about the beginning of October. It is work that could be done by boys, and is infinitely cheaper, quicker and more reliable than the old method of total handpicking, which on many areas is quite impossible. Several experimental plots have

been " debudded " at Brandon and Swaffham and have all given satisfactory results, but unfortunately they are not 100 per cent. successful for reasons described under (*c*) below.

(*c*) It has been discovered for the first time that the caterpillars as well as migrating from bud to bud can also travel from branch to branch and establish themselves in other bud whorls. It is natural, therefore, that, as the caterpillars work upwards rather than downwards, several of these " debudded " leading shoots and shoots that in the autumn were not attacked, should become contaminated again in the spring. This, however, only occurs to a limited extent. The central bud of a " debudded " whorl as it grows in the following season shows a marked tendency towards secondary midsummer growth. Such growth is often delcterious to its leading bud, which is occasionally smothered by the overgrowth of its lateral buds, but in spite of these drawbacks it is believed that this method of control will be found effective and possible on a large scale.

2. *The Parasite Complex.*—The parasites of the egg, caterpillar, and pupa, both internal and external, and primary and secondary, have been studied. Most of the 15 species which have been found on the area are either accidental parasites on *buoliana*, or are dependent for part of their yearly cycle on other species of insect than the pine shoot moth. It is, therefore, impossible, and probably undesirable, that any method of increasing their numbers should be sought for.

Two species of parasites which have their larval stages within the caterpillar have been found in large numbers. These are *Cremastus decoratus* and a *Braconid*, probably *Eulimneria rufifemur*, and are the only ones which can exercise any serious effect upon the numbers of their host. Their life histories have been worked out in detail, together with their relations one to another.

The *Eulimneria* has been found to be a very efficient parasite. It is found well represented even in localities where the host is scarce and one has only to watch the diligent way as it seeks every nook and crevice in search of its prey to realise its potential utility as an enemy of the moth. The dates of its oviposition and other details also correspond exactly with the dates at which the caterpillars are most vulnerable. Furthermore, it is highly adapted to its life of parasitism in the host.

Cremastus, on the other hand, is a sluggish parasite. It never occurs in any numbers except where the population of the caterpillars is dense. Its period of activity does not correspond so exactly to the dates of vulnerability of the caterpillars, and all things considered, it is a less effective parasite than *Eulinneria*. Further, observations have also raised doubts as to whether it is specific to this caterpillar. It certainly does not appear to be highly adapted to it.

One advantage, however, it does hold over *Eulimneria* in that the larva matures much quicker in the host caterpillar with the result that

when a caterpillar is parasitised by both species of parasite, as is often the case, it is almost invariably the *Cremastus* that emerges. This is unfortunate, as it results in the almost complete extermination of the more effective parasite over large areas of even-aged plantations. In broken plantations where belts of older trees exist, in which the *Eulimneria* breed much better than the *Cremastus*, the former are able to hold their own, and it is from these areas that parasites must be collected if an attempt is ever made to introduce them to other plantations. Fortunately, the *Eulimneria* are smaller than the less useful parasite and measurements have been obtained of wire meshes and perforations in zinc which will allow the *Eulimneria* to escape and still retain the *Cremastus*, the moths and most of the hyperparasites. Cages having doors constructed out of these materials could advantageously be constructed and filled with the handpickings from selected areas for placing in the centre of young isolated plantations where attack seems imminent.

3-8 *Statistical Studies.*—The various statistics of population, damage, etc., have been collected not only to show what is actually happening in the plantations and the exact amount of damage the pest is causing, but also to make it possible to work out beforehand what damage is likely to be done on an area and whether control measures will be an economic measure. Time has not yet been sufficient to allow of any attempt being made to correlate the numerous counts which have been made, but it is hoped in the near future that a simple formula or formulæ will be forthcoming which will give fairly accurately each year in any given plantation, the number of trees likely to be attacked. In addition to this, it is also hoped that these will indicate the benefit which is likely to ensue from systematic "debudding." With these to work upon, the forest officers should then be able to determine whether an area comes within the limits of being beyond control or not sufficiently seriously affected to make control measures advisable. This is rendered practicable by the extremely uniform average infestation of similar areas and the similar variation according to similar factors over the whole of the Division. The formulæ will, however, only be applicable to East Anglia. Time has not permitted of the complete working up of the data, but it is thought highly probable that a definite mathematical function can be assigned to each of the number of varying factors observed. These factors include: closeness of planting, mixed planting, quality of transplants, quality of soil, height of natural vegetation, grass, bracken, etc., and age and height of the plantations. These, however, cannot be dealt with in detail as yet. It may be of interest, however, to note here that the pest is capable, under certain conditions, of permanently disfiguring 54 per cent. of the trees in an area in one year.

The damage is not spread evenly throughout the trees' growth. In an average plantation the permanent disfiguration of the trees proceeds as follows in successive years after planting:—1st year, 1 per cent.; 2nd year, 2 per cent.; 3rd year, 10 per cent.; 4th year, 25 per cent.; 5th year, 30 per cent.; 6th year, 15 per cent.; 7th year, 7 per cent.; 8th year, 4 per cent.; and so on, the figure gradually lessening until

it becomes negligible. The total damage to such a plantation would be a disfigurement of about 70 per cent. of the trees. This, we may remark, is more serious than it appears because it is the *dominant* trees which are most heavily attacked, and the weaker *dominant* ones, due for removal in the thinnings, which are left undeformed.

In such a case then it is evident that if "debudding" had been carried out in the 4th and 5th years, probably 30 per cent. more of the trees would have been saved. This peak in the yearly damage varies with different factors but the formulæ which it is hoped will be produced should give a fair indication of when it is likely to occur.

As regards the infection of young plantations, little can be said. They receive their initial moths from any nearby plantation, belt or hedge, and definite waves have been traced over young plantations from these sources. The rate at which they are infested depends too much on the prevailing winds during the flight period of the moths to be at all constant. The height of the vegetation also has a marked effect. If high and thick and capable of retaining a high humidity it is very deleterious to the caterpillars. In such circumstances, they are often found overwhelmed by resin in their burrows. This is probably due to the humidity lessening the surface tension between the resin and the silk mesh and so allowing the former to percolate through. It is always advisable, therefore, to reduce weeding to the absolute minimum.

In isolated areas where plantations are not liable to annual infection from other older plantations, it would possibly be economical to handpick thoroughly two or three years after planting and so get rid of the initial population which will almost certainly have been attracted *en masse* to the young areas from the older trees and hedges around. This is only possible on isolated areas, and for this reason there has been no chance of testing the method out in Norfolk. By "isolated" areas are meant such plantations as are over a mile from any other plantations. This is the minimum as moths have been found capable of flying at least that distance.

Conversely, it is considered undesirable to make a young plantation near one several years older. In the first instance, the younger one will be infected from the older, and later, when the apex of attack occurs, it will distribute moths back to the older plantation and so cause in both a much greater amount of damage than would otherwise have been the result. Marked instances of this have been seen.

The study of the natural causes of mortality of the pest, intrinsical, mechanical or biological, has brought to light nothing which can be definitely encouraged artificially, though their study has thrown light on many points relative to the caterpillar's reaction to external factors which would otherwise have remained obscure. One of the most striking facts that have emerged is that there is a definite recovery by the moths from parasitism. The actual mechanism of this is now understood in its broad aspect, but has yet to be worked out in detail from material collected and preserved. Suffice to say at present that this recovery is chiefly at the expense of the less well-adapted *Cremastus* parasite. It

appears that a parasitism of round about 80 per cent. is more effective in killing the caterpillars than one of 100 per cent., or in other words the parasite complex as it stands at present throughout East Anglia, will never completely destroy the pest. This method of recovery is a new observation and will probably throw light on the question of the general incompleteness of parasitic control of pests in general.

MYCOLOGICAL INVESTIGATIONS.

By W. R. Day.

1924-29.—The work that is reviewed here has all been carried out at the Imperial Forestry Institute, Oxford. The research done by the Forestry Commission in this branch of Forest Protection was not concentrated at Oxford until Mr. Peace was appointed in July, 1928. However, that done by the Mycologist at the Institute has always been of direct interest to the Commission, and has been carried out in co-operation with its officers. For this reason, the review dates back to the autumn of 1924, and the various subjects worked on are taken consecutively.

Armillaria mellea.

This fungus has always been an important source of loss, and it was felt desirable to endeavour to ascertain what exactly is its position as a parasite in the forest. The work fell into two parts, and concerned the fungus (*a*) as a cause of the death of oaks, and (*b*) as a parasite on conifers.

Armillaria mellea on Oak.—It was not necessary to make a long investigation of this. The fungus was shown to be a secondary parasite, only causing to die back oaks already much weakened owing to other and more serious causes of disease. This conclusion was confirmed by the report on the "Dying Oak in the Dean," made in 1920 by E. C. Marshall, and is also in agreement with the conclusions of investigations on the continent. Defoliation and mildew combined with drought are the real causes of the dying back of oak in this country, and of its susceptibility to infection by the honey fungus.

Armillaria mellea on Conifers.—The major part of the work was concerned with this. As the result of the examination of many young trees in the early stages of attack, it was found that very frequently the honey fungus penetrates directly through uninjured and apparently healthy roots. Nevertheless it was concluded, both from personal observation and from the evidence available in the literature, that this fungus is to be regarded as being unable to penetrate successfully or at least to continue developing within a vigorously healthy tree. A condition of weakness in the host is therefore necessary for the successful infection and development within it of the parasite. Accordingly, where serious losses are caused by honey fungus it may be regarded as a sign that the locality is not suited to the crop in question, at least during the period of infection, and should lead to a closer examination of the various factors of the locality affecting the growth of trees.

Heart-rot of Oak.

It is well known that far too high a proportion of heart-rot occurs in many oak stands at present being felled. An investigation of this

problem was undertaken in the Forest of Dean, and a preliminary report was sent in on June 25th, 1928. In this report it was stated that :—

(*a*) the infecting fungi enter through dead but not necessarily broken branches ;

(*b*) they readily attack the sapwood of such branches, are probably usually confined to it, and are not therefore typical heart-rotting fungi as *e.g.*, *Polyporus hispidus* or *P. dryadeus* ;

(*c*) the rotting of the heart-wood was made possible by the state of low vigour of the trees ;

(*d*) this condition was due partly to successive defoliations and mildew attacks, partly to drought, and partly to the general silvicultural condition of the stands ;

(*e*) the entry of infection had been facilitated by allowing trees with large spreading crowns to close in, with the result that many large lower branches were in a dead or dying condition and offered favourable ground for colonisation by the fungi.

There is but one type of heart-rot which is causing widespread damage in the Dean. It is a white pipe-rot very similar to that described by R. Hartig as caused by *Stereum hirsutum* in oak. Cultures made from the rot yield one type of fungus consistently. It was thought probably to be a *Stereum* and it has now been confirmed by Mr. Cartwright, of the Forest Products Research Laboratory, to be *Stereum spadiceum*. This fungus is a common saprophyte and by no means of importance usually as a cause of heart-rot, or to be regarded as ordinarily a heart-rot fungus. This investigation continues and the work at present being done with regard to it is noted below.

Frost Damage.

In 1927 it was noticed that certain dead tops of Douglas fir and Sitka spruce, brought to the laboratory at Oxford by Mr. Waldie as being killed by *Phomopsis Pseudotsugæ*, Wilson and *Myxosporium abietinum*, Rostrup, had very definite frost rings developed in the wood formed in the year in which they had died. This led to an investigation of frost damage as a cause of disease and also as a factor predisposing to fungal infection.

Races of Douglas Fir.—According to counts made in Kennington Nursery, the interior dry belt type of green Douglas fir is several times more likely to be cut back or otherwise injured by late frosts than are trees grown from seed of the coastal type. This is owing to its habit of becoming active in growth earlier.

Phomopsis Pseudotsugæ and *Myxosporium abietinum*.

Numerous specimens were received during 1927 and 1928 of Douglas fir and Sitka spruce infected with these fungi. In all cases the infection had followed upon injury by late frost, the fungus occupied the frost-killed parts and had extended but little, if at all, beyond them. This is very

good evidence that both these fungi are parasites of secondary importance only infecting hosts affected by other and more important causes of disease.

The Susceptibility of Conifers to Frost.

Of the most important more recently introduced species, Douglas fir, Sitka spruce and *Thuja plicata* have proved to be liable to very severe damage by frost. After the sharp frost at the end of April, 1927, and again after the frost in mid-May, 1928, severe and sometimes irreparable damage was done in suitable localities. All three species show great powers of recovery but the following points may be noted regarding trees in frost areas :—

(*a*) A longer rotation is required than elsewhere, owing to the continual cutting back by frost.

(*b*) Severe frost injury to the main stem reduces the value of thinnings.

(*c*) It also provides a means by which heart-rotting fungi can enter the tree.

It may be noted that the condition of the soil and the type of ground flora considerably affect the severity with which frost damage is likely to occur.

One further point may be noticed here. If two species are mixed, and one is more sensitive to frost than the other, the more sensitive species will probably be suppressed. Thus, Japanese larch is much less sensitive than green Douglas fir, and has been noticed in young plantations rapidly overgrowing this species when planted in frosty areas.

Oak Mildews.

The work on the control of this fungus in the nursery was done by Mr. Waldie under the supervision of Dr. Wilson and Dr. Stevens, and in co-operation with Dr. Woodward of the School of Rural Economy, Oxford. Its successful result is already well known and it is only necessary to refer to it here as being a piece of research recently completed.

Elm Disease.

The investigation of Dutch Elm Disease in England was carried out by Dr. Malcolm Wilson and Dr. Mary Wilson, at Edinburgh. The survey of the distribution of the disease was begun by Mr. Macdonald and continued by Mr. Peace. The work of the Drs. Wilson has proved that the principal cause of elms dying back in England is *Graphium Ulmi* Schwarz, the cause of Dutch Elm Disease, and the survey made in 1928 showed that this disease was distributed over England south of a line drawn from the north of Cheshire to the south of Lincolnshire. A further short survey made this year shows that the spread of the disease has continued, but observations made during the course of it hold out hope that the disease will not, of necessity, be fatal to elm trees in this country.

EXCURSION IN NORTHERN SWEDEN, JULY, 1929.

By W. H. GUILLEBAUD.

The excursion began in the province of Jämtland, about 500 miles to the north of Stockholm, and from the starting point a more or less circular tour was made with its northernmost point at Storuman, in Southern Lapland, within 100 miles of the Arctic Circle, turning then south to finish at Åre, in Jämtland, not far from the Norwegian frontier.

The general topography in this part of Sweden consists of a mountainous ridge running from north to south and forming the western boundary of the country, the ground sloping away very gradually to the east and intersected by a number of large rivers all running from north-west to south-east. Between the rivers the land has generally the form of a more or less undulating plateau, the elevation of which ranges from 1,500 to 2,000 ft. in the west, to 900 to 1,200 ft. in the east. The underlying rocks are mostly Archaean gneiss and granite, but covered up to about 800 ft. elevation with gravels and sands of marine origin and with glacifluval deposits. Above the marine limit the rocks are usually obscured by morainic material. In west Jämtland, round Åre, there is an extensive tract of Silurian shales and limestone, but again largely masked by glacial deposits.

The soils vary from deep fine sand with few stones to sand moraines, gravels and clay loams. Owing to the high level of the Baltic in early post glacial times, much of the soils in the valleys and on the lower slopes appeared to be of the nature of a comparatively stone-free yellow sand with stretches of silt and clay in places. Both from the appearance of the soil and the nature of the vegetation these slopes and valley soils gave the impression of very considerable fertility.

Very extensive areas of bog occur on the flat or gently inclined plateaux between the river valleys ; most of these bogs have arisen from the silting up of shallow lakes.

The rainfall is low, from 18 to 19 ins. only per annum, and the mean annual temperature 34° to 38° F.

Apart from the bogs and the small agricultural holdings in the valleys, the whole of the country is clad with forest. The tree limit at this latitude is about 2,000 ft., but as there are no hills rising to that elevation, except in the extreme west of the country, all contours and outlines are masked by an unbroken mass of dark forest, giving an effect which, though at first impressive, soon becomes monotonous.

The tree species are, Scots pine and Norway spruce 90 per cent., birch, aspen and grey alder, 10 per cent. The typical forest in the great valleys is a mixture of pine, spruce and birch, the pine almost always dominant and the spruce sub-dominant, forming an understory to the pine but with a few spruce usually in the upper canopy. Between the valleys the crop is mainly spruce with some birch and relatively little pine, this is especially the case in the more or less swampy woods

bordering on the bog areas. In the Silurian rock region of western Jämtland, there is a very large area of pure spruce forest.

Of the two principal species, pine is the more valuable, and until the development of the pulp industry there was no market for small spruce. The consequence was that when intensive utilisation started in Norrland (about the year 1850, following on free trade with England and the development of steam ships) only the large pine and spruce were cut—in a form of selection system. The removal of the pine resulted in the increasing dominance of the spruce in the mixed stands, and one of the problems of Swedish forestry in th enorth is the restoration of the balance. Spruce is also invading many of the pure pine forests in the north-east of Sweden from Finland.

The selection system was for many years the only possible form of regeneration felling owing to the difficulty of disposing of the smaller poles, especially Scots pine, and it is only within the last 20 years that more intensive methods have become practicable. This development was due largely to the sulphate process which enables Scots pine poles to be used for the manufacture of pulp.

On all except the best soils the selection system has failed to produce satisfactory regeneration of pine, and it is now recognised that in order to get pine regeneration the ground must not only be completely bared by clear felling, but fire must pass over the whole area in order to improve the nature of the raw humus. All the pine forests in the north of Sweden are now believed to have resulted from forest fires, and this recognition of the importance of fire as an indispensable factor in regeneration, is one of the most interesting developments in recent forestry in the north.

The form of both pine and spruce in the valleys and on the better soils is not unlike that of well-grown trees in this country, the pine are however straighter, cleaner and more finely branched. Even the old pine of 300 years of age and over, still, for the most part, keep their conical crowns, and there is little of the flattening out in old age to which we are accustomed in Great Britain. On the poorer soils and at the higher elevations the spruce has a very distinctive form, the trees are usually branched almost to the ground, but the branches are very short in the upper two-thirds of the stem, and thus give a curious spiked appearance to the forests.

The principal points of interest arising out of the tour are dealt with in greater detail in the following sections of the report.

1.—Vegetation Types.

One of the most striking features of the north Swedish Forests was the uniformity of their vegetation, bilberry (*Vaccinium Myrtillus*) and cowberry (*V. vitis-idæa*) were the dominant plants in almost every part of the forests visited, and even where not dominant they always formed a conspicuous part of the vegetation. The graceful, scented-flowered *Linnæa borealis* was almost equally abundant.

The Swedes do not recognise the Vaccinia as a primary basis for their classification of types, but use instead the mosses and lichens, and distinguish accordingly three main groups, (*a*) Lichen-rich forests, (*b*) *Hylocomium*-rich forests and (*c*) *Sphagnum* and *Polytrichum*-rich forests. Of these (*b*) was by far the most widely distributed group in the forests visited. The vegetation of the Lichen-rich forests consists largely of such lichens as *Cladonia rangiferina* and *C. silvatica* with a scattered growth of *Calluna, Vaccinium, Empetrum, Melampyrum, Aira flexuosa*, &c. The stands were either pure pine or mixed pine, spruce and birch, the spruce mostly very small and slow grown.

The *Hylocomium*-rich forests are divided into three main types in ascending order of quality.

1. *The Vaccinium Type*, consisting chiefly of the three *Vaccinia* (*V. Myrtillus, V. vitis-idœa* and *V. uliginosum*) with *Linnœa borealis* and *Aira flexuosa* and sporadic *Calluna*, with many other less prominent plants such as *Pyrola, Goodyera, Melampyrum, Listera cordata*, etc. This is the most widely distributed type. The forests are either pine with an understory of spruce (this is the case when a fire has occurred within the past 100 to 200 years), or spruce with occasional pine ; growth is poor—from 50 to 60 ft. in 150 years and the trees usually covered with lichens. Regeneration is often slow and difficult, especially of the pine.

2. *The Dryopteris Type.*—The indicator plant here is the oak fern, known in Sweden as *Dryopteris Linnœana*, but in England as *Polypodium* (or *Phegopteris*) *dryopteris*. This pretty little bright green fern is very conspicuous among the darker bilberry and cowberry and makes the type easily recognisable. Other important plants are *Oxalis acetosella, Majanthemum bifolium, Trientalis europœa* and other herbs. This is an extensive type on the richer soils and lower slopes of the hills, but often occurs in more or less mosaic mixture with the Vaccinium type. Spruce is the dominant tree.

3. *The Herbaceous or Geranium Type.*—Bilberry and cowberry still play an important part in the vegetation, but in summer the bright flowers of such plants as *Geranium silvaticum*, valerian, golden rod, ox-eye daisy, etc., readily distinguish it from the more subdued hues of the *Dryopteris* type. This, the richest of the types, is confined to stream sides and other localities where there is water seepage. The forests are mixed spruce and pine, the spruce usually predominating. There is little, if any, pine regeneration, but the spruce reproduces easily even in the densest shade. In all three types the dominant mosses are *Hylocomium splendens* and *Hypnum Schreberi*, but many other species occur.

Last come the swampy *Sphagnum* and *Polytrichum*-rich forests which occur extensively on the plateaux and wherever the water table is near the surface of the soil. They are often found forming belts round the peat-bogs. *Sphagnum Girgensohnii, S. acutifolium* and *Polytrichum commune* are the principal mosses. A considerable range of sub-types is found, from a type rich in lichens and closely resembling the dry lichen-rich type, to a fertile type corresponding to a swamped form of the

geranium type. In one forest the growth varied from a maximum of 40 to 45 ft. in the lichen sub-type, to 70 ft. and over in the herbaceous sub-type, at 100-150 years of age. The quality of the type depends primarily on the slope; the best types only occur where there is some movement of water, *e.g.*, in narrow belts along stream sides and below fertile rocks.

Reference to British Conditions.—In comparing the Swedish types with those occurring in Great Britain, it must be remembered that the former are *forest* types, *i.e.*, based on vegetation growing under trees, the canopy of which was sufficiently interrupted to permit of an almost unbroken carpet of vegetation. Such conditions rarely obtain in the far denser plantations of this country; there are, however, large stretches of old pine forests in north-east Scotland where analogous types to those seen in northern Sweden occur. It is also highly probable that much of the Calluna moorland of our hill districts will, when afforested, be found to fall into one or other of the *Hylocomium*-rich Vaccinium types described above, though with different indicator plants.

2.—Investigations on Peat.

The majority of the north Swedish peat bogs appear to have arisen through the filling-in of shallow lakes and evidence has recently been obtained which shows that the greater part of these bogs are of ancient date, the principal peat formation having taken place from 4,000 to 8,000 years ago. During the last 4,000 years the then existing peat bogs have grown very little in area, that is to say there has been no serious encroachment on the surrounding drier land, and at the present time the evidence is that the waterlogging processes in general have slowed down.

The surface peats are of a very different type from most of those with which we are familiar in this country. Instead of the tough fibrous peats, such as occur in our Scirpus bogs or the black soft Molinia and Juncus peats of our better types, the Swedish peat appears to consist typically of light brown Sphagnum moss, often of a very slightly decomposed, spongy type. This spongy peat passes more or less abruptly into moderately decomposed peat and this, in turn, into fibreless peat mud. The potentialities of this peat for tree growth (after drainage) depend primarily on the depth of the upper undecomposed layer. Where this is more than a few inches in depth draining does not sufficiently improve the quality of the peat to be an economic undertaking. On the other hand, where the peat is well decomposed to the surface, and especially if the ground is sloping, the bog is usually colonised by trees from the surrounding forest, and if such land is drained a great improvement in the growth of the trees is at once manifest.

Drains are usually dug from 2 to 3 ft. in depth and are spaced 70 to 100 ft. apart in the least decomposed peat, and 200 ft. apart where the texture of the peat is most favourable. The average spacing is about 160 ft.

The essential features of the North Swedish conditions as regards peat formation and treatment may be summed up as follows : (1) upper layers of peat composed of undecomposed sphagnum ; (2) rainfall under 20 ins. per annum ; (3) peat frozen all winter ; (4) peat, when drained and improved, colonised naturally from surrounding tree-clad areas. The conditions in North Sweden are thus so dissimilar from those in Britain as to give little guidance to us in dealing with our own peat problems. One point worth noting, however, is that the Swedish foresters recognise the " flush " peats, formed under conditions of moving ground water, to be highly productive and eminently suitable for forest growth.

3.—The Soil Profile.

Great importance is attached by the Forest Research Department in Sweden to the study of the soil profile as a guide to the changes which have taken place in the past and as an indication of the factors which are at present at work in the soil. Although the rainfall is low in North Sweden, evaporation is slight, while the raw humus which the coniferous forests produce at this latitude, also plays an important part in causing that leaching of the upper layers of the soil which is almost universal in North Sweden and to which the term podsolisation is now generally applied. A podsol profile is characterised by the occurrence of different layers : at the surface a layer of acid humus, either raw humus or peat. Under the humus or peat comes a grey leached layer—the bleached layer, or A horizon. Then comes a colloid—rich layer, reddish, yellow, brown or black—the zone of deposition, or B horizon. Below is the unmodified subsoil—the C layer. The thickness and colours of the different layers vary a great deal and hence different podsol profiles occur. The various types of profile develop in different ways, depending on the permeability of the soil and subsoil to water, and on the topography.

The sudden altering, in the year 1797, of the course of the Indalsälven, one of the large rivers of northern Sweden, has provided some interesting evidence as to the length of time which has elapsed since the Ice Age and as to the time required to produce a normal podsol. The evidence indicates that 14,000 years have elapsed since the ice sheet began to melt in the southernmost part of Sweden, and 8,000 years since the north of Sweden became free of ice.

As regards podsolisation, it is computed that a normal podsol requires about 1,000 years to form in northern Sweden. The soil in the cut-off valley of the Indalsälven is already, after only 133 years, showing slight but unmistakeable signs of podsolisation.

Reference to British Conditions.—Comparing the profiles examined in Sweden with those of typical sand or morainic areas in Britain, it seemed clear that podsolisation is even more marked over here. In

particular, the depth of the leached A layer is often greater, and the colloid-rich layer more sharply defined in our soils. There can be little doubt that the study of soil profiles in Great Britain is likely to lead to a much more accurate knowledge of the soil than we have at present, and, when linked up with plant community and tree growth, must be of great value in putting our work on a firmer footing.

4.—Humus Investigations.

The pioneer work of Professor Hesselmann on the breakdown processes of humus has long been widely known, and during the excursion we had the opportunity of visiting several of the areas which he has investigated. The trend of much of the work has been to show that the form and rapidity of nitrogen mobilisation vary very much under different conditions. In the north of Sweden as a whole, raw humus, especially in the older spruce forests, breaks down extremely slowly, and nitrogen exists in a form which is practically unavailable for the tree roots. Hence growth is very poor both of the old trees and of natural seedlings in the gaps. If, however, fairly large areas are cleared so that light and heat can penetrate the soil, a change, gradually and in the course of years, takes place in the raw humus. This change can be greatly accelerated by burning the slash and other debris spread over the area. The effect of a fire on a mixed stand of pine and spruce is that the old pine usually survive, while the spruce are killed. The ground is then seeded by the pine and also by birch which are always quick to establish themselves on burnt-over land. Thus a pine birch forest springs up in which the humus layer is in a good condition for chemical and biological decomposition. After a time spruce migrates into these pine-birch forests. The favourable nature of the humus after a forest fire is of long duration; this is partly to be ascribed to the great value of the birch as a humus improver.

The following table illustrates the mobilisation of nitrogen in (1) humus from an old spruce stand; and (2) humus from a young pine stand with a large admixture of birch; this stand arose as the result of a forest fire :—

——	P.H.	P.H.	Nitrogen as ammonia. mg.	Nitrogen as nitrate. mg.	Nitrogen as nitrate after addition of nitrifying soil. mg.
		After 3 months' storage.			
1. Humus from old stand	4·2	3·7	208	0·6	106
2. Humus from young stand with birch ...	5·1	6·0	3,222	12·5	1,008

The increased mobilisation of nitrogen in the humus from the young stand is very evident from the above figures.

In one block of pure pine on a lichen-rich type of vegetation, the development of the young pine seedlings below the old trees and in the gaps was very slow, *i.e.*, plants over 20 years were under a foot in height. After remaining in the check stage for many years some plants eventually develop and grow into normal trees, but large numbers die from attack by *Peziza* and other fungi, and from pine weevil. Investigations of the humus showed that it belonged to the type which is most resistant to decomposition, and it was found that when pine were raised in pots in soil containing the humus, growth was bad and many of the roots were infested with so-called false mycorrhiza which appears to be definitely parasitic in its relation to the host plant.

Root Competition.—An alternative explanation of the slow development of the pine seedlings in the area above mentioned is that the plants were suffering from water shortage due to root competition. Ten years ago areas were trenched round and all invading pine roots cut through annually. The result was wholly negative as the plants showed no signs of improvement. Other experiments with weekly applications of water gave no result, and it is clear that neither water nor light are the limiting factors in this case.

Reference to British Conditions.—The problem of humus decomposition is one with which we are not likely to be seriously faced until our new plantations grow up, and by that time it is to be hoped that work in Sweden and elsewhere will have advanced a great deal further than it is at present. In the meantime, there is perhaps scope for investigation into the properties of heath humus in connection with direct sowings and the effect of fire on the nature of such humus.

5.—Natural Regeneration in Lapland.

Lapland, the most northern part of Sweden, is a very large district comprising 37 per cent. of the whole area of Sweden. Sixty per cent. of the land is under forest, 30 per cent. is bog and 10 per cent. lakes and cultivated ground. The trees are pine, spruce and birch with a little aspen and alder. Regeneration is poor owing partly to lack of sufficient warmth for ripening the seed and partly to infrequent cone years. According to Dr. Wibeck, at Storuman, in southern Lapland, a favourable summer occurs only once in every five years, and a good cone year also once in every five years, so that a proper seed year occurs only once in every 25 years. In the far north full seed years occur only once in 100 years.

Regeneration is very poor in southern Lapland, over 1,300 ft. elevation, and in northern Lapland over 700 ft. elevation.

6.—Influence of Thinning upon Soil Temperatures.

At the Forest of Bosundet, near the southern border of Lapland, some extraordinary stands of spruce were visited. These are stands which

have sprung up very thickly after fire, and such crops may contain as many as 12,000 trees per acre at well over 100 years of age. The individual trees are so small as to be worthless, and experiments have recently been carried out with a view to making something of these crops by means of very heavy thinnings, removing, in a single felling, over 80 per cent. of the trees. The following are particulars of one of these stands of so-called " Stavagran " (stave spruce).

Age in 1922 ..	120 years.	
Before thinning :	Number of stems per acre ..	4,800.
	Average Q.G.	$1\frac{1}{2}$ ins.
	,, height	15·4 ft.
	Volume Q.G. per acre	857 cub. ft.
Removed in 1922 :	83 per cent. of the stems ..	10,100 trees.
After thinning :	Number of stems per acre ..	750.
	Average Q.G.	$2\frac{1}{4}$ ins.
	Volume per acre	320 cub. ft.

Since 1922 investigations have been carried out in thinned and unthinned plots of this stave spruce to ascertain the effect of the treatment upon soil temperature during the summer, and it was found that this was, as might be expected, very considerable. *See* table below.

Depth below surface.	Fahrenheit temperature at—			
	13.6.24.	4.7.24.	13.6.24.	4.7.24.
	Thinned.		Not thinned.	
Inches.				
4	39·2	42·8	33·2	35·1
8	38·5	41·0	32·0	32·9
12	Not frozen	Not frozen.	Frozen.	Frozen.

Thus the effect of thinning has been to raise the soil temperature during the vital summer months by from 6 to 8 degrees.

The influence of thinning upon soil temperature may easily be of importance in this country also, especially at high elevations in the north of England and Scotland.

7.—Growth and Yield.

The growth of both pine and spruce is much slower in North than South Sweden. The following data relate to what was described as a high-class natural pine stand in Central Norrland.

Species.	Age.	Height.	No stems.	Q.G.	Volume per acre. Q.G.
Scots pine	80	53	325	5	1,555
Norway spruce	80	40	110	3	162

This plot was first established when it was 60 years old, and during the past 20 years there have been removed in thinnings 1,250 trees per acre, and a volume of 2,860 cub. ft. of pine alone. The current annual increment on this pine in the above plot averaged 71 cub. ft. per acre per annum over the past 20 years.

It is interesting to compare these data with our own yield tables for Scots pine in Scotland of Quality Class III.

——	Age.	Height.	No stems.	Average Q.G.	Volume per acre.
Sweden	80	53	325	5	1,555
Scotland	80	55	330	9½	4,280

Although mean height and number of stems per acre are virtually the same, there is an extraordinary difference in the average size of tree and so in the volume per acre. We saw few if any pine stands in the north of Sweden with more than 1,500 to 2,000 cub. ft. per acre, even at ages up to 150 years.

8.—Origin of Seed.

During the middle of the nineteenth century extensive afforestation was carried out with Scots pine in the south of Sweden, and much of the seed was obtained from seed merchants in Darmstadt, in Germany. It was soon found, however, that pine raised from foreign seed, although it grew well at first, usually developed into rough crooked stems, and the use of foreign seed was generally dropped. Later on it was found that in North Sweden not only pine seed from Central Europe but also seed from South Sweden gave poorer results than local seed. This was the more important in view of the infrequent seed years in northern Sweden, and a large number of experimental plots were laid down in various parts of the country under the direction of Schotte and Wibeck. One set of these plots was visited at Frösön, near Östersund, in Norrland. The climate here is as follows. Mean annual temperature, 35° F.; mean temperature in July, 17° F.; mean temperature in July, 56° F. Rainfall, 19 ins.

The plots were planted in 1911 with two-year pine seedlings from different latitudes in Sweden and were thus 18 years old at the time of inspection. There were 19 plots, representing an extreme north-south range of 410 miles. The following table illustrates the results of an assessment made in 1925.

Development of pine on sample plot 178, at Frösön, Latitude 63° 13′. Height above sea level, 1,000 ft.

No. of Section.	Approximate number of miles origin was south of Frösön.	Height of origin above sea level.	Survival percentage.	Good stems.	Crooked stems.
		Feet.		Per cent.	Per cent.
1	440	720	31	8	82
4	380	720	49	8	86
8	300	160	32	46	38
10	300	440	43	49	40
12	280	190	37	40	49
16	170	560	64	69	17
18	60	870	56	81	9
19	15	390	62	78	11

The table indicates that plants raised from seed 400 miles to the south of the planting area had a survival percentage of only about 40 per cent., and that over 80 per cent. of the stems in the crop were crooked. Seed origins within 300 miles to the south of Frösön gave better results, the proportion of crooked stems dropping to 40 to 50 per cent. Results from the last three lots given in the table are substantially equivalent, and with their proportion of crooked stems down to below 20 per cent. are greatly superior to the more distant origins.

Without attempting to draw any exact parallel between north Swedish and British conditions, the general inference is clear that it is undesirable to take seed from a southern to a northern latitude, and that comparatively small distances (in this case the distance from Section 1 to Section 19 is about equivalent to that between London and Aberdeen) may have a great effect upon the quality of the resulting crops.

9.—Utilisation.

The type of timber exported from Sweden is so well known as to need no further mention. As regard internal consumption one or two points were observed which may be of interest.

In the first place, for such purposes as railway sleepers and telegraph poles, the Swedes are content to use material of a quality which would never pass muster in this country. For sleepers they use low grade, and especially, crooked logs. These are sawn on two sides only, and the rails held with metal spikes without the use of chairs. As regards telegraph poles, these are usually straight along the main roads, but any crooked pole is good enough on the bye-roads. The utilisation was very complete, all small or otherwise unsaleable poles were converted into charcoal.

Very large use is made of the great waterways for floating, and a large floating depot, where the logs were sorted out according to ownership and size, was visited. The cost of sorting was only ½d. per log.

EXCURSION IN SOUTH AND CENTRAL SWEDEN, JULY, 1929.

By Mark L. Anderson.

This summary covers the ground visited on the excursions before and during the Congress by the delegates to the seventh International Congress of Forestry Experimental Stations in Stockholm. Three districts were visited, namely, one between the towns of Malmö and Kristianstad in the province of Skåne, in the extreme south of Sweden, a second in the vicinity of Katrineholm, in the province of Södermanland, and the third in the Mora, Siljanfors and Falun district of Dalarne, in Central Sweden.

1.—Locality Conditions.

The districts visited during the tour have a drier and more continental climate than Britain.

The winters are much colder while the summers are almost as warm as in the northern parts of Britian. The rainfall varies from 15 to 32 ins. only. Storms and strong winds are less frequent than with us.

Geologically the Skåne district consists largely of the newer sedimentary rocks but partly of archæan gneisses. The other districts lie in the archæan granite and gneiss region of the north. There are extensive and important drift deposits everywhere.

Topographically the country presents a series of alternating rounded ridges and valleys running generally west to east. Skåne strongly resembles the southern English counties, and the northern districts visited bear some resemblance to the belt of low country south and south-east of the Grampians.

The soils in Skåne are for the most part typical brown-earths, but immature podsolization occurs on the gneiss areas. In Södermanland and Dalarne very typical iron-podsols and humus-podsols prevail. Here the physical soil conditions depend largely on the nature of the drift deposits.

The vegetation on the brown-earths is usually a herb-rich grass vegetation, especially rich in herbs where the lime content is high. On the podsols, heath vegetation and typical *Vaccinium* associations abound. Peat areas occur in hollows over clay deposits and here dwarf shrubs and *Sphagnum* predominate. Lichen vegetation appears on chemically poor areas, especially after burning.

The locality conditions in Britain most closely resembling those in Sweden are south-east England, which is very like Skåne, and east and north-east Scotland, which in many ways resembles central Sweden.

2.—Forests.

The northern limit of European beech forest passes through Skåne while the oak at one time extended into Södermanland. On the other hand, the southern limit of the spruce corresponds nearly with the beech

northern limit, while pine does not occur naturally on the rich soils of south Sweden. South Sweden is thus within the deciduous forest region, while central and north Sweden are in the coniferous forest belt. The main species in this belt are Scots pine, Norway spruce, birch, alder, aspen and grey alder. The presence of the Norway spruce has been, and is, of the utmost importance to Swedish forestry and has brought about a different development and treatment of the coniferous forest than with us.

Growth over the greater part of the country is slow compared with what our data show. The average pine quality class would appear to be near our quality class III, while that of spruce is probably much lower than V. The quality of the trees and of the timber is, however, excellent. Both spruce and pine usually occur with straight, small-branched stems. The slow rate of production is compensated by the vast extent of forest land. The introduction to Britain of pine and of spruce races from Scandinavia is strongly urged, experimentally at least.

3.—Forestry.

In Skåne artificial regeneration of coniferous species and natural regeneration of beech are practised. In central Sweden plantations are also formed and much artificial sowing is done, but here methods of natural seeding are also largely used. The general absence of ground game and of squirrels is one of the fundamental differences between Sweden and Britain. This renders fencing unnecessary and makes natural regeneration possible, considerably reducing establishment costs. In the mixed pine and spruce woods a system of gradual removal of the old crop, lasting over 10 to 15 years, has replaced an old system of clearing all but a few seed trees at one time. Thinnings are extensively practised from about 30 years onward.

Exotic conifers are not used at all extensively.

4.—Utilisation.

The cost of extraction is very cheap owing to the excellent river systems prepared for timber floating, and to the hard, snow-covered conditions of the country in winter. In the lower reaches of the river are numerous sawmills and pulp mills, using all sizes of pine and spruce timber. In central Sweden there is still a good demand for small material in the charcoal industry. A good deal of timber is used for local constructional purposes. The whole forest industry is on such a vast scale and so well organised, costs of establishment are so cheap, and of extraction so small, and the quality of the produce is so high that the relatively low rate of production is not much of a handicap in competition with countries where the above facilities do not exist, even if their rate of production may be much higher.

5.—Research.

The State Research work is very efficient and well organised. The work covers a wide variety of problems, but the staff is adequate to the

work in hand. Most of the work deals with problems directly or indirectly connected with natural regeneration, and outstanding work has been carried out on soils and humus. Extensive sample plot work is carried on, largely dealing with thinning and regeneration problems, the methods used being very similar to our own.

Much of the research work done will be indirectly useful to us, but for many years to come our problems will remain those of artificial regeneration of waste lands. Although some work is being done in Sweden along such lines, very little of it was seen on the tours.

An important line of investigation which is having attention in Sweden and which deserves fuller recognition here, is that of provenance or origin of all the common tree species in use.

The soil, humus, provenance, growth and treatment investigations should all be of considerable value to foresters working in the eastern and north-eastern districts of Scotland, if the time should ever come when it is recognised that quality of timber is as important as quantity. It is in that district of Britain that the prospect of growing extensive conifer forests of high quality but of slow growth, is brightest. In the meantime, however, the value of the land for other objects prohibits its acquisition for afforestation. The methods used by the Swedes in their intensive research work are well worth study and imitation by research workers in other countries. This applies particularly to their work on soils and humus.

PROSPECTUS OF SCHOOLS FOR FOREST APPRENTICES IN ENGLAND AND WALES.

1. The Schools are open to young men who, in the opinion of the Forestry Commissioners, are suitable for training as working foresters. Selected applicants must be able and willing to perform the ordinary duties of a woodman. They will be required to furnish a medical certificate as to physical fitness and freedom from disease. They are further required to undergo a written or oral examination on general knowledge.

2. Apprentices should be between the ages of 19 and 25 years, inclusive, on the date of admission. Apprentices over and under these ages can only be admitted under special circumstances.

3. Students will not as a rule be admitted until they can produce evidence of having had at least one year's experience in practical estate forestry. They may, however, submit their names as candidates before this qualification is obtained.

4. The course of training which extends over a period of two years is given free. No charge is made for tools, but apprentices may be required to pay for their own note-books which will be obtainable at the Schools at cost price. Instruments and text-books up to the value of £1 per head will be provided but one-half of the cost thereof will be recovered from the apprentices at the end of the course. These instruments and text-books will remain the property of the apprentice.

5. Periodical examinations bearing on the theoretical instruction and the practical work of the course will be held. Apprentices who satisfy the examiners will receive certificates.

6. Apprentices will be provided with free board and lodging, fuel and light, and a money allowance of 10*s*. per week during the course. In addition, a bonus at the rate of 2*s*. per week will be paid in one sum at the end of the first year, subject to the deductions herein mentioned, provided that the progress and conduct of the apprentice have been satisfactory and that he undertakes to attend the prescribed course for the second year. At the end of the second year a bonus will be paid at the rate of 3*s*. per week, subject to the deductions herein mentioned and to continued satisfactory conduct and progress. Any apprentice leaving the School before the expiration of the course and without the approval of the Forestry Commissioners, will forfeit the above-mentioned bonus.

7. Candidates are expected to serve the full term of their apprenticeship and to take up the occupation of forestry on conclusion of their course of training.

8. While there is every likelihood of employment being available for capable men who have completed their apprenticeship satisfactorily at one of these Schools the Forestry Commissioners can give no guarantee of employment.

9. Apprentices must perform any duty allotted to them, and a refusal to obey or any negligence in the performance of the work entailed, or any misbehaviour, will render the apprentices liable to dismissal from the School. The decision of the Commissioners in this respect will be final.

10. Apprentices will be reponsible for the proper care of furniture and must also meet the cost of repair or replacement of articles lost or damaged by them. They may be required to provide their own cutlery, etc.

11. Apprentices may be transferred from one Forest Apprentices' School to another, or from a School to any part of the country to take part in afforestation work for the State. Apprentices may be required to attend day or evening classes arranged by the Local Education Authority.

12. The hours of work and the time allotted to theoretical instruction will be regulated according to season. There will be a half-holiday on Saturdays. A break of 18 working days between the first and second years in each course will be granted as leave, with the addition of Bank and other public holidays and two extra days at Christmas. The money allowance of 10*s.* per week will be paid during leave, but no payment will be made in lieu of board and lodging. During illness, if an apprentice remains at the School and is eligible for sickness benefit resulting from compulsory National Health Insurance, then, for any period during which he is eligible to receive such benefit, the weekly allowance (10*s.*) will not be paid and he will be required to pay 5*s.* per week towards cost of board and lodging; if he does not remain at the School the weekly allowance will not be paid.

13. Apprentices are required to provide themselves with bicycles and maintain them in proper order.

14. While attending the School apprentices are required to wear uniform clothing provided by the Commission. The cost of this, not exceeding £3, will be deducted under normal circumstances from the bonus payable at the end of the first year.

15. Each applicant for admission to the Schools must, prior to his acceptance for training, sign a form to the effect that he has read and understood the foregoing regulations, and agrees to be governed by the same. This form in the case of an applicant under 21 years of age must also be signed by the applicant's parent or guardian.

16. Applications for admission should be addressed to :—

the Assistant Commissioner for England and Wales,
Forestry Commission,
1, Whitehall,
London, S.W.1;

or to the Assistant Commissioner for Scotland,
Forestry Commission,
25, Drumsheugh Gardens,
Edinburgh.

MOOR PLOUGHING: OPERATIONS AT ALLERSTON.

By R. L. Robinson.

At the moment of going to press some interesting ploughing experiments have just been completed on heather moors at Allerston. The areas lie at an elevation of about 700–800 ft., they are flat to undulating, in winter very wet, and in summer very dry. The predominating vegetation is heather, but scirpus and other unsatisfactory indicators are fairly common. The difficulty of getting trees away under such conditions is a matter of common observation.

The unfavourable surface conditions arise mainly from the presence of an iron pan which prevents effective drainage. As a rule, there is associated with the heather a thin light layer of peat, below that a varying depth of bleached sand or sandy clay (4 to 12 ins., or even more), then the iron pan, rarely more than $\frac{1}{8}$ in. thick, and below the pan a considerable depth of yellow sand or sandy clay. Sometimes the bleached layer is replaced by packed small stones, and larger stones or even boulders occur locally throughout. A considerable area of this type of ground was ploughed by mechanical traction in 1928 and 1929, but the costs exceeded 30*s.* per acre, and the pan was broken to a limited extent only. Nevertheless the resulting improvement in drainage and general appearance of the ground is remarkable.

The recent experiments involved the use of a powerful caterpillar tractor and various types of strong ploughs, also of a subsoiling implement. The preliminary trials have been very promising and indicate that with certain improvements in the type of plough the all-in cost of the operation should not exceed 15*s.* per acre. Powerful machinery of this sort is remarkably effective in getting below the pan and turning it over on the surface, where it rapidly weathers. The process also affords an unusual opportunity of observing the structure of these pan (podsol) soils, and in particular of the wavy surface of the pan itself. Very rarely is the pan a plane surface; more frequently it undulates in all directions like the surface of some golf greens. At one point it may be 4 ins. from the surface and a foot or two away 8 or 12 ins.

The effect of the pan on root development is also clearly seen. Roots rarely penetrate it, but the upper surface is often matted with rootlets (particularly scirpus), which had arrived so far and could go no deeper.

From these experimental beginnings ploughing will now be commenced on a commercial scale at Allerston, where a stretch of nearly 1,000 acres awaits treatment. At a later stage it is hoped to extend the experiment to certain types of peaty ground.

Silvicultural Significance of Soil Cultivation.—It seems probable that in the past we have not paid sufficient attention to breaking up the soil on certain types of ground before planting, and that the future may see consideration developments in this direction. Recent improvements in power units, such as caterpillar tractors, may enable us to carry out cheaply operations which could formerly be done only at prohibitive cost.

In pan areas the benefit seems obvious enough. One would expect not only to improve the productive capacity of the soil by a quality class or more, but also to reduce the first cost of afforestation. Losses after planting should be reduced, and it should also be possible to use smaller and cheaper plants. As regards peat areas, the outcome of cultivation is perhaps more speculative, although it is worth while noting that in turf planting we have already advanced a step in that direction.

REVIEWS AND ABSTRACTS.

THE STRUCTURE AND LIFE OF FOREST TREES.

By M. Büsgen.

(Translated from third German edition by T. Thomson.)

Foresters have to guard themselves against two dangers, namely, not seeing the wood for the trees and not losing sight of the trees in the wood. In the latter part of last century, the second was probably the greater danger, owing to the influence of German thought. In recent years, this has been appreciated and there has been a distinct reversion to closer study of the life history of trees. In such study foresters have sought a solution of many of their more baffling problems through a closer insight into the inner workings of tree growth.

Büsgen's book, a translation of the third edition of which Mr. Thomson has now presented to us, is one of the products of this movement. It is unique as bringing together in a way that had not been done before, the products of the investigations of botanists and foresters, with an endeavour to correlate them. Mr. Thomson has rendered a valuable service in translating it for us. There must be many to whom it will prove very valuable, who are not able to read German. As is essential in scientific books of this kind, he has made a close translation. It is not always easy translating in this way to avoid the German idiom, but on the whole, he has been extraordinarily successful and presents the book in a very readable form. The printing and reproductions are extremely well done and the references have all been carefully checked. Mr. Thomson is to be congratulated on this achievement.

One minor criticism which one is tempted to make, is with regard to the general format of the book. The publishers have attempted to model it to the form of a general text book, but this is apt to mislead as to its character. Büsgen is not a text-book writer and it is to be imagined he never intended that this book should be treated as such, although in the hands of its editor the third edition has approximated more to that form.

The book as Büsgen presented it in its second edition, was far more in the nature of a series of studies of the life history and structure of a tree, taken stage by stage, from the shoot to the root, but without any great pretence of connection. The second edition owed a good deal of its interest and suggestion to this treatment.

Chapter by chapter the writer collects together results of the researches of foresters and botanists and brings us as it were, to the limits of our knowledge, with vague suggestions of what lies beyond. It is as if he were a guide taking us to the high places in a clearing in an unexplored country. The mists baffle a longer view, but the guide is just able to indicate something of the character of the country which lies beyond. It is this treatment which makes the book so inspiring.

Dr. Munch, the editor of the third edition, is a scientist of a far more exact type, and it was inevitable that in his edition, the book should lose some of this indefiniteness and take a more concise form. He has, however, contributed a good deal to exact knowledge which enhances the value of the book without robbing it of all its suggestiveness. His chapters on the races of trees and movement of water in the tree are valuable contributions by him on subjects upon which he is a recognised authority.

The book is one which can be read through or browsed, as each chapter is more or less self contained. Chesterton, in one of his essays, recommends a daily obeisance to a lamp post as a cure for the dull drab lives of suburbanites. We foresters also, are apt to take things too much for granted. A tree is too often just a tree to us. We want to capture a new sense of reverence at the wonder of it. That way the solution of our problem lies—and the discovery of many more. Büsgen shakes us into that frame of mind each time we read him. We need it, because the problems with which we are faced are so much more complex and hidden, so much deeper in the heart of nature than those of the agriculturist whose point of view we have been too apt to adopt as our own.

D. W. Young.

THE LEADING CONIFEROUS TREES OF IMPORTANCE FOR SWEDISH SILVICULTURE.

By Professor Lagerberg.

(*Skogen*, 15th January, 1930.)

The Murray Pine: Pinus contorta Murrayana.

Scarcely any of the North American conifers introduced into Europe have been the subject of such lively interest in recent years as *Pinus contorta* var. *Murrayana*. Much has been published about this species in both Finnish and German literature recently. Plantations, most of which were established after the year 1910, have shown that the tree is from the start very quick growing and that its production during the first few decades can in favourable cases be as much as double that of Scots pine. As regards the quality of the timber, investigations carried out in Finland, Germany and North America have shown that the wood is suitable for the manufacture of sulphite cellulose. It takes preservatives freely and so can be used for sleepers and similar purposes.

The Murray pine appears to have been discovered in 1805 in the west part of Montana. Its common name, *Pinus Murrayana*, was given first in 1853 by Balfour, on the basis of material obtained from the north of California. It soon became clear, however, that this species could

not be satisfactorily distinguished from *Pinus contorta*, a tree occurring at the lower elevations along the Pacific Coast, and discovered in 1825, near the mouth of the Columbia River, in Washington State. There can be no doubt that we have to deal merely with one species of *Pinus contorta*, but consisting of a wide range of different geographical forms. It is convenient, however, to distinguish the mountain type of *Pinus contorta* as var. *Murrayana*, even though a complete series of transitional forms exists between it and the coastal variety. On account of its good growth, *Murrayana* has an entirely different silvicultural value from the typical *contorta*.

The species as a whole has a wide geographical distribution. Its northern limit extends in the Yukon district, of Alaska, to beyond the 64th degree of latitude, while its southern limit is in the northern part of the Californian peninsular, at about 31½ degrees of latitude. Its east and west range is also great, being from the coast to the west part of South Dakota. Within this wide region the tree extends from sea level up to an elevation of about 11,000 ft. The coastal form has very little value as a forest tree. It forms usually open stands, the character of which depends on the peculiar branch and crown development of the trees. In the northern part of its zone of distribution it occurs even on *Sphagnum* mosses and also colonising sand dunes and other poor localities. The English names of "scrub pine," "shore pine" and "sand pine" describe well its appearance and choice of site. The tree is of small dimensions, usually from 16 to 22 ft. in height, but often smaller and very seldom over 33 ft. The branches are relatively coarse and stiff and form a dense, round-topped crown. In general the tree much resembles *Pinus Montana*.

On the west slopes of the Cascade Mountains, *Pinus contorta* undergoes a gradual change in type with increasing elevation. The thick, deeply furrowed bark of the coastal form becomes less and less extensive, and finally appears only at the base of the stem, being replaced above by thin, light brown bark. The stems are straighter and of considerable height, the branches thinner and shorter, and crown formation more conical. The tree as a whole resembles to a considerable degree the Swedish far-north pine. The needles are longer and brighter than in the coastal form and less twisted, and their colour a lighter green. The cones are less oblique. The wood is soft, short-fibred, easily worked, and has a not very distinct heart. The colour is something like that of spruce or silver fir. The wood is less resinous than in the coastal form.

The English name of the *Murrayana* is the Lodgepole pine and refers to a more or less specialised use, the young, straight, cylindrical stems being particularly suitable for tent poles. This then, is the type which occurs throughout the principal part of the species distribution. It is the dominant tree in the northern parts of the Rocky Mountains and is the most important species in Yellowstone Park, forming here the upper tree limit at 10,000 ft. elevation. According to Sargent, it attains its greatest dimensions in the Sierra Nevada, while in southern California it is the principal forest tree at about the same elevations as in Colorado. The

Murrayana is no second-class tree ; in height and diameter it comes quite near to the Scots pine in Sweden. The height in closed stands ranges in general between 50 and 90 ft. and the average stem diameters are 12 to 14 ins. The largest trees measured have given a height of 160 ft. and a diameter of 6 ft. The best growth is found on the north and east aspects. *Murrayana* makes no especial demands upon the soil and is in particular indifferent to lime content. It grows well on a dry gravel, but prefers slightly sloping ground with a good moisture supply. The best growth is found on such sites. The following table gives an idea of the productive capacity of the tree according to data prepared by Tigerstedt from measurements taken in the natural stands in the national forest of Babine, in British Columbia, latitude 54 degrees. The quality classes are based on the mean height attained at an age of 80 years.

Age.	40-ft. class.		80-ft. class.		100 ft. class.	
	No. of stems per acre.	Vol. per acre Q.G.	No. of stems per acre.	Vol. per acre Q.G.	No. of stems per acre.	Vol. per acre Q.G.
Years.						
15	3,035	250	2,000	—	—	—
65	2,430	2,350	610	4,450	510	5,250
115	1,420	3,920	360	7,530	300	8,850
165	730	2,630	180	5,100	—	—

The complete table with data given at 10 years' interval would have shown the remarkable fact that the timber volumes do not increase after the 115th year, but on the contrary, diminish. This is due to the fact that the Lodgepole stands in the high rainfall areas of British Columbia are not a climax type. They have replaced other stands and readily are replaced by them. This applies especially to the spruce *Picea Canadensis*, which comes in as an under-story, and after the 115th year tends to crowd out the *Murrayana*.

As regards the maximum age of *Murrayana* there are records of trees up to 300 years old, but as a rule the limit is between 100 and 175 years, the principal cause of death being the destruction of the older stands by fire, the trees being easily killed owing to their thin bark. As is well-known, however, fire plays the principal part in the regeneration of *Murrayana*. The trees cone heavily but a large proportion of the cones do not open on ripening. With the passage of time, therefore, the reserve of cones increases more and more, and in the event of a fire there are many times more seeds than are sufficient to re-stock the area. The seed retains its germinative capacity to a great extent in the closed cones. In one case it was found that the seed in a 75-year-old cone still had a germinative capacity of 8 per cent. The great heat of a forest fire does not harm the well-protected seed but only causes the

cones to open (incidentally the artificial extraction of *Murrayana* cones is relatively difficult, requiring a temperature of 60 to 65 degrees centigrade). Although a light demander, yet when grown in even-aged stands it can bear overcrowding for long periods. One 70-year-old stand has been recorded with no less than 100,000 stems per acre, and a mean height of only 4 ft. The trees re-act very rapidly to thinning.

Up to the present, *Murrayana* has not played any very important part in the timber utilisation of its native country, but in British Columbia it is believed that it may become the most important tree after Douglas fir and Western Hemlock.

As regards the experience gained of this tree in Europe, Lagerberg mentions a large plantation formed in Germany, near Nürnburg, about the year 1890, which was a complete failure, owing probably to the use of an unsuitable strain of tree, but good results have been obtained in more recent times in Germany and in Sweden and Finland.

The Colorado race of *Murrayana* is slow growing and not to be recommended. The Montana race does well for the first ten years, but the growth then falls off. This race has done best on drained marshes. The Alberta race is better than either of the former, and in some cases the production has been twice as great as that of the Montana race. Trees grown from this seed are completely hardy and at 16 years of age show no tendency to fall off in growth. The coastal race, that is *Pinus contorta* in the limited sense, is killed out completely by frost within the course of a few years. The localities from which seed should be collected for plantations in the northern parts of Europe are the inner parts of British Columbia and Alberta.

Lagerberg gives details of various trees and plantations of *Murrayana* in Sweden, including an 18-year-old plantation in the Royal Park at Bejurfors. This stand was measured in 1929 with the following results :—

——	Number of stems per acre.	Basal area.	Mean quarter girth.	Mean height.	Vol. overbark per acre Q.G.
Before thinning ...	1,590	67	2½	22	820
Thinnings	350	11	2¼	19	120
After thinning	1,240	56	2½	22	700

The stand was not pure, but contained a certain admixture of pine, spruce and birch, which were neglected in the measurements.

In Finland, Tigerstedt considers, on the basis of sample plot examined in that country, that *Murrayana* of a suitable race will, under proper treatment, exceed the production of Scots pine by over 100 per cent. during the first few decades.

The most suitable type of plant for planting is the lyr-lyr transplant, and 4 ft. 6 ins. spacing is adequate in view of the rapid growth. The tree

is specially suited for areas overgrown with grass, old arable land, etc.

Metzger, who has written on this tree in Germany, recommends mixing it with grey alder in alternative rows, the rows being orientated to face the prevailing wind direction. Tigerstedt also recommends *Murrayana* as a valuable tree for those large areas in Eastern Finland where the grey alder at present is a serious hindrance to the introduction of more valuable timber trees. The *Murrayana* would be much more likely to hold its own against the root suckers of the alder than the common pine. In Sweden, however, Lagerberg considers that birch would have to replace alder as a broad-leaved tree for admixture with the pine.

Finally, as regards branch suppression, this is usually slow and incomplete, even small branches remaining for long periods attached to the stems. The removal of such dead branches will probably be necessary in order to improve the quality of the timber.

W. H. GUILLEBAUD.

THE SILVICULTURAL TREATMENT OF ASH.

By OBERFÖRSTER SWART.

(*Zeitschrift für Forst und Jagdwesen, July*, 1929.)

The appearance of this useful article is especially opportune in view of the fact that at the present time our methods of establishing, or attempting to establish, ash in the forest are being called in question.

Swart begins by remarking on the extraordinary neglect given to such an important species by the forestry text books in general. Further, much of what little is found in the test books is, in his opinion, decidedly questionable.

It would appear that in Germany the success of planting ash pure on open tracts of land has been no greater than in this country. Indeed, he describes the consequence of this method of establishment to be complete overgrowth of the soil by weeds and the production of apple tree plantations; yet there can be no doubt that in many of the areas where ash had failed so miserably it was the right species for the locality. He considers that the keynote to the biological character of the ash is its need for association with other species of a different biological type. Knowledge of the biological characteristics of ash must lead to the conclusion that pure planting of cleared areas represents the most unsuitable method imaginable. Ash requires, in order to thrive, a certain measure of shade, and where any shelter exists in the form of shrub growth, every advantage must be taken of it. Where no such shelter exists, then an advance growth is indispensable. Swart considers that it is both an economic and a silvicultural error to attempt to plant

ash on open land at the same time as the nurse species. The latter should have from 4 to 7 years' growth in advance of the ash.

Of all the species available for use as a nurse for ash, Swart considers grey alder to be by far the most suitable. It will thrive with a relatively small amount of soil moisture, quickly suppress even strong weed growth and remains as a tree of the second size, always in a subdominant position to the ash in later years. He recommends, for the artificial planting of ash on cleared areas, the advance planting of 2-year grey alder plants at 4 metres (13 ft.) spacing, filling up after 4 to 7 years with ash at 13 ft. by 6 ft. 6 ins. By the time the ash are introduced the alder should be large bushy plants and the side branches of the latter will require trimming back to enable the ash to be put in. Strong ash transplants are recommended for the purpose (judging by the photographs accompanying the article, plants from 3 to 4 ft. in height are employed). According to local experience, the grey alder closes even at that wide spacing distance in the 6th to the 7th year and then provides ideal conditions for the development of the ash, which suffers no check in growth. Constant trimming is, of course, necessary to relieve the ash.

Swart admits that it is uncertain whether and to what degree the strong propensity of the grey alder for root suckering will be an obstacle to the natural regeneration of the ash in the future. If this should prove to be a difficulty it would be necessary to resort to planting.

Where an adequate overhead cover is actually in existence, as in coppice areas or in areas overgrown with weeds such as birch, thorn, dogwood, etc., ash can be established under the shade of the mother stand, either by sowing stratified ash seed or by the planting out of small natural seedlings or of 2-year nursery seedlings, using the notch method. The rule is to bring up the ash in close groups under the full shade of the old crop, thinning out the latter as soon as the ash are properly established, but keeping as much shade as possible consistent with the minimum light requirements of the ash. Such treatment leads to the early suppression of the side branches which fall off almost without leaving any trace of scar, the avoidance of forking, and an early natural suppression of the weaker stems. The last trees of the mother crop should not be removed until the ash are from 15 to 20 ft. in height. Almost as soon as the final clearing has been made the pure ash stand should be under planted with either common or grey alder, using 2-year seedlings. The development of the alder permits the necessary heavy thinnings in the ash to be made without injury to the soil (in Swart's view the crowns of ash should be wholly isolated when the trees are from 30 to 40 years old). Eventually, when the ash are mature, the soil conditions should be ideal for its regeneration.

W. H. G.

THARANDTER FORSTLICHES JAHRBUCH, 1929.

Dr. Lorenz writes an interesting article on the future supply of raw material for the German paper factories. It would appear that about half the wood required is already imported from neighbouring countries, chiefly Poland and Finland, and that the proportion imported is rising rapidly. This shows that the home production of pulpwood is not keeping pace with the demand, and it is anticipated that the supplies from other European countries will shortly be inadequate. The author of the paper is of opinion that as the North American supply is being consumed so rapidly (he estimates it will be short of raw material in 30 years), attention should be turned to African timbers and that their possibilities in connection with pulping should be investigated. This has apparently already been started under his supervision.

Professor Bernhard gives an interesting account of the bye-products of the Turkish forests. The seed of the stone pine appears to yield a large and valuable harvest, some 400 or 500 tons being exported chiefly via Smyrna each year to such countries as Italy, France and Egypt, where it is employed by confectioners for purposes similar to those for which pistachio nuts are in common use.

Quercus aegilops produces a further interesting bye-product in the acorn cup which, just before ripening, is very rich in tannin and largely collected and exported on this account.

It is interesting also to learn that Turkey supplies some 28,000 tons of hazel nuts for the chocolate factories of Europe and that the sap of *Liquidambar orientalis* is exported in considerable quantities to the perfume makers of Paris.

The question of the wide application of selection forest methods is discussed by Geheimer Forstrat Dr. Martin, and he maintains that although this sytem is particularly useful in certain countries and with certain species, it is not advantageously applicable to many parts of Germany. Particularly in the Prussian pine forests, Dr. Martin considers such a system quite out of place, owing to dryness of the soil. According to him it would appear on such soils the old trees are absorbing all the available moisture and that natural seedlings fail in competition with them, and, in consequence, are stunted and often die. His general attitude towards the " Dauerwald " question is one of caution, and he warns foresters against changing over to it without very good reason and without knowing exactly what the change will involve.

A. D. HOPKINSON.

REVUE DES EAUX ET FORÊTS, MAY, 1929.

In a paper entitled " Forestry in Yugo Slavia," M. Ljoub Markovitch, Inspector of Forests, Belgrade, refers *inter alia* to the dying off of oak in the Slavonian forests in the following terms.

A visitation of *Lymantria dispar*, accompanied by *L. Chrysorrhœa*, *Bombyx (malacosoma) neustria*, etc., has defoliated all the oak trees in many plantations, and the appearance of *Oidium*, in 1909, upon the second flush of leaf in June, over the same areas, has been the cause of serious physiological trouble through the almost total removal of the foliage. The following years the plague again attacked the same woods. Further than this, it increased in virulence, and after several years of attack numbers of trees have died off in all the woods affected. Already, in 1914, it had become necessary to extract many dead trees, and in the following years the deaths assumed alarming proportions. Half-grown woods, which represent 60 per cent. of the Slavonian forests, were the most severely attacked, and the pure woods offered the least defence to the attacks.

From 1909–1918 foresters appear to have proceeded to remove the dead trees without troubling about the danger to the future of the forests. According to M. P. Manoylovitch, Conservator of Forests, there were exploited :—

From	1909–1918	over	26,068	acres,	28,022,000 cubic feet.
,,	1920–1925	,,	64,525	,,	33,108,000 ,,
	TOTAL	,,	90,593	,,	61,130,000 ,,

This is at the rate of about 3,500,000 cub. ft. per annum. Thanks to his initiative and his observations of the phenomenon of 1909–1916 and of 1920–1925, the Director-General of Forests was able, in 1924, to organise systematic research with the help of the Universities of Zagreb and Belgrade and the foresters of Slavonia. The results of these researches are still uncertain, several hypotheses have evolved and are tabulated as follows :—

1. M. le Dr. Georgevitch, professor at Belgrade, places the principal blame upon the honey fungus.
2. M. le Dr. Langhoffer, professor at Zagreb, considers the larvæ of *Lymantria dispar* to be the principal culprit.
3. M. le Dr. Petracitch, professor at Zagreb, attributes a large part of the damage to caterpillar, and also considers that exploitation by clear felling has had a considerable influence.
4. M. le Dr. Skoritch, chairman of the Conference at Zagreb, and M. le Dr. Jossifevitch, of Belgrade, view the principal factor in the combined action of the caterpillars, the *Oidium quercinum* and *Armillaria mellea*.
5. M. Stebout, professor at Belgrade, blames the soil, but M. le Dr. Seiwert, professor at Zagreb, relying upon a large number of soil analyses, scouts the podsol theory.
6. M. Manoylovitch, Conservator of Forests, will adm itno primary factor but that of *Oidium quercinum*.

While these researches and observations have been going on several means of fighting the pests have been tried, especially the destruction of the eggs of *L. dispar*, which is not efficacious in the case of severe attack of this caterpillar. Parasites of the larvæ and of the *Oidium*, as well as birds, have so far had but little effect, and only after five to six years has an epidemic been able to stop the invasion of the larva of *L. dispar*.

The writer goes on to develop his own theory, which is that the real cause of the present disasters is traceable to incorrect silvicultural methods in the past and that pure and even-aged stocking predisposes oak woods to attack. He maintains that the pests of to-day have ravaged the Slavonian Woods from time immemorial without previously killing out the trees *en masse*, that honey fungus is endemic and of itself in a healthy wood will kill but few trees ; that soil conditions have not changed for the worse ; that the floods to which the locality is subject have been a permanent factor and cannot be one of the causes of the trouble.

It is held that if these four factors have any more unfavourable influence now than in the past it is owing to the treatment the forests have received in the course of the past 50 years.

He believes that the *Oidium*, which put in an appearance in 1909, found conditions very favourable to its development and is much more dangerous in the oak woods of Slavonia than in other oak forests of Yugo-Slavia or of other countries.

He advises the strengthening of resistance to pests in the oakwoods by correct silviculture and admixture with the oak of the other natural hardwoods of the district, such as the ash and elm and the two minor species, hornbeam and field maple.

W. L. Taylor.

Revue des Eaux et Forêts, November, 1929.

The Dying Off of Oak in Yugo-Slavia, especially in Slavonia. (By M. Auguste Langhoffer, Head of the Entomological Branch, Faculty of Agriculture and Forestry, University of Zagreb.)

In several parts of Yugo-Slavia and particularly in the famous oak forests of Southern Slavonia (Posavina), the trees are attacked from time to time by the caterpillars of *Lymantria dispar*, L., *Euproctis chrysorrhœa*, L. and *Malacosoma neustria*, L., besides other larvæ of less importance.

Of these the larvæ of *L. dispar* call for special notice, developing as they do so abundantly and with such rapidity as completely to defoliate the pedunculate oaks within a few weeks. The subsequent attacks of *Oidium quercinum* are followed by a more or less complete withering of the oaks. Various theories have been suggested in explanation of this phenomenon, which is very disquieting, and which seriously threatens the oak woods. It is held by some that podsol soil conditions are the

principal cause, but this theory is not altogether to be upheld. It is not probable that podsol conditions occur in one part of the soil of the forest of the Slavonian plain and not in another, and some of the same oak woods which have been attacked are found to have recovered after several years, although soil conditions remain the same.

It is to be observed that the soils of the Slavonian forests are saturated with water because of their low altitude and the frequent floods in the basin of the River Sava and its tributaries. At the same time, oak woods can absorb a lot of water, and it is under very humid conditions that the best of the Yugo-Slavian oaks flourish. It is also said that the dying off is caused by *Oidium*, but this is not the principal cause, for the first young leaves of the oak are able to withstand this fungus without peril.

These are the two theories most frequently advanced in explanation of the dying off of the oak trees.

The writer has been concerned with the study of insects for nearly forty years, and in the matter now in question he states that he has for several years assembled facts and dates without forming any *a priori* ideas. After visiting more than seventy points of attack, enquiring of the foresters in charge and making personal investigations, he has convinced himself that the primary cause of the dying off amounts to this :—the earliest leaves are ravaged by the caterpillar, after which comes the *Oidium*, which attacks the secondary leaves. The attack of the caterpillars is an absolutely necessary link in the chain of events which leads to the dying off of the trees.

There are several proofs of this. In 1909 the trees did not wilt off in large numbers and at the same time *Oidium* was not in evidence. Since 1909 several catastrophic recurrences of dying off have been notified (1909–1912, 1915–1918 and 1920–1928). The attack of the caterpillars was followed by a regular and consistent mortality. The oaks withered only in those areas in which the caterpillar occurred, and it was always the tree which had suffered defoliation by the caterpillar that perished. Before 1909 the oaks had always been attacked by caterpillars which devoured the leaves, but the trees had resisted and had not perished. New leaves had flushed, and there had been no unfortunate consequences. But the *Oidium* supervened and the trees died wholesale. Caterpillars ravaged the earliest leaves ; at the beginning of June there was a second flush and then the fungus attack brought the disaster. Summer heat facilitates the dying off, the secondary flush of leaf is weak and less resistant. They wither and fall off one by one, and the tree, being unable to produce a complete foliage a third time, is enfeebled and open to the depredations of harmful insects and forthwith dies. All this depends on the number of caterpillars and the attack of *Oidium*, but also on the resistance of each individual oak tree. Some trees resist at first ; they vegetate again several times, and it is in the following year that they succumb.

This explains phenomena which appear peculiar. The fungus can attack the first leaves also, but it is not then dangerous, the temperature not having yet attained the optimum required for its development

(26–28 deg. C.), the oaks are usually able to withstand the attack and the leaves do not wither. In the same way, when the moisture is light, the *Oidium* is not enabled to develop and attack the second flush of leaf. In 1927 the summer was very warm and moisture so to speak, was lacking, the circumstances being most unfavourable to the development of *Oidium* the oaks for the most part preserved their leafage. In this year even the *Oidium* occurred late and the leaves had become resistant.

In order that the forest should perish, it is first of all necessary that a violent attack of the caterpillar should ravage the young flush of leaf and the *Oidium* should follow. It is thus that in one forest devastated areas can be found and other parts in which caterpillars have not " collaborated " with the fungus, have escaped. The next year another area in the same forest receives the combined visitation and dies.

If there has been no attack of caterpillar there is no dying off in spite of subsequent occurrence of *Oidium*. Those trees that die out sporadically each year here and there through the forest are not in the same case. It is not, however, only the caterpillar and the *Oidium* which must be taken into account. The writer is confident that many trees enfeebled by the attacks referred to, would be able to survive if they were not also visited by one or more of the following pests :—*Agrilus biguttatus*, Fabr., *Platypus cylindrus*, Fabr., *Xyleborus monographus*, Fabr., *Gasterocercus depressirostris*, Fabr., and others, also including fungi such as honey fungus.

The duration of an attack in the forest varies. It is usually three years, but sometimes more and sometimes less. The period of immunity can last several years, but not always for a decade, in spite of the dates recorded by some authors.

There are different means of defence against the caterpillar pest. Certain birds eat the eggs, even insects (*Ichneumonidæ* and *Tachinariæ*, which are often very numerous). Up to the end of 1925 more than 61,000,000 cub. ft. of timber has died in this way. The damage caused by the caterpillar is thus very considerable, and the younger forests are above all susceptible to attack. The larva of *L. dispar* is the greatest danger to be borne in mind when taking measures against the harmful caterpillars in the forest by destruction of the eggs. In the first year the ova are deposited low down and it is not difficult to destroy them at the beginning of the winter. Cold can kill these eggs, but it must be severe cold. It is impossible to foresee if the cold will be sufficiently severe and for this reason it is preferable to tar the deposits of eggs. Later the eggs are laid higher up, it is more difficult to reach them and the method referred to above cannot be applied. It is then necessary to destroy the larvæ by means of arsenical powders dispersed from an aeroplane.

W. L. T.

(*Note.*—As to the dying-off of oak in both France and Yugo-Slavia, *see also* the Forestry Commission's Journal No. 6, pp. 70 and 71.)

In the 22nd part of the 1929 volume, there is a short and interesting contribution on the subject of the control of insect pests by " dusting " from aircraft. This gives a summary of the results that have been obtained in the last few years from experiments in this form of control. Various preparations, such as silesia, heritol, hercynia and esturmit, provided by well-known firms whose names are given, have been tried against pests such as the oak tortrix, the nun moth, *Lophyrus pini*, etc. The results have been fairly satisfactory in some cases but much less so in others. Against the oak tortrix the preparation known as silesia gave good results, while against *Lophyrus* heritol proved extremely effective.

For work of this kind the preparation to be used must fulfil certain conditions :—

1. It must have a sufficiently high arsenic content (20-30 per cent.).
2. It must not have too high an arsenic content as it would then prove injurious to other animals. For this reason, silesia with 40 per cent. arsenic has proved unsuitable.
3. It must form a fine dust and must show no tendency to form lumps.
4. It must be sufficiently adhesive.

As a result of the first test in 1925, it appeared that success is dependent on the following circumstances :—

1. A sufficiently high air temperature as the activity of the caterpillars increases with rising temperature.
2. Calm weather. The dust cloud tends to break up if the wind is blowing at more than 6 ft. a second.
3. Dry weather. Rain rapidly washes the preparations from the trees.

The greatest disadvantage of this method of attack is that it kills off the useful insects as well as the injurious ones. Further tests, however, are being made with a new preparation which will spare useful insects such as the ichneumonids.

Dusting from the air has been carried out over large tracts of forest. From 35-45 lbs. of calcium arsenate, in the form of one or other of the preparations, is used per acre, and the total cost works out at from 10*s.* to 12*s.* per acre.

The same subject is dealt with from another point of view by Escherich in Part 1 of this volume. In his article, Escherich gives a well-illustrated description of experiments that have been carried out in Germany, in which the dust clouds were liberated from the ground. The preparation used was " Forstesturmit," supplied by March, of Darmstadt, and this was sprayed among the crowns from a long tube through which it was forced by a fan driven by a 5-h.p. petrol engine. The machine is mounted on runners and is horse-drawn. It consists of a fan driven by the engine

and a container for the poisonous powder, to which is attached a length of rubber tubing. To this is fixed a straight tin tube about 13 ft. in length. The dust is driven by the fan first through the rubber pipe and then through the metal tube from which it emerges in a dense cloud. The metal tube is directed by means of a bamboo stick jointed to it, and can be depressed when necessary to allow the machine to pass under trees, etc. Five men are necessary for working this dusting machine, one man in charge of the motor, two men filling and two directing the dust-cloud from the tube. All are required to wear masks and goggles.

With a 13-ft. tube, the dust cloud was spread satisfactorily through the canopy of a pole wood 40 ft. high. For taller stands, a longer tube was used, but the extra 10 ft. in length made it very cumbrous to handle.

The success of the operation was found to depend on whether full advantage was taken of the wind, light or moderate winds being the most favourable, and calm weather disadvantageous. In favourable conditions it was found that with a moderate wind the machine had an effective range of about 50 yards. About 25 acres can be covered in a day and the cost, which varies, works out at rather more than £1 per acre in the most favourable conditions.

As a result of several trials, Escherich indicated the need for several improvements, most of which have been incorporated in a new Platz model brought out in 1929. This machine is more powerful and has an engine of 6 b.h.p.

In Part 2 of the 1930 volume, Dr. Fabricius, of Munich, gives an account of the damage done to exotic trees in the vicinity of that town by the severe weather in the winter of 1928-29. Observations were made on 83 conifers and 62 species of broad-leaved trees in the Grapath forest garden, and supplementary notes were made in the Botanic Garden at Munich. The weather during last winter was remarkable both for the extremely low temperatures recorded and for the abnormal spell of dry weather, and subjected all the species to a thorough test.

The following table gives a short summary of the author's observations as they affect the more important conifers.

Severe damage—*Sequoia gigantea*, cedars.

Moderately severe damage—*Tsuga heterophylla*, Sitka spruce, Lawson's cypress.

Moderate damage—*Thuya plicata, Abies nobilis.*

Slight damage—Douglas fir, *Abies grandis*, Nootka cypress.

No damage—Douglas fir vars. *glauca* and *caesia*. Norway spruce, *Picea nigra, P. alba*, Japanese larch, Weymouth pine, Cembran pine, Corsican pine, *Pinus ponderosa, P. contorta.*

The author is at pains to emphasise that susceptibility to injury by severe winter conditions has nothing to do with susceptibility to late spring frost, and that species which can withstand the severest winter conditions may be the first to suffer from late frosts in spring.

J. MACDONALD.

NOTES AND QUERIES.

Larch in Breconshire: Records of a Profitable Crop.

The records of the financial returns of a pure larch plantation growing within four miles of the Commission's Brecon Forest are fortunately available, owing to records of treatment and expenditure having been kept throughout the 27 years of its growth. The plantation, 16 acres in extent, was planted in spring, 1890, and felled in spring, 1917. The area, mainly covered with bracken and brambles at the time of planting had previously been used for sheep grazing at an annual rental of 2*s.* 6*d.* per acre. The elevation was 900 ft. above sea level, the aspect northerly and well-sheltered, and the soil a fairly deep sandy loam overlying Old Red Sandstone. No outlay on fencing was necessary as the area was already enclosed at the time of planting.

Some 1,037 18-24-ins. transplants per acre were used and these were delivered and heeled-in on the area at a cost of 26*s.* per thousand. Planting was carried out on a piece-work basis for 10*s.* per thousand, beating up in the following season required 3,000 plants, costing £4, and the planting came to an additional £2 for the 16 acres. Weeding was carried out during the first season at a cost of £3 for the total acreage, and for the second season the expenditure under this head was £2 10*s.* The above amounts represent the total cost of establishing the plantation.

A light thinning was considered necessary in the winter of 1908, and the total cost entailed was £5, dead and sickly trees only were removed. In 1913, another thinning was carried out, the trees which were sold to a timber merchant being estimated to contain 5,500 cub. ft., realising £110. When the plantation was sold standing, in 1917, the price paid was 25*s.* per ton, railway weight. The total yield was 1,050 tons, and the price obtained £1,312 10*s.*, the purchaser agreeing to burn the lop and top. It will be seen, therefore, that the amount realised was equivalent to £82 per acre, or £3 per acre, per annum, gross.

A. H. Jones.

Two large Conifers.

In 1926 I showed to Sir John Stirling-Maxwell and Mr. R. L. Robinson a very fine Sitka spruce standing about 10 ft. outside our boundary at Eggesford, Devon. They suggested that the Commission should purchase it, in order to preserve this fine specimen. The owner of the land gave the ground upon which the tree stood to us for so long as the tree was standing. The tree itself belonged to a firm of timber-merchants, who valued it at 400 cub. ft. at 1*s.* per foot or £20, but it was eventually purchased for £12 10*s.* Their estimate of the volume was a good one, as will be seen below. The soil is an excellent one, a clay loam about 8 ft. deep. The tree was in a mixed wood, containing oak, beech and larch, but many of the trees were cut out about four years ago and the Sitka spruce was left rather isolated. The vegetation below it is thick rhododendron. The aspect is eastern, the elevation 300 ft., and the situation is sheltered by adjoining higher land.

In one of the gales of December, 1929, the tree was blown down, together with many other trees of all species in the same wood. I measured it and found the total height to be 121 ft. and the volume (tape over bark, quarter-girth measure), 439 cub. ft., the age being 88 years. The timber is sound, and the tree is straight and fairly clean for about 30 ft., the first branch, however, being at 17 ft.

The tree was measured in 10-ft. sections as follows :—

At	Quarter-girth.	Volume T.O.B.
Feet.	Inches.	Cubic feet.
5	37	95
15	33	76
25	31¼	68
35	29	58
45	26½	49
55	22¼	34
65	19½	26
75	15	16
85	11½	9
95	9	6
105	5½	2
		439

At 110 ft. the diameter is 4 ins. and there is a top of 11 ft., making 121 ft. in all.

It is distressing that the tree should have fallen, but close by it, on our land, there still stands a very large Douglas fir which, so far, has withstood all the severe gales. It is, however, a very branched and bushy specimen. This tree was presented to us by the timber firm of Messrs. Bartlett, Bayliss & Co. Its top is dead. The age is not known for certain, but the late Earl of Portsmouth, whose property it originally was, told me that it was one of the first batch introduced into England. Nisbet in " The Forester " gives this date as 1828, so that it is probably 102 years old.

The tree was climbed and measured in 1908, and the measurements were then as follows : –

At height.	Length of Section.	Quarter-girth.	Volume T.O.B.
Feet.	Feet.	Inches.	Cu. feet.
5	10	55	210
20	20	44¼	272
40	20	32¼	144
60	20	24¾	85
80	20	19	50
100	20	9¾	13
Top	17	—	—
	127		774

In January, 1930, an attempt to re-measure the tree was made by Mr. Russell, but owing to wind and rain it was not safe to climb above 20 ft. The girth at 5 ft. was 21 ft., or 63 ins. quarter-girth. Thus, the volume of the bottom 10 ft. length is 275 cub. ft. At 20 ft. the quarter-girth is 45 ins., and the volume of this 20-ft. section, is 281 cub. ft. Thus, since 1908, an additional volume of 74 cub. ft. has been added to the bottom length of 30 ft. With the additional growth above this point and with the timber in a few very large branches, good trees in themselves, the total contents are probably not much less than 1,000 cub. ft. The height is about 130 ft., of which about 20 ft. is dead.

C. O. HANSON.

GALE DAMAGE: KERRY FOREST.

Old Plantations.—Damage in plantations, aged 35 to 40 years, comprising about 125 acres of Norway spruce, Scots pine and European larch, with a few Douglas fir and Sitka spruce, is very slight considering the woods are at an elevation of about 1,400 ft. above sea level and fairly exposed to S.W. winds, and felling by timber merchants has taken place along the exposed margin.

A few Norway spruce have broken off in the centre of their boles and a number have been blown, but this has occurred in the centre of the woods, as well as on the windward side, and in almost every case the main factor in the actual fall of a tree has been water-logged ground, such damage being confined to areas having a clay subsoil where, through the action of tree-roots or for other reasons, the surface drainage has been impeded.

A noticeable and rather interesting point is that the Douglas fir and Sitka spruce, including those on the exposed side, have proved wind-firm, but in these woods they show no advantage in height-growth over the Norway spruce, although their girth is greater. On attaining the height of the Norway spruce the tops of Sitka spruce are cut off by winds, whilst those of the Douglas fir dwindle off to very small diameter and eventually die back to the height of Norway spruce and again throw a new leader, which repeats the process.

P. 24–25 *Plantations.*—These plantations contain Douglas fir, on lower slopes with Sitka, and Norway spruce on upper slopes, and the recent winds have blown quite a number of larger Douglas fir flat; on the other hand, the Sitka spruce on higher and more exposed ground have remained wind-firm, although many have reached the height of the Douglas fir on the lower slopes.

In February and March, 1929, a number of wind-thrown Douglas fir were firmed and staked, and in the recent gales only 3 per cent. of these were again blown. From this result one can suggest that when blown, firmed and staked, Douglas fir form more root and root-fibre and less top growth; and a plant with such a history may actually be firmer than

neighbouring trees which have never suffered. It is quite clear, however, that the practice of firming up and placing a turf against the windward side of a blown tree is not enough. The main object seems to be, to arrest the sway of the plant by staking, for without this the plant sways and twists and is again thrown even if it does not chafe itself through at the soil-level.

A portion of canvas, turf, or grass should always be placed round the stem of the plant where it is tied to prevent the twine from cutting the bark.

C. R. WELLINGTON.

DIRECT SOWING.

It has been asserted that, if only for reasons of economy, much more direct sowing instead of planting should be carried out in this country as is the case in France.

The writer saw some of the direct broadcast sowing carried out recently in Auvergne, on heather land comparable to the better types in this country. On one area, the quantities of seed (Scots pine) used were stated to be as follows :—

Sown in spring,	1927 ..	Approx. 5½ lbs. per acre.
,, ,,	1928 ..	,, 1 to 2 ,, ,, ,,

It was proposed to make another sowing of 1 to 2 lbs. per acre in the spring of 1929, and any remaining blanks thereafter would be filled up by planting. Thus an average of at least 8 lbs. of seed per acre was to be used. At the present cost of Scots pine seed collected by the Commission, the cost per acre of the seed alone would amount to at least as much as the cost of 2,000 Scots pine 2 yr.-1 yr. plants, plus average charges for transport and labour in planting. Though certainly not conclusive, this seems to support the opinion that if we are to economise by direct sowing, some method other than broadcasting, which would reduce the quantity of seed required must be adopted.

It may be interesting to note that before sowing, all the areas are burnt. When the burning is not clean, sowing may be undertaken at once, but if a complete burning is obtained, sowing is postponed for a year. This is in order that there may be some vegetation to protect the seedlings, and also because it is believed that immediately after a complete burning the concentration of potash in the surface layer is too high for the satisfactory development of the seedlings. A dense growth of moss under heather is a great hindrance. It cannot be burned easily and, if left, prevents the seed reaching the soil. Where conditions permit, the ground is usually harrowed after the first sowing.

A. H. GOSLING.

The Preparation of Pitwood.

A few notes on the methods employed in the preparation of pitwood and the costs thereof may be of interest to those who have not had the opportunity of practical experience.

As nearly all the home-grown pitwood supplied to South Wales, Bristol, and parts of the Midlands, is sold on a tonnage basis, and as the prices obtained are generally much about the same per ton, it is essential that the various methods employed should compare favourably one with another.

I will therefore try to give briefly my suggestions as to the best way of handling, in practice, the various methods and operations to secure more or less standard costs and reasonably secure and comparable profits.

Pitwood cut on a tonnage basis should not cost more than 3*s.* 6*d.* per ton for felling, trimming, cross-cutting and grading into 13-ft., 9-ft., 6½-ft., and 4½-ft. pitwood, and 3 ft. 3 ins. cogwood, railway weights to be accepted by both employer and employed. The most important factor affecting any variation in the rate is that of the percentage of the different lengths, *i.e.*, a big percentage of the long lengths will cheapen the operation and a preponderance of the short lengths may make it relatively more expensive. The above rate does not include the burning of lop and top.

If pitwood is prepared by the Imperial cord (128 cub. ft.) it should be stacked 2 ft. 4 ins. high, the stacks of 13's being 4 ft. 6 ins. long, the 9's 6 ft. 9 ins., the 6½'s 9 ft., the 4½'s 12 ft., and the cogwood (3 ft. 3 ins.)—18 ft.; and the average weight per cord, through and through, not too long cut, should be 39 cwt. The payment per cord, on the 3*s.* 6*d.* per ton basis, but subject to the same adjustment as above, should thus be 6*s.* 6*d.*

When preparation is paid for by measure, the payment for 13 ft. is usually based on a price of 1½*d.* per cub. ft. or 12*s.* 6*d.* per 100 cub. ft. t.u.b., this price being inclusive, as in previous methods. It is usual to pay for 9's by the count at 2½*d.* each, and in order to get at a comparative cost they should be measured and averaged and taken at 24 cub. ft. to the ton. As a rule (5-8 ins. diameter tops) they go about 16 props to the ton, thus again costing 3*s.* 6*d.* The 6½'s and 4½'s are cut by the dozen, the former at 1*s.* and the latter at 8*d.*; about 3½ dozen 6½'s of 3½-6 ins. diameter top go to the ton, and about 5 dozen of 4½'s of 3-5 ins. top diameter. Cogwood is usually paid-for by the cord, the rate being 6*s.* 6*d.* per cord, or, again, equal to 3*s.* 6*d.* per ton.

Sometimes pitwood is supplied in irregular or random lengths termed Bristol poles; these vary from 6 ft. to 14 ft. in length, with a top diameter between 3 ins. and 8 ins., and are mainly for the Bristol and Staffordshire collieries. It is usual to pay for them by the score, an average price being 1*s.* 9*d.* per score, but the only safe way is to fix a price for each individual area after measuring sample scores and converting them to tonnage, then applying the 3*s.* 6*d.* per ton rate with any necessary

adjustment to cover the reduction of cross-cutting, grading, etc., and the fact that the output for the same quantity of felling and trimming should average higher than that of South Wales specifications.

It is clear that when cutting is by tonnage, the forester will need to complete the sale as soon as possible in order to get the correct weights ; this is also essential to save loss of weight by drying ; it is as well to note that when two or more gangs are employed on the fellings, etc., some care and arrangement may be necessary to get the weights which apply to each gang. When cording is done there are no difficulties as to payment, but foresters must watch the tendency on the part of many cutters to put crooked wood and short ends in the middle of the stacks. Payment by count or measure gives the forester a much better chance of seeing that the wood is properly cut and also permits him to get his wages accounts made up promptly and to keep accurate record of stocks in hand, but it is more difficult to reconcile stocks prepared with stocks sold.

The sale of produce " in the wood " has the advantage that any loss by drying, in the event of delayed removal, falls upon the purchaser.

J. EDWARDS.

AN IMPROVISED TIMBER SHUTE.

The following particulars may be of interest to those who have in their Divisions some inaccessible woods which contain pitwood, the extraction of which would swallow up any profit to be made from the timber. The idea was put into practice by Mr. W. J. Humphries, the forester in charge of the Highmeadow Woods in the Dean Forest, to extract pitwood from a shelf-like plateau in the Wye Valley, of several acres in extent, which had a steep slope both above it and below it. Horse haulage is very difficult in this place and would render the extraction of this lot of timber unprofitable, though the railway siding lies only actually about 100 yards from the area in question.

A small shallow trench about 3-ft. wide, 8 ins. deep, with a rounded section, was dug down the hill side and larch poles laid along the edges. 8-ft. sheets of 20-gauge corrugated iron were then bent into a curve to fit the trench and nailed at the ends to the larch poles which acted as longitudinal sleepers, the ends of the sheets being placed so that the upper sheet overlaps the one below it.

The lengths of pitwood prepared varied from 3 to 9 ft., and arrangements were made to allow for the different velocities of the timber by having a movable section of track—consisting of 2 sheets of iron nailed to poles which could be put in the trench for light pitwood and removed for heavy pieces. The position of the section is adjusted so as to allow the 9-ft. lengths to travel over more bare earth than the shorter and lighter lengths, and the whole thing is arranged to drop the pitwood at

the road side. The cost was under £5 for putting down 70 yards of shute, and it has passed already 100 tons of pitwood which would otherwise have cost 6*s*. or 7*s*. per ton to be brought to the same place. The timber at present is tushed to the top of the slide and one man can send down several truck loads of timber in a day at a cost of only a few pence per ton.

A. H. POPERT.

POULTRY HOLDINGS.

In a previous Journal I gave a brief description of life on a forest holding. In this short note I shall endeavour to offer a few suggestions which might be of benefit to the poultry holder starting with the Commission.

First of all the poultry holdings of the Forestry Commission in Scotland are excellent and up to date. A commodious poultry house is supplied and a large, well-fenced run, capable of carrying a good stock of poultry. While quite a number of holders go in for poultry holdings who have a fair amount of experience with poultry and who do quite well with them, there is also a large number who go into these holdings with very little or no experience of poultry. Consequently, they are rather handicapped and only start with a very few fowls—in some cases of an inferior type. The mistake which is commonly made to start with is, that the holder, who probably has not got the means to purchase poultry, buys a certain number of eggs either from the nearest farmyard, cottage or van. Sometimes cheap advertised eggs are sent for. A few weak chicks are usually the outcome. Disappointment follows, no eggs being obtained when other people's fowls are laying, and the holder rather down-hearted, is inclined to say that poultry do not pay. Consequently, his poultry holding, which should be a source of income, is neglected.

There is a surprisingly large number of people, when asked if their poultry pay, will at once say "No" without having anything definite to go on. They either surmise that their own do not pay or they go by random remarks of other people. They may be quite right in saying so; there may be various reasons why their poultry do not pay—reasons too numerous to mention here.

I myself have kept a record of my own poultry for a period of over three years (a record of all stock, eggs, food, etc., bought, and all eggs, fowls, etc., sold or used) and can prove by these figures that if poultry are kept and looked after in a proper manner they will pay, and pay well.

May I suggest that where required, some practical assistance might be given to holders to help them to make their holdings a success:—

1. One very good way would be to give holders a course of lectures, say, in the winter evenings, by some capable person, who has had some practical experience, and who could find this possible.

These lectures besides being a pastime, would be very profitable

for the holder. He would be inclined to become more interested in his holding, and when he found he could make it pay, he would give him a different outlook. He would talk and think about his poultry when he was at his work, instead of the usual local gossip or grouse about the weather.

2. Another suggestion might be that if pamphlets on poultry-keeping could be obtained and distributed among holders, these would be a benefit; or if one good up-to-date Poultry Book could be allocated to each forest; or perhaps the Commission's Library could stock a few books on up-to-date poultry keeping, these would be an additional help.

3. Another suggestion might be to give holders who are starting poultry-keeping, names and addresses of experienced poultry holders at present with the Commission, who could supply them, if they wished, with reliable eggs for hatching at a reasonable rate.

There are other suggestions which could be made, but these few remarks are written to show that those of us who can, would be doing a " good turn " to the Commission and especially to the holders, if we did what we could to help them to help themselves and, through time, to see each holder with a fully stocked profitable poultry holding.

S. H. A. PATERSON.

PROTECTION AGAINST FIRE.

The following does not actually deal with measures to be taken against fire, it has more to do with action at the time of an outbreak. Before dealing with methods adopted at Wareham Forest, it is necessary to give some description of the area. Roughly, Wareham Heath is in one block of 2,900 acres, yet divided into three by two main roads about 5 miles in length, bordered by molinia and heath and very exposed to south-westerly winds. In the middle of the central area there is a hill, an old British camp called Woolsbarrow (reserved by owner), which overlooks practically the whole of the forest.

During the early spring of 1929 the weather became so hot and dry that I found it impossible to keep gangs working at the most dangerous places; in some cases the work would be about 3 miles away as the crow flies, and 6 miles by road from danger points: Ordinary measures against fire had been taken, such as stacks of branches collected, lines turfed and pits dug at intervals of 100 yards in a drain along the road, the drain keeping up a supply of water throughout the year. In addition, I considered it necessary to have some means of warning the men when working at a distance, that our area was in danger or on fire.

It was decided, after receiving permission from the owner, to erect a flag pole on Woolsbarrow to be used as a signal station. A 40-ft. larch pole was obtained and erected after fixing galvanised pulley and the necessary wire stays, halyard, etc. A length of crêpe cotton, coloured red,

was made into a flag 9 ft. by 4 ft. 6 ins., the material costing 2*s.* 4*d.* A boy was placed on look-out duty with instructions to hoist the flag immediately he saw smoke on or near our area, and to proceed at once to the scene of the fire, at the same time the ganger was warned to keep an eye on the flagstaff. In addition, two foresters on adjoining estates bordering the Commission's boundary, were informed that the flag would be hoisted in case of an outbreak of fire on their land as well as on ours, and arrangements were made to help all round. I might add that the most dangerous part of the road is from 700 to 1,200 yards from the look-out station, there being a lot of steam traffic. A pair of French binoculars was provided, which would enable the look-out to recognise road engines causing damage. In addition to the above measures the Divisional Officer made arrangements with the O.C. Tank Corps at Bovington, 7 miles distant, to send a number of troops with spades and shovels, as required by the forester.

As all the men use cycles they were able to be on the scene before the fire could spread to any extent, or at the earliest possible moment. The arrangements worked well on the occasion of a small fire, which was rapidly extinguished. Possibly some foresters would find the same method would help them and, if so, I would suggest in place of a signal halyard the use of flexible wire, and a larger flag, say, 12 ft. by 6 ft.

S. W. Colwill.

Weeding young Plantations.

The manner of dealing with weeds in newly-formed plantations has recently undergone considerable change. Formerly all such growth was removed at great expense and was afterwards kept down over the whole area, but now clearing is limited to the lines of trees and even this amount of attention may be further restricted with advantage. Where birch, briars and bramble of two-years' growth have been allowed to remain, the results have been better than where the ground was cleared, and this was the case also with spruce planted in P. 26 among brambles and coarse grass. It was found that Corsican pine planted in P. 27 in tall bracken and grass did not benefit from the removal of the latter, but the fern had to be cut away. In this connection it may be remarked that natural seedlings manage to struggle through weeds and one rarely sees self-sown plants springing up on absolutely bare ground.

By careful watching and giving a little assistance at the right time to prevent trees from being smothered, one's object may be obtained just as well by more expensive means.

B. Gale.

One-sided Root Systems.

The large number of plants with roots all on one side prompts me to write this note. Of plants dispatched from nurseries to planting areas,

nearly 70 per cent. have one-sided roots, and it is especially noticeable in older plants that have been transplanted more than once; 2 + 1 plants are not so bad in this respect. A large portion of this one-sided system can almost certainly be attributed to a lack of constant supervision during lining out and lifting. There is always a tendency on the part of workmen when lining out, to keep a sloping side to the trench, whereas it should be kept vertical, and also to make the trench insufficiently deep. These faults are especially liable to appear when piece-work is in operation. Plants are pushed up to this sloping shallow trench, and the roots, as one would expect from such a procedure, are all forced on one side, whereas in a vertical trench, the plant is held upright and the roots hang in a natural position before having soil pushed against them. Take for instance seedlings direct from the seedbed, the roots are as uniform as possible at such a young stage. The fault then is evidently confined to the next stage of progress, *i.e.*, the transplanting into lines. The standard of tilth in transplant beds is or should be of such a texture that the uniform growth of roots is not interferred with; this then confines the fault to the actual way the trees are lined out. A certain amount of badly distributed roots will be found despite the utmost care, but then we do not expect 100 per cent. results under any conditions.

More careful supervision can minimise to a great extent the number of one-sided and deformed root systems, with a corresponding benefit to the successful and quicker establishment of new plantations. Lifting is another item needing constant attention. There is always the tendency to push the spade down in a slanting position, bruising and cutting off one side of the roots, instead of pushing it straight down before actually lifting the trees. This is apparently common sense to anyone with the least knowledge of nursery work, but the standard of root systems issued from nurseries, is, in my opinion, clear evidence of its neglect. A forester usually has a great many other jobs to attend to in addition to his nurseries and plantations, and so cannot be expected to give his constant attention to nursery operations. Personally, I would do all lining out and lifting operations by day work. A competent man with a thorough knowledge of all correct methods of nursery work, should be in constant attention whenever nursery operations are being carried out, and he should insist upon them being done correctly. All this appears only common sense, and so it is; but how often we overlook the simple things.

G. H. Button.

The Concentration of Staff.

The advantages and disadvantages of concentrating or scattering staff, are questions which must be judged on the geography and other factors which must, necessarily, differ in each forest, and while supervision is undoubtedly made easier by getting men in one or two compact gangs, the scattering of staff working in groups of three or four men, over the forest, may easily prove very advantageous.

The main disadvantage in scattering is lack of efficient supervision, which is a very important matter, especially on a new area where men have to be trained, but generally the work on new areas can be so arranged to avoid scattering, and give the forester a better chance of supervision.

In Gwydyr Forest, I have found that the main points in favour of scattering staff, are the consequent avoidance of additional fire and trespass patrols, and also that men can be kept working within comparatively easy reach of their holdings, thus saving a great deal of time in an area of high rainfall.

At Gwydyr we have between twenty and thirty holdings occupied, and these are distributed at fairly regular intervals over the forest, and as far as possible work is arranged in sections to avoid men crossing each other's path or walking farther than two or three miles.

Not only are the forest holders quite a good type, who can generally be trusted to do their work well without close supervision, but this arrangement tends to create a better feeling among the men, especially in inclement weather, and it has undoubtedly helped to get through our winter programme when weather conditions were very bad.

The main advantage, however, is in checking fire damage and trespass; Bettws-y-Coed, particularly, is very popular with visitors, and the plantations are a labyrinth of footpaths, leading to various view points, waterfalls, etc., and if not controlled, people stray from the paths, roll about on the trees, switch them with walking sticks, light camp fires, etc., and so on. The presence of workmen is not only in itself a deterrent, but the public can be warned before damage has been done. That this is necessary is evident from the fact that when spoken to by workmen or patrols, they always plead ignorance, and say they thought it was common land.

During last summer's drought, at least eight fires were checked which might have proved very disastrous had it not been for the presence of workmen, who, whilst working at different points, are notified of each others whereabouts.

Owing to the undulating ground, the special patrolmen cannot cover ground which is far away from the pathways, and it is difficult to locate smoke. When men can be employed satisfactorily at different points of the forest, fire danger is undoubtedly minimised, thus lessening the worries of the forester.

J. L. Shaw.

Sawmilling for Forest and Estate Purposes.

When Radnor Forest was first started, in 1925, it was decided to make a number of forest workers' holdings. This, of course, meant that a number of new buildings would be required in addition to the buildings already belonging to the several farms of which the property was composed. In view of the high cost of hauling material from a town or railhead, the nearest of which is 7 miles away, the last 3 miles of which

being up a very steep by-road, it was decided to convert our own timber as far as possible. There was only one clump of oak on the place, and this being good, clean stuff, was felled by our own men in a slack time, at 10*s.* per 100 ft. cube. A contractor was found who was willing to tush and convert the lot to any sizes required, at a price of 1*d.* per ft. for tushing and 6*d.* per cub. ft., *e.g.*, in the log, for conversion. The boles of the trees were sawn into boards and various sizes of scantling, and the tops, etc., into stakes. In addition, some of the best planks were selected and cut out, and made up into gates, at a price of 7*s.* 6*d.* per gate. This alone meant a great saving as previously gates were costing us 19*s.* each, exclusive of hauling.

On the other side of the forest, some four or five years previously, a larch plantation had been felled by timber merchants, and a quantity of this had not been removed. On account of the trees having lain so long the bark had fallen off, and in some cases the sap wood was decaying, making them unfit for sale, so it was decided to convert the best of this, and also a small spruce plantation which was suffering badly in the numerous gales for which this place is noted. The same contractor was engaged to convert this, but on different terms, being paid at the rate of 6*s.* per 100 ft. super for boards, 4*s.* 6*d.* per 100 ft. run for scantlings (any size), 1*s.* 6*d.* per dozen cutting and pointing stakes, and 9*d.* per dozen dropper stakes. Gates, 9-ft., were, as before, 7*s.* 6*d.* each, and hunting gates, 4-ft. 3-ins., 4*s.* Slabbing was paid for at 1*s.* per 100 ft. run.

Now as to the use of the material. In several cases, if a holder needed a small shed, fowlhouse, or pigsty, we found him the material, and also roofing, hinges, nails, etc., and he erected it in his spare time. One of the holders, who is used to estate carpentry, erects and repairs other buildings, for which he is paid extra, for his knowledge, use of tools, etc. For some of the more pretentious buildings, a contractor is engaged, who tenders solely for erection, we supply and have all material. The whole scheme, I think, is very satisfactory, and I am sure a great saving must have been made. We have now a plentiful supply of material to equip the holdings now in course of erection, and also a plentiful supply of gates and fencing stakes (of which a great number have been sold at 45*s.* per 100).

Personally, I think that in these days where most men have a fair knowledge of motors, an oil engine and small saw bench would be a great saving on any forest where there is standing timber, and where forests are in fairly close proximity to one another, one bench to two or three forests would be sufficient. I am sure that in running out a few boards for repairs, material for making and repairing gates, etc., the initial cost of buying would soon be replaced, besides which it would make work for holders, etc., during bad weather.

P. HARRISON.

Lack of local Demand for Timber.

In the southern counties at present it is only by purchasing timber at ridiculously low prices that many timber merchants are able to make a living. Some firms after buying a wood fell only the best trees and of those felled they take away merely selected lengths. Frequently when clearing areas for replanting one comes across much good timber from trees which have been felled but not removed.

The machinery used in portable mills by the timber merchants is often quite out of date. The saws are of a wasteful type, producing far too much sawdust and the men employed do not know how to make the best use of the timber at their command. In many industries there has been a marked improvement in machinery recently, but in sawmilling in country districts we still see the same plant working which did service before and during the war. Proper organisation and more efficient methods of timber conversion are badly needed. A committee of experts who could enquire into the methods adopted might be the means of making considerable changes with beneficial results.

Something might also be done in connection with the Commission's forestry schools. If training in sawmill operations was provided at these centres the subsequent spread of technical knowledge might be expected to have a useful effect on the timber trade in course of time. Scholarships, perhaps, could be given which would be tenable with efficient timber firms on much the same lines as in the case of mining classes under County Councils. We are wholly dependent on timber merchants when we come to sell our produce, and on this account the betterment of existing conditions is of considerable importance.

Robert Butter.

Suggested Meeting of Foresters.

It would be of great advantage to foresters and foremen in charge of the Commission's operations, if the Commissioners arranged a meeting for the foresters of each Division to take place once a year. The meeting could take the form of a tour of one of the Commission's operations.

Foresters seldom meet with anyone interested in their work, so are unable to exchange opinions, discuss methods or gain experience to help them in their task of establishing forests. Reports of the meetings could be published in the Commission's Journal and would make interesting reading.

R. B.

Turf Planting on a large Scale.

The turf planting which has been carried out in the last two or three years has proved to be increasingly beneficial to the growth of the plants, and with these favourable signs a more extended use of this method

has been advised. To start with, only the worst type of bogs were turfed, but now it is considered advisable to extend this to more solid ground of certain types, and I propose to mention one particular instance where turf planting would most likely have reacted favourably on the growth and general condition of the plants.

For those who are not acquainted with the sheep-grazed moors, it will be well to state here that when the sheep are removed from any area, the appearance of the vegetation and in fact the vegetation itself shows an almost immediate change, and the growth of previously almost unnoticed species continues rapidly, and usually unfavourably to any tree growth. At Gwydyr Forest there is an area of about 30 acres planted in P.23 with Sitka spruce, where the vegetation originally consisted of a mixture of some of the better grasses, together with Scirpus, Calluna and Ulex, the two latter of which were probably hardly noticeable, although to-day they are two and sometimes 3 ft. high. The Sitka pursuing their usual course in such areas went into check, while the surrounding gorse and heather flourished. This has involved a very heavy case of weeding, but at last, in this past growing season, they have begun to get a better colour and show signs of recovery, although it may still take another two or three years before any appreciable growth is made. It certainly teaches us a lesson never to despair of a spruce until it is dead. Although, unfortunately, no exactly similar area has been turf planted, I think from the beneficial effect of turfing in every type so far attempted, there is little doubt it would have very greatly reduced the check period on this area and saved a large cost in weeding.

There is, undoubtedly, ample evidence to justify a much larger turfing programme being undertaken as far as early growth and the general health of the plants are concerned, but the cost on a large scale is bound to be proportionately large. Where it has been undertaken extensively on piece-work, the cost has, of course, varied in consideration of many factors, but the general price paid for cutting a chain of shallow turf drainage and placing the turfs is 2*s.* 6*d.*, and in fairness to employer and employee I do not think that as a whole it can be reasonably reduced any lower at the present moment. No unreasonably high wages are made at this rate even with the best weather conditions prevailing.

The depth of the turf varies with the type of the ground. Broadly speaking, the principle is that the turf shall always be as thin as is practicable. In a very spongy wet type a thick turf about 8 ins. thick may be taken out and the plants actually planted with their roots mainly in the turf. In the drier types such as a tight peat, a thin turf is cut, of about 3 or 4 ins. thick. In planting this thin turf a mattock is usually used, but a light spade does equally well. The turf is split from the edge to the centre and the plant is placed in the slit in the centre of the turf, with the roots slightly spread out in the decaying vegetation underneath. In general the best place for the cut to be made is the north end of the turf, where the prevailing wind is west or south-west, which is the case

in most areas where turf planting is undertaken. The drying out of the roots is very liable to take place where the turf is not properly "bedded-down" on to the natural surface. This has to be watched particularly in heather areas and also in those areas where *Juncus communis* is in abundance. Turfing on a small scale is being tried at Beddgelew and Vaughan, with deep narrow turfs cut out of drains 15 ins. wide at the top, about 8 ins. wide at the bottom, and about 15 ins. deep, laid on their sides instead of upside down. The results should still be satisfactory, the only difference being that the quantity of decaying vegetation under the turf is reduced by half. This method is best suited to areas where there is a deep and not too wet peat, and the area covered per chain of drains would be very much larger than that covered by other methods, the actual area depending on the thickness of the turf. The problem of cost is, however, still one for consideration, as although fewer drains would be cut (often in itself a disadvantage), there would be much more cutting required in such as were made, and the carrying distance for individual turfs would be greatly increased.

Although it is generally considered that a turf which has been cut some months before planting may give the best results, this is still in experimental stages; but I can state that some late turf planting done in P. 29 in turfs cut not much more than a month previous to planting have shown good results to date.

The sheep draining, or rutting, spade which is made for right- or left-foot is perhaps the best tool for cutting the sides of turf drains. For cutting the turfs themselves into the right length a cross cut spade is used, and a drain-drag or gaff, or garden fork is used for laying out the turfs. For undercutting the turfs a type of turfing iron used in ordinary turf-laying is found to be very useful. Sometimes a peat knife is used.

The cost of planting the turfs per 1,000 varies from 10*s.* to 12*s.* 6*d.* with different areas, but I think there is no doubt whatever that a man has to work very hard indeed to make a decent wage at the rate of 10*s.* per 1,000, especially in areas where there is much bad weather through the planting season; there is then a very grave danger of bad work, particularly where sufficient supervision cannot be provided to keep constant watch over the men.

When the initial cost of turfing is balanced against the resultant saving in weeding and beating-up costs, it is by no means certain that in many areas turf planting will not be an economy in the end, especially in view of the fact that it appears to give spruces a good "kick" and reduce the length of the check period.

I do not think there is any reason why, in specific areas, turfing should not be used with species other than spruces, and in particular I would suggest those pines which are planted in places where it is thought that nothing else will grow, providing always that there is sufficient soil to allow of its being done. After all, the main trouble which turfing overcomes is the lack of aeration, and the roots of all plants require soil aeration. I am carrying out a small experiment in

this method at Gwydyr Forest in P. 30 with Scots pine and *Pinus contorta* on a tight *Calluna-scirpus* peat, and it will be interesting to note what benefit, if any, is derived from the turfing.

The whole subject is still in its infancy, and there is ample scope for research which may prove very valuable as we gradually encroach on the poorer types of soil conditions.

R. H. Smith.

Turf-planting—Practical Points.

The following notes apply particularly to conditions in Cardiganshire and Montgomeryshire, where a fair amount of turf-planting has been done during the last two years with considerable success.

The following plants usually found abundantly in "turfed" areas give rise to various difficulties in cutting turfs.

(*a*) *Sphagnum.*—Owing to the spongy nature of this moss and the peat formed from it, turfs are generally rather unsatisfactory; they dry out and shrink to perhaps a half to a third the original size, and lack sufficient weight to keep them well bedded down. Fairly satisfactory results can be obtained by cutting thicker turfs and by lifting during dry weather during the summer, when the ground being drier the operation can be performed more easily as less effort is wanted in lifting the weight of water and shrinkage after spreading is less pronounced.

(*b*) *Polytrichum.*—On very wet ground the same remarks apply as for *sphagnum.* On drier ground some difficulty is found in getting the turf to settle well, and for this reason it is particularly desirable to "turf" several months in advance of planting.

(*c*) *Tufted molinia.*—Turfs are bound to be very uneven and extra care is needed in laying, to avoid air spaces between the turf and the ground; turfs also need careful lifting as the peat is usually apt to crumble.

(*d*) *Juncus squarrosus.*—The roots of this plant are dense and very tough, making cutting much more laborious, but the turfs are usually good and settle well.

(*e*) *Juncus communis.*—The cutting is apt to be tough owing to the roots, but the peat is soft and breaks up rather too easily. Turfs are better cut larger than usual, especially as large plants, which are less likely than small ones to be smothered by dead rushes can be used, thanks to the good shelter afforded by the vegetation.

(*f*) *Molinia-scirpus* generally affords good turfs and the cutting gives no particular difficulty.

(*g*) *Calluna-molinia.*—When heather is long it must be removed from the line of the turf drain. It is not generally necessary to pull the heather from the place where each turf is to be placed as long as it is well bedded and not supported from the ground by branches.

Short dense heather areas make it more difficult to bed the turf as they dry out more easily.

Tools.

Much depends on the tools commonly used in the district for cutting fuel peat and for draining. The following have been found most effective :—

Side-cutting.—A knife mounted on the end of a straight shaft, the blade approximately 15 ins. long and curved gradually through about 30°, the sharpened edge being on the outside of the curve. Old hay knives have been used with some success.

Undercutting.—Spades can be used, but tend to make turfs uneven in thickness and to leave the " turf drain " in steps. The best implement so far found is a flat heart-shaped knife about 8 to 9 ins. wide, mounted on a T-handled shaft with a slight swan-neck at the socket.

Lifting and spreading.—A strong three-pronged drain-drag is best for all but the very crumbling peats, when a spade may have to be used.

Method of Cutting.

After marking out and, if necessary, mowing surface vegetation, the sides of the turf-drain are cut with the side-cutting knife to the required depth, usually 4 ins., the cross cuts being made at the same time at 15-in. intervals. Two men follow, one undercutting and the other lifting the turfs to one side. The width of the undercutter should be such that two cuts per turf are enough. Finally, the turfs are shifted and spread. With a planting spacing of 5 ft. four complete rows of turfs should be secured, but in practice owing to broken turfs, etc., this is not always secured.

Lay-out of " Turf-Drains."

Turf-drains do not form an integral part of the main drainage system, and may be quite independent of it, but they can be made to fulfil the following purposes : (*a*) When marking out drains proper it is difficult to judge the exact amount of drainage necessary, and as it is undesirable on account of cost to overdrain, turf drains can later be made along lines where it is thought further drains are or may be required ; these can be deepened at a moderate cost should additional drains be needed. (*b*) On wet hillsides there is often a number of small channels which do not carry sufficient water to justify deep draining, but which can be successfully confined and led away by means of " turf-drains." (*c*) On ground with no slope or with uniform slope " turf-drains " run between and parallel to the " cut-off " drains and help in removing flood-water. (*d*) Small springs can be tapped when the cost of a full drain is not justifiable. (*e*) Isolated bogs are often found at the top of well-drained slopes far removed from the main drainage systems, and with no natural outlets and an effective " run off " can be made by cutting a " turf-drain " straight down the hillside into a main drain at the bottom,

provided the slope is steep, so that a big lot of water can run away quickly without overflowing; in most types of ground these run-offs will in time cut themselves out into good channels. (*b*), (*c*) and (*d*) must be regarded as purely temporary measures required merely for the establishment of the crop, as they will silt up and cease to function after a year or two.

Time and Season for Cutting Turfs.

"Turfing" is best done during the summer previous to planting so as to give turfs time to settle well, and when the ground is dry the work is done much more easily, as the turfs will be (except in very wet areas) lighter to spread and shrinkage will be less.

"Turfing" also affords suitable work during short periods of frost, when planting and nursery work are held up, but when the ground is not too hard to cut. The winter is not the best season for cutting on the whole, as turfs cut then are not likely to be settled in time for the current season's planting, whilst they may not be ideal for the next year owing to excessive disintegration or the establishment of strong weed-growth.

Turfs from the Main Drainage Systems.

The same tools are usually employed as for cutting "turf-drains," but the sides can be done with the "sheep-drain spade," which, in suitable peat, will cut to the full depth of the drain in one cut. When this is used a large part of the depth of the drain can be lifted in one, and the turf must then be cut off with a spade afterwards.

Where the peat is very fibrous and does not break easily, a second layer of turf can be lifted from underneath the first. This second horizontal section is physically better than vertical sections, because it is much less likely to break up prematurely, and where it can be used a considerable saving is effected. Normally the lower peat from bottoming the drains is piled in a ridge along one side of the drain, and serves in lieu of a row of turfs; in very wet ground this ridge should be made along the lower side of a "cut-off" drain to benefit by the latter, and to avoid impeding surface water. Turfs spread from drains should normally be spread on the upper side of a "cut-off" unless the whole area must be "turfed" as though at the time of making a "cut-off" drain the lower side may be the wetter, the conditions will be reversed if the drain is effective. There are always exceptions to the above.

Methods of fixing Piece-Work Rates.

Assuming turfs are always cut from drains or from "turf-drains," they can be paid for by the hundred turfs or by the chain. The usual practice is to pay different rates for turfs from drains, and for those from "turf-drains," and where this is the case, and where the two operations are being done on the same area a rate per chain is the most satisfactory, and less likely to lead to confusion. It is necessary for the man in charge of the work to make careful checks to verify that the

correct quantity of turfs are being spread per chain. When quantities are paid for by the hundred a check is needed to ensure that the correct size is being maintained.

Planting Turfs.

The most suitable plants used have been two-year one-year Sitka spruce, about 6 ins. long, though smaller plants have been used with equal success as long as the turfs were not more than 4 ins. thick.

The essential points are that the root tips should be between the under surface of the turf and the ground, and that the plant should be firmly planted. To ensure this it is often necessary, especially in the case of small plants, to plant deep. Generally speaking, the best place for the root collar is in the turf rather above the middle, but no harm seems likely to be done if it is still deeper, provided the roots are in the right place. As the turf is subjected to sun, frost, wet and wind, it tends to crumble, and the planting slit to open at the top, but no injury is done if the roots are correctly placed. "Deep" planting avoids the risk of frost lift, and loosening by wind, but the latter is not likely to occur if small plants are used. The use of larger plants is only justifiable where weed growth is very strong, as may happen in dense *Juncus* or *Molinia* areas, but if a turf not less than 15 ins. square is used small plants should get away without weeding in almost any vegetation.

For planting, a light spade or the turf cutting knife is the most suitable tool for slitting the turf. A vertical cut should be made, reaching from the centre of one side to the centre of the turf, the turf lifted up and the plant inserted hard up against the end of the cut, the roots being spread out flat underneath. The turf should then be replaced and the slit well closed.

The slit should be made on the side remote from the most dangerous atmospheric influence, which is (*a*) in early planted areas, especially near the west coast and in exposed situations, south-west winds, (*b*) in late planted areas, east winds; (*c*) in low rainfall areas, possibly the drying influence of the sun in the south.

General.

The practice of turf-planting, apart from the primary object of reducing or abolishing the check period in spruces on wet unfavourable sites, deserves consideration for the following reasons:—(*a*) In dense grass, weeding can be greatly reduced or abolished. (*b*) Small plants can be used affording a saving in nursery and transport costs. (*c*) In many areas where other work is not available, turf-cutting affords excellent summer employment, reduces the amount of work done during the bad weather season, and to some extent provides work during frosty intervals during the planting season. (*d*) Frost hollows and dense grass areas subject to severe frost may be more successfully planted if "turfed." (*e*) Failures, and thus beating-up costs are reduced.

It is unlikely that the extra cost involved would be justifiable solely for any one of these five reasons, but they all deserve consideration when deciding whether an area should be turf-planted or not.

Apart from enhanced first cost, the only disadvantage, noted in this district is that, in severe weather, hares sometimes take a special fancy to small Sitka on turfs, and pull them right out. This can probably be avoided by planting late in the season.

F. C. BEST.

LIST OF TECHNICAL STAFF.

Officers of Divisional, District and Analogous Scales.

Since the last issue of the *Journal*, changes have occurred as follows :—

Headquarters.

Mr. J. A. B. Macdonald, appointed District Officer on probation, Imperial Forestry Institute, Oxford.

England and Wales.

Mr. G. J. L. Batters, appointed District Officer, Division 1 (after probation).
Mr. F. C. Best, appointed District Officer, Division 2 (after probation).
Mr. R. H. Smith, appointed District Officer, Division 2 (after probation).
Mr. D. F. Stileman, appointed District Officer on probation, Division 3.
Mr. D. V. Murray, appointed District Officer on probation, Division 4.

Schools for Forest Apprentices.—The School in Scotland has been transferred from Beaufort, Inverness, to Benmore, Argyll.

Scotland.

Northern Division.—Address of office is now 51, Church Street, Inverness.
Mr. H. C. Beresford-Peirse appointed District Officer on probation Northern Division.

Foresters—Full List.

Name and Address.	*Grade.*	*Forest.*
England and Wales.		
Division 1.		
McGlashan, J. ; Low Dalby House, Lockton, Pickering, Yorks.	I ..	Allerston.
Bewick, W. J. ; Thrunton, Whittingham, Northumberland.	II ..	Rothbury.
Laney, H. ; Forester's House, Beck Wythop, Thornthwaite, Keswick, Cumberland.	II ..	Thornthwaite.
Anderson, J. T. ; Spring Cottage, Falstone, North Tyne, Northumberland.	II ..	North Tyne Valley.
Reid, D. ; The Haven, Coldyhill Road, Newby, Scarborough, Yorks.	II ..	Allerston.
McNab, C. ; Middle Redford, Hamsterley, Witton-le-Wear, Co. Durham.	II ..	Hamsterley.
Gough, W. R. ; c/o Mrs. Hunter, Wrench Green, Hackness, Scarborough, Yorks.	II ..	Allerston.

Name and Address.	*Grade.*	*Forest.*
	England and Wales.	
Hodgson, W.; Chopwellwood, Rowlands Gill, Co. Durham.	II	Chopwell.
Gilson, R.; Ampleforth, Yorks ..	II ..	Ampleforth.
Simpson, G. A.; Abbotshaws, The Flatt, Newcastleton, Roxburghshire.	II ..	Kershope.
Division 2.		
Edwards, J.; Ministry of Labour Camp, Presteigne, Radnorshire.	Head ..	Mortimer (Camps).
Roberts, W. G.; Castle View, Wigmore, Leominster, Herefordshire.	II ..	Mortimer.
Williams, Jack; Pandy Glasdir, Llanfachreth, Dolgelley, Merioneth.	I	Vaughan.
Jones, G. W.; Linmere, Delamere, Northwich, Cheshire.	I ..	Delamere.
Squires, C. V.; Brookbatch, Acton, Bishops Castle, Shropshire.	II	Walcot.
Shaw, J. L.; Diosgydd Isaf, Bettws-y-Coed, Carnarvonshire.	I ..	Gwydyr.
Anderson, J. W.; Tygwyn, Pentrellyn Cwmmer, Cerrig-y-Druidian, Merioneth.	I ..	Clocaenog.
Harris, W. A.; Chamberlayne Lodge, Arley, Bewdley, Worcestershire.	II ..	Wyre.
Fraser, R.; Forester's Lodge, Aberangell, Mont.	II ..	Dovey.
Harrison, Percy; Forester's Lodge, Cascob, Presteigne, Radnorshire.	II	Radnor.
Brown, G. H.; Hafod Ruffyd Ganol, Beddgelert, Carnarvonshire.	II ..	Beddgelert.
Cowe, J. F.; Pottal Post Lodge, Penkridge, Staffs.	II ..	Cannock Chase.
Inglis, A.; Haughwood Cottage, Mordiford, Hereford.	II ..	Haugh.
Lomas, J.; Pant Perthog, Mont.	II	Dovey.
Edwards, D. T.; Berwynfa Cynwyd, N. Wales.	II	Cynwyd.
Jones, D.; Ffrwydy Gwilt, Rhydymain, Merioneth.	II	Vaughan.
Smith, H. J.; Mines Arms Hotel, Pantrhydygroes, Cardiganshire.	II ..	Myherin.
Smith, J. J.; Kingwood Lodge, Frodsham, Cheshire.	II ..	Delamere.
Wellington, C. R.; Pantyllydiart Farm, Kerry, Mont.	II ..	Kerry.

Name and Address.	*Grade.*	*Forest.*
	England and Wales.	
Division 3.		
Lewis, T.; Crown Lodge, Tintern, Chepstow, Mon.	I	Tintern and Chepstow.
Butter, R.; Underdown, Haldon, Exeter.	I	Haldon.
Wallington, A. W.; Parish's Lodge, Overstowey, Bridgwater, Somerset.	II	Quantocks.
Williams D. N.; Broadwood, Dunster, Taunton, Somerset.	II	Exmoor.
Dyer, H. C.; Botany Bay, Tintern, Chepstow, Mon.	I	Tintern.
Hollis, G. W.; The Colony, Pembrey, Carmarthenshire.	II ..	Pembrey.
Wallington, H. J.; Harefield Lodge, Plumley, Ringwood, Hants.	II	Ringwood.
Colwill, S.W.; Forester's Lodge, Cold Harbour, Wareham, Dorset.	II	Wareham.
Pritchard, R.; Drawbridge Bungalaw, Halfway, nr. Liskeard, Cornwall.	II ..	Bodmin.
Jones, A. H.; Llaneglwys, Erwood, S.O. Brecon.	II ..	Brecon.
Weir, A.; Forester's Lodge, Alltwallis Road, Carmarthen.	II	Glangwili.
Pallett, R. E.; The Laurels, Kilmington, Frome, Somerset.	II ..	Bruton.
Wild, P.; Craig Wen Cottage, Abercarn, Newport, Mon.	II	Llanover.
Harrison, P.; Tidvil House, Rugby Road, Resolven, Neath, Glam.	II ..	Rheola.
Caddy, T.; Gwernlycu, Coed Ely, Llantrisant, Glam.	II ..	Llantrisant.
Edwards, L.; Afon Wen, Duffryn Valley, Port Talbot, S. Wales.	II ..	Margam.
Division 4.		
Simpson, A.; Forest Lodge, Alice Holt, Farnham, Surrey.	— ..	Alice Holt and Woolmer.
Richards, G. H.; Clapper Oak Cottage, Minley, Farnborough, Hants.	II ..	Bramshill.
Butler, R.; Jewsley Cottage, High Street Green, Chiddingfold, Godalming, Surrey.	II ..	Chiddingfold.
Jones, T.; Piddington Lodge, Piddington, Northants.	I ..	Salcey.

Name and Address.	*Grade.*	*Forest.*
England and Wales.		
Nelmes, F. : Whitelimes, Cranbrook, Kent.	I ..	Bedgebury.
Johnson, A. E. ; Park Villa, Stelling, Canterbury, Kent.	II ..	Lyminge.
Cottenham, W. ; c/o Mrs. Fox, Woodnewton, Peterborough, Northants.	II ..	Rockingham.
Gulliver, G. H. ; Forest Lodge, Syresham, Brackley, Northants.	II	Hazelborough and Brackley.
Aston, T. ; Thatch Cottage, West Dean, Seaford, Sussex.	II ..	Friston.
Phelps, S. E. ; Dean Barn, Buriton, Petersfield, Hants.	II ..	Buriton.
Saunders, H. J. ; Harley Way Lodge, Brigstock, Kettering, Northants.	II ..	Rockingham.
Division 5.		
Hankins, C. ; Tangham Farm, Capel St. Andrew, Woodbridge, Suffolk.	Head	Rendlesham.
Anderson, T. E. ; Preston Lodge, Edwinstowe, Mansfield, Notts.	I ..	Clipstone.
Tribe, W. ; Laughton Lodge, Gainsborough, Lincs.	II ..	Laughton.
Hendrie, T. ; Forest Lodge, Brandon Road, Swaffham, Norfolk.	II ..	Swaffham.
Clark, J. S. ; Santon Downham, Brandon, Suffolk.	II ..	Thetford.
Kidd, J. ; Brookview Cottage, Bourne, Lincs.	II ..	Bourne.
Bewick, R. ; 11, Appleton Road, Blidworth, Mansfield, Notts.	II ..	Sherwood.
Johnson, H. ; Forest Lodge, Weeting, Brandon, Suffolk.	II ..	Thetford.
Everett, F. W. ; Broom House, Brandon, Suffolk.	II ..	Thetford.
Price, A. ; Lynford Nursery, Brandon, Suffolk.	II ..	Thetford.
New Forest Division.		
Forgan, W. ; Denny Lodge, Lyndhurst, Hants.	Head	New Forest.
Aston, O. R. T. ; Signal House, Parkhurst Forest, Newport, I. of W.	I ..	Parkhurst, Brightstone and Combley.
Aston, S. ; Wood End, Wickham, Hants.	I ..	Bere.

Name and Address.	*Grade.*	*Forest.*
	England and Wales.	
Parker, F. H.; Lodge Hill Cottage, Lyndhurst, Hants.	II ..	New Forest.
Adams, J. H.; Stockley Cottage, Brockenhurst, Hants.	II ..	New Forest.
Blake, W. G.; Coppice Linwood Cottage, Fritham, Lyndhurst, Hants.	II ..	New Forest.
Gale, B.; Rhinefield Cottage, Brockenhurst, Hants.	II ..	New Forest.
Dean Forest Division.		
Smith, Frank; Worcester Lodge, Coleford, Glos.	Head	Dean.
Walker, A. E.; Crown Lodge, Oxenhall, Newent, Glos.	II ..	Dymock.
Humphries, W. J.; Marians Lodge, Coleford, Glos.	I	Dean.
Christie, W.; Reddings Lodge, Coleford, Glos.	II	Dean.
Taylor, G.; Russell Lodge, Parkend, Lydney, Glos.	II	Dean.
Adams, I.; Brandricks Green Lodge, Parkend, Lydney, Glos.	II	Dean.
Lees, G.; Crabtree Hill Lodge, Cinderford, Glos.	II	Dean.
Watson, F.; Perch Lodge, Coleford, Glos.	II	Dean.
Morgan, T.; Parkhill Lodge, Whitecroft, Lydney, Glos.	II ..	Dean.
	Scotland.	
N. Division.		
Cameron, J.; Auchterawe, Fort Augustus, Inverness-shire.	Head ..	Inchnacardoch, Portclair and Creagnaneun.
Anderson, W.; Polloch House, Glenfinnan, Inverness-shire.	I ..	Glenhurich.
Mason, W.; Nevis Farm, Fort William, Inverness-shire.	II	Nevis.
McEwan, J.; Portclair, Invermoriston, Inverness.	I ..	Portclair.
McClymont, W.; Aultsigh Cottage, Invermoriston, Inverness-shire.	II ..	Creagnaneun.

Name and Address.	*Grade.*	*Forest.*
	Scotland.	
Mackay, K.; Hilton Embo, Dornoch, Sutherland.	II	Dornoch.
Murray, W.; Ratagan, Glenshiel, Kyle, Ross-shire.	I ..	Ratagan, Glenshiel, Inverinate and Eilanrach.
Macdonald, D.; Leckanashie, Lochcarron, Ross-shire.	II ..	North Strome and South Strome.
Macintosh, W.; Easter Buntait, Glenurquhart, Inverness-shire.	II ..	Glenurquhart.
Gunn, J.; Forestry Commission, Fort Augustus, Inverness-shire.	II ..	Inchnacardoch.
Rose, A.; Smithton, Culloden, Inverness.	II ..	Culloden.
Kennedy, J.; Inchree, Onich, Inverness-shire.	II ..	Glenrigh.
Cameron, R.; South Laggan, Invergarry, Inverness-shire.	II	South Laggan and Glengarry.
Stewart, P.; Station House, Clachnaharry, Inverness.	II ..	Craig Phadrig and Kessock.
Mackenzie, G.; Slattadale, Achnasheen, Ross-shire.	II	Slattadale.
Mitchell, H.; Forestry Commission, Glenshiel, By Kyle, Ross-shire.	II ..	Glenshiel.
N.E. Division.		
Warren, A.; Teindland Cottage, Head Orton, Morayshire.		Teindland, Altonside and Ordiequish.
Sinclair, W.; Craibstone Nursery, Bucksburn, Aberdeenshire.	I ..	Craibstone Nursery.
Shaw, R.; Fetterdale, Tayport, Fife.	I ..	Tentsmuir.
Lamb, J. A.; Seaton, Nursery, Tillydrone Road, Woodside, Aberdeen.	I ..	Seaton Nursery.
Mitchell, F. M.; c/o Kennedy, Kintessack, By Forres, Morayshire.	II ..	Culbin.
Robbie, J. D.; c/o Davidson, The Crook, Alves, By Forres, Morayshire.	II ..	Monaughty.
McConnell, J.; Brechin Road, Friockheim, By Arbroath, Forfarshire.	II ..	Montreathmont.

Name and Address.	*Grade.*	Forest.
Scotland.		
Corbett, J.; "Glenview," Auchenblae, Fordoun, Kincardineshire.	II ..	Drumtochty.
Clark, F. J.; Ordbrae, Huntly, Aberdeenshire.	II ..	Bin.
Allan, J.; Hillfield, Kemnay, Aberdeenshire.	II ..	Kemnay.
Kennedy, J. M.; Badaguish, Glenmore, Aviemore, Invernessshire.	II ..	Glenmore.
Ross, A.; West Lodge, Pitfour, Aberdeenshire.	II ..	Deer.
Allan, T., Gordonsburn, Huntly, Aberdeenshire.	II ..	Clashindarroch.
S.E. and W. Division.		
Cameron, Hugh; Glensalloch House, Barcaldine, Ledaig, Argyll.	II	Barcaldine.
Macintyre, J.; 1, Langholm Street, Newcastleton, Roxburghshire.	II	Newcastleton.
Spraggan, D.; Guithas Cottage, Ardgarten, Arrochar, Glasgow.	I ..	Ardgarten.
Reid, J. M.; Auchendarroch, Duror, Oban, Argyll.	II	Glenduror.
Paterson, S. H. A.; Hazel Bank, Manse Road, Aberfoyle, By Stirling.	I	Loch Ard.
Simpson, A. N.; Tulliallan Nursery, Kincardine, Fife.	I	Tulliallan Nursery.
Calder, J. M.; Glenbranter, Strachur, Argyll.	II	Glenbranter.
Fraser, A. M.; Glencorse, Parkgate, Dumfries.	II	Closeburn.
Graham, A.; Eshiels Cottage, Peebles.	II ..	Glentress.
Kennedy, J. A. M.; 38, Maxwell Street, Dalbeattie, Kirkcudbrightshire.	II ..	Dalbeattie.
Cameron, Alistair; Kinloch Street, Ladybank, Fife.	II	Edensmuir.
Macmillan, H.; Drynairn Cottage, Ardentinny, Argyll.	II ..	Glenfinart.
Ross, W. L.; Comrie Keltneyburn, Aberfeldy, Perthshire.	II	Drummond Hill.
MacRae, M.; c/o Taylor, Black Road, Kelty, Fife.	II	Blairadam.

Name and Address.	*Grade.*	*Forest.*
	Scotland.	
Grant, A.; Benmore House, By Dunoon, Argyll.	II ..	Benmore.
Drysdale, A.; Aros Mains, Salen, Mull.	II ..	Salen.
Donald, R. R.; Benmore School, Benmore, By Dunoon, Argyll.	II ..	Benmore.
	Research and Experiment.	
Gray, W. G.; Wayside, Kennington, near Oxford.	II ..	—
Grant, A.; Forestry Commission, Fort Augustus, Inverness-shire.	II ..	—
Brookman, H. A.; Altonside, Lhanbryde, By Elgin, Morayshire.	II ..	—

REGISTER OF IDENTIFICATION NUMBERS

FOREST YEAR, 1929.

The order of arrangement is as follows :—

Serial number (preceded by the last two numbers of the forest year in which supplies were received) ; quantity ; species ; crop year ; origin ; vendor ; purity per cent. ; germination and fresh seed per cent.

29/1 8 ozs. ; *Pinus brutia* ; crop year unknown ; Turkey ; gift from Turkish Government.

29/2 61 lbs. ; *Quercus sessiliflora* ; 1928 ; France (Boulogne Forest) ; gift from French Forestry Service.

29/3 27 lbs. ; *Quercus sessiliflora* ; 1928 ; France (Champenoux Forest, Meurthe and Moselle) ; gift from French Forestry Service.

29/4 25 lbs. ; *Quercus sessiliflora* ; 1928 ; France (Flavigny Forest, Meurthe and Moselle) ; gift from French Forestry Service.

29/5 41 lbs. ; *Quercus sessiliflora* ; 1928 ; France (Gâvre Forest, Loire Inférieure) ; gift from French Forestry Service.

29/6 43 lbs. ; *Quercus sessiliflora* ; 1928 ; France (Verdun, Meuse) ; gift from French Forestry Service.

29/7 40 lbs. ; *Quercus sessiliflora* ; 1928 ; France (Blois, Loir and Cher) ; gift from French Forestry Service.

29/8 7¼ lbs. ; *Picea alba* ; 1928 ; Denmark ; J. Rafn.

29/9 530 lbs. ; *Quercus rubra* ; 1928 ; Holland ; Nederlandsche Heidemaatschappij.

29/10 2,556 lbs. ; *Quercus sessiliflora* ; 1928 ; Germany (Harz Mountains) ; Schultze & Co.

29/11 5,290 lbs. ; *Fagus sylvatica* ; 1928 ; Czechoslovakia ; Schultze & Co.

29/12 2½ lbs. ; *Pinus Peuke* ; crop year unknown ; Bulgaria ; gift from Bulgarian Government.

29/13 24½ lbs. ; *Cupressus macrocarpa* ; 1928 ; France (South-west) ; Vilmorin-Andrieux ; 99·8 ; 15.

29/14 5 lbs. ; *Carpinus Betulus* ; 1928 ; France (Central) ; Vilmorin-Andrieux.

29/15 4,850 lbs. ; *Castanea vesca* ; 1928 ; France (Central) ; Vilmorin-Andrieux.

29/16 1 lb. ; *Pinus monticola* ; 1928 ; Canada (Fraser Valley, British Columbia) ; Canadian Government.

29/17 3 lbs. ; *Pinus ponderosa* ; 1928 ; Canada (Salmon Arm, British Columbia) ; Canadian Government.

29/18 5 lbs. ; *Rhamnus Purshiana* ; 1928 ; Canada (Fraser Valley, British Columbia) ; Canadian Government.

29/19 1 oz. ; *Picea omorika* ; 1928 ; Serbia ; Sample from Vlado Puljizević.

29/20 1,437 lbs.; *Pinus Laricio*; 1928; France (Corsica); Joseph Grimaldi; 98·9; 49 + 6.

29/21 5 lbs.; *Abies cephalonica*; 1298; Italy (North); Vilmorin-Andrieux.

29/22 37 lbs.; *Pinus montana* var. *uncinata*; 1928; France (Mont. Louis, Pyrenees); gift from French Forestry Service; 97·7; 64 + 22.

29/23 246 lbs.; *Pinus Laricio*; 1928; France (Corsica); Jacques Grimaldi; 99·7; 51 + 12.

29/24 20 lbs.; *Juglans regia*; 1928; France (Central); Vilmorin-Andrieux.

29/25 15¼ lbs.; *Sequoia sempervirens*; 1928; Europe; Vilmorin-Andrieux; 96·1; 3.

29/26 8 ozs.; *Pseudotsuga Douglasii* var. *caesia*; 1928; U.S.A. (Colorado); Del Norte Seed Co.

29/27 110 lbs.; *Larix europaea*; 1928; Silesia (Sudeten); K. Gebauer; 83·6; 44.

29/28 31½ lbs.; *Alnus incana*; 1928; Czechoslovakia; K. Gebauer.

29/29 3 lbs.; *Abies concolor*; 1928; U.S.A. (California, altitude 5,500 ft.); E. S. Mainwaring.

29/30 2 lbs.; *Pinus Lambertiana*; 1928; U.S.A. (California, altitude 4,500 ft.); E. S. Mainwaring.

29/31 534 lbs.; *Picea excelsa*; 1928; Austria (altitude 660–1,640 ft.); J. Stainer; 98·9; 93 + 1.

29/32 5 lbs.; *Larix occidentalis*; 1928; Canada (Fraser Valley, British Columbia); gift from Canadian Government.

29/33 6½ lbs.; *Abies grandis*; 1928; Canada (Fraser Valley, British Columbia); Canadian Government.

29/34 12 lbs.; *Acer macrophyllum*; 1927; Canada (Fraser Valley, British Columbia); gift from Canadian Government.

29/35 5¾ lbs.; *Alnus oregona*; 1928; Canada (Fraser Valley, British Columbia); Canadian Government.

29/36 20¼ lbs.; *Tsuga heterophylla*; 1928; Canada (Fraser Valley, British Columbia); Canadian Government; 97·9; 69 + 6.

29/37 60 lbs.; *Pseudotsuga Douglasii*; 1928; Canada (Fraser Valley; British Columbia); Canadian Government; 90·1; 64.

29/38 430 lbs.; *Pinus Laricio*; 1928; France (Corsica); P. Spinosi; 98·4; 48 + 8.

29/39 116 lbs.; *Pinus maritima*; 1928; France (Landes); Vilmorin-Andrieux; 100; 90 + 5.

29/40 1,084 lbs.; *Pinus sylvestris*; 1928; England (East); own collection; 99·3; 90 + 3.

29/41 111 lbs.; *Quercus palustris*; 1928; U.S.A. (East); J. Rafn.

29/42 3 lbs.; *Cedrus deodara*; 1928; Italy; J. Rafn.

29/43 10 lbs.; *Cupressus macrocarpa*; 1928; U.S.A. (California); J. Rafn; 98·5; 16 + 3.

29/44 10 lbs.; *Juglans nigra*; 1928; America; J. Rafn.

29/45 6¾ lbs.; *Thuya plicata*; 1928; Europe; J. Rafn.

29/46 1¾ lbs.; *Pinus contorta*; 1928; America (West, Coastal region); J. Rafn.

29/47 551 lbs.; *Quercus pedunculata*; 1928; Holland; Nederlandsche Heidemaatschappij.

29/48 1 lb.; *Abies amabilis*; 1928; U.S.A. (Olympic Range, Washington); J. Rafn.

29/49 1½ ozs.; *Sequoia gigantea*; 1928; U.S.A. (California); J. Rafn.

29/50 6 lbs.; *Pinus Pinea*; 1928; Italy; J. Rafn.

29/51 5½ lbs.; *Pinus Cembra*; 1928; Austria; J. Rafn.

29/52 867 lbs.; *Pinus Laricio*; 1928; France (Corsica); O. J. Rossi; 99·3; 46 + 8.

29/53 2 lbs.; *Pinus maritima*; 1928; France (Corsica); Sample from O. J. Rossi.

29/54 2 lbs.; Reputed *Cedrus atlantica*; 1928; France (Vaucluse); gift from French Forestry Service.

29/55 511 lbs.; *Picea sitchensis*; 1928; Canada (Queen Charlotte Islands, British Columbia); Canadian Government; 94·1; 83 + 1.

29/56 1 lb.; *Abies pinsapo*; 1928; Italy; Vilmorin-Andrieux.

29/57 5 lbs.; *Pinus halepensis*; 1928; France; Vilmorin-Andrieux.

29/58 4 ozs.; *Chamaecyparis Lawsoniana*; 1928; France; Vilmorin-Andrieux.

29/59 191 lbs.; *Pinus insignis*; 1928; New Zealand; New Zealand State Forest Service; 99·5; 78 + 2.

29/60 39 lbs.; *Alnus incana*; 1928; Austria; J. Stainer.

29/61 4¼ lbs.; *Picea omorika*; 1928; Serbia; Sarajevo Forest Department.

29/62 226 lbs.; *Larix europaea*; 1928; Switzerland (Münstertal, altitude 4,900–6,600 ft.); J. Roner; 89·2; 51 + 1.

29/63 5 lbs.; *Pinus montana* var. *pumilio*; 1928; Switzerland (St. Valentin and Graun, Malserheide, altitude 4,900 ft.); J. Roner.

29/64 1 oz.; *Pinus albicaulis*; 1928; U.S.A. (Cascade Mountains, Washington); gift from U.S.A. Forest Service.

29/65 5 lbs.; *Cupressus macrocarpa*; 1928; England (West); own collection.

29/66 22 lbs.; *Pinus Laricio*; 1928; England (East); own collection.

29/67 6½ lbs.; *Pinus maritima*; 1928; France (Corsica); Joseph Grimaldi.

29/68 10 lbs.; *Pinus Laricio*; 1928; Cyprus (Troodos); Cyprus Government.

29/69 5 lbs.; *Pinus maritima*; 1928; Portugal (Leira); gift from Portuguese Government.

29/70 ½ oz.; *Nothofagus obliqua*; 1928; Chile; gift from Chilean Forestry Service.

29/71 ½ oz.; *Nothofagus procera*; 1928; Chile; gift from Chilean Forestry Service.

29/72 6½ lbs.; *Pinus maritima*; 1928; France (Maures and l'Estirel); gift from French Forestry Service.

29/73 220 lbs. ; *Pinus sylvestris* ; 1928 ; Scotland (East) ; E. S. Grant.
29/74 382 lbs. ; *Pinus sylvestris ;* 1928 ; Scotland (East) ; own collection, extracted at Tulliallan.
29/75 3¼ lbs. ; *Pinus sylvestris* ; 1927 ; Scotland (East) ; own collection, extracted at Tulliallan.
29/76 234 lbs. ; *Pinus sylvestris* ; 1928 ; Scotland (East) ; own collection, extracted at Seaton.
29/77 4 ozs. ; *Pinus sylvestris* ; 1928 ; Scotland (East) ; J. Smith.
29/78 10 lbs. ; *Pinus sylvestris* ; 1928 ; Scotland (West) ; own collec tion, extracted at Tulliallan.
29/79 80 lbs. ; *Larix europaea* ; 1928 ; Scotland (East) ; own collection, extracted at Seaton.
29/80 72 lbs. ; *Larix europaea* ; 1927 ; Scotland (East) ; own collection, extracted at Tulliallan.
29/81 58 lbs. ; *Larix europaea* ; 1928 ; Scotland (East) ; own collection, extracted at Tulliallan.
29/82 3 lbs. ; *Larix europaea* ; 1928 ; Scotland (West) ; own collection, extracted at Tulliallan.
29/83 3¼ lbs. ; *Larix europaea* ; 1928 ; Tyrolese Alps ; J. Rafn & Son.
29/84 2¼ lbs. ; *Larix europaea* ; 1928 ; Swiss Alps ; J. Rafn & Son.
29/85 2¼ lbs. ; *Larix europaea* ; 1928 ; Western Alps ; J. Rafn & Son.
29/86 1 lb. ; *Picea excelsa* ; 1928 ; Scotland (East) ; own collection, extracted at Tulliallan.
29/87 2¼ lbs. ; *Pinus Laricio* ; 1928 ; Scotland (East) ; own collection, extracted at Seaton.
29/88 32 lbs. ; *Acer pseudoplatanus* ; 1928 ; Scotland (East) ; own collection, extracted at Seaton.
29/89 60 lbs. ; *Fraxinus excelsior* ; 1928 ; Scotland (East) ; own collection, extracted at Seaton.
29/90 6 lbs. ; *Pyrus Aucuparia* ; 1928 ; Scotland (East) ; own collection, extracted at Seaton.
29/91 2 lbs. ; *Thuya plicata* ; 1928 ; Scotland (East) ; E. S. Grant.
29/92 5 lbs. ; *Thuya plicata* ; 1928 ; Scotland (East) ; own collection, extracted at Tulliallan.
29/93 2 lbs. ; *Thuya plicata* ; 1928 ; Scotland (West) ; own collection, extracted at Tulliallan.
29/94 38 lbs. ; *Abies nobilis* ; 1928 ; Scotland (East) ; own collection, extracted at Tulliallan.
29/95 12 ozs. ; *Larix leptolepis* ; 1928 ; Scotland (West) ; own collection, extracted at Tulliallan.
29/96 8 ozs. ; *Pseudotsuga Douglasii* ; 1928 ; Scotland (West) ; own collection, extracted at Tulliallan.
29/97 5 ozs. ; *Picea alba* ; 1928 ; Scotland (East) ; own collection, extracted at Seaton.
29/98 8 ozs. ; *Acer platanoides* ; 1928 ; Scotland (East) ; own collection, extracted at Tulliallan.
29/99 8 ozs. ; *Pinus montana* var. *pumilio* ; 1928 ; Scotland (East) ; own collection, extracted at Tulliallan.

29/100 15 ozs. ; *Abies amabilis* ; crop year unknown ; U.S.A. (Olympic Forest, Washington) ; Sir John Stirling-Maxwell.

29/101 188,000 seedlings (2 years) ; *Pinus sylvestris* ; crop year unknown ; origin unknown ; Captain Dunbar, Pitgaveny.

29/102 100,000 transplants (2 + 1) ; *Pinus sylvestris* ; crop year unknown ; origin unknown ; G. R. Christie, Fochabers.

29/103 440,000 transplants (2 + 1) ; *Pinus sylvestris* ; crop year unknown ; origin unknown ; Howden & Co., Inverness.

29/104 304,000 seedlings (2 years) ; *Pinus sylvestris* ; crop year unknown ; origin unknown ; Howden & Co., Inverness.

29/105 160,000 seedlings (2 years) ; *Pinus sylvestris* ; crop year unknown ; Scotland (East) ; C. Black.

29/106 62,864 lbs. ; *Quercus pedunculata* ; 1928 ; England (East) ; own collection.

29/107 551 lbs. ; *Quercus pedunculata* ; 1928 ; England (West) ; own collection.

29/108 96 lbs. ; *Quercus pedunculata* ; 1928 ; England (North) ; own collection.

29/109 7,410 lbs. ; *Quercus sessiliflora* ; 1928 ; England (East) ; own collection.

29/110 3,503 lbs. ; *Quercus sessiliflora* ; 1928 ; England (West) ; own collection.

29/111 154 lbs. ; *Quercus sessiliflora* ; 1928 ; England (North) ; own collection.

29/112 20,261 lbs. ; *Quercus Robur* ; 1928 ; England (West) ; own collection.

29/113 300 lbs. ; *Quercus Robur* ; 1928 ; England (North) ; own collection.

29/114 8 lbs. ; *Quercus Ilex* ; 1928 ; England (East) ; own collection.

29/115 150 lbs. ; *Quercus Cerris* ; 1928 ; England (East) ; own collection.

29/116 10,689 lbs. ; *Castanea vesca* ; 1928 ; England (East) ; own collection.

29/117 4,103 lbs. ; *Castanea vesca* ; 1928 ; England (West) ; own collection.

29/118 81,000 transplants ; *Fraxinus excelsior* ; crop year unknown ; origin unknown ; W. Power & Co., Waterford.

29/119 457 lbs. ; *Fraxinus excelsior* ; 1928 ; England (East) ; own collection.

29/120 42 lbs. ; *Fraxinus excelsior* ; 1928 ; England (West) ; own collection.

29/121 65 lbs. ; *Fraxinus excelsior* ; 1928 ; England (North) ; own collection.

29/122 536 lbs. ; *Acer. Pseudoplatanus* ; 1928 ; England (East) ; own collection.

29/123 660 lbs. ; *Acer Pseudoplatanus* ; 1928 ; England (West) ; own collection.

29/124 110 lbs.; *Acer Pseudoplatanus*; 1928; England (North); own collection.
29/125 6 lbs.; *Acer platanoides*; 1928; England (North); own collection.
29/126 522 lbs.; *Aesculus Hippocastanum*; 1928; England (East); own collection.
29/127 26 lbs.; *Aesculus Hippocastanum*; 1928; England (West); own collection.
29/128 80 lbs.; *Juglans regia*; 1928; England (West); own collection.
29/129 300 lbs.; *Fagus sylvatica*; 1928; England (East); own collection.
29/130 64 lbs.; *Carpinus Betulus*; 1928; England (East); own collection.
29/131 218 lbs.; *Carpinus Betulus*; 1928; England (West); own collection.
29/132 10 lbs.; *Carpinus Betulus*; 1928; England (North); own collection.
29/133 7 lbs.; *Alnus glutinosa*; 1928; England (East); own collection.
29/134 3 lbs.; *Alnus glutinosa*; 1928; England (North); own collection.
29/135 266 lbs.; cones; *Alnus glutinosa*; 1928; England (West); own collection.
29/136 3 lbs.; *Larix europaea*; 1928; England (North); own collection.
29/137 7 lbs.; *Chamaecyparis Lawsoniana* var. *erecta viridis*; 1928; England (West); own collection.
29/138 170 lbs.; *Cupressus macrocarpa*; 1928; England (East); own collection.
29/139 104 lbs.; *Pyrus Aucuparia*; 1928; England (North); own collection.
29/140 88 lbs.; *Tilia europaea*; 1928; England (East); own collection.
29/141 ½ bushel; *Sequoia gigantea*; 1928; England (West); own collection.
29/142 ½ bushel; *Abies grandis*; 1928; England (West); own collection.
29/143 20,000 seedlings (2 years); *Alnus incana*; 1926; origin unknown; B. Reid & Co., Aberdeen.
29/144 50,000 transplants; *Fraxinus excelsior*; crop year unknown; origin unknown; Little & Ballantyne, Carlisle.
29/145 30,000 transplants; *Fagus sylvatica*; crop year unknown; origin unknown; Commissioners of Crown Lands.
29/146 55,000 transplants; *Fagus sylvatica*; crop year unknown; origin unknown; J. O. Boving; Tring.
29/147 121,000 natural seedlings; *Fagus sylvatica*; crop year unknown; England (East); own collection.
29/148 7,000 natural seedlings; *Fraxinus excelsior*; crop year unknown; England (East); own collection.
29/149 100,000 transplants; *Fagus sylvatica*; crop year unknown; origin unknown; English Forestry Association.

(B 12/1621)Q Wt. P3529–556 300/250 4/30 H & S, Ltd. Gp. 12 E