JOURNAL

OF THE

FORESTRY COMMISSION.

No. 1: FEBRUARY, 1922.

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FRASER STORY.

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INTRODUCTION.

The Commissioners have for some time felt the need of a means of bringing about a better circulation of information of a character which cannot conveniently be communicated through the ordinary official channels. They have, therefore, decided to issue a Journal from time to time for private circulation among the staff.

In introducing the first number of the Journal I should like to draw particular attention to the section dealing with reviews and abstracts of current literature. These abstracts are necessarily brief, but they give the gist of the selected papers, and as all the periodicals reviewed are in the Commission's library, those who wish to study the subjects more deeply will be able to obtain the original articles. "Notes from the Divisions" will doubtless be further developed in future issues. All noteworthy observations in forestry matters made in the field should be recorded. It is well to remember that original observations on things which are new, uncommon, or even merely interesting, are always of value and if recorded may one day prove of considerable importance. The scope for communications of this kind would appear to be great and it is hoped that free use will be made of the Journal for this purpose. The Journal also affords an opportunity of discussing the many knotty problems which arise in daily forestry practice. Queries are invited, and in the answering of these all are requested to co-operate.

The Editing Committee will be dependent on members of the staff for "copy" and it is hoped that all will contribute to make the Journal a success.

L.

(B6588) Wt. P2596—221. 125. 3/22. Sir J. C. & S. Gp. 32.

ORIGINAL ARTICLES.

Loss Caused by Frost-lifting.

In December, 1920, a series of questions on frost-lift was circulated to all Divisional Officers in England and Wales and Scotland, and also to Officers in charge of Crown Forests. The replies which were received revealed considerable differences of opinion, which are probably due in the main to differing local conditions.

The result of the enquiry may be summed up briefly as follows :—

1. The loss owing to frost-lift was relatively small in the spring of 1921 in England, and apparently not severe in Scotland.

At Craibstone, where frost is known to be very bad, all the seed beds (with the exception of some experimental beds) were sheltered by lath shelters plus a mulch of beech leaves, which appears to have given efficient protection.

The most susceptible species are Sitka spruce, Douglas fir, European larch and Norway spruce.

2. Opinions differ as to the effect of density of seedlings in the seed bed upon frost-lift, but in the majority of the replies it is stated that frost-lift is more severe in thinly sown beds.

Experiments carried out by Dr. Steven at Craibstone with Norway spruce appeared to show fairly conclusively that this is the case. The following table gives the actual statistics (each bed contained 48 square feet).

Bed No.	Method.	Density of Sowing. (Lbs. per acre.)	Percentage of Seedlings Thrown.
1	Broadcast	170	22
2	,, ...	226	36
3	,, ...	284	27
4	,, ...	342	17
5	Drill	85	75
6	,, ...	142	60
7	,, ...	198	48
8	,, ...	255	37
9	4-inch Band	113	57
10	,, ...	170	47
11	,, ...	226	44
12	,, ...	284	31

The very heavy losses in the light-density drill-sown beds are especially noteworthy.

3. There is also a considerable divergence of opinion as to the influence of method of sowing upon frost-lift, but the general opinion, supported by the figures in the above table, is that drill-sown beds suffer more than broad-cast beds, unless the former are sown very dense.

4. There seems to be no indication from the appearance of a seed bed during a frost that frost-lift is taking or going to take place.

5. Frost-lift is worse in the lower part of sloping beds and wherever there is a tendency for water to collect, pointing to the necessity for efficient drainage.

6. It is generally recognised that in any nursery where frost-lift is expected it is advisable to shelter Sitka spruce, and usually also Douglas fir. The remaining species are usually not protected, except at Craibstone.

The reports sent in from both England and Scotland indicate that last winter was an exceptionally mild one, and that unusually little frost-lift has been experienced. The experiments, however, carried out at the two nurseries of Craibstone and Beaufort seem to show that even in a mild winter the losses may be sufficiently serious. Thus at Craibstone in the unsheltered beds, 86 per cent. of Douglas fir seedlings were thrown in the drill-sown bed, and from 75 to 37 per cent. of the Norway spruce in the different densities.

At Beaufort 48 per cent. of the Sitka spruce were thrown and 20 per cent. of the Douglas fir in the unsheltered beds. The Scots pine and the Norway spruce beds appear to have escaped appreciable loss.

From information received it appears that at a large commercial nursery in the north of Scotland the whole of the Douglas fir was thrown by the frost during the winter. The beds were not protected and the germination was exceptionally thin.

The forms of shelter employed are very numerous, and depend upon the local conditions and the method of sowing. Where damage from frost-lift is very great, as at Craibstone, overhead shelter is insufficient, and a mulch of leaves is required in addition. For drill-sown beds the use of moss between the drills appears to give quite satisfactory results. Overhead shelter, consisting of lath gratings resting upon a framework of posts and rails, is used in some of the large commercial nurseries and also in some of the Commission's nurseries. If the shelter given is not sufficient, branches can be spread over the gratings.

The lath shelters are expensive, costing about 1*s.* 6*d.* to 1*s.* 9*d.* per square yard, but they should last several years and have the great advantage of being readily removable and thus can be used in the summer as protection against drought if required. Other forms of shelter employed are canvas, boughs stuck in along the side of the beds, sawdust, cinders, leaves, &c.

7. Frost-lift is said rarely to occur in sheltered beds; the exceptions appear to be when the crop is abnormally thin on the ground and during a very wet winter when there is a series

of frosts in between the wet spells. Presumably the complete control of frost-lift is only a question of increasing the degree of shelter provided.

Dr. Steven in a report based on investigations in Scotland makes the following recommendations. When the variations in liability to frost-lift are determined for nurseries and parts of nurseries, it should be possible, taking into consideration the varying susceptibility of the different species, so to place the seed beds as to eliminate exceptional losses.

Even when excessive losses from frost-lift are eliminated in this way, protection will in general have to be given in the following cases :—

(i) Thin crops of Douglas fir and Sitka spruce will require intensive protection.

(ii) Thin crops of other species and full crops of Douglas fir and Sitka spruce will require ordinary protection.

(iii) Douglas fir, Sitka spruce and, in certain localities, other species, will require protection against unseasonable frosts in spring and summer.

It would appear desirable to employ some method of protection which could be used in cases (ii) and (iii) above, and intensified for (i).

In small nurseries a sufficient supply of spruce or broom branches will usually be available, with sufficient labour to handle and control this form of protection. In large nurseries shelters of lath gratings or canvas will probably be more economical. This type of shelter will suffice for cases (ii) and (iii) ; for section (i) the shelter should be intensified by application to the soil of well-decayed manures applied so as not completely to cover the plants.

W. H. G.

The Protection of Seedlings from Frost.

In view of the increased production of exotic tree-seedlings for economic planting in Britain generally, and the necessity of providing some form of protection from frost during the first year, a short description of the various methods tried in the Department of Agriculture's nurseries throughout Ireland, during the last ten years, may be of practical interest.

In the first year the beds protected (chiefly Sitka spruce, Douglas fir and *Thuja plicata*) were merely covered with branches, bracken or heather, with a thin layer of leaves or dried grass spread over all, but on account of the humidity of the climate during the winter months, and the generally sodden state of the beds, added to the early commencement of growth in spring, " damping off " caused considerable loss. Moreover, the seedlings, as a result of the close covering, were too sensitive to resist

the effects of slight night frosts or frosty winds when it became necessary to remove the covering, and loss from this cause was also frequent.

In order to avoid the ill-effects noted above, a framework of light posting, topped with fencing wire and raised about 1½ feet above the level of the beds, was stretched along each side, and a covering of branches, &c., was laid on the top. This method was found preferable in all respects to the former, the free circulation of air beneath the covering preventing " damping off " and allowing one to retain the covering until all danger of injury from late frosts had passed.

The third method tried was to replace the covering of branches, &c., by lath screens. This has been found the most satisfactory method of all, and has been continued with unvarying success during the last eight years, at the end of which time the original screens are still in use and apparently none the worse for wear. These screens are made up in 9-ft. lengths, eighteen pieces, 4½ ft. × 5 ins. × ¼ in., being nailed to two side runners 9 ft. × 2 ins. × ¾ in., and a space of 1 in. left between each of the cross pieces. With timber at about 2*s.* per cubic foot, these screens can be made up and tarred at about 9*d.* per lineal yard, and taking the average life of the screen as twelve years, the cost equals about ¾*d.* per yard (of a 4-ft. bed) per annum, or allowing from 1,000 to 1,500 Sitka spruce seedlings per yard run of bed, the additional cost of the growing of seedlings covered in this manner would not exceed ½*d.* or ¾*d.* per 1,000. In fixing up the framework for these screens it is desirable that one side should be slightly below the level of the other, so as to allow sufficient slope for the " run off " of heavy rain into the alleys between the beds. This is of great advantage in preventing the beds formed on heavy soils from becoming moisture laden, and the seedlings are, therefore, less subject to frost-lift.

The advantages of this covering may be summarised as follows :—

(*a*) Air and light are admitted freely to the seedlings.

(*b*) They can be readily examined at any time.

(*c*) There is no danger of introducing disease into the nursery as may and frequently does happen when branches are used.

(*d*) The beds can be covered up in autumn before any danger from frost occurs, and seedlings may be left to grow and ripen off their growth up to the end of October.

(*e*) In spring, growth starts freely under the screen, which may safely be left on until all danger of frost has passed.

The disadvantages are :—

(*a*) Danger of the screen being pressed closely down on the seedlings in localities where heavy snow-falls occur.

(*b*) Lightness of protection in the case of extreme frosts, though the higher temperature and drier state of the beds to a certain extent counteract this evil.

Sitka spruce seedlings sheltered by these screens this season were found to be from 3 ins. to 3½ ins. high at the end of May, while those in beds covered with branches, &c., were only from 1½ ins. to 2 ins. high.

J. C.

Foresters' Schools.

It has been suggested that a note on the general lines of training followed in the Commission's schools for forest apprentices may be of interest, more especially to those who have not had an opportunity of visiting these institutions. Training is now confined to three schools, viz. : Parkend in the Forest of Dean ; Chopwell, near Newcastle ; and Beauly, near Inverness. The total number of apprentices at present at these schools is sixty-one. Burley Lodge School in the New Forest was closed at the end of last year, and Birnam school which it was thought would be required for forest apprentices, but has not been used for that purpose, also has been closed. At Brockenhurst in Hampshire a course in forestry is available for disabled soldiers, and fifteen men are in training there, but as the course is of shorter duration than that provided for apprentices and is of a different character, I do not propose to refer further to it in this note.

The chief reason why all the school buildings are not so fully utilised as was at one time anticipated is that scarcely any men are presenting themselves for training from private estates. Landowners, for the most part, are unable to afford financial assistance to their men for this purpose, and the breaking up of large estates, together with the feeling of uncertainty as regards land tenure, is evidently having a deterrent effect.

At forest apprentices' schools the proportion of time spent in the class-room as compared with the time devoted to manual work varies somewhat at the different schools, but roughly speaking not more than five or six hours per week are taken up by indoor instruction, so that about 80 per cent. of the men's time is free for practical work in the woods and nurseries.

Roughly and briefly indicated, the syllabus of instruction at the schools is as follows :—

First of all the apprentices are taught the principles of sylviculture, including such matters as climate and soil in their relation to tree growth, the composition of woods, the theory and practice of thinning and the sylvicultural characteristics of the commoner trees. Under forest protection the students receive

instruction as regards all the more destructive insect and fungus pests, learn how to recognise damage done by these, and the conditions which encourage or prevent attack. Methods of protection against frost, drought, weeds, fire, &c., are also dealt with. The measurement and valuation of felled and standing timber receive attention, and particular stress is laid on the necessity of the men having an elementary but thoroughly practical knowledge of surveying. In the neighbourhood of each school is a considerable area of woodland and as far as possible variety of practical instruction is provided in nearly all kinds of forestry operations, such as preparation of planting ground, fencing, nursery work, planting, felling, transport of timber and the construction of roads. An effort is made to place each student in rotation in the position of foreman, and each has to keep records of work done and calculate the cost of the various operations.

Except for a short period on the re-opening of the schools, only men who have had some previous experience of forestry or estate work have been admitted. In future it is hoped to draw the men chiefly from the Divisions and to test their fitness, both mental and physical, before admission.

It must not be expected that apprentices on completing their training will be ready to take up each and every duty without guidance ; it should not be forgotten that they may still be lacking in experience. The men must usually be given time to adapt themselves to changed conditions, and comparatively few will be able at once to assume control over large gangs of men. The aim kept in view during training is not that the men should merely be taught the manner of using a variety of forestry tools, or should learn the names of innumerable insects and fungi, but that the education should go beyond this, causing the men to reason things out for themselves, to learn the " why and wherefore," and generally to comprehend the relationship between trees and their surroundings.

F. S.

Training of Foremen.

The experience of the past year has confirmed me in the opinion that some training for foremen was necessary. The particular parts of the work in which this point came out most strongly were in the care of the plants, between lifting in the nursery or receipt on rail and the actual planting, in the method and depth of planting, and in the care of the plants after planting. I am aware that comprehensive rules relating to these aspects of the work can be written on a half sheet of notepaper, but this is not sufficient. Untrained men do not know the scientific facts which underlie these rules. They have no knowledge of the natural history of the plant, and treat the rules as counsels of perfection to be followed at discretion.

In spite of repeated instructions I found plants were constantly left exposed till the roots were bone dry. Plants were stuck in either too deep or not deep enough, and the consolidation of the soil round the roots and the position of the roots in the soil were matters which received scant attention.

There was evidence, too, of a tendency to give too little attention to the plants on arrival by train, though District Officers, generally, were able to check this. The dangers from heating are not appreciated by the untrained man. Consequently there is a tendency to leave the plants too long in the packages, either at the station or on the ground. The same tendency was constantly noticed in the heeling-in of the plants ; in spite of frequent instructions, the temptation to leave the plants in bundles and thus facilitate transport to the men planting, proved too strong.

It is not that the men are not keen. A man who would light-heartedly endanger a whole consignment of plants by leaving them in their packages for several days would spend hours of his own time in chasing a sheep from a plantation. The point is, an untrained man has no knowledge of the physiology of plants, and in most cases the damage caused by neglect of this sort is not immediately apparent to the untrained eye, at any rate. When wholesale failure follows in the plantation they attribute it to a fate over which they have no control.

Trained men, of course, are just as likely to be as careless as untrained men, but slackness of that sort can be dealt with. Where carelessness springs from ignorance it is a more difficult matter.

During the past planting season I had one trained man working for me as a foreman, and although he had to be spoken to occasionally about some matters, he was keen, and his work throughout showed a proper appreciation of the elementary physiological facts of plant life, which almost invariably was lacking in the work of the untrained men. He is young, and not able to get quite so much out of the men placed under him as the older untrained men did. The planting cost of the work done by his gang was consequently higher. I am much happier about his work, however, and feel confident it will prove cheaper in the long run.

These considerations convince me of the necessity for training foremen. Their training need not be of an elaborate character, but the elements of plant physiology and its immediate application to planting should play a prominent part in it. We can give the men training in the practical side of the work in the field. It is not practicable to teach them the elements of the theoretical side of the work there.

I would revert to my original suggestion that men of eighteen or nineteen should be given a year's training in one or other of the forest schools. Those who complete that course satisfactorily

should be sent to work under Divisional Officers for one or two years (two planting seasons at any rate), and those who prove their worth should be taken back at the end of that time to one of the forest schools and given a further course of one year or more, to complete their training as foresters.

The danger that such a scheme would leave in the ranks of the foremen a group of dissatisfied men, I believe, has been over estimated. After a year or more in the field, quite a large proportion would elect to stay on as foremen rather than face another year of the discipline which the school life entails. As a rule it would be only the keenest and best men who would want to go back. Men who, though good on the theoretical side, proved unsatisfactory on the practical would be dropped at the end of their period of probation. Possibly amongst the men who did not elect to go on their full course there might be some so satisfactory that a Divisional Officer would wish to make them foresters. There is no reason why they should not become foresters and go as far up the scale as their competence will allow them. It need not necessarily, therefore, be a case of once a foreman always a foreman. As a rule, however, the men who had taken a full course would have a distinct advantage over the others, which is, of course, only right and proper.

D. W. Y.

Notes on Co-ordination Work.

Comparatively little field work was undertaken last summer, both on account of pressure of office work and in consequence of the exceptional weather conditions of the past summer, which it was considered would tend to rob field observations of much of their value as regards general application.

Attempts have been made to establish personal touch with foresters in the British Empire and the United States of America, and are proving successful ; useful information has been received, or promised, from New Zealand, South Africa, and various persons in the Dominion of Canada and the U.S.A. The main subjects upon which information is sought are nursery methods, planting, direct sowing, and preparation of ground (including draining) ; some useful data as to the use of explosives in the latter operation have been received. Mr. Ellwood Wilson, of the Laurentide Pulp and Paper Company, of Quebec, invariably employs a planting machine, of American origin, which he highly recommends, especially as regards the quality of the work done ; a specimen of the machine is being secured, and will be experimented with. In the large nurseries at Indian Head, Saskatchewan, transplanting laths (Ben Reid pattern) are used for lining-out and found to give much better and quicker work, root-pruning of transplants is employed, and the plough is used for lifting from the lines, plants being spaced 2½ ins. to 3 ins.

by 12 ins. It is found that with the plough the roots are damaged less than in hand lifting, and that the work is done three or four times as quickly. Details of the precise pattern of plough employed, and of the organisation adopted, have been received.

From information collected in the field to date, it would appear that payment of labour at piece-work or contract rates is increasingly popular ; planting organisation presents no radical changes, and is following normal development. The use of small planting gangs, of not more than eight men, each gang under a responsible leader, and planting in echelon, with two or three boys per gang, for the supply of plants, may now be considered the standard organisation, and the use of measuring sticks, pickets, and other aids to accuracy of spacing has generally been abandoned, except in the early stages of training a crew. Increased care in the protection of plant roots from drying up has been noticed, and this is assisted by the now common practice of establishing small dumps of plants, every two or three acres, over the planting area ; this distribution of plants involves little additional initial cost and saves much time in bringing the plants to the planters.

Observations tend to show that even on steep slopes it is equally practicable to plant uphill, along the contour, or down hill (men facing the slope). Possibly owing to the smaller plants in use, the Schlich and Mansfield spades (for vertical notching) and the dibble (No. 50, List of Tools in Use) are increasingly favoured ; on several estates definite experiments were conducted before the commencement of the planting season proper, to decide the style of planting and pattern of tool best suited to the area, or parts thereof. The highest planting rate which has come to notice is that of 1,500 per man per day ; in this case small larch were being planted with the vertical notch (Mansfield) ; the rate was maintained by the gang for a fortnight, and the plants succeeded.

In the nurseries it is noteworthy that the transplanting lath (Ben Reid pattern) is now almost universally adopted, and that very substantial reductions in lining-out costs have resulted from its use. Many officers are keenly interested in the possibility of making further use of the plough ; wheeled cultivators are almost universally used, and many handy home-made tools for weeding between seed-bed drills, or between plants in the lines, have been seen.

In many cases officers have experienced difficulty in obtaining tools of good quality and of the exact pattern required ; this is especially noticeable in the case of spades, mattocks, Schlich and Mansfield spades and brushing hooks, &c. Various investigations have been made, and lists of tools issued, with the object of ensuring that any officer, when in doubt as to the exact specification of the tool he requires, shall be able to select one which has been found suitable elsewhere, and to give definite specifications

(including maker's name and No.) when ordering; also that Head Office, in the absence of such definite information, may be in a position to supply a reasonably satisfactory pattern.

O. J. S.

Afforestation in the U.S.A.

Some interesting information has been received as to planting operations by the U.S. Forest Service in their Rocky Mountain Division. The reports received deal with three forests and one nursery; the nursery has an output of 600,000 to 700,000 plants per annum. The areas planted during forest year 1920, on the forests under report, were as follows:—

		Approximate Planting Cost (labour only) per thousand Plants.
Michigan Forest ...	300 acres ...	12*s.*
Nebraska Forest ...	500 ,, ...	20*s.*
Pike Forest ...	740 ,, ...	36*s.*

This planting cost excludes supervision. The wages are 14*s.* to 16*s.* per day; for horses, 3*s.* 6*d.* per day plus feed is charged.

The Nebraska Forest comprises a rolling terrain of almost pure quartz sand, subject to wind drift, and having a rainfall of less than 30 ins., and an evaporation of 40 to 50 ins. Capillarity is good and the soil rarely dries out to a depth of more than 8 ins. except under sod. Michigan Forest is a sandy plain, somewhat more loamy than Nebraska—with a sparse growth of scrub oak and *Pinus divaricata*. Pike Forest is a mountainous area with heavier soil and a considerable amount of scrub oak; the plantations here are located at upwards of 7,000 ft. above sea level. Further details of the areas are unfortunately lacking.

On both Pike and Nebraska Forests, spring planting only is practised; at Michigan, where both spring and autumn planting are found, little difference between their results is noticed.

Species, spacing and age of plants used are as follows:—

	Species.	Age.	Plants per Acre.
Michigan:	*Pinus resinosa*	2-yr. Seedlings	700–£50
	,, *Strobus*	2-yr. ,,	
Nebraska:	*Pinus ponderosa* ...	2 + 1 Transplants	1,800
	,, *divaricata* ...	2 + 1 ,,	
Pike:	*Pinus ponderosa* ...	2 + 1 Transplants	600–850
	Douglas fir	2-yr. Seedlings	
	Englemann spruce ...	2 + 1 Transplants	

Carefully conducted experiments, which have extended over three years, tend to show that at Pike Forest the mortality

among 2 yr.-1 yr. *P. ponderosa* is slightly less than among seedlings, but that with Douglas fir and Englemann spruce there is no appreciable difference.

Planting at Pike is by pitting without preliminary preparation of the ground; men apparently plant about 400 trees per man per working day (eight hours). Planting bars (see below) are used in parts of the area. At both the other forests, preparing ground is by ploughing, furrows being planting-apart distance, but in places, for economy, the distance between furrows exceeds the distance between plants in these furrows. Oliver two-way "Sulky" ploughs are used. At Michigan, men plant in the furrows with a "planting bar," somewhat similar to the dibble used at Cannock Chase for P. 21, except that the "bar," which is 40 ins. long, has an iron (gas pipe) handle cold shrunk upon the blade, which is a wedge 9 ins. by 3 ins. At Nebraska a "trencher plough" is used to open a V shaped slit, about 12 ins. deep and 3 ins. to 4 ins. wide at top, down the furrows, and men plant in this slit, which they fill in between plants (for details of method see page 25, *U.S. Bulletin*, No. 475, "Reforestation on the National Forests"). In both methods the performance is 2,200 plants per planter per eight hour day. With bar planting it was found that one plough could make furrows for two men; with the other system, the balanced gang consisted of foreman, four planters, trencher and plough, but the trees were closer together in the furrows and the plough apparently moved faster. From examination of the reports and recommendations therein it appears that given similar conditions the bar method is the quicker and cheaper of the two. With the bar method at Michigan small crews of four or five men are used; at Pike (pitting) gangs of fifteen men are employed under a working foreman.

At Pike Forest, planters carry their own plants in waterproof bags slung from the shoulder and steadied round the waist; the plants are moistened by adding water if necessary. It is found that men plant as quickly as if the trees are handed them singly by "tree passers," but in this connection the low planting rate (400 per man per day) must be borne in mind.

Failures appear somewhat extensive, and extend over five years. Certain results in Pike Forest which bear on the planting methods are given below:—

Method of Planting.	*Pinus ponderosa*, 2yr.-1yr.	
	Total failures per cent. to date.	
	3rd. Year.	5th Year.
Planting-bar ...	52 per cent.	82 per cent.
Pitting ...	40 ,,	40 ,,

The reporting officer suggests that possibly the results of poor planting do not become apparent till the fourth and fifth years.

Other information supplied is as follows :—

		Total Failures per cent. to date.	
		1st Year.	4th Year.
Nebraska :	*Pinus divaricata*, 2yr.-1yr....	20–30 per cent.	40–50 per cent.
	,, *ponderosa*, 2yr.-1yr....	35–50 ,,	55–70 ,,
Michigan :	*Pinus resinosa*, 2yr. ...	40 ,,	—
	,, *Strobus*, 2yr.	40 ,,	—
		3rd Year.	5th Year.
Pike :	Englemann spruce, 2 yr.-2 yr.	40 per cent.	47 per cent.

Nursery Procedure.—Seedlings are lifted with the spade, transplants with some form of mechanical " digger " (probably one of those mentioned in pp. 50 and 51 of *U.S. Bulletin*, No. 479 —" Nursery Practice in the National Forests "). In one nursery plants are graded and packed immediately behind the " digger " (to save heeling-in) in wooden boxes (*see* Savenac method, pp. 65, 66 of U.S. *Bulletin*, No. 479), which hold 3,000–3,500 2 yr.-1 yr. *P. ponderosa*. Wet sphagnum moss is used as packing. In the Monument nursery, a modified Oliver sod-plough is used for lifting transplants.

In one nursery, where severe winters make it necessary to mulch lines, it is proposed to lift plants for spring planting during open weather in the autumn, heeling them in during the winter, thus reducing the area to be mulched. Such treatment of Douglas fir or Englemann spruce results in about 10 per cent. more failures when planted out, but this loss is considered to be off-set by the saving in mulching cost. Root-pruning experiments are in progress. Acid treatment has failed to prevent " damping off."

Douglas fir seed from San Juan (Island ?) is strongly recommended as giving exceptionally good rate of growth.

Transplanting laths are used for lining out; the cost is 2*s.* 4*d.* per thousand, and the performance 50,000 per day per five-man crew.

The relative expenditure per annum on the different categories of plants are given as follows :—

	Cost per Thousand. (Includes apportionment of overhead charges.)	
	During Year. (Normal Exchange.)	Total to end of Year. (Normal Exchange.)
	s. *d.*	*s.* *d.*
Seedlings during their first year	7 8	7 8
,, ,, ,, second year ...	4 4	12 0
Transplanting (including lifting and preparing ground)	11 5	23 6
Transplants during their first year in lines (includes protection by mulching during winter)	8 9	32 3

General Notes.—All statistical forest returns and estimates of planting, &c. (equivalent to those submitted to our Divisional Officers), are by compartments, which vary from 10 to 100 acres, and in cases extend to 300.

The use of 2 yr.-2 yr. plants is strongly discouraged (on account of high cost). It is suggested that Douglas fir requires less moisture (at Pike Forest) than *P. ponderosa*, and it is, therefore, being planted under oak scrub. (*Note.*—The question of shelter is not mentioned, but seems an important factor here.) There is generally little surface vegetation, but even where coppice shoots, &c., occur, no prepared ground, except ploughing or weeding or cleaning, is undertaken, as its cost would not (it is considered) be justified. Fire lines are cleared and prepared the season prior to planting (surface vegetation burned in strips between ploughed strips).

Photographic records, photographs being taken from permanently established " camera-points," are regularly used to supplement written records.

To persuade men to stay over the whole planting season a bonus system is used by which those who stay on receive about 1*s.* 8*d.* per day more than those who leave while operations are in progress. Attempts to introduce piece work rates have so far proved abortive owing to the type of labour employed.

O. J. S.

Report on Research and Experimental Work.

The following notes refer to recent work in experiment and research.

1. *Work by Mr. Marsden in England and Wales.*—(1) An experiment has been started at Rapley Nursery on the season of sowing seed. Quarter pound samples of seed of larch, spruce,

Scots pine and Douglas fir were sown on November 15th and December 15th, and it is proposed to sow further lots of the same seed on the fifteenth of January, April and May.

Each species is being treated as follows :—

(*a*) One-third red-leaded and sheltered by laths ½ in. apart, and protected from birds and mice by wire.

(*b*) One-third red-leaded and not sheltered, but protected with wire.

(*c*) One-third red-leaded and not sheltered and not wired.

Mice have already done considerable damage to some of the plots.

(2) Eight permanent sample plots have been laid out since the beginning of October, and a further three plots are in process of establishment. Of the eight sample plots established, three were in Somerset on Mr. Luttrell's estates at Dunster and East Quantoxhead, and five on Sir Henry Hoare's estate at Stourton, Wiltshire.

The Dunster plots consisted of two Corsican plots (thinned to B and C = light and heavy grades) twenty-two years old, and Quality Class I.

The East Quantoxhead wood provided a mixed plot of *Tsuga albertiana* and European larch, planted 4 ft. by 4 ft. by alternate trees.

The following particulars may be of interest :—

Species.	Age.	No. of Trees per acre after Thinning.	Average Height.	Q.G.	Volume per acre U.B.Q.G.
	yrs.		ft.	ins.	cu. ft.
Tsuga	19	450	35½	3½	500
Larch	20	445	32½	3¼	400

The five sample plots measured at Stourton are of especial interest because they were measured in two crops of Douglas fir of nearly the same age, both of which were planted pure, but one at 8 ft. × 8 ft. and the other at 4 ft. × 4 ft.

Three plots were established in the 8 ft. × 8 ft. wood and thinned to B, C, and D grades respectively (= light, heavy and *éclaircie par le haut*), and two plots in the 4 ft. × 4 ft. wood, thinned to C and D grades respectively.

The following table shows the average volume in each of the two sets of plots before thinning :—

Method of Planting.	Age.	No. of Trees per acre.	Average Height.	Average Q.G.	Form Factor.	Volume U.B.Q.G
	yrs.		ft.	ins.		cu. ft.
A. 8 ft. × 8 ft.	23	690	59	5½	·375	3,450
B. 4 ft. × 4 ft.	20	1,645	45	3½	·358	2,220

Comments.—(1) Both plantations are on similar soil and growing under similar conditions, though some distance apart.

(2) The mean height increment of A is 2·6 ft. per annum, compared with 2·25 ft. for B. Taking the 1920 British Yield Tables, A is slightly below the average of Quality Class I, and B corresponds with the average of Quality Class II. It is impossible to say whether the apparent difference in quality is due to method of treatment or to factors of the soil and locality, but it is very possible that the former is the case.

(3) The mean annual volume increment is 150 cu. ft. per acre per annum in A, and 111 cu. ft. per acre per annum in B. This difference corresponds fairly closely with the figures derived from the Yield Tables, viz. : 154 cu. ft. for Quality I at 23 years, and 102 cu. ft. for Quality II at 20 years.

(4) A has a higher form factor than B, showing that up to the present the wide spacing has not had any bad effect upon the form of the trees. (N.B.—When the average Q.G. at breast height is low, as in plot B, the timber form factor of the plot is not a reliable guide to the tree form.)

(5) The maximum diameter of the side branches in A very rarely exceeded 1 in. In B the maximum diameter was ½ in. This is a point of great interest; the difference in the size of the side branches is much less than would be generally anticipated with such a difference in the planting distance of the two plots.

(6) Snow break is common over the estate and has caused very considerable damage in the 4 ft. × 4 ft. Douglas (outside the plots); there has been no damage from snow in the wide planted wood.

(7) Apart from the original difference in planting cost, A will now require much less labour to thin than B and will yield saleable material.

Three Japanese larch plots are in process of establishment in a 13-year old wood on Sir Henry Hoare's estate at Stourton.

The plots are to be thinned to the B, C and D grades respectively (= light, heavy and *éclaircie par le haut*).

Two experimental plots have been laid out at Tintern in a wood which is under conversion from oak coppice to coniferous forest. In one plot the ground has been completely planted at the standard planting distance; in the other a saving of plants has been effected by accepting promising coppice shoots where they occur with a view to these shoots forming at first part of the crop, but to be removed subsequently in the thinnings. The conifer used was Japanese larch. The plots will be kept under observation and their respective development recorded.

2. *Work by Dr. Steven in Scotland.*—A detailed experiment on the season of sowing Douglas fir seed has been started in the Edinburgh Botanic Gardens. The first sowing was made on December 1st and it is proposed to sow at monthly intervals up to March, and after that every fortnight up to June 1st. On each date of sowing 10,000 seeds are to be sown. Each drill will contain 400 seeds, and there will be five sets of five drills each, spaced along a seed bed, sown on each date of sowing.

The object of working in so great detail is to minimise chance errors due to soil variations or other disturbing factors.

The whole of the seedlings produced will be counted and information thus obtained as to the nursery germination of the seed and the extent to which this is affected by season of sowing; also as to the liability to frost damage, and the root and shoot development of seedlings produced from seed sown at different seasons.

The seed will be red-leaded and the beds covered lightly with humus as a protection against winter frost.

A second experiment on the season of transplanting coniferous seedlings is also under way. The object of the experiment is to obtain comparative data concerning the growth of root and shoot, throwing by frost, and death-rate of seedlings of different species transplanted at different seasons.

The seedlings are being transplanted at monthly or fortnightly intervals from autumn to early summer.

During October and November the following sample plots were measured :—

On the Novar estate, Ross-shire, two sample plots were laid out in *Abies grandis*. The cutting of the thinnings has had to be delayed at the request of the owner. Two sub-plots of Douglas fir were completed. One was taken in a pure plantation and the other in a larch-Douglas fir mixture. Special information was recorded on branching, &c.

On the Beaufort Estate, Inverness-shire, two comparative thinning plots were established in a Douglas fir wood.

On the Gairloch Estate, Ross-shire, one temporary sample plot of Douglas fir was measured in Flowerdale. The wood consisted originally of a mixture of Douglas fir, larch, Norway

spruce and Scots pine, planted 4½ ft. × 4½ ft.; the last three species have been for the most part suppressed or killed by the Douglas fir. The stocking of the Douglas fir is good. The stems on the whole are straight and not heavily branched.

Elevation 100 ft. Aspect South. Exposure, moderately sheltered. Slope fairly steep. Soil 10 ins. to 15 ins. loam over boulder till.

The following are the principal measurements for the plot :—

Age.	No. of Stems.	Height.	Q.G.	Form Factor.	Volume U.B.Q.G. per acre.
yrs.		ft.	ins.		cu. ft.
54	215	82	12¼	·358	6,575

Planting experiments will be reported on in the next issue of the Journal.

3. *Work by Mr. Hiley at Oxford.*—Mr. Hiley has been making a study of the early growth of coniferous seedlings, especially in relation to the relative rates of growth of the radicle and hypocotyl, under different temperature conditions.

In one type of seedling failure, which is not uncommon in seedbeds, the radicle may be seen to be curled so that its tip is near the micropyle of the seed. This is apparently due to the root cap of the radicle becoming caught in the micropyle, so that the subsequent growth of the radicle can only result in a curve. Such seedlings seldom mature.

Observations recently made on Corsican pine transplants which had been root-pruned in various ways last March (1 yr.-1 yr. plants) show that in every case the growth above ground has been retarded as a result of pruning.

Only one method of root-pruning has improved the root form ; this method consisted in cutting off with scissors all the roots to three inches below the soil surface level. The roots branched freely just above the cuts and produced abundant fibres ; there was an absence of deep-going roots such as characterised the controls.

Plants in which only the lateral roots were pruned made comparatively few new roots.

W. H. G

Peat Research.

As a first instalment of notes which may subsequently appear in the Journal in connection with my research on peat, the following particulars of literature on the subject may be of interest :—

1. *Definition of Peat.*

Talbot, H. W. *Jour. Amer. Peat Society*, 12.22, 1919.

"Peat is partly decomposed and disintegrated vegetable matter that has in one way or another accumulated in areas of poor drainage where chemical changes incidental to ordinary atmospheric conditions have been retarded or suspended."

2. *Origin of Peat Deposits.*

Soper, E. K. "The Peat Deposits of Minnesota." *University of Minnesota Bulletin*, No. 16 (1919).

Lewis, F. J. "Peat Deposits of Britain." *Science Progress*, Oct., 1907 ; *Scottish Geographical Magazine*, 1906.

Geekie, J. "On the Buried Forests and Peat Mosses of Scotland and the changes of Climate which they Indicate." Trans. Roy. Soc. Edinburgh, xxiv, 1867.

3. *Classification of Peat Lands.*

Warming, "Oecology of Plants."

Hardy, M. "Botanical Survey of Scotland." *Scottish Geographical Magazine*, 1906.

4. *Some Factors Causing or Contributing to the Inhibition to the Growth of Plants in Peat other than Peat Plants.*

Acidity—

Livingston, B. E. "Physiological Properties of Bog Water." *Bot. Gazette* 39, 1905.

Dachnowski, A. "Toxic Property of Bog Water and Bog Soil." *Bot. Gazette*, 46.

Truog, E. "Soil Acidity : its Relation to the Growth of Plants." *Soil Science*, Vol. V, No. 3, March, 1918.

Skene, M. "The Acidity of Sphagnum and its Relation to Chalk and Mineral Salts." *Annals Botany*, 29, 1915.

Jost's Plant Physiology, p. 39.

Thatcher, K. M. *Journal of Ecology*, Sept., 1921.

Acidity may affect plant growth by :—

(*a*) Affecting the availability of mineral substances and food substances to the plant ;

(*b*) Affecting transpiration ;

(*c*) Causing pathological conditions in the roots ;

(*d*) Affecting the activity of micro-organisms in the soil.

Negative results were obtained by Livingston and Dachnowski in their experiments on the effect of acidity.

According to Truog soil acidity may cause inhibition due to its affecting the availability of mineral substances to the plant. He states " that for nearly all crops an acid soil condition is unfavourable to the highest development of the desirable biological conditions and processes of soils." He holds that the organic matter of soils is preserved as such in an acid condition, preventing the liberation of plant food and mineral matter. Nitrification and nitrogen fixation may be markedly checked and toxic substances preserved and accumulated in an acid soil much more than in a non-acid one. He states that certain elements such as calcium, magnesium and potassium become less available when a soil becomes acid, while other elements such as iron, aluminium, manganese, zinc and other heavy metals become soluble and available. He cites the case of phosphorus in an acid soil where soil phosphorus is gradually converted from calcium phosphate to iron and aluminium phosphates, in which form the phosphorus is non-available to the plant.

Jost mentions that dilute acids retard transpiration, while dilute alkalis accelerate transpiration. Miss K. M. Thatcher has shown that the direct effect of peat was to increase the transpiration rate as compared with that of plants in loam of the same percentage saturation.

Acidity is considered by Truog not to cause pathological symptoms in roots. He maintains that cell sap is practically always acid, even more so than the acid medium in which the plant may be growing. He found that the addition of lime to acid soils usually caused a slight reduction in the acidity of the cell sap and he concludes that " the acidity of the soil solution never becomes high enough to be directly toxic or destructive to the plant roots."

Low Temperature of the Substratum and of the Air over the Bog.

Cox, H. J. " Frost and Temperature Conditions in the Cranberry Marshes of Wisconsin." *Bulletin* T., U.S. Dept. Agric. Weather Bureau, 1910.

This factor is regarded by many investigators as important. The amount of water in the soil influences the soil temperature. The amount of heat which would raise the temperature of 1 lb. of dry soil by 5°F. to 7°F. would cause a rise of only 1°F. in 1 lb. of water. Hence the drier the soil the more rapidly it becomes warm. Peat soils always contain a large percentage of water and therefore are generally lower in temperature than other soils. This has been demonstrated by Professor H. J. Cox. He shows :

(*a*) That a bog with a dense growth of saturated sphagnum gives lower temperatures than a sandy loam at the edge of the bog. The depths at which the temperatures were taken were 3 ins. and 6 ins., and the times of

reading were 6 p.m. and 7 a.m. At 6 p.m. for both depths the difference in temperature was as much as 10° ; at 7 a.m. a difference of about 2° was noted.

Also sphagnum gave lower temperatures than bare peat.

(*b*) That the temperature *over* a bog is lower than the temperature over a sandy loam until a height of between 36 ins. and 48 ins. is reached, when they tend to approximate.

(*c*) That there was a much greater difference between the temperature of the air and that of the soil on the bog than on neighbouring dry land.

(*d*) That " frost remains in the soil of an unflooded bog until comparatively late in the season, and there have been found instances of frost in the soil in marshes as late as July."

The Evaporating Power of the Air.

Dachnowski, A. " Vegetation of Cranberry Island (Ohio) and its Relation to the Substratum, Temperature and Evaporation." *Bot. Gazette*, 52, 1911.

Cox, H. J. " Frost and Temperature Conditions in the Cranberry Marshes of Wisconsin."

Thatcher, K. M. *Jour. Ecology*, Sept., 1921.

The evidence produced by Dachnowski is against this factor as being of any importance. Cox's work also gives negative results.

Miss K. M. Thatcher in her transpiration experiments found that :

1. Plants in peat were able to survive sudden increases in the evaporating power of the air ;
2. The relative transpiration increased with increase in the moisture content of peat.

Aeration.

Dachnowski, A. " Toxic Properties of Bog Water and Bog Soil." *Bot. Gazette*, 46, 1908.

Transeau, E. H. " Bogs and Bog Flora of the Huron River Valley." *Bot. Gazette*, 41, 1906.

Dachnowski denied that lack of aeration directly caused the inhibition to plant growth in peat, although he found that aeration considerably lessened the toxic properties of bog water.

Transeau found that in peat in the case of *Larix americana*, Mycorhiza took the place of root hairs. He came to the conclusion that lack of aeration favoured the growth of Mycorhiza.

Rigg considers from the evidence available that aeration may be a contributing factor indirectly.

Deficiency of Available Nitrogen.

Pearson, G. A. *Journal of Forestry*, 17. (Rev. of Hesselmann's work.)

Dachnowski, A. "Physiologically arid Habitats and Drought Resistance in Plants." *Bot. Gazette*, 49, 1910.

Robinson, C. S. "Organic Nitrogenous Compounds in Peat Soils." Mech. Agric. Coll. Exp. Stat. Tech. *Bulletin*, 7, 1911.

Jodidi, S. L. "Organic Nitrogenous Compounds in Peat Soils." Mech. Agric. Coll. Exp. Stat. Tech. *Bulletin*, 4, 1909.

Coville, F. V. "Experiments in Blueberry Culture." Bur. Pl. Ind. *Bulletin*, 193, 1910.

Nitrification is believed to be absent from Sphagnum bogs, moor and heath lands.

Dachnowski believed that the nitrogen in peat is bound up in organic compounds which are unavailable for growing cultivated plants. Robinson found that the nitrogen in peat occurs in numerous unknown forms. Jodidi states that all the nitrogen in peat is of an organic nature and available nitrogen increases with the weathering of peat; while Coville in his work on the Mycorhiza of the Swamp Blueberry states that there is every reason to believe that the Mycorhiza of the plant transforms non-available nitrogen into available nitrogen.

Hesselmann in his investigation into the causes of the non-reproduction of Scots pine in heath lands in Norway found that where pine seedlings do develop there is a noticeably higher percentage of available nitrates present.

Low Surface Tension of Bog Water.

Regg, Turnbull and Lincoln. "Physical Properties of some Toxic Solutions." *Bot. Gazette*, 61, 1916.

Regg, Turnbull and Lincoln found no data in their investigation to support this theory.

Drought.

Warming. "Oecology of Plants."

Burns, G. P. "Edaphic Conditions in the Peat Bogs of Southern Michigan." *Bot. Gazette*, 52, 1911.

Dachnowski's works, *e.g.*, "Peat Deposits of Ohio." *Geol. Survey of Ohio, 4th Series, Bulletin* 16.

Burns supports the drought theory, while Dachnowski is against it. Warming states that roots can utilise water present in the soil only to a limited degree. By decreasing the amount of water the remainder becomes more and more firmly held by the soil until a point is reached when the plant is unable to remove the water from the soil. This is probably what occurs during a dry season in peat.

Toxic Substances in Peat.

Rigg, G. B.	" The Toxicity of Bog Water." *Amer. Jour. Bot.*, 3, 1916.
	" The Effect of some Puget Sound Bog Waters on the Root-hairs of Tradescantia." *Bot. Gazette*, 55, 1913.
Livingston, B. E.	" Physical Properties of Bog Water." *Bot. Gazette*, 37, 1904.
	" Physiological Properties of Bog Water." *Bot. Gazette*, 39, 1905.
Dachnowski, A.	" Toxic Properties of Bog Water and Bog Soil." *Bot. Gazette*, 46, 1908.
	" Bog Toxins and their Effect upon Soils." *Bot. Gazette*, 47, 1909.
Transeau, E. M.	" Bogs and Bog Flora of the Huron River Valley." *Bot. Gazette*, 41, 1906.

Evidence points to this factor as being a very important one. Rigg Dachnowski and Transeau, for instance, have produced experimental evidence to show that there are decidedly toxic substances in peat. The toxic substances may be decomposition products or certain mineral substances which are in a soluble form.

5. *Cultivation or Utilization of Peat Lands.*

Connor.	" Agricultural Value of Indiana Peat and necessary Fertilisers." *Jour. Amer. Peat Soc.*, 13.
Feilitzen, H. von	" Cultural Experiments on Moorlands." *Jour. Amer. Peat Soc.*, 12.
Shear, C.	" Utilisation of Peat Lands for Cranberry Culture." *Jour. Amer. Peat Soc.*, 7.
Rennie, R.	" Essays on the Natural History and Origin of Peat Moss." 1807 and 1810.

Feilitzen showed that increased crops were obtained on an imperfectly decomposed peat soil by mixing sand with the top layers of the peat. The crop used was hay.

Connor found that in Indiana neutral peat soils responded to a dressing of a potash manure : acid ones to lime and phosphates.

E. V. L.

NOTES FROM THE DIVISIONS.

ENGLAND AND WALES.

Division III.

Planting by Unskilled Labour.—With inexperienced men one of the chief difficulties was to get them to dig the holes deep enough, and then to place the rootlets properly.

Straight lining, in planting, was naturally impossible at first —but that improved.

Here rough measuring sticks, cut to the desired lengths, were used for spacing purposes. Without this assistance it was found that the distances soon became very irregular. Over-deep planting was also a common fault.

Tools.—The tools found most useful were :—

(*a*) The 5 lb. mattock, especially on stony ground. Some women handled this with ease.

(*b*) The spade for soft ground. The best shape approximates to the grave-digger's spade, *i.e.*, 6-ins. × 12-ins. blade.

The light entrenching tool was a failure and the cause of much bad planting. It was too light, too short, and curved too much to make a deep hole. Even with small plants, the tendency was to chip out a cup-shaped piece of soil, with the result that the roots did not get in deep enough. A suitable tool of this nature for 9-in. plants and under could, however, easily be made by making it 1 lb. or so heavier, narrowing the blade to 3 ins. or 4 ins., making it 2½ ins. longer, and lessening the curve to almost straight.

W. H. L.

Division IV.

The Acquisition of Felled Woodlands.—Experience gained during the first year's operations demonstrates the greatly enhanced cost entailed in cases where land acquired for planting is encumbered with débris left from a previous crop. Moorland, with only rough vegetation such as heather, cost in preparation about 16*s.* per acre, and the work might have cost much less if the season had allowed of heather burning. As compared with such expenditure the case of Haldon may be instanced, where, in consequence of two years' delay in replanting after felling, coppice shoots, bramble and other coarse vegetation had sprung up, necessitating clearing at a cost of £2 per acre, the wage being the same as in the moorland work just mentioned.

Still more striking instances occurred in connection with the Eggesford Estate, where longer time (three to six years) had elapsed since the date of felling. One area cost £3 per acre, another £4 per acre, and the largest area (85 acres), cleared partially

by piecework, cost not less than £6 per acre, and, indeed, a portion of it £8 per acre. The value of the land is stated to have been £3 10*s*. per acre, but it was sold to the Commissioners for £1 15*s*. Even at this low purchase price the total cost before commencing planting amounted to £8 15*s*. per acre owing to the cost of clearing having averaged £7. It is to be observed that for this sum at least three times the acreage of ordinary waste land could have been acquired.

Such initial cost is a severe handicap on the crop now being established. On the other hand better increment may be anticipated than in the case of woods formed on bare land. At Eggesford additional advantages accrue from having the area already enclosed by useful hedges and approachable by good roads. Taking all things into consideration it would appear advisable not to acquire old forest land at present unless the lop and top has been cleared prior to taking possession.

C. O. H.

Division V.

Planting among Coppice Shoots.—A number of over-grown ash plants (6 ft. to 9 ft. high) being on hand at Brackley Hatch, it was thought that they might be planted under the light cover provided by hazel coppice, but would probably fail if planted out in the open. An area of 20 acres was therefore dealt with in this way and the experiment proved successful. The ash were placed from 9 ft. to 12 ft. apart, and filled in with spruce transplants, the latter being six years of age. The hazel coppice was from 6 ft. to 9 ft. high, representing the growth of three or four years.

Under the protection of the coppice, the ash plants established themselves satisfactorily and the spruces retained their natural dark green colour, comparing favourably in this respect with the yellowish-green of those planted in the open. The growth of the spruce has been from 6 ins. to 9 ins., whereas the plants without overhead shade have made only 3 ins. to 4 ins. of height-growth.

As experience elsewhere has proved, plants with matted grass round them are always retarded in growth, so much so that it may be better in all cases to remove the turf, even if its clearance entails considerable expense.

Complete removal of coppice in a case such as the above seems to be scarcely called for ; in fact, if any benefit is likely to be derived from its shade and shelter, it would be better to retain some of it. This certainly appears to be the case in the neighbourhood of Northampton, where there is a constant though moderate demand for the small material obtainable from coppice.

R. G. F.

SCOTLAND.

Northern Division.

Squirrel Damage.—However much the unusually mild winter of 1920–1921 may have affected plant development in other directions, it certainly has had a beneficial result so far as squirrel damage amongst forest trees is concerned. From various parts of the Northern Division (Scotland), reports and actual observations appear to indicate that squirrels found sufficient food on the ground during the winter months and paid very little attention to the bark and shoots of trees, the amount of damage done being insignificant compared with that of previous normal winters.

The number of squirrels killed during 1920 on estates in the counties of Inverness and Ross and Cromarty, the proprietors of which are members of the Highland Squirrel Club, amounted to 1,893, compared with 1,530 in 1919.

Motor Saw.—The following is a description of a handy motor-driven circular saw at present working on the Black Isle, near Inverness :—

The engine is a 3 h.p. machine belonging to the type known as Mule Team. Five lines of these engines are made by the Associated Manufacturers Company, Waterloo, Iowa, U.S.A.

The lines are as follows :—

1. Johnny Boy
2. Busy Boy
3. Chore Boy
4. Hired Hand
5. Hired Man

} Of 3, 4, 6, 8, 12, 18 h.p. Mule Team type.

This particular engine is a " 3 Mule Team Chore Boy " line one. It is started with benzol and runs on paraffin oil. Three gallons of benzol are used per month and two gallons of paraffin per day. It works for nine hours daily and can keep three girls and one man employed, the wages being respectively 5*s.* and 10*s.* per day for girl and man. It is used for cutting up the discarded small ends, tops and branches of trees down to 2 ins. in diameter, thus utilising material which generally goes to waste or is burned. From this material pieces up to 10 ft. long are obtained and cleaned of small branches and cut into lengths of from 1 ft. to 6 ft. for use as pit timber. The motor saw cuts on an average 5,000 pieces of different lengths per day, and is said by the mill manager to make over £400 per month from this waste material, which nearly pays the whole working expenses of the ordinary portable mill employing eleven hands, along with the expenses of the motor saw itself. The whole motor saw outfit rests on a wooden platform, under which is an ordinary cart axle so that wheels or skids can be fitted, and it can easily be moved by a donkey or mule to any part of a wood where there is a quantity

of tops or other similar material. It would be extremely useful and economical for cutting up firewood, and there has been no trouble with the engine beyond the plug shooting occasionally. The cost of the complete 3 h.p. outfit is at present about £50–£60.

G. R.

Curious Damage to Scots Pine Seedlings.—In the autumn of 1920 it was discovered that a number of Scots pine transplants at Borgie (ex Craibstone Nursery) were suffering from some cause that could not be diagnosed. The stems were ringed about one to two inches above ground. The diameter above the ring became substantially larger than that below it, and the leading shoot eventually dropped off.

The appearance of the disease was exactly like that caused to Douglas fir by *Phomopsis-pseudotsugæ*, and it was thought that the damage might be due to an extension of the disease to the Scots pine. The mycologist, however, could find no trace of fungus in the specimens submitted to him, and it was thought that the damage must have been done by careless handling in the lining out boards.

L. A. N.

Labour.—There was a shortage of labour on the three schemes in the Glen Mhor District when planting was commenced in October, 1920. No men could be obtained locally and it was necessary to import them from other parts. These included eleven fishermen from Barra, who were employed during the winter and spring. None of the imported men had any previous experience of planting and most of them were indifferent planters, but they did useful work clearing scrub and draining.

Autumn Planting.—In order to make up arrears a considerable area was planted on each of the three schemes during autumn. These plants have done well and failures do not appear to be more numerous than in the case of spring planting. The lower slopes and more sheltered parts were planted and the more exposed parts left until spring.

G. H.

North-Eastern Division.

MONAUGHTY AREA.

Weather.—The weather from the beginning of October to the end of March was most remarkable, and during the whole of this period not one complete working day was lost through bad weather. If a forenoon were wet the afternoon was usually dry, and *vice versa*. There was practically no frost and on no occasion was work stopped for this.

Drying frosty West and North-West winds formed the prevailing weather all the winter and frequently these were unusually strong. To prevent the drying-up of the roots special precautions had to be taken against these cold winds. Plant-carrying bags

were used, made up of three or four bags inside each other with a quantity of sphagnum moss amongst the plant bundles. The planters' aprons were latterly made double, with a fold over the mouth, and as only a few plants (four or five) were handed out at a time, and the others kept in moss, we in most cases succeeded in keeping the roots moist.

Labour.—The total planting squad here averaged 25 to 30 men, only one or two of whom had planted before. Most of them, however, had handled spades and forestry tools, and with close supervision for several days new men usually became quite adept fairly quickly. We had absolutely no " labour troubles " and as far as I could learn there was very little discontent in the squad all winter, and, indeed, for the coming planting season I expect to have most of the same men available, though many of them come distances of not less than five miles.

Large and Small Plants.—The difference in planting large and small plants is most noticeable. Up to the end of February we planted nothing but larch, mostly 2 yr. seedlings, and were putting in about 650 per man per day, including paring or " screefing " 9-in. to 12-in. patches. After that date the bulk of our planting consisted of large spruce (2 yr.-2 yr. and 2 yr.-3 yr.) and men could not get in much more than half the above number with a maximum of 500, besides the fact that at least two men were required to carry plants. These larger plants in the aprons handicapped the men very much. Considerably deeper and larger notches had to be made, and getting them to sit straight (the most difficult problem of all) caused much extra work. I would suggest the use of large plants only in the very roughest of grass herbage.

Heather Burning.—A small proportion of the planting ground on this area had the rough heather burned over before planting commenced. This had the advantage of making planting easier, but on the other hand the slightest frost stopped work; also it was distinctly noticeable even before the end of March that the plants on " burned " ground were not nearly so happy looking as those amongst the heather and grass. During the summer this will become more noticeable and the highest percentage of deaths will most probably be on these places. Planting on heather entails a little more work, but even in fairly rank heather I think it is worth the extra labour, especially on places exposed to strong drying winds, such as we experienced here.

Early Spring Growth.—Growth on larch this season was particularly early and on the 15th of February young larches just planted out were beginning to burst their buds. On 27th February I found one young natural larch with male flowers full blown and leaf buds well flushed, and this tree was not in a sheltered situation. Within ten days of the above date male flowers were in full bloom and leaf buds on all trees were in active growth. This resulted in a correspondingly early move on the

part of chermes, which gave every indication at this time of being a severe attack. About the middle and end of March I found *Myelophilus piniperda*, *Hylurgops palliatus*, and *Hylastes ater* breeding in Scots pine stumps felled in the back end of winter, with *Pityogenes bidentatus* and *Tomicus acuminatus* beginning to move in the lop and top lying on the ground, also several *Hylobius abietis* in their breeding ground. Amongst Scots pine here *Retinia resinella* is the most harmful insect, and is the only noticeable moth damage.

J. McE.

SEATON NURSERY.

Wind.—There is a prevailing wind here from the South-West, but the nursery is practically open to winds from all directions, with the exception of the North-East. There were cold winds from North-West, North, North-East, and East. Taking it all round there is generally a wind from South-West or West, the chief drying winds coming from these directions, also the North-West. Very rarely do we really have a calm day. Wind from South-East direction, as a rule, brings rain.

Lining-out.—When operations were commenced here we had no skilled labour, but after some time two skilled men were secured and each was given a squad. Later on we had five squads going, three of these being unskilled. These three squads, however, soon became quite practical and efficient on being shown how the lining-out should be done, and being under supervision all the time. Only once did we have any trouble over the lining-out. This was caused by some very small Sitka spruce which would not remain in the transplanting boards when being carried from the shelter to the trench. The matter was soon rectified by having rubber draught tubing fitted on the boards. On an average the skilled men were lining out 18,000 plants per day, the unskilled men 12,000 to 15,000. During lining-out operations all precautions were taken to guard against drying-up of roots. Only sufficient plants were taken from the heeling-in place to the shelters to keep the squads going for one hour or thereabouts, whilst in the shelter the plants were kept in a box, the roots being moistened in addition to being covered by wet cloths, and so protected from wind or sun.

J. A. L.

South-Eastern Division.

Fungi and Insects.—During the past summer there has been considerable damage done in certain plantations of Scots pine by *Cenangium abietis*. This fungus has till now been regarded as of little importance in this country, but it would appear that this view must be altered and *Cenangium* treated as a very possible source of danger.

The symptoms that first attract attention are browning of the needles other than those of the current year's growth; subsequently defoliation, and later on probably death of the attacked

part. Small black fructifications appear on the twigs. The worst damage was observed in a mixed plantation of pine and spruce in Roxburghshire. This is growing alongside a stream and in a damp atmosphere and subject to frost damage. In this case very few pines escaped crippling or even death. There is a near ally of this fungus, *Brunchorstia destruens*, which attacks the black pines, such as *Pinus austriaca* and *P. Laricio*. It also has been found to be fairly common and doing considerable damage.

Chrysomyxa abietis has been found to be fairly wide spread on Norway spruce during this year. It has been discovered by the writer on spruces fifteen and forty-five years old in Roxburghshire and on others sixty to seventy years old at 1,250 ft. elevation in Perthshire. This parasite is not at present really dangerous and its attacks are generally limited in locality range inside a wood.

Phomopsis pseudotsugæ has done a considerable amount of damage in many plantations of Douglas fir.

In one or two nurseries small patches of seedlings were observed being killed by *Botrytis Douglasii*, and in a wet year methods of cultivation are frequently adopted which would tend to spread this disease. In particular, certain classes of top dressing would have this effect.

Armillaria mellea has been discovered in Peeblesshire and elsewhere defoliating Sitka spruce. In many cases the damage was furthered by severe attacks of *Aphis abietina*. *Armillaria* is recorded as a defoliator of certain newer conifers. In one instance, however, no *Armillaria* was found, but the trees were severely attacked by *Aphis*, and it is possible that this insect was the sole cause of defoliation.

Beyond the usual attacks of *Hylobius abietis*, *Hylurgus piniperda*, and *Chermes spp.* there is little to report of observed damage by insects. *Chermes sp.* was seen on Douglas fir in Peeblesshire and in Central and Western Perthshire (Murthly, Dunkeld, Ardchullary). No damage appeared to be done to this host. The other hosts of the insect were not found to be attacked.

Rabbit Damage.—The severe drought had the effect of causing rabbits to do an exceptional amount of summer damage. In many places grass was completely dried out, and if larch or spruce trees grew in the vicinity bark-gnawing was resorted to. Usually this damage is done only in winter, or at least to the greatest extent then.

Use of Douglas Fir Thinnings.—Thinnings taken from a Douglas fir plantation about twenty years old were converted into posts for a temporary fence. The posts were 2-in. to 2½-in. top diameter and were not peeled or dried before erection. During summer quick drying took place and the posts became

cracked, frequently almost to the ground level. It is expected that moisture will get into these cracks, creating an excellent germinating bed for destructive fungus spores. It would seem to be advisable to dry material of this kind slowly and, if possible, creosote it before erection.

An Instance of Damage by Drought.—During the summer a large beech tree about 180 years old was kept under observation. This tree grew among others alongside an avenue, but it seemed to be the one selected by a number of school boys who wished to play games. The soil on which it grew is boulder clay and it soon became extremely hard. To begin with the drought produced no ill effects, but about the middle of July, the whole of the leaves became brown and dead. Buds had been formed and the tree assumed the winter condition except that the brown leaves remained hanging. The leaves browned in less than a week. Rainy weather had the effect of causing a fresh burst of weakly green foliage, which is yet on the tree. It would appear that the excessive trampling had so decreased the pore spaces in the soil that drying (by capillary action) was enabled to proceed to extraordinary depths. The other old trees alongside showed no harmful effects of the drought.

The Hybrid Larch.—There has been much discussion recently on this tree. Dr. Henry calls it *Larix eurolepis* Henry, assuming that the parents are *L. leptolepis* (female) and *L. europœa* (male). If this be the case the tree is a natural hybrid. There are, however, other possibilities which should not be neglected, and while at present it would appear that Dr. Henry's conclusions are right, it is advisable to keep the other points in mind.

For this note the interesting point is the rate of growth of the hybrid. Trees planted at Dunkeld have in seventeen years reached a height averaging between 35 and 45 ft. Specimens have been cut with heights of 48 and 52 ft. Douglas fir is entirely dominated where it is mixed with the larch. The soil in this particular wood is mainly a deep gravelly loam over river gravel. The situation is sheltered from winds, and the elevation is about 250 to 300 feet. It is understood that the tree grows well at fairly high elevations, even where exposure is considerable.

The sylvicultural characteristics of the tree, so far as they can be judged from the young plantations that exist, are probably nearer to those of Japanese larch than to the European species. The shade bearing capacity is, for instance, greater than in the latter species, but not so great as in the former. Allowances must be made for age, the fact that younger trees can bear greater shade than older ones of the same species rather complicating comparisons.

The tree is invariably straighter in stem growth than is the Japanese larch. It is not subject to canker, although it has been found attacked.

It appears that the hybrid larch is likely to prove a valuable addition to our forest trees and every endeavour should be made to obtain considerable plantations of it throughout the country.

J. M. M.

The Effect of Shade upon Young Plants during Drought.—The usual procedure in the case of a newly formed plantation is to start cleaning the young plants as soon as the rough herbage appears likely to outgrow them.

Where bracken is present it is attacked with sticks and sickles as soon as the young succulent fronds appear above the ground. This is repeated when considered necessary two or three times per annum for the first three or four years until the bracken is practically killed out or the plants have outgrown it.

This, in a wet season, no doubt, is the correct thing to do, but in such a dry summer as we have experienced this year, the benefit of such work is not only doubtful, but from experience at Glentress Forest it appears that the early cutting of bracken is directly harmful.

In places in this forest where bracken is absent, the percentage of deaths from drought has been abnormally high. Where it was cut early, the plants suffered severely, being badly browned and for a long time giving no sign of sending out shoots.

The work of cleaning being stopped, the second growth of bracken came up and protected the young plants from the glare of the sun and also prevented, to a great extent, evaporation of moisture from the soil, resulting in a fair proportion of the plants recovering and putting on growth.

The only places where the plants have produced nearly normal shoots are where the bracken was left untouched until the rains came in August. All species were affected in the same way.

At Tweedenhead, too, the effects of shade were very noticeable. The majority of the plants here were planted on peat with the Mansfield spade, on patches prepared by the removal of the turf.

The coarse grasses with which the greater part of the area is covered have shaded the plants and conserved moisture, thus preventing the slits made with the spade from opening. Where the grass is less rank the slits have opened and the death rate has been very high.

From these observations it appears that it will usually be advisable to guard against drought during the spring and summer months by leaving the herbage, whether bracken, grass or heather, until the young plants have been given a chance to gain proper roothold. The beginning of August appears to be quite a suitable time, as the summer droughts should be past by then, and there will be time enough to complete cleaning operations before the winter work of beating up and new planting commences, and before the herbage dies and falls down over the plants.

W. H. W.

Western Division.

Effect of High Winds on Young Plants.—On the Benmore Estate at an altitude of about 200 to 300 ft. Douglas fir, about three years planted, had been entirely torn out of the ground by the wind and deposited at some distance from where they had been growing. This had resulted from strong winds blowing from different directions, each breaking the roots at the windward side and eventually leaving the tree practically no connection with the soil. This was noticed in a mixed conifer plantation where firming of plants had been neglected. Probably if the plants had been properly firmed they could have been saved. Other species although loosened had not been torn out of the ground. *Thuja gigantea* appeared to have suffered least, probably owing to the pliable nature of its stem when young.

Abies nobilis.—This species was observed on the Glenbranter Estate, in a mixed plantation of conifers about 40 years old, to be of larger dimensions than any other species including Douglas fir. Elevation about 400 ft. A young plantation of this species was observed at about 700 ft. on the Drimsynie Estate and appeared to be thriving and looking distinctly better than common larch at the same elevation.

Chinese Spruce.—Certain species of Chinese spruce were observed by Mr. Hunter Blair to be growing rapidly on a wet and peaty soil in the parish of Straiton, Ayrshire. Species were not known. Trees were only about 6 years of age.

Larix Kurilensis.—A plantation of this species near Dalbeattie has failed, owing to the trees being cut back by spring frosts.

Pine Sawfly.—Damage by *Lophyrus pini* was noted in Ayrshire late in March.

A. D. H.

Seed Crop.—The production of seed in Argyll was very poor. Although beech trees flowered freely, the fruit did not mature properly, nearly all beechnuts being empty. Scots pine cones also produced a very small percentage of good seeds.

Browning of Scots Pine Needles.—At the end of the winter (March) the Scots pine at Inverliever began to turn brown on the windward side (S.W.) and to drop its needles ; this process, however, became more noticeable after 31st March—the browning beginning before and the needle-cast mainly taking place after that date.

Drainage.—It is noticeable at Inverliever not only that growth (spruce) in peaty areas is immensely better in the rows of trees immediately flanking drains (and in the worst places is almost confined to these), but that the row on that side of the drain on which the divots have been thrown out is always in advance of the other. This is irrespective of whether one side is above or below the other, as it occurs similarly on level ground, and the

trees are in no case planted on the divots. It would appear rather to be connected with the weathering of the upturned peat, which may provide more nourishment to the plants in its vicinity.

Soil-indicators.—The great value of a system of soil-indicators such as that issued last year by the Forestry Commission for Inverliever is very apparent. Incidentally it may be mentioned that a certain area at Inverliever, where larch has been disappointing for no obvious reason of soil or exposure, was notoriously bad ground for sheep—many deaths occurring on it in winter.

Chermes.—The damage to silver fir by chermes is increasing all through the county ; at Inverliever it is very serious indeed.

Blackgame.—These birds, together with roe-deer and hares, are doing serious damage to silver fir, and it is not always easy to discover which is the culprit in a given case. A rough distinction seems to be that blackgame make a ragged tear and sometimes crease the needle without cutting it, while roe-deer shear off the needle or branch cleanly.

Mice.—Land at Inverliever that has been fenced against stock for some years becomes infested with mice, which harbour in the tufts of coarse grass. Hawks and owls are fairly numerous, but do not keep them under at all adequately. They are doing considerable damage to young beech plants, often gnawing them right through just above the collar.

Depression of the Wet Bulb.—The average depression of the wet below the dry bulb at Ford is markedly less than at other stations on the W. coast for which records are published, *e.g.*, in 1919 the mean depression for the whole year at Ford was 1·8°F., at Oban 2·2°F. and at Fort William 2·7°F. I have not been able to work out the actual humidity per cent. which these figures imply, not having the necessary tables, but am confident that it is abnormally high.

Sea Spray.—During a south-westerly gale I have found that the air is full of flying salt spray on the high parts of the forest at Inverliever—the sea being about 10½ miles distant in the direct line to windward, and the elevation of the place up to 900 ft. If salt is deleterious to tree growth, this indicates that its effects may have to be looked for at some distance from the sea.

A. G.

IRELAND.

Northern Division.

Effects of the Drought.—Nothing of an unusual character has occurred in my Division during the period under review, but following a wet and backward spring a period of drought intervened, which continued throughout the entire growing season and caused considerable loss in transplanted trees both in the

nurseries and in the newly-formed plantations ; while a severe frost which occurred during the second week in May also caused a considerable loss in European and Japanese larch, and Douglas fir seedlings. With regard to the loss in larch, it was noticeable that the Japanese species suffered to a much less extent than the European, and that slightly frosted plants of the former made a much better recovery during the season.

In the newly-formed plantations the effect of the drought was most noticeable in the case of Douglas fir and Sitka spruce, but whereas the check was only of a temporary character in the case of Douglas fir, practically no recovery was made by the Sitka spruce, whose young shoots, unless where the trees were planted on actually wet land, were shrivelled up and growth since then has remained practically dormant.

The present year's experience has demonstrated the necessity of further investigation into the degree of dependence of the various species upon a sustained and abundant supply of moisture, soil or atmospheric, during the vegetative period ; and also the moisture-holding capacity of soils, mineral or peat, during prolonged droughts. Investigation and the collation of data are required most of all in the case of Sitka spruce, whose adaptability as an economic species is limited by its heavy demands on moisture.

Attack by Keithia.—No limitation of the attack previously reported of *Thuja plicata* (*Thuja gigantea* or *T. Lobbi*) by *Keithia thujina* is apparent, and especially in the West of Ireland, where favoured by the humidity of climate, its spread has been rapid. At Aghrane, County Galway, where an area of 10 acres was planted with 50 per cent. of Thuja, practically all the plants have been killed outright. So far, however, the disease has been confined to this species, as *Cupressus Lawsoniani* growing contiguous to the former in the nursery and planted in admixture outside has completely escaped infection.

J. C.

Southern Division.

Insect Damage.—Chermes Cooleyi has not yet been found in my division.

This year Sitka spruce was very badly attacked by aphides (greenfly). In the *Quarterly Journal of Forestry* it is stated that only weakly Sitka spruce or those growing on unsuitable soil are affected, but in this division trees growing under what appear to be most suitable conditions and putting on leaders up to 3 ft. per annum have been attacked. Although the aphides are found on Norway spruce the latter have not suffered to anything like the same extent as the Sitka, neither have any of the other spruces—*Picea alba, P. rubra, P. Morinda*, &c.—suffered. It is rather curious

that a *Picea pungens* in my garden was very badly attacked and almost completely defoliated, but not a single aphis could be seen on the Norway spruce growing in the next garden 20 or 30 yards away.

A very severe weevil-attack on Douglas fir at Camolin has already been reported to the Commission's entomologist. Pine sawfly has appeared in Scots pine in the nursery at Camolin.

Germination of Seeds.—The large percentage of failures in Douglas fir 2-yr. seedlings lined-out in the spring of 1921 cannot entirely be accounted for by the drought, as Sitka spruce lined-out at the same time and under the same conditions have not suffered to the same extent. I think the failure is largely, if not almost entirely, due to thick sowing of the seeds originally. This brings me to what is probably the most important question now awaiting investigation, and that is the germination of tree seeds. If we could tell what percentage of seeds were going to germinate a very great saving in the cost of production of seedlings would be effected. For instance, the Douglas fir above referred to could easily have been sown half as thickly, and we would have at least twice the number of strong seedlings. On the other hand, had these seeds not had such a high percentage of germination, and had they been sown half as thickly, a very great expense in weeding would have been incurred. As an experiment I had a bed of Douglas fir 2-yr. seedlings at Camolin thinned out and the result is very satisfactory.

Weeding in Nurseries.—Another matter which, however, cannot be dealt with satisfactorily on paper, is the degree of weeding necessary either in beds or in lines. As regards beds, I do not think there can be any two opinions in the matter. They should be kept scrupulously clean, but as regards the lines I have an open mind. I am rather of the opinion that cleaning is being overdone, but as one does not like to have a dirty-looking nursery one does not interfere with the forester in the matter of weeding lines.

Damage by Fire.—We have been fortunate during the year as regards damage by fires, Ballyhoura being the only place affected. We lost about 11 acres of newly-planted Corsican pine there as a result of a fire which spread from the military camp at Ballyvonare. This is probably the last place where I should have expected a fire, as there is little on the ground except stones, and the heather is very thin.

Effects of Drought.—The dry weather has had a very adverse effect on the plantations made this year at Dundrum. While the clayey nature of the soil has had a good deal to do with it, late planting is probably mainly responsible.

A. J. K.

NOTES AND QUERIES.

Tortrix viridana destroyed by Ants.—Some time ago, when in the Tintern Woods, Mr. John Roberts informed me that he had observed that wherever there were a considerable number of ants the attacks of the oak-leaf-roller moth were not so bad as where ants were scarce. He also said that he had watched the ants going up the trees and coming down again with the caterpillars.

I had never observed this personally until the spring of 1920, when in an oak wood near Chagford (Devon) I happened to see large numbers of ants going up and down the oaks. My wife and I watched two trees for ten minutes, and between us we counted 40 caterpillars being carried down by ants. Can any practical advantage be taken of this ?

C. O. H.

Bark-beetles introduced in Pit-props.—At most of our ports bark-beetles and other bark and wood-boring insects are regularly brought into this country on imported timber, but few of them ever gain foot-hold in our woods.

Early last summer an interesting Mediterranean bark-beetle was recorded on driftwood near Swansea, but at the time no particular interest was aroused by it. In August, however, two exotic bark-beetles were found breeding in the Dean Forest, by Mr. D. J. Atkinson, who sent them on to me for identification. Both are Mediterranean and South European species, *Tomicus sexdentatus* and *T. erosus*. This latter is the species found at Swansea and *T. sexdentatus* was found near Cardiff in 1919, Mr. Story having received specimens from that locality.

Mr. Atkinson has since given me specimens of the larvæ and of the "workings" of both these beetles, and there is no doubt that they have become established in the Dean Forest.

Fortunately both species are secondary pests, *T. sexdentatus* markedly so, but their occurrence in our British woodlands serves to show the risks we run of introducing forest pests in imported timber.

J. W. M.

Pine Shoot Beetle boring into Spruce Shoots.—That the pine shoot beetle *Myelophilus piniperda* breeds in spruce is well known but there are no records of its travelling in the shoots of spruces. It has been recorded as boring in larch shoots, and Mr. J. M. Murray recently sent me some Douglas fir shoots which appeared to have been attacked by this beetle.

In September of this year, while in Mr. Annand's division, I noticed near Bracus Hillock Cottage, Montreathmont Muir, an isolated spruce which looked rather ragged, and from the ground beneath it I collected several fallen and tunnelled shoots. Two of these contained adult *Myelophilus*. The spruce in question has since been identified by Mr. J. W. Bean as *Picea Morinda*.

J. W. M.

Western Hemlock.—I have received the following letter from Mr. C. J. Chaplin, Supervisor of Timber Tests, Forest Products Laboratories, McGill University, in reply to an enquiry regarding the qualities of Western Hemlock timber :

" The explanation of the poor reputation western hemlock (*Tsuga heterophylla*) enjoys is that for many years before it came on the market, eastern hemlock (*Tsuga canadensis*) had been cut for commercial purposes, and the name hemlock is thus most frequently associated with the latter species.

" It is unfortunate that the eastern species has poor qualities both in strength and durability. However, as you see from the tables of strength figures, the western hemlock stands comparatively high, while it is stated that it gives rather better than twice the period of service of eastern hemlock when used as railroad cross ties, and equal to that of western yellow pine (*Pinus ponderosa*). In fact, it may be said that its chief fault in use is the tendency to split when nailing rift-sawn boards. Otherwise, it is a serviceable wood of fair quality.

" It is used for frames of buildings, rough construction, ties and poles. It is an important material for the manufacture of boxes and also is used extensively in the production of pulp in British Columbia.

" I might add that the name ' Alaska pine ' is used in trade to avoid the prejudice encountered when listed as hemlock."

W. H. G.

Lectures to Staff.—With a view to interesting members of the staff in the science and practice of forestry, a series of lectures has been inaugurated in Edinburgh and will be continued during the winter months.

It is intended to hold lectures on somewhat similar lines in London. The titles of the papers, which are being given in Drumsheugh Gardens, Edinburgh, this year are as follows :—

" Introduction to Forestry "	Dr. Borthwick.
" The Growth of Conifers in Scotland " ...	Dr. Steven.
" Continental Forestry "	Mr. Sutherland.
" Some Factorial Experiences in the Highlands "	Mr. Cameron.
" Forest Nurseries "...	Mr. Murray.
" Trees in Design "	Miss Burnet.
" Responsibilities and Relationships in a Department "	Mr. Ditchburn.
" Supply and Distribution of Seeds and Plants "	Mr. Christianson.
" History of Land Tenure in Scotland "...	Mr. Wood.
" The Commission's Work in Scotland " ...	Dr. Borthwick.

An excursion to Glentress will be arranged on a convenient Saturday afternoon in May or June.

Unemployment Schemes.—In November last the sum of £250,000 was allotted to Forestry from the Unemployment Fund, and it is satisfactory to note that at the end of January approximately 4,000 men were at work, of whom 1,400 were employed by the Commission and 1,600 by private owners and the remainder by the Office of Woods and Local Authorities. As a result it is estimated that at least 9,000 acres will be planted this season on private estates, and preparation is being made for the planting of a further 9,000 acres in subsequent years.

F. S.

ABSTRACTS OF ARTICLES IN CURRENT PERIODICALS.

Quarterly Journal of Forestry.

VOL. XV, No. 4, OCTOBER, 1921.

The official information contains :—

Report of the Judges on the Plantations and Estate Nurseries Competition 1921, embracing the counties of Derby, Notts, Lincoln and Northants.

Report of the Forestry Exhibition at the R.A.S.E. Show at Derby, and

Reports of Branch Meetings of the R.E.A.S.

Original articles contributed are :—

"*Costing and Costs of Formation.*" R. C. Marshall. In which the writer indicates the necessity for examining closely each operation performed in nursery work and planting, in order to discover possible leakages of time and money. The influence of the proper organisation of planting gangs in keeping down costs is also discussed.

"*A Note on the Fall of Winged Seeds.*" H. J. Denham. Objects falling freely in air are subject to air resistance which increases rapidly with the rate of fall, and sooner or later a limiting velocity is attained at which the tendency to further acceleration is checked by an overwhelming increase of air resistance. In the case of such plants and trees as rely upon air currents for the dispersal of their seeds, the question of this limiting velocity becomes of immense importance and experiments were made in order to determine it for a number of seeds. The results obtained are given and their application is discussed with reference to the dispersal of seeds of *Pinus sylvestris.*

"*The Economical Production of Commercial Timber Crops.*" W. H. Bennett. The writer examines many aspects of the problem of successfully establishing plantations and their treatment, urging the desirability of raising plants in home nurseries. Relative costs of notching and pitting are given and the influence of the distance of planting upon costs of formation and tending, the health of woods and the quality of timber is discussed.

Reviews.—Reviews and notices of recently published text books and current periodicals are given.

In Current Topics and Short Notes an action for wrongfully felling trees is discussed in its legal aspect by B. W. Adkin, a report upon the Forestry Section at the Bristol Show 1921 is given, the English Forestry Association Trading Scheme is outlined, and a note appears on damage by hornets.

A. P. L.

Transactions of the Royal Scottish Arboricultural Society.

PART II, VOL. XXXV, DECEMBER, 1921.

Some of the principal features of interest may be alluded to. An article entitled "Some Remarks on British Forest History," by Mr. H. G. Richardson, is of considerable importance, and the abundant references to sources of original authority for statements made will, it is to be hoped, serve as a valuable guide to those interested in British forest history. It has been said that history spends half its time in repeating itself and the other half in getting itself revised. That the first part of this statement is true no student of forest literature will dispute, and as regards the second part we believe that the last word has been said regarding the history of forestry in the Middle Ages, so that in this case revision will not be necessary.

An article by Mr. J. P. F. Bell on the advantages of shelter belts should be welcomed as coming from a leading authority in agriculture. The writer shows that farming and forestry are not opposed, but that they can be mutually of much benefit to each other. The article should go a long way towards checking the wanton and senseless destruction of valuable shelter, which has been unfortunately only too prevalent in late years.

Mr. George Leven has some interesting and new observations to put on record concerning certain differences in growth, habit, and bark form of the Japanese larch. This article should be studied carefully.

"Branch Growth of Douglas Fir," by Mr. M. L. Anderson, is a useful addition to sylvicultural literature, and will serve as a warning against the futility of overcrowding this species in plantations.

"Continental Notes," by Mr. Hobart Hampden, are up to the usual high standard maintained by that writer and authority on forestry. Special attention might be called to the remarks on conditions for seed germination and the important inhibiting rôle played by carbonic acid (CO_2) given off by surrounding humus. The phenomenon no doubt applies also to root action in humus or peat, and the hint will not escape Mr. Laing's attention in his peat investigation.

The activities of the Petawawa Experiment Forest Station are described by Mr. James Kay. The station was established in 1918 by the Honorary Council of Scientific and Industrial Research. The work at present undertaken is similar to that of the Swedish Station, and every indication shows that "live" work is in progress.

Under "Notes," Dr. M. Wilson records an attack by the honey agaric, *Armillaria mellea*, on a potato crop. This is a unique record as far as Britain is concerned. A description, with plate, is given of an overhead saw for estate work, by Mr. A. Fleming. This appears to be an economical and practical labour and timber-saving device.

A number of books are reviewed. Mr. F. R. S. Balfour has a delightful article entitled "Notes on the trees and shrubs of the Departments of Savoie, Haute Savoie and Isere. This article is out of the beaten track of recent years, and it brings the reader once more into touch with the arboricultural aspect of trees and shrubs. Forestry has two sides, the æsthetic and the utilitarian and in these commercial days we are liable to overlook the former. It can be said, with some few notable exceptions, arboriculture has not the same grip on the present generation as it had on those of former days.

With a little attention here and there to grouping of colour and form the forester can make his woods and nurseries real resorts of pleasure, and that is why arboriculture should not be neglected. It is to be regretted that this side of forestry does not receive a little more attention than the syllabuses at some forestry schools seem to indicate. But let us not be too pessimistic. There is hope. Among the many hundreds of essays recently sent in to the R.S.A.S. by school children, the subject of "The Woods in Summer" seemed to make the greatest appeal, next to "The Autobiography of a Tree." The beauty of the woods and trees at various seasons was much enlarged on by the youthful writers. One young essayist in the North introduced his subject in true Scottish fashion by asking this question: "With the absence of trees where would be the beauty of the woods?"

This may sound involved, but undoubtedly this schoolboy had in his mind the picture of a dreary, treeless area and, of course, without trees there can be no woods and without woods no beauty. Probably in later years he may feel inclined to substitute "arboriculture" for "trees" in his question, and this would about meet the case.

The usual reports on the Annual Excursion, the Forestry Exhibit at the Highland and Agricultural Society's Show, and the Nursery and Plantation Competitions are also given in this part, together with other matters of current interest.

A. W. B.

Indian Forester.

NOVEMBER, 1921.

Under the title "The Swing of the Pendulum," by C. R. Robbins (10 pp.) an interesting description of the various French modifications of the system of "Successive regeneration fellings and thinnings" is given, with special details of Duchaufour's method. This aims at maintaining a proper control over the management of the forest, while giving the forest officer a larger area in which to carry out regeneration fellings and a freer hand in the selection of regeneration areas.

An article on "Thinnings," by Trowscoed (7 pp.) deals with the method of thinning certain Indian species and urges the necessity for thinning in the canopy of the dominant trees.

The other articles deal with sport and matters of no particular interest to British officers.

C. O. H.

The Australian Forestry Journal.

VOL. IV, No. 9, SEPTEMBER, 1921.

A note by "Cognitor" (3 pp.) on "The Evolution of Forestry in New South Wales" deals with a part of this subject entitled "Practice and Progress." It is well worth reading as the problems discussed are similar to those met with by our own Commissioners in England. A Forestry Commission for New South Wales was established under the Forestry Act, 1916, consisting of three members. The Chief Commissioner was appointed in October, 1916; a trained Officer was appointed about the same time as an additional Commissioner for Forest Management; and a Minister of the Crown is the third Commissioner. It is gathered the Commission is not yet fully constituted.

The policy in the Act is to select at least 5½ million acres of the "best timbered lands of the State" as State forests (*i.e.*, less than 3 per cent. of the total area of New South Wales), of which over 5 million acres have already been selected, and of these 875,000 acres have been brought under working plans. To provide for a supply of soft woods (now imported to the value of £2,000,000 per annum), not less than 5,000 acres a year will be planted for the next twenty to thirty years.

Elsewhere in the Journal appears a summary of the New South Wales Forestry Commissioners' Report, 1920–21, which shows that 1,000 acres were afforested (planted), 112,774 acres proclaimed and brought under the Forest Act; 171 State forests were developed (surveyed, sylviculturally treated, roads made, houses erected, fire belts cleared, &c.) at a cost of £95,759; administration cost £57,835; and the total revenue collected was £190,742.

The Victorian note deals with an address on Forestry by Mr. Owen Jones, of the Victorian Forestry Commission, who amongst other things refers to the "tallest tree in the world," which he thinks is an authenticated *Eucalyptus regnans*, 347 feet high, at Colac. He mentions that Victoria produces annually 500,000 lbs. of eucalyptus oil, and refers to the evidently successful introduction of *Pinus insignis* and *P. ponderosa* in their plantations.

W. H. L.

Journal of Forestry.

(Official Organ of the Society of American Foresters.)

VOL. XIV, No. 6, OCTOBER, 1921.

"The Jonson Absolute Form Quotient: How it is used in Timber Estimating." This is an interesting paper by H. R. Wickenden. Briefly, the theory of the method is that the volume and taper of trees of any given diameter and height is determined entirely by one single factor, *i.e.*, the ratio between two diameters on the tree. One diameter being that at breast height, the other midway between there and the top. The ratio is called the Absolute-form-Quotient. This quotient expressed in decimals is called the form-class. There is really no difference numerically between "form-quotient" and "form-class."

Two sets of tables are prepared, one for volume, the other for taper. Therefore given the diameter, form-class, and height of a tree, the tables show its volume and taper series.

The method is said to give accurate and reliable results.

"Fur Culture on the National Forests" is an article by Smith Riley. It deals principally with the beaver and describes a method whereby certain rivers may be restocked where this valuable furbearing creature has been exterminated by over-trapping.

The following papers occupy the next thirty-two pages:—

"The Calculation of the Mean Fibre-length of a Tree."
"Volume Increment on Cut-over Pulpwood Lands."
"Indian Timber Lands."
"Yellow Pine Reproduction."

These articles are of relatively little interest to the home forester.

H. G. Lachmund has some useful observations on the relationship between fire scars on trees and subsequent fungus attack.

"Co-operation in Forest Protection," by R. S. Kellogg, is an abstract of a statement submitted to the Forestry Committee of the Chamber of Commerce of the United States in June, 1921.

The author is the Chairman of the National Forestry Programme Committee. The programme of this Committee is

a very complete one, embracing within its scope all phases of forestry which can be promoted by legislation and by the setting up of adequate machinery.

The provisions of the Snell and McCormick Bills to improve national forestry are given, and the efforts and aims of the National Forestry Committee to ensure the benefits of these legislative provisions being fully realised are well worth careful study. "Reclamation of Grass Lands," by Utah Juniper, on the Tusayan National Forest, Arizona, shows that the eating of juniper berries by sheep leads to the distribution of the seed over the grazing lands.

Mr. W. G. Hastings in an admirably clear manner deals with "Forest Taxation," and reduces what appears in America to be as complicated a problem as in this country, to what he considers to be a logical basis upon which taxation should be founded.

The next article, "Demand for a Change in Policy of the American Forestry Association," is a purely domestic affair. Suffice it to say that the demand was acceded to.

Under "Reviews," a very interesting account of *Bulletin* No. 207, Special Agents Series, by Axel H. Oxholm, is given. The *Bulletin* deals with the forest resources, lumber industry and lumber export trade of Finland.

Bulletin No. 3 of the Forestry Commission receives a lengthy notice and the authors are congratulated upon "this substantial addition to the forestry literature, not only of the United Kingdom, but of the entire world."

Periodical literature also receives attention.

Editorial comment deals with the return to normalcy of the American Forestry Association, and the passing of the Commission of Conservation of Canada. Reading between the lines, apparently in the opinion of American foresters the change, *i.e.*, the dissolution of the Commission of Conservation, was not a desirable one.

Under "Notes," a few paragraphs are devoted to: "Fire Prevention"; "The Penobscot Forestry Club"; "Proposed Training of Forestry Officers at Oxford"; "New Tanning Material in France," the plant which yields the material *Acacia arabica*, which is believed to be abundant in French West Africa, and that it may count in the future as one of the resources of the colony.

The first issue of a forestry journal in Chinese is noted. The journal is published by the Chinese Forestry Association, Nanking, China, and the first number of the magazine, which is designed to be popular in character and to serve as a means of creating public interest in forestry throughout China, appeared in March, 1921.

A. W. B.

Forstwissenschaftliches Centralblatt.

PARTS 8 & 9, 1921.

The above issue contains five original articles. Two of these are written by Dr. Heinrich Wilhelm Weber. One deals with the organisation of forestry science under production and management, with the history and critical examination of the scope and divisions into which the science has been divided as applied to private and State forestry. The other article by the same author deals somewhat scathingly with the present-day attitude of certain so-called scientists towards the opinions and thought of former generations.

An article on the utilisation of beech wood, by Dr. Zucker, is of interest, as it shows the many uses to which the wood of this valuable nurse of the forest can be put. Apparently beech wood is now, owing to its cheapness, largely replacing oak in Germany. Its value during the war, especially for munition cases and clog soles is emphasised.

Those interested in forest history will find an article by Dr. Hans Eschenlohr, on the development of systematic forestry in the territory adjoining the town of Memmingen. The difficulties with which the early pioneer Michael Schwegelin (1540–1583) was faced, and the manner in which he met them, is of interest. Although it is still the present-day problem in many places, namely the destruction of the forest by over-extension of grazing.

Dr. Rubner, of Munich, has an interesting article on the influence of light on the form, mass production and distribution of trees. The paper is more of academic interest than of practical utility.

No. 49.—The influence of " Brandwirtschaft " on the forests of Finland is worth studying. It might be recalled that Brand-wirtschaft is a sylvicultural system whereby temporary use is made of the land for agricultural purposes at the end of each rotation. After the timber has been cleared, the surface is burned over and the ash is scattered over the area.

No. 50.—Deals with the new price lists for enlarged sheets of the land survey maps.

No. 51.—The year book of the Silesian Forestry Society for 1920 is mentioned. An interesting reference is made as to the difference between the Alpine and the Polish larch (Südeten-lärche).

No. 52 refers to a work on the culture of micro-organisms.

No. 53 calls attention to the 1921 edition of Kunze's reckoning tables for timber measurements. The final section under " Notes " deals with the activities and curricula of the various Bavarian universities and high schools where forestry is included in the facilities.

A. W. B.

Revue des Eaux et Forêts.

OCTOBER, 1921.

A note on "Considération sur la détermination de la possibilité des futaies jardinées," by Arlen (one page), points out that the determination of sustained yield under the Selection System resolves itself into a simple calculation of basal areas permitting at each revision of the Working Plan a comparison of the volume of the growing stock at two successive periods.

Revue des Eaux et Forêts.

NOVEMBER, 1921.

L'Abies Pinsapo (pp. 333–337) is an interesting paper on *Abies Pinsapo* for reafforestation purposes in Southern France, but of little or no practical value to British foresters.

Pp. 347–350.—An instructive paper on the advantages of direct exploitation and sale of standing timber instead of marketing through timber merchants.

W. L. T.

Algemeine Forst und Jagd Zeitung.

SEPTEMBER–OCTOBER, 1921.

The chief contents of this number are :—

(1) Experimental investigation of the evaporation of water from land in its natural consolidated condition. (Drs. M. Helbig and O. Roessler.)
(2) The sustained yield in Forest Management. (Dr. Baader.)
(3) The "Sector Tree-felling Machine." (Otto Lehmann.)

(1).—The first article is one more likely to interest the man engaged in research rather than the ordinary reader. Taken as a whole these investigations have served to reveal the great complexity of the subject rather than leading to any conclusive results.

The article starts with an excellent summary of the problems relating to the evaporation of water from the soil with reference to original papers. Improved methods of investigating the problem were devised. The earlier experiments were devoted to checking results of previous workers. The main experiments were devoted to investigating the amount of evaporation on land in its natural condition as compared with cultivated land. All previous workers have devoted their attention to bare tilled land.

The earlier experiments confirm that the chief factors controlling evaporation are temperature and degree of saturation of the atmosphere, and that evaporation is proportional to the surface exposed (*i.e.*, rough or undulating land gives a greater amount of evaporation). They show however, that the maxima and minima of evaporation lag behind those of atmospheric temperature.

The main experiments show that naturally consolidated land suffers considerably less evaporation than cultivated land. One interesting series of experiments showed that naturally consolidated land which has been previously pierced all over with a spade under normal conditions has a smaller evaporation, but in very hot or dry weather it has an almost equally greater evaporation than naturally consolidated land.

Another plot similarly treated and then rolled gave practically the same results as the pierced land under normal conditions, but under very dry conditions the evaporation approximated to but remained still slightly below that of the naturally consolidated land.

Further experiments with various coverings to the soil showed that a covering of leaves checked evaporation. Land overgrown with grass suffered a much greater evaporation, while land overgrown with moss had only a very slightly higher evaporation than the naked natural soil.

(2).—The second article (by Dr. Baader) deals with the principles underlying continuity of management.

(3).—The third article (by Otto Lehmann) gives a detailed description of a new machine for felling trees with a narrow hand saw. The writer claims great achievements by this machine.

D. W. Y.

Tharandter Forstliches Jahrbuch.

VOL. LXXII, No. 5, 1921.

This number contains two articles and a set of tables.

The articles are (1) an inaugural lecture given by Professor Dr. Münch in the Tharandt Forest Academy on 9th May, 1921, entitled "Recent Progress in Plant Physiology and its Application to Forestry," and (2) "A Review of the more important Events, Literature and Progress connected with Forestry Science and Practice," by Professor R. Beck.

The tables give the net yield from the State Forests of Saxony during the year 1919, and are tabulated by Oberförster Heiniche.

(1).—Dr. Münch's lecture deals chiefly with the origin and heredity of climatic varieties of tree species, the influence of wind on plant growth, and the importance of carbon dioxide in plant nutrition.

As regards the origin of tree seeds, the Professor emphasises the great differences in the characteristics of Scots pine and spruce peculiar to different parts of Europe, and refers to the work of Kienitz, Schott, Cieslar, Engler and others on this subject. He considers these differences may be traced to varying conditions of growth as influenced by continental and high-lying situations on the one hand, and maritime and low-lying localities on the

other ; such factors as light, snowfall, &c., playing an important part. The bad forms of many types of Scots pine throughout Europe may possibly be due to the species having been confined in recent times to poor, moory ground, leading to the perpetuation of crooked and badly shaped stems through heredity. This distribution may be largely due to the artificial plantations of pine being formed on the poorer classes of soil, and also to the natural occupation of better land by broadleaved trees, confining the Scots pine to the inferior sites. The Professor entirely disagrees with Mayr in assuming that each species behaves much the same as before when planted outside its limits, and contends that the influence of the locality has produced numerous types which correspond more or less to the climatic conditions under which they were grown. He considers that this point should be carefully considered in planting exotic conifers which possess a wide range of distribution. Professor Münch recommends that Scots pine stands, which possess the desired characteristics as regards form, should be reserved for seed production, and every effort made to secure stocks of seed from the best types. He traces the inferiority of many plantations to those planted during a period of about 20 years before and after 1900, chiefly as the result of using seed obtained from seed merchants without enquiry as to its origin.

The influence of wind on tree growth is chiefly considered from the physiological aspect. He quotes Bernbeck's investigations on the effect of wind on growth. These indicated that the normal position of leaves and branches was interfered with by wind action, and this had an injurious effect upon assimilation. A similar effect was produced by the cooling effect of wind and also by increased transpiration indirectly leading to a reduced use of carbon dioxide by the assimilating organs.

The effect of wind on exposed and sheltered aspects is described, and the Professor thinks that anemometers should be made as much use of in studying qualities of locality as rain gauges and soil analyses.

The question of carbon dioxide in plant nutrition is discussed more as a speculation than from any direct evidence as to its value. This point is of importance in the retention or removal of forest litter, but there does not appear to be any definite evidence that the production of carbon dioxide which takes place on a forest floor has any direct influence on the growth of the trees which may be present. This is a matter for further investigation.

(2) Professor Beck's article deals chiefly with recent literature on sylviculture, from which he deduces the fact that there is a growing body of foresters who favour forest management being brought back to more natural conditions than those which are associated with clear fellings. This article is rather an academic criticism of the various sylvicultural methods which have been evolved from time to time in German forestry, and is written

chiefly round a system which is being strongly advocated, namely the "Permanent Forest Cover System," the exact definition of which appears to be a matter of some difficulty.

According to the writer the permanent forest cover corresponds closely to what British foresters recognise as "uneven-aged high forest," but has a somewhat wider meaning in so far as it concerns itself with all organisms which assist in perpetuating and regenerating the forest over a comparatively large area.

The compartment, unless naturally regenerated, involves the laying bare of the forest soil at certain periods, and disturbs the numerous biological associations and processes which make up the forest as a complex organism. The object of the permanent forest cover system is to avoid these interruptions and enable tree growth to maintain a perpetual increment in the cheapest and most efficient manner.

It is claimed that this system is most advantageous in small forests in the hands of private proprietors, but the fact is recognised that the system has its disadvantages, unless very carefully and scientifically carried out. One of these is the extra expense involved in felling and removing timber in small quantities over a large area as compared with the concentrated volumes and operations associated with clear fellings. Examples are referred to which illustrate the principles of the permanent forest cover system, the most important point brought out being that the greater the predominance of young and middle-aged classes the greater the average increment.

The importance of this question in British forestry cannot be very great at the present time, as the problem is rather to replace woods already felled, or those which disappeared centuries ago. Many reasons could be given, apart from sylvicultural ones, for advocating clear felling in British forestry provided that arrangements are made for shelter belts in exposed districts. It is a well-known fact that the cost of annual operations is less when carried out on one or two compact areas than when spread over an entire estate or forest property, and this may influence the particular system of management to a greater extent than sylvicultural considerations.

State Forests of Saxony.—From a total forest area of 172,835 hectares, or over 400,000 acres, the net returns amount to 226 marks per hectare. The equivalent to this sum in pounds sterling is difficult to judge owing to the rate of exchange fluctuating so rapidly during the last two or three years. The capital represented by standing timber is stated to be 471,949,000 marks, on which a return of 8·29 per cent. interest was obtained. This high return is due to the favourable financial conditions brought about by primeval forests having been preserved for many centuries, thus avoiding the heavy outlay necessary when land dis-afforested centuries ago must be re-purchased and put under timber.

A. C. F.

Zeitschrift für Forst und Jagdwesen.

NOVEMBER, 1921.

Article No. 1.—*Humusstudien* (Humus Studies), by Möller and Hausendorf, pp. 789–839.

Article No. 2.—*Für den Plenterwald* (In Support of the Selection System), by Dr. Zentgraf, pp. 840–845.

1. "Humus Studies."

This important paper is divided into three sections :—

(A) Report on field experiments with Scots pine from 1903 to 1915.

(B) Report on research carried out in the forest garden at Eberswalde.

(C) Historical account of the attitude of workers in soil research towards the humus problem in its relation to sylviculture.

(A).—*Report on Field Experiments.*—The German Government initiated extensive experiments in 1903, as the result of work published by Möller in 1902, showing that on the soils of the Mark all food substances, especially nitrogen, required to produce vigorous growth of young Scots pine, are contained in very large measure in the peaty, fibrous raw humus, which, in most methods of soil preparation, is thrown aside as injurious to the young plant.

The Government directed that in a large number of forest districts in Prussia, comparative plots should be laid out, in one of which the humus layer should be mixed with the underlying sand after removal of the surface vegetation, and in the other the humus layer should be removed altogether and the soil prepared for planting in the usual way.

The reports on these experiments sent in every three years have, with few exceptions, confirmed the value of the new method of cultivation and demonstrated in a convincing manner the manurial properties of raw humus when mixed with mineral soil. In particular a series of carefully conducted experiments in the Regierungsbezirk of Posen showed that the addition of artificial nitrogenous manure to the worked strips did not increase the growth of the Scots pine, while the effect of the addition of these manures to the strips from which the raw humus had been removed was not so great as the mere mixing of raw humus with the soil.

An experiment, conducted by the late Forstmeister Dittmar, showed the superiority of the new method of cultivation over the method sometimes employed whereby the land is trench-ploughed so as to bury the top humus layer at the bottom of the trench. The following table shows the result.

The strips were sown with Scots pine seed.

TABLE I.

Method of Soil Preparation.	No. of Trees per acre in Year.			Loss in Trees.				Mean height.		Diameter increment 1911–1915.	Mean length of Needles.	Weight of 100 Needles.
				In 1904.		In 1911.						
	1904.	1911.	1915.	No.	%	No.	%	1911.	1915.			
								ft.	ft.	mm.	ins.	grams.
I. Strips grubbed	11,250	6,910	4,450	6,800	60	2,460	34	6·0	11·9	15·1	2·6	11·2
II. Strips dug over	11,250	7,230	5,670	5,580	50	1,560	22	6·0	11·2	8·8	2·4	10·0
III. Strips trenched	11,250	7,080	3,520	7,730	69	3,540	50	5·5	6·8	1·3	2·2	8·4

The strips investigated were 80 metres in length and contained 120, 140 and 87 trees respectively; 150 pairs of needles were measured and weighed in each case.

In I a heavy machine, termed a wühlgrubber, was dragged through the soil, churning up the turf and mixing it with the mineral soil below. The machine consisted of a heavy drum studded with 24 spikes each 2 ft. in length. The drum is geared up by a chain and a system of cogs with the main axle, so that the drum rotates slowly as the machine passes over the soil. The transmission is not direct and the rotating speed of the drum is reduced in comparison with the forward motion.

In II the raw humus was dug into the soil.

In III the soil was trench-ploughed, burying the raw humus in the bottom of the trench.

The greater reduction in number of trees in I as compared with II is due to the better growth in the former leading to suppression of the weaker trees. The much heavier loss in III was due to feeble vitality and lack of power of resistence to drought and also to the growth of weeds.

The use of the plough for making Scots pine plantations (whether by sowing or planting) is condemned by Möller as the worst possible method of soil preparation, because it throws the top layer of raw humus to one side where it dries out and the nitrogen is lost, while the young plant is placed on the underlying soil which experiment has shown to yield only the poorest growth.

It is admitted that the mixing together of the sand and the humus is more expensive than simple ploughing, but beating-up is more costly still, and this may be to a very large extent avoided by the manurial action due to cultivation with the grubber.

(B). *Report on small-scale Researches carried out in the Forest Garden at Eberswalde.*—The methods adopted were as follows :— Tin containers, 2 ft. in depth with a sectional area of from 1 to 4 sq. yds. and open at the base, were placed in holes of corresponding size prepared in the forest garden. In most of the experiments

one container was filled with humus-free yellow sand taken from 12 ins. to 18 ins. below the surface, and the other with a uniform mixture of one-third of the same sand and two-thirds of raw humus obtained in the following way. The humus layer under an old crop of Scots pine growing on poor, sandy soil was removed in broad strips with the use of broad hoes. The vegetation consisted of a strong growth of bilberry. The strips were well beaten with the back of the hoes and the bilberry plants shaken out, leaving the humus behind. A varying number of small conifers was planted in the containers and the growth observed from year to year.

Several examples are given, of which the two following may be taken as typical.

(*a*) Scots pine, spruce, larch and silver fir planted in 1906.

In August 1919, *i.e.*, after 14 years, the height in feet of the highest plants of each species in the two plots was as follows :—

TABLE II.

	Scots pine.	Silver fir.	Spruce.	Larch.
A Sand ...	8	0·5	2	2
B Sand *plus* raw humus...	13	2·5	15	23

The relatively poor growth of the Scots pine in B, as compared with the spruce, was due to the shade of the much taller larch which affected the light, demanding Scots pine more than the spruce.

(*b*) Larch, Douglas fir, spruce, silver fir.

In this experiment the raw humus was taken from under a pure stand of beech. Three containers were used and filled respectively with (*a*) pure sand, (*b*) one-third sand and two-thirds humus, and (*c*) pure humus. They were planted in April 1911.

TABLE III.

Species.	A Sand.		B Sand *plus* raw Humus.		C Raw Humus.	
	Maximum height in feet.					
	1912.	1919.	1912.	1919.	1912.	1919.
Larch... ...	0·5	4·25	1·67	16·75	1·67	11·75
Douglas fir ...	0·5	2·17	1·67	13·5	1·67	13·75
Spruce ...	0·5	1·0	1·33	8·0	1·33	8·75
Silver fir ...	—	0·5	—	1·17	—	0·5

Larch and Douglas fir, one year seedlings. Spruce and silver fir, two-year seedlings. All planted in April 1911.

Experiments with beech showed that this species failed wholly when grown on pure raw humus and did little better on the mixed raw humus and sand than on the pure sand.

TABLE IV.

Species.	A Growth in sand.			B Growth in sand *plus* raw Humus.		
	Highest.	Lowest.	Mean.	Highest.	Lowest.	Mean.
	ins.	ins.	ins.	ins.	ins.	ins.
16 Scots pine...	6·3	2·0	4·0	11·4	2·0	8·3
16 Silver fir ...	4·3	1·6	2·6	4·7	2·8	3·9
16 Spruce ...	11·8	3·5	5·9	26·0	13·4	19·7
5 Larch	27·6	18·9	22·8	65·3	39·4	52·4

Planted in May 1906, measured in autumn 1908.
Scots pine, spruce and silver fir 1 year seedlings.
Larch, 3-year plants.

Incidentally, according to Möller, Forstmeister Erdmann is correct in saying that beech is one of the species which make the least demand upon the soil. It will keep alive and finally develop more or less normally on the poorest sand. It requires, however, much time and patience before it becomes properly established. The mixture of raw humus with sand gave excellent results with oak.

Conclusion.—Raw humus, suitably mixed with mineral soil, makes the best possible manure for all the conifers and also oak, but not for beech.

(C).—*Historical Account of the Attitude of Workers in Soil Research towards the Humus Problem in relation to Sylviculture.*—The importance of humus has long been recognised by German foresters, but until about 1890 the whole weight was laid upon the improvement of the physical properties of the soil brought about by humus, while its importance as a source of available nitrogen was not recognised. Thus, Liebig stated in 1840 that the plant derives its nutrition solely from inorganic sources, the nitrogen in the humus being in a combined form and not available for the plant roots. This view has long held the field, and is still believed in by many.

Liebig's statement that when humus decays it does not yield any available nitrogen has been supported by investigations carried out by Ebermayer, Ramann, Albert and others who were unable to detect the presence of free nitrates in forest soils, while adjoining fields manured with animal excreta contained abundance of free nitrates. The problem was approached from a different angle by Möller, working from 1902 onwards, who has

proved that manuring with raw humus gives results which are identical in kind with those obtained by the addition of artificial nitrates. The mode of absorption of the nitrogen from the humus, whether by the agency of bacteria or mycorhiza, remains an open question (Ramann has concluded, however, from Möller's investigations that probably mycorhiza plays no part in the nitrogen assimilation).

The most interesting points in the remainder of this article may be shortly summarised as follows.

(1) Möller and Geist, working independently, found the upper fibrous layer of the raw humus to be a much more valuable manure for trees than the lower, more decomposed, mild humus.

(2) The best implement for large-scale operations is the Geist-Kähler Wühlgrubber, which cultivates the soil to a depth of 12 ins., mixing up thoroughly the humus with the mineral soil. Six to eight horses are required to drag the machine through the ground, but Hausendorf has devised a petrol tractor which takes the place of the horses.

Oberförster Schultz, in 1911, made extensive experiments with this grubber. He found that the machine went well on heather-covered waste land and that strips 4 ft. apart could be cultivated at a pre-war cost of 8*s*. per acre (18 acres were cultivated with the grubber in 36½ working hours = 2 hours per acre). The soil was sandy but contained stones and boulders. Felled areas can be worked with the grubber ; the stumps do not form any obstacle provided they are not too high. The machine is costly to use over land covered with strong bilberry growth, this must first be removed ; on such land the costs mount up to 30*s*. per acre.

(3) The use of the grubber, or of any similar implement for working the soil, is only applicable to areas where the raw humus layer is sufficiently thin to permit the mixing of the mineral soil with the raw humus. Generally speaking, the method is of value in areas of low or moderate rainfall and on light soils ; it is doubtful if it is applicable where the rainfall is high and the raw humus tends to accumulate with the formation of peat.

(4) Von Falckenstein found that the growth of woods on the barren sand dunes of Melchow in Prussia is very variable, and that apparently the rate of growth (quality class) is directly proportional to the amount of humus present in the soil below the trees.

A forest crop on these poor sandy soils results in a great accumulation of nitrogen, the whole of which may be lost by faulty sylvicultural methods, *e.g.*, von Falckenstein calculated that the value of the available nitrogen lost to the soil due to clear felling on the Melchow sand dunes amounted to £56 per acre (pre-war value). Nitrogen is only accumulated in an available form on such soils provided there is a sufficient moisture

content in the upper soil layers, and this can only be maintained by increasing the humus contents of the soil and by permanent tree cover.

(5) Hesselmann, the Swedish authority on soils, has devised the following methods for determining the nitrifactive activity of the soil.

(*a*) Chemical analysis of soils kept in flasks or beakers for several months, tests being made on the portion of the sample at frequent intervals.

(*b*) The inoculation of sterile nitrogenous media with the soil under investigation, after a period of incubation the free nitrate formed can be readily determined.

(*c*) Growing certain plants on the soil in question which have the property of absorbing free nitrate from the soil and storing it in their cell tissues. These plants Hesselmann terms "nitrophilous" plants; the most important are members of the Chenopodiaceae also *Epilobium angustifolium*, *Impatiens* and *Rubus idaeus*, *Senecio* and *Poa nemoralis* function to some extent in the same way. Tissues of these plants, grown on a soil containing free nitrates, give the characteristic reaction when treated with diphenylamine and concentrated sulphuric acid.

Article No. 2.—*Für den Plenterwald.* ("In Support of the Selection System.")

Two main advantages are claimed for the selection system, which system the author states can be applied to every species and every quality of soil.

1. *The semi-shade Form of Trees produced in the Selection Forest.*—The partial overhead shade retards the growth in youth keeping the annual rings small, while later when the trees are freed and respond to the increased light the rings are maintained at much the same width and timber of first quality is produced. Further, owing to a better utilisation of light and soil the selection system produces more timber per unit area than the even-aged system.

Trees grown in a selection forest pass the time of maximum height growth and branch suppression under semi-shade. The branches spread horizontally to catch the light, and quickly decay and fall off. In the absence of overhead shade the branches always grow at a sharp angle upwards, thus tending to expose the least surface of the leaves or needles to the direct sun rays. These ascending branches are more difficult to suppress and slower to decay than the horizontal branches of the semi-shape type. The timber of trees grown in well-managed selection forests is, therefore, both more uniform in character and cleaner than the timber grown by any of the even-aged systems.

2. *The permanent Maintenance of vertical Canopy.*—The even-aged systems produce only a horizontal canopy which prevents the rain and light from reaching the ground to a sufficient degree to maintain the activity of the surface soil, while free access is given to the wind, which is an important factor in causing soil deterioration. In all these respects the selection system has the advantage ; it possesses its own forest climate and is entirely independent of external disturbing influences.

W. H. G.

Schweizerische Zeitschrift für Forstwesen.

No. 12, DECEMBER, 1921.

The first article gives a short account of the life and work of the great leader in Swiss forestry, Elias Landold (1821–1896).

The second article is devoted to the management, care and provision of labour in forestry. Oberförster W. Schadelin discusses the relationship between employer and employed. The guiding principle is that a mutual understanding is necessary if each is to derive the greatest benefit from the industry concerned. Unreasonable demands or self-interest on either side is harmful in its ultimate reaction on both.

The question is considered, apart from the wage problem, under four headings, viz. : (1) Perquisites ; (2) Improvement of working conditions ; (3) Health and accident insurance ; (4) Disability and superannuation.

The writer of the article believes that much can be done to lighten and improve the quality of labour by proper organisation. He touches on the work of the American engineer, F. W. Taylor, and says the Taylor system was evolved from conditions appertaining to large factories and that the principles are to be taken only partially and with a grain of salt as applicable to the totally different industry of forestry. A fundamental difference exists between work in the forest and work in the factory. To mention only one difference—he points out that forest work can only to a very small extent be reduced to mechanical routine, since, instead of one, numerous hand grips and movements must be made, while in the factory the work is so minutely divided that each worker has a relatively small number of hand grips and movements to make, and frequently for hours on end the same grip and motion are required. At the same time the author admits the enormous advantage of the system in mechanical industries and refers his readers to further literature on the subject, and suggests that a study of the subject although founded on and applicable to conditions as they exist in big factories may nevertheless be productive of fruitful thoughts in regard to forestry work.

The next article gives a comparative statement of the growing stocks in Communal and State forests in Aargau. The State forests carry heavier stocks than the Communal forests.

The Report of the Swiss Forest Society's meeting on 28th and 29th August, 1921. An interesting discussion took place concerning the future plans for forestry education, and the desirability of modifying the present system in order that a better balance may be established between the various branches of knowledge with which the trained forester should be familiar.

A useful list of books is given at the end. The Report of the Swiss Central Experiment Station is fully described. The investigation concerning the shrinkage during seasoning in summer- and winter-felled timber is of importance, and appears to be a valuable contribution to forest utilisation literature. The same number contains the first instalment of a paper on the production and financial returns of oak in Switzerland. The first instalment deals with the morphological and biological properties of the pedunculate and sessile oaks and their cultivation in the nursery.

A. W. B.

LIST OF STAFF.

Headquarters.

At 22, Grosvenor Gardens, London :—

Story, Fraser	... ...	Divisional Officer (Education and Publications).
Guillebaud, W. H.		District Officer (Research and Statistics).
Sangar, O. J.	... ...	District Officer (Co-ordination).

At Forestry Museum, Royal Botanic Gardens, Kew :—

Munro, J. W.	... ...	District Officer (Entomology).

England and Wales.

Assistant Commissioner's Office (1, Whitehall, London) :—

Pritchard, H. A. ...	Chief Technical Assistant.
Marsden, R. E. ...	District Officer (Research and Statistics).

Division 1 (Petergate House, York) :—

Long, A. P.	... ...	Divisional Officer.
Bilson, C. F.	... ...	District Officer.

Division 2 (Castle Chambers, Shrewsbury) :—

Young, D. W.	... ...	Divisional Officer.
Dumas, A. B.	... ...	District Officer.
Simpson, I. L.	... ...	District Officer.

Division 3 (City Hall Buildings, Cardiff) :—

Lovegrove, W. H.	...	Divisional Officer.
Dent, R. P.	... ...	District Officer.

Division 4 (8, The Close, Exeter) :—

Hanson, C. O.	... ...	Divisional Officer.
Lowe, G. ...	... ...	District Officer.
Popert, A. H.	... ...	District Officer.

Division 5 (1, Whitehall, London) :—

Taylor, W. L.	... ...	Divisional Officer.
Forbes, R. G.	... ...	District Officer.
Hankins, C.	... ...	District Officer

Foresters' Schools :—

Felton, A. L.	... ...	Instructor, Forest of Dean.
Marshall, R. C.	... ...	Assistant Instructor of Dean.
Rowe, M. H.	... ...	Instructor, Brockenhurst.

Scotland.

Assistant Commissioner's Office (25, Drumsheugh Gardens, Edinburgh) :—

Borthwick, A. W.	... Chief Technical Assistant.
Cameron, J. ...	... Land Acquisition Officer and Valuer.
Steven, H. M.	... District Officer (Research and Statistics).
Anderson, M. L. ...	... District Officer (Statistics).

South Eastern Division (25, Drumsheugh Gardens, Edinburgh) :—

Murray, J. M. ...	... Divisional Officer.
Watson, H. ...	... District Officer.
Whellens, W. H. ...	... District Officer.

Western Division (48, West Regent Street, Glasgow) :—

Hopkinson, A. D.	... Divisional Officer.
Blair, J. H. ...	... District Officer.
Graham, A. ...	... District Officer.

North Eastern Division (156, Union Street, Aberdeen) :—

Annand, J. F. ...	... Divisional Officer.
Bird, D. H. ...	... District Officer.
Clarke, I. A. ...	... District Officer.
Mackay, J. W. ...	... District Officer.

Northern Division (35, Queensgate, Inverness) :—

Scott, F.	... Divisional Officer.
Home, G.	... District Officer.
Newton, L. A. ...	... District Officer.
Robinson, G. ...	... District Officer.

Foresters' School.

Fraser, J.	... Instructor, Beaufort.

Ireland.

Assistant Commissioner's Office (9, Upper Mount Street, Dublin) :

Northern Division :—

Crozier, J. D. ...	... Divisional Officer.
Ager, W. E. ...	... District Officer.
Stewart, D. ...	... District Officer.

Southern Division (9, Upper Mount Street, Dublin) :—

Kilmartin, A. J. ...	... Divisional Officer.
McCaw, D. ...	... District Officer.
McRae, A. ...	... District Officer.
O'Beirne, M. ...	... District Officer.

OBITUARY.

It is with much regret that we have to record the death of Mr. R. W. Hunter, Forestry Instructor at Chopwell School, and Lecturer in Forestry at Armstrong College, Newcastle-on-Tyne.

Mr. Hunter, who was 34 years of age, died on 17th January, from pneumonia following an attack of influenza.

After a course of study in agriculture and land-agency at Leeds University, Mr. Hunter took up forestry under Mr. J. F. Annand, at Newcastle, in 1909. Subsequently he obtained the National Diploma in Agriculture and also the Certificate in Forestry of the Highland and Agricultural Society. He was engaged for three years in the Land Valuation Department, and for a similar length of time in the Timber Supply Department where he worked under Mr. Annand as Chief Assistant.

He took up his duties at Chopwell in October, 1919, and at the time of his death he had fifteen forest apprentices under his care at the School and at Armstrong College a considerable number of agricultural students, who are taking forestry as part of their course in agriculture.

Mr. Hunter was an enthusiastic forester and a successful teacher. His devotion to his work and his cheerful disposition make his loss keenly felt by all who came in contact with him. Much sympathy is felt with his widow in her bereavement.