

CHAPTER I.

GENERAL.

The development of forest research and its organisation in India, which has been taking shape during the past few years, partly on account of a better appreciation of the need of the scientific study of our resources and in part as a result of the extraordinary demands of the war, has gone forward a good step during the year.

The enlargement of the central Research Institute at Dehra Dun has been under consideration for the last four years, and a scheme entailing an expenditure of 30 lakhs has now been sanctioned by the Secretary of State. This scheme will involve the transfer of the present Institute to a new site and for this purpose possession was taken of 1,337 acres of very suitable land just as the year was closing. The five main branches of the Institute remain the same, but with the exception of the silvicultural branch all will gradually undergo very considerable expansion at Dehra in personnel as well as in plant and materials. The silvicultural branch, as is inevitable from the great amount of local work to be done, is being partially decentralised from Dehra, and the latter will eventually be left chiefly as a co-ordinating and advisory centre for the work of the Provinces; this decentralisation will not diminish the responsibilities of the central Silviculturist.

The principal directions of the enlargement of the economical branch at the central Institute are towards obtaining a greater knowledge of the technical properties of the Indian timbers and prolonging their life in various ways which have been studied much more closely in the United States of America and Canada, as well as the study of pulp and paper possibilities on a semi-commercial scale.

Still greater changes are taking place in the Provinces. On 1st January 1920 new Forest Circles of Working Plans and Research work were instituted both in Burma and the United Provinces, while on the 1st February a Utilisation Circle, such as had previously existed in the United Provinces, was added in Burma. These Provinces had previously each had a research officer or silviculturist.

It is planned to establish a complete research institute in Burma which will keep in touch with the central Institute. While research work in the properties and use of timbers will be undertaken in the moist heat of Lower Burma and at the big commercial timber centre of Rangoon, it is intended to place the Burma Forest Research Institute in Maymyo and for this purpose plans have been prepared and the site is being cleared. No officers have been appointed yet but on the return of those now on leave it is proposed to create posts of silviculturist, botanist, and entomologist and a chemist will also be engaged in due course. The Institute itself will provide office and laboratory accommodation for these officers and their staff, and will also house the herbarium and a reference library and accommodation for photographic work.

The deputation of special officers for the investigation of silvicultural problems took effect both in Madras and in Bengal during the year. Each of these also has a utilisation officer. Forest research is claiming attention in other provinces as well, as is evident from the account of the investigations under way and in some at least the failure to appoint special officers is due solely to the extreme shortage of staff.

These few words will be a sufficient introduction to the work done during the year in the central Institute and in the Provinces, as reported to this office.

CHAPTER II.

SILVICULTURE AND WORKING PLANS.

CENTRAL INSTITUTE.

Statistical.—Owing to the absence on leave of the Silviculturist, plot work, ledgering, and experimental work were considerably in arrears when Mr. Howard took over charge in October and a large amount of time has been spent in bringing these two items up to date. Plot work is not completely up to date yet but it will be so before the touring season of 1920 begins. Ledgering is practically up to date. Experimental work is always rather behind hand owing to the impossibility of carrying it out from Dehra Dun but with the appointment of local silviculturists this branch of research should make more headway than hitherto.

During the year 26 sample plots were remeasured and 7 new ones inaugurated and 24 experimental plots inspected. There are now 294 sample plots and 76 experimental plots distributed among the various provinces which have been set out by officers of this Institute.

The methods and forms approved by the Board of Forestry in 1919 have been used entirely in remeasurements this year and at the same time the old measurements made under the former methods have been corrected as far as possible. Besides the above a large number of old measurements on plots not due for remeasurement have also been corrected to the new method.

In order to make these corrections it was not sufficient merely to substitute the diameter equivalent to the measured girth and convert the volume calculated from Troup's quarter-girth volume tables into volumes calculated under the πr^2 method as this would still contain any error introduced by girth measurement. In order to ascertain this error all recently-remeasured plots were measured both by girth and diameter and the error calculated therefrom. The species so measured were sal and deodar. It was found that the *average* error for both species is a constant and the same constant for each. It is possible that the constant will not be the same exactly for other species but the difference is likely to be exceedingly small and it is thought that the constants found may be used by local

silviculturists for any such conversion they may have to make for any species except in the case of extreme abnormalities like buttressed trees. Any slight error thereby introduced is probably less than the ordinary error of measurement. It must be added that the use of these constants for any individual tree may give a wrong result but that, when applied to each individual of a crop, the resulting crop averages will be correct.

To convert a girth into the average of two diameters taken at breast-height the girth should be multiplied by '3119.

To convert a volume measured by girth and calculated by the quarter-girth formula from Troup's tables into a volume measured by two diameters at right angles and calculated by the πr^2 method from Schlich's tables multiply by 1'2224.

It may be added that the resulting volume from a girth measurement gives a result on the average about 4.5 % larger than the volume from a measurement of two diameters at right angles. The maximum error has not been worked up in detail, but it goes as high as 7.5 % in excess on some trees over 5 feet girth which, though they give the same average error, are rather more variable than the smaller trees.

The arrears in measuring plots on June 30th were 18 sample and 2 experimental plots in Bashahr which were to be done during the rains of 1920.

Regeneration.—Experiments in the natural regeneration of sal have as yet yielded no conclusive results in actual practice in the forest on a large scale. Though the clear-felling experiment at Thanu, which is referred to in last year's report, certainly looked promising at the beginning of the rains its worth cannot be judged till it has passed through a cold weather.

If sal seed could be kept till the rains broke properly it would go far towards solving the problem of artificial regeneration in such divisions as Gorakhpur where labour is available in the rains. At any rate it would avoid all the heavy nursery expenses and the delay in waiting for root and shoot cuttings to start ahead. An experiment was therefore started this year and sal seed kept for 15 days before sowing. The principle adopted was that sal must germinate at once or lose its germinating power and the seeds were therefore encouraged to germinate immediately on cotton-wool and coarse gravel. So far the results are promising and if it succeeds the method is easily practicable.

The small experiments at Zabarkhet, a large blank in the sal forest near Lachiwala, which is also a frost hole, have passed into the next stage. So many of the results depended on intensive weeding in the rains, which is often not possible under the local conditions prevailing in Dehra Dun, that this has been ruled out for further work. It appears from the former small experiment that chir pine (*Pinus longifolia*) sowings do better unweeded than weeded, while sissoo (*Dalbergia Sissoo*) sown in December on clear ground are a foot high before the rains break and the grass comes, and root and shoot cuttings of sissoo put out in December on clear ground are 3 feet high before the rains break.

The present experiments are reduced in number but on a larger scale than those of the preceding year. They consist of an acre of chir pine sowings on land ploughed up before the rains which will now be left untended, secondly half an acre of sissoo which will be sown in December and then left, and thirdly $3\frac{1}{2}$ acres of root and shoot cuttings of sissoo which will be put out in December and then left untended. In addition two smaller experiments of $\frac{1}{4}$ acre each have been started, one planted with bamboo (*Dendrocalamus strictus*) seedlings and the other sown with *Butea frondosa*. Although chir pine is out of its natural habitat here it is considered a legitimate species to try since so long as some crop is induced to grow in this frost hole, it matters little what it is.

It is hoped that these experiments are large enough to allow of conclusions of practical worth being drawn and if successful they will be extended next year.

The experiments of tan-yielding trees and shrubs, which are mentioned in last year's report, are incomplete. That concerning *Anogeissus latifolia* will best be completed in the Provinces, since the difficulty lies not in obtaining the pollard shoots but in protecting the young shoots from damage by monkeys and browsers.

Period of Growth.—An experiment was started last December to find at which period height growth occurs in the species available here both exotic and indigenous. It appears so far that in Dehra Dun for seedlings up to three years old December to February is a period of rest and often up to the end of March. Vigorous height growth then begins and continues till the end of June. At present it is not known what happens after that.

Other Experiments.—Various other experiments regarding sowing, transplanting, cultivating camphor for yield of leaves, and the cause of twisted fibre in the chir pine (under Mr. Champion's direction) continue in Kaunli garden.

Tours.—The Silviculturist spent 136 days on tour, visiting Kulu, Haldwani, Changa Manga, Bengal and Jaunsar.

Photographic Records.—The photographic branch contains 3,567 photographs, 3,448 negatives, 450 lantern slides and 12 coloured transparencies.

Publications.—No publications have been actually issued during the year but apart from those mentioned in the list of publications a single tree yield table for first quality sal in Bengal has been worked out from measurements of single trees made on tour in Bengal and will appear shortly.

UNITED PROVINCES.

Statistical.—The Research Division laid out 16 permanent sample plots of *Holoptelea integrifolia*, *Shorea robusta* and three principal hill species. Most of the old divisional sample plots have been abandoned but a few are kept up and their figures will be of use later on when the time comes for preparing yield tables.

Natural Regeneration of Sal.—Numerous experimental 1-acre plots in the plains and submontane divisions were made in the 1918 seed year to see the effect of leaf burning and preliminary soil working on sal regeneration, and another plot of 1913 seedlings in the Haldwani Division remained under observation. While seedlings in adequate numbers become established and persist when climatic and other conditions are favourable, their subsequent progress without further tending is shown to be very slow. Even though the weeds are cut back yearly in the 1913 plot in the cold weather the 7-year-old sal plants do not exceed 2 feet in height yet. In the very unfavourable locality of the Jaspur Range, Ramnagar Division, special experiments were continued on the lines laid down by Mr. Hole, Forest Botanist, i.e., clear-felled strips were made in the forest, the grass and litter burnt, and either sal seed sown or the strips left to natural seed. No rains weeding or subsequent tending has been made. The results obtained are frankly disappointing, as out of 20 strips, 18 have failed entirely. It may be regarded as definitely established that simple clear

felling in strips is not the solution of the problem of sal regeneration in these forests. Probably clear-felled strips, combined with weeding and soil loosening in the rains, would give better results, but it is thought the cost would be prohibitive.

A striking contrast to the above is afforded by the experimental patch of sal plants at Chorgalia (Haldwani Division). The sal seed was sown in June 1915 on prepared fertile loam in the open, weeded and tended the first year, and subsequently irrigated each hot weather. In January this year the plot was measured and the best plants found to exceed 16' in height.

To summarise the results of experiments and observations in the United Provinces, successful establishment and rapid development of sal seedlings appear to depend chiefly on—

- (a) Good soil aeration.
- (b) Good moisture content in the soil.
- (c) Freedom from competitive weed growth.

Other things being equal, where one or more of these factors is unfavourable results will be correspondingly poor.

Artificial Regeneration and General Silviculture of Miscellaneous Bhabar Species.—The increasing commercial importance of numerous Bhabar species, among which may be mentioned *Dalbergia Sissoo*, *Adina cordifolia*, *Holoptelea integrifolia*, *Bombax malabaricum*, *Acacia Catechu*, *Albizzia procera*, *Garuga pinnata*, *Odina Wodier*, *Hymenodictyon excelsum*, *Anogeissus latifolia*, *Lagerstræmia parviflora* and bamboos, has necessitated a careful study of the principal factors affecting their regeneration, and a large number of experiments have been started this year, both in small experimental plots and in large scale plantations, the results of which will be recorded next year. Hand in hand with the experiments on their artificial regeneration, observations have been made on the silviculture of these forests and these are being published in a Bulletin.

Afforestation.—A considerable amount of research and experiment was carried out in the Afforestation Division during the year, which may be briefly summarised as follows :—

(i) *Introduction of New Species.*

Holoptelea integrifolia, *Terminalia Arjuna*, and *Gmelina arborea* were extensively sown and gave very promising results. *Anogeissus latifolia*, *Adina cordifolia*, and *Cedrela Toona* failed.

Roots of sal, bamboos and various grasses of the drier submontane forests were planted out experimentally. The sal failed entirely, bamboos were only partially successful, but the grasses showed signs of being successfully introduced by this means.

(ii) *Employment of Famine Labour in Ravine Reclamation.*

The reclamation and afforestation of ravines by famine labour was tried during the year on a large scale and proved in every way highly satisfactory. The substitution of manual labour for mechanical cultivation increased the cost by no less than 200 %, but famine works being designed to employ the maximum manual labour of every description are necessarily costly and often of doubtful utility. In the case of ravine reclamation every class of labour can be employed, the work can be expanded, curtailed, or closed down at any time without leaving it incomplete and the shifting nature of the work makes it highly sanitary. Furthermore, the work is an insurance against future fodder famines as it is a direct means of encouraging and developing local grass reserves. The actual work done was of a very high standard. In future famines, it seems probable, that very extensive afforestation work will be done by famine labour.

Twisted Fibre in Pinus longifolia.—Mr. Champion continued his investigations on this subject. Research up to date indicates that the tendency to spiral fibre is inherent in the seed. This conclusion agrees with that of Professor Toumey of Yale University who investigated the same phenomenon in *Pinus Jeffreyi* in the mountains of Colorado. A paper will be published on this subject when the investigation has proceeded further; it is of great importance in Kumaon and possibly elsewhere also.

Publications.—Besides the record noted in Chapter VII "Enumerations of miscellaneous species of the Ramnagar and Kalagarh Divisions" by A. Smythies was put into print.

BIHAR AND ORISSA.

Regeneration.—A few experiments in the regeneration of sal are reported but they have not proceeded far and no conclusions can be drawn from them.



Photo-Mech. Dept. Thomason College, Roorkee.

Photo by T. B. Chitrakar.

A Sal taungya in its third year; Nimati sowing of 1917, Buxa Division. Area 11 acres.
Plants 30 months old - average height 5 feet. This area contained some grass before regeneration and there is still some there.

BENGAL.

Regeneration.—Excellent progress continues to be made in solving the problem of regenerating the fire-protected sal forests of the Bengal Terai by means of the combination of forestry with agriculture. Long continued fire-protection has resulted in a heavy evergreen undergrowth rendering purely natural regeneration impossible. A forest record of this work will be published shortly.

The whole subject is also dealt with in a comprehensive manner in his "Note on a tour of inspection in the Goalpara (Assam), Buxa, Jalpaiguri, Kalimpong and Kurseong Divisions (Bengal)," June 1920, by Sir George Hart, Inspector-General of Forests. To quote from the latter and put his conclusions briefly—the object of the experiments in Goalpara is to get rid of the evergreen, replace it by bata grass and then induce natural regeneration of sal. Annual cutting back of the undergrowth and firing in the hot weather during the past five years have given partially successful results. The main idea of these experiments is to continue annual burning until the last traces of the evergreen undergrowth have been removed, then to restart fire-protection which, with some lightening of the sal overwood will, it is believed, cause the bata grass to thin itself out and bring about conditions favourable to the natural regeneration of sal. The Inspector-General continues:—"I am not very hopeful that treatment on these lines will ever result in our obtaining really adequate natural regeneration of the sal in these forests. The officers in the adjoining Bengal Divisions, who have been studying the problem for years past, do not believe in it and pin their faith on clear felling followed by artificial regeneration, either with or without field cultivation, as may be possible, the sal and other species being used to suit soil conditions. I believe they are right; but as the difficulties to be overcome in Goalpara would be much greater than they are in Bengal the importance of the regeneration experiments to be carried out in the former during the next 10 to 15 years can hardly be overrated, as the future treatment of the forests will depend on their results. For this reason it is very desirable that the sanctioned appointment of a local Silviculturist should be filled as soon as possible and that the work should be entrusted to the officer selected for this post." In the four Bengal Divisions the area of *taungya* plantations thus made in the last five years is 1,450 acres.

The chief difficulty is to get enough labour to work on forest village terms and carry out the field cultivation thoroughly. Where sufficient labour is available both for cultivation and subsequent tending the cost of the artificial re-stocking of the forest should not exceed Rs. 15 per acre. The other lessons of the last five years' work are thus summarised by the Inspector-General of Forests :—

- (i) It is useless to attempt to re-stock grass land without field cultivation.
- (ii) Wire fencing, proof against pig and deer, is essential in order to protect the villagers' field crops and the young forest crop. This fencing must be provided by the Department.
- (iii) In the case of sal two years' field cultivation is essential. In the case of other quicker growing species the second year's cultivation may often be dispensed with if the first year's work has been done thoroughly.
- (iv) Sal plantations should be limited to soils which are obviously suited to the production of sal timber of good quality. In other localities the quicker growing soft-wooded species can be raised with less difficulty and are likely to give better financial results. These species include *Cedrela Toona*, *Bischofia javanica*, *Dalbergia Sissoo*, *Bombax malabaricum*, *Michelia Champaca*, *Amoora Wallichii*, *Duabanga sonneratioides* and others. (*Vide* Plate 3.)
- (v) The mixture of species by individuals is not likely to be as satisfactory as the mixture in strips and small blocks.
- (vi) With the sal, sowing in lines is preferable to sowing in patches (*talli*), owing to the greater effect of the former in killing out the heavy growth of grass which follows the cessation of field cultivation.

The best sal plantations have made 10 or 12 feet of height growth in three years from seed.

ASSAM.

Regeneration.—The principal experiment in the Goalpara Division has already been referred to. In the Eastern Circle of Assam the want of data regarding the natural regeneration of the more important species in the *evergreen* forests has in three cases rendered it

impossible to revise working plans so as to be of any real value; hence experimental regeneration fellings have been started in the Lakhimpur and Sibsagar Divisions to determine the best methods of inducing and aiding the seedlings of the more important species, more especially sal, Hollong (*Dipterocarpus pilosus*), Nahor (*Mesua ferrea*), Ajhar (*Lagerstræmia Flos-Reginæ*), Hollock (*Terminalia myriocarpa*), Poma (*Cedrela Toona*) and Bonsum (*Phoebe Hainesiana*). The solution of these problems is the more necessary because some of the finest forests in East Assam are about to be leased to big timber firms and it is proposed to work them under a method of concentrated fellings. During the year the two Extra Assistant Conservators of Forests on special duty collected some useful information regarding the germinating power of the seed of the principal species and the most suitable method of sowing them. Generally speaking, the Conservator writes, the natural regeneration of these species is satisfactory, and it is hoped that by means of thorough and repeated climber-cutting and a certain amount of cleaning it will be possible to regenerate the areas over which fellings will be carried out without having recourse to artificial work to any great extent.

Mr. R. N. De's experiments at Tingrai in the proposed extension of the Upper Dehing Reserve in Lakhimpur Division have been mostly in connection with the re-stocking of exploited areas artificially. Three blocks of forest each 10 acres in area were selected in Dipterocarp and Mesua forest and all undergrowth up to 9" in girth and bamboos (*Pseudostachyum polymorphum*) were felled and climbers cut. In the first block enough trees of exploitable size and saleable species were left to form a canopy giving an even distribution of light and shade. In the second all such trees were removed without any attention being paid to spacing for light and shade, this experiment illustrating the regeneration of "such a forest as we may expect to find when the Assam Railway & Trading Co. will have finished their fellings and extraction, working under a scheme of concentrated fellings." In the third block all trees of inferior species up to 4' in girth which are not required to give shade were felled. Parts of these areas were sown up with seed of half a dozen valuable species at the end of April 1920, in patches 13' x 13', a large number of seeds being sown in each patch. The Dipterocarp seed had been collected in January and February, and by April while 40 per cent of

it had been destroyed by insects nearly all the rest had lost its germinating power. Some of the same lot sown in the 3rd week of February germinated with a percentage of 66. The Extra Assistant Conservator (Mr. De) has noted that there is plenty of natural regeneration of Hollong (*Dipterocarpus pilosus*) in the forests and in an area over which fellings had passed previously as many as 720 Hollong, 548 Nahor and 648 Sam (*Artocarpus Chaplasha*) were found in a 1-acre sample plot.

In this locality "Atlas" compound has been found very effective in killing girdled trees when painted on the girdles during June.

In the Sibsagar Division interesting results are being obtained in the experimental fellings in the Nambor reserve where the principal species are *Bonsum* and *Hollock*, both of them being in great demand by timber traders. *Hollock* occurs almost pure over extensive areas in the Sadiya frontier tract and it forms a nearly even-aged over-mature forest in which there is practically no natural regeneration. So Mr. Adhikari's experiments will probably prove very useful as soon as the lessees commence felling. In the 7 acre experimental plot I of Nambor about 30 trees, principally *Bonsum*, have been left to an acre, all undergrowth cleaned, advance growth helped and the area burnt over in April. The progress of natural regeneration under this treatment is being watched very carefully and no artificial work has been done. In plot II of the same reserve the principal species are Nahor (*Mesua ferrea*), Amari (*Amoora Wallichii* and *Dysoxylum procerum*), Bhelu (*Tetrameles nudiflora*). Nahor is the evergreen shade bearer *par excellence* forming a forest in which all girth classes are represented and which is free of climbers and undergrowth. It is, however, readily damaged by fire. Amari and Bhelu have quite opposite characteristics and cleanings and controlled fire are useful aids to their increase. The timber of Nahor is so hard, gritty, and heavy that large sizes are not of much commercial value although it is valuable for posts, piles, and pit props.

A detailed study of the early stages of the artificial regeneration of various deciduous and evergreen species was also commenced in Sibsagar during the year.

BURMA.

Regeneration.—No details of the concentrated regeneration in Tharawaddy and Toungoo are given in the Conservator's report, but he quotes certain points in connection with teak *taungya* work to which the Divisional Forest Officers of Katha and Myitkyina draw attention. They are—

- (a) The absolute necessity for the careful collection of good seed (the inference being that this is too frequently ignored and plantations fail accordingly).
- (b) Burying the seed for a year in localities where white-ants abound. These insects devour the corky pericarp, and germination is expedited thereby in a very remarkable manner, so that seedlings attain a height of 1' to 3' by the end of the first rains.
- (c) If, during the first season, growth is unsatisfactory, seedlings should be cut back and weeds burnt during the succeeding hot weather.
- (d) Young teak up to three years old damaged by the extraction of timber, if cut back, will produce shoots in a year as tall as seedling teak three years old.
- (e) If a plantation fails, the best thing is to try a second field crop, preferably sessamum, and re-sow the area. If it fails a second time, write it off.
- (f) General experiments are in progress as regards spacing, dibbling, early burning, and suitable species to mix with the teak. *Gmelina arborea*, *Cedrela* sp., *Morus laevigata*, *Michelia Champaca*, *Cassia fistula*, *Bursera serrata*, *Pentacme suavis* and *Dipterocarpus turbinatus* are under investigation as suitable species.

A very important silvicultural phenomenon is the flowering of *Bambusa polymorpha* which is believed to have begun in earnest in certain Divisions of the Pegu Yomas. With a view to this flowering a large number of experimental gaps were made in the bamboo canopy in 1918-19 in several of those Divisions but the results have not been reported except from Shwegyin Division. There except where supplemented by broadcast sowings, the natural regeneration is disappointingly little; as however the prevalent bamboo in the area is reported to be *Oxytenanthera albociliata* this is not to be wondered at.

Experiments made in Shwegyin with the seed of *Kanyinpyu* (*Dipterocarpus alatus*) showed that if the seed were buried for $\frac{1}{3}$ of their length in the ground, apex downwards and stalk end up, they germinated freely, and the radicle went straight into the ground: in a reversed position germination took $2\frac{1}{2}$ months. Wings should be removed, as if left attached the seeds are easily moved by wind and rain. Mr. Hopwood continues, "My own experiments in Tenasserim entirely support these ideas. There can be no doubt that *Dipterocarp* seed must be sown as soon as practicable after it falls (Mr. Cubitt arrived at the same conclusion in the Malay States) and Mr. Thomson's method of sowing appears to promise the best results. The storage of *Dipterocarp* seeds or even their transport for long distance appears inadvisable."

In the Meiktila Division in accordance with the scheme for increasing the available quantity of *Cassia auriculata* for tannin bark, plantations aggregating 417 acres were made at a cost of Rs. 1,050. The experiment proved a failure and has been abandoned; the failure is attributed to caterpillar attacks (perhaps a species of *Catopsilia*) followed by drought. Where it occurs naturally the plant is hard to eradicate. For other remarks regarding the propagation of this important plant see next page. A careful investigation into the best method of propagation may yield better results than have been obtained in Meiktila.

Publications.—Two works of importance were compiled during the year: (1) "Observations on the Germination and Behaviour of Free Seedlings with special reference to *taungya* plantations" by H. R. Blanford, O.B.E.; (2) "A Handbook of Forest Products of Burma" by A. Rodger, O.B.E. The first was published and the second is still in the press. A note on the Nilambur Teak plantations written by Mr. Rodger mainly from the Burma point of view was also published.

CENTRAL PROVINCES.

There are no officers on special duty in the Central Provinces. Hence, although a good many investigations of the type necessary for the forests of the Province have been begun or carried on, there cannot be the same homogeneity and continuity in them as result from the inquiries of officers on special duty. It appears from the report that the Conservators' conference of 1919 decided the work to be done and that its instructions were carried out by certain of the Divisional Forest Officers.

Rates of Growth.—In the Jubbulpore Division sample plots were opened with a view to ascertaining the suitability of a rotation of 30 years for coppice. The species selected for measurement were teak, *Terminalia tomentosa*, *Lagerstræmia parviflora*, *Anogeissus latifolia*, *Ougeinia dalbergioides*, and others which are fairly common, or in demand. The record deals with single measurements, apparently of the largest shoots in the best clumps, and secondly with repeated annual measurements and the present conclusion is that the girth growth is unexpectedly slow. A similar experiment is in hand in South Raipur. In the latter Division also two sample plots for the girth increment of sal are kept up.

Regeneration and Progress of the forest crop.—In South Raipur there are also certain plots to trace the establishment and development of sal seedlings and again the effect in the latter of removing the ground cover over the latter and lightening the canopy. No conclusions can be drawn as yet from these plots.

In the Melghat silvicultural research work is confined to teak, namely the study of (1) the effects of light and shade on the growth of teak seedlings whether propagated artificially or naturally; (2) the cheapest and most successful method of regenerating the species; (3) the rate of growth of teak in plantations and in natural mixed forest. The first and second are still being carried out while the conclusions arrived at by the Divisional Forest Officer (Mr. Best) regarding the third have been published in the "Indian Forester," Vol. XLVI, No. 4. The Melghat has about a thousand acres of teak plantations which were formed in clear-felled areas, between 1868 and 1879 under the supervision of Mr. Ballantyne but they have not received regular attention. Mr. Best's measurements go to show that teak plantations formed in frost-free localities in the Melghat and thereafter moderately thinned show a good profit, but those made in places effected by slight frost only pay if thinned, while those in bad frost areas do not pay under any circumstances.

Experimental sowings of *Cassia auriculata* were made both in the Jubbulpore and Hoshangabad Divisions. In the first, $3\frac{1}{2}$ seers an acre were sown over an area of 31 acres and of the results the Divisional Forest Officer writes: "The areas selected in some cases were not suitable, otherwise germination was good. It has been found that light sandy soils are most suited to the species, preferably on a gentle slope

at the foot of a hill. The species is hardy and though frost killed the leaders last cold weather in some of the plots it has by no means killed the seedlings which have thrown out new shoots in 75 % of the plants. I have not found grazing do any harm either ; the leaves are not eaten by cattle but grass is kept down and a service done." In Hoshangabad the ground was cleared of tree growth and the soil thoroughly broken up by plough and harrow or by hoe; one seer of seed was sown to an acre in one area in the 2nd week of August and in a second area in the last week of July. Germination failed completely in water-logged places, was partially successful on black cotton soil and successful on well-drained red soil.

MADRAS.

Programme of Research.—The programme for the newly appointed Forest Research Officer in Madras lays down the study of the silviculture of the deciduous semi-evergreen and evergreen forests of the West Coast with a view to (1) the regeneration of the most valuable commercial species in the most economical manner, and (2) the subsequent treatment of the crop in accordance with the silvicultural requirements of the several species. His attention is confined to 10 named deciduous and 11 named evergreen species and the forests which they form in three localities, namely the Chenai Nair reserved forest on the slope of the Ghats, the teak plantations and natural forest of the Nilambur valley and the *Hopea* forest of South Kanara.

Organisation.—Notes collected during the year were ledgered. The building up of an executive and clerical staff and other work necessary to make this forest research a self-contained unit received attention during the year.

Regeneration.—A nursery was formed at Dhoni, and the nursery experiments during the year dealt specially with *Hopea parviflora* and *Artocarpus hirsuta*. In addition, 10 half-acre plots were laid out for studying the effect of varying degrees of shade on the germination of the seed and the growth of the seedlings of the same two species, with which it is planned to try the underplanting of teak both in Nilambur and elsewhere. From the observations made so far, it appears—

- (1) that seeds of *Artocarpus hirsuta* are capable of retaining their germinating power for a longer time than those of *Hopea parviflora* (a Dipterocarp);



Col. Dept. Thomason College, Roorkee.

Photo by T. B. Chitrakar.

Lampati (*Daubanga sonneratioides*) plantation in Bengal, 9½ years old at about 1000 feet.

Largest tree, 3 feet 4 inches in girth.

- (2) that seeds of *Hopea parviflora* of good quality collected straight away from trees and not picked off the ground after they have fallen naturally are capable of retaining their germinating power for at least a fortnight from the date of collection if they are preserved carefully from damp;
- (3) that the percentage of successful germination of *Hopea* is greater if the seeds are dibbled in prepared patches under light shade than when sown in seed beds fully exposed to the sun;
- (4) that the seeds of *Hopea* should not be covered with more than a very thin layer of soil and they should be sown with their wings lying horizontally in the beds; and
- (5) that the removal of the pericarp does not effect the germination of the seed.

Further observations however are required before any definite conclusions can be drawn.

Seven other half-acre experimental plots were laid out before the close of the year with a view to the raising of pure crops of *Bombay malabaricum*, *Tetrameles nudiflora*, *Terminalia paniculata*, and *Gmelina arborea* as timber for boxes and crates.

CHAPTER III.
FOREST BOTANY.
CENTRAL INSTITUTE.

Ecology of Sal and Soil Aeration.—The result of the investigations of past years will appear shortly as a Forest Record. Further investigations are in progress at Debra Dun. Owing to the poorness of last year's seed crop the work was considerably hampered, but this year a better crop was obtained and all the necessary sowings have been completed.

Forest Grasses.—Experiments on the cropping of Ulla grass (*Anthistiria gigantea*) for paper pulp were continued on the previous lines in the Pilibhit Division of the United Provinces.

Spike Disease of Sandal and Zizyphus.—Inoculation experiments are being continued in Dehra Dun and investigations continue in Madras and Coorg.

Mycology.—The root diseases of sal and sissoo, *Polyporus shoreæ* and *Fomes lucidus*, are being studied and investigations into the cause of "redwood" in Spruce have been commenced.

Systematic.—Large numbers of specimens were received from Forest Officers for identification chiefly in connection with the preparation of descriptive lists and local floras. During the year 131 specimens were identified here. The work has incidentally brought to light species of the following genera which are probably new and descriptions of which will be published when verified: *Berberis*, *Corydalis*, *Diospyros* and *Hopea*.

Publications.—During the year the following publications appeared:—

Gupta, B. L.—New Indian Species of Forest Importance, "Indian Forester," Vol. XLV, pp. 388—392.

Hafiz Khan, A.—Red Wood of Himalayan Spruce (*Picea Morinda*, Link) loc. cit., pp. 496—498.

Herbarium.—1,003 sheets were added to the herbarium during the year, the principal contributors being Messrs. A. E. Osmaston, R. N. Parker, C. G. Rogers, B. L. Gupta, H. Tireman and P. J. Draper.

Library.—12 volumes exclusive of periodicals were added at a cost of Rs. 105 and 20 were added by donation.

Tours.—No tours were made as Mr. R. S. Hole, Forest Botanist, was on leave during the whole of the year.

Indents.—A large number of indents for seeds were complied with and they were despatched to various places in India, and to Natal, Uganda, the Soudan, Abyssinia and Egypt, Cape Verde, New South Wales, Chili and the United States of America.

UNITED PROVINCES.

Mycology.—The fungus *Periderium corticola* has long been causing serious trouble in the plantations of *Pinus longifolia* near Almora. Research on the subject is in hand but no results are available for publication yet.

BENGAL.

Mycology.—In the Inspector-General's note of his tour of inspection in Bengal and Assam, to which reference has been made already, he discusses a matter of grave import to all officers concerned with the administration of sal forests, namely the mortality of sal and the part which the root fungus *Polyporus shoreæ* (Wake) has in it. The manufacture of dry timber, especially sal timber, by forest-workers is undoubtedly a common malpractice in the Sub-Himalayan forests and very damaging to the canopy. In the eight years ending 1912-13 the average outturn of dry sal from the Buxa forests amounted to the large total of 6,23,098 cubic feet. Though the figures were held to be inaccurate the system of exploitation was changed to one of extraction on a six years' rotation, the trees being marked before felling and sold by auction. The large outturn under the old system was considered by the local officers to be due to creepers, insects and unknown causes and the Forest Zoologist was called on to inquire into the possible causes of death by insects. Mr. Beeson came to the conclusion that insects were only of secondary importance and it was while he was engaged on the investigation that he discovered the root fungus. The average outturn of dry sal timber during the past six years is 1,30,844 cubic feet which the Divisional Forest Officer (Mr. Glasson) considers is derived from a normal and natural annual

production of 3,00,000 cubic feet of dead sal. By means of other calculations he found that the death-rate did not greatly exceed one per cent per annum.

In the Buxa Division ten special root fungus sample plots have been laid out, two of which have been under observation for 4 years and the others from $2\frac{1}{2}$ to $3\frac{1}{2}$ years. They represent all types of sal forest and are inspected regularly and the results properly recorded. The Inspector-General continues: "In regard to the rate at which deaths occur which may be definitely associated with the fungus, the observations made up to June 1919 show some tangible result; for while the average annual percentage of deaths in all ten plots due to all causes has amounted to 1.86, that which can definitely be assigned to the fungus has amounted to 1.4 per cent. These figures are somewhat in excess of the average death-rate referred to in the preceding paragraph; but it must be remembered that the observation plots were specially selected in localities in which fungus attacks were particularly obvious so that the death-rate in these plots may reasonably be assumed to be somewhat higher than the general average for the sal forests as a whole.

The record of observations for the 10 plots also shows an increased number of attacked trees at the end of the observation period, but as noted above it is not safe to make any deductions regarding the spread of the disease at present for many of the trees might have been infected at the first inspection though this was not at that time noticeable. Finally analysis of the death according to girth classes shows that the mortality due to, or associated with, the fungus is about the same in all classes, namely 4 per cent in the case of trees under 2 feet in girth, 6.1 per cent from 2 feet to 3 feet, 5 per cent from 4 feet to 5 feet, 6 per cent from 5 feet to 6 feet and 5.3 per cent over 6 feet."

BURMA.

Botanical Garden.—The garden at Maymyo which has hitherto been maintained by funds provided from the budget of the Agricultural Department is being placed under the control of the Forest Botanist of the local Research Institute and funds for its upkeep will be provided in the Forest Department budget. Successful experiments have been carried out with the cultivation of mulberries, this at the instance of the

Development Department, the idea being to start a centre for sericulture at Maymyo. The Development Commissioner has been definitely promised that the garden can now guarantee to raise mulberry plants sufficient to stock a plantation for feeding the silk-worms.

The expenditure incurred on the garden in 1919-20 was Rs. 15,793.

Herbarium.—During the year 1,200 botanical specimens were received for the herbarium, many of which still await identification. Of those identified perhaps the most important from an economic point of view are the Yemanés of Mergui which proved so useful for box making and turn out to be two species of *Lophopetalum* (*fimbriatum* and *filiforme*) and not *Gmelina*. By far the largest collections are those sent in by Mr. C. G. Rogers, lately Chief Conservator; these were obtained by him in South Tenasserim, the dry zone and Katha.

CHAPTER IV. FOREST ECONOMY.

CENTRAL INSTITUTE.

The feature of the year's work has been the deputation in August 1919 of the Forest Economist, Mr. R. S. Pearson, to America and England with the object of reporting on the organisation of forest research in the former country and of purchasing plant consisting of timber testing machines, seasoning plant, a saw-mill and other modern fittings for the Economic Section of the Research Institute. With a similar object Mr. Raitt, Cellulose Expert, proceeded to England in October 1919 with a view to purchasing an experimental pulp and paper making plant. During the year under report therefore the work of the branch has consisted mainly in the purchase of new plant and fittings for the proposed extension of the Institute and work at Dehra has been practically limited to the routine work of replying to enquiries regarding sources, outturn and prices of forest products. Field work has similarly been limited to an examination of the markets for turpentine and rosin throughout India, inspection of the timber seasoning experiments in South India and an investigation regarding possible developments of the trade and the outturn and prices of timber in South India and the Andamans.

Observation and Encouragement of the Paper Pulp Industry in India and Burma:—During October 1919 Mr. Raitt proceeded on leave to England with the object of purchasing the requisite experimental pulp and paper making plant for the new workshops. With the erection of these plants it will be possible to carry out exhaustive experiments on the various kinds of bamboos, grasses, and other raw materials which exist in India and Burma and which now await the results of such experiments for their development.

The question of utilising bamboo and large grasses for the manufacture of paper pulp has been under investigation for a long time at this Institute and had it not been for the great war there can be no doubt that the bamboo pulp industry would have been started ere this. Now that it is again possible to obtain machinery, definite steps have

been taken to erect pulp mills in India. Thus, one mill is nearly complete near Calcutta and should be in a position to start work early in 1921, obtaining its bamboos from the Chittagong Hill Tracts; another is to be erected in Burma obtaining its bamboos from the Pegu Division, while a third scheme is contemplated in Tavoy. Bamboo pulp is actually being manufactured at present in Cochin State and also in Burma, though not on a large scale. The question of utilising Elephant grasses for paper pulp requires much further enquiry which cannot be carried out until the experimental pulp and paper machines are erected.

Antiseptic Treatment of Timber:—The experimental creosoting plant was received from England during the year and is being erected. A fresh supply of 350 green sleepers of Spruce and Silver Fir has been obtained from the Punjab for the conduct of the first series of experiments and steps are now being taken to purchase an electric motor to facilitate the working of the plant.

The experiments with sleepers of five species of timber treated by the Powell process, with chloride of zinc and oil, with Avenarius Carbolineum and with mixed creosote and Earth oil, which were laid down in the open lines, commencing in 1911, have been reported on during the year and are doing well. The results of these experiments have induced various railway companies to take a greater interest in the question, and two companies are contemplating the erection of plants to treat conifer and other timbers. The question of starting this business is largely bound up in the question of cost. Efforts have been made all over the world to reduce the cost, due to the rise in price of creosote. A method advocated was to treat sleepers first with chloride of zinc and then, in order to prevent the salt being washed out of the timber, to immerse the sleepers in oil; this was tried in India, but with only partial success. A process has now been evolved in America, known as the Card process, by which the salt and oil are introduced simultaneously, which is claimed to give most satisfactory results. The Forest Economist visited, while in America, an installation working according to this system, and it is thought that it would be quite applicable to Indian conditions and may solve one of the difficulties of introducing treated sleepers into this country.

Physical and Mechanical Properties and Seasoning Powers of various Timbers :—

(i) Natural Seasoning.

An initial experiment was started on a small scale in 1914, in nearly all provinces of India, to season various timbers by natural methods. These experiments were completed in 1918, and gave such promising results that it was decided to extend the scope of the enquiry after the results of the first enquiry were available and recorded in Indian Forest Records, Volume VII, Part I of 1919.

These detailed seasoning experiments were initiated last year at various centres in the Punjab, United Provinces, Assam, Bengal, Bihar and Orissa, the Central Provinces, Coorg and Madras, the records for which have been compiled, examined and put in order while the experiments were inspected in detail at two centres in Madras. These experiments now await the final inspection during the coming season.

(ii) Artificial Seasoning.

This subject has been studied in detail by Mr. Pearson while on deputation in America and England with the result that the standard American and English experimental seasoning plants, *viz.*, a 3-chambered Tiemann and a 4-chambered Sturtevant, plant, have been purchased and are expected shortly in India.

(iii) Mechanical Properties of Timber.

It having been for long realised that the present timber testing machine in the Economist's workshop is quite inadequate, three of the latest standard pattern machines have been purchased in America and two others in England and all these are now on their way to the Research Institute.

Detailed mechanical tests on *Eucalyptus Globulus* and *Acacia melanoxylon* from the Nilgiris and *Olea ferruginea* from the Punjab have been carried out during the year.

In view, however, of the purchase of the new machines, tests on the old machine have been suspended and timber from eleven other species has been received and is now laid down to season pending the arrival of the new plant.

Finding of Markets and new uses for Timbers, including the Issue of Bulletins:—Bulletins on the following timbers were completed during the year and are now in the press:—

1. *Bombax malabaricum*.
2. *Adina cordifolia*.
3. *Odina Wodier*.
- *4. *Lagerstrœmia Flos-Reginæ*.
- †5. *Dipterocarpus pilosus*, while that on
6. *Hopea odorata* is still under compilation in Burma.

The number of enquiries from firms and others on the subject not only of the utilisation of Indian timbers for special purposes but also of the sources and available supplies of such timbers indicate the extreme importance of this head of research, and the necessity for the collection of reliable data regarding local outturn and prices.

Probably the greatest stimulus which has been given to Indian timbers in Europe during recent years is an exhibition of Indian, Andaman and Burmese timbers at the Empire Forest Exhibition, which was held in July 1920 in London. The exhibits consisted of a complete double staircase, one side made of Andaman Padauk, the other of *Terminalia bialata*, and in front parqueting of these timbers and *Dipterocarpus turbinatus*. Several rooms were panelled with a variety of timbers such as *Albizzia Lebbek*, *Terminalia tomentosa*, *Dalbergia Sissoo*, with suites of furniture inlaid with Walnut to match. A large variety of articles, such as golf clubs, walking sticks, turnery work, carving, boot-trees, and parqueting work, made of Indian timbers, was also exhibited. This fine exhibit, which was arranged by Professor Troup, C.I.E., and Mr. Alexander Howard of Messrs. Howard Brothers, was the centre of much interest and resulted in numerous enquiries being made for Indian timbers.

Gums, Resins and Oil-resins:—The possibilities of an industry based on the tapping of Salai (*Boswellia serrata*) for its gum-oleo-resin as a source of turpentine continues to attract considerable attention. Bulk samples obtained from Khandesh were examined at the Indian Institute of Science, Bangalore, and samples of products have been

forwarded to an interested Bombay firm for transmission to London for valuation. Tapping operations commenced in Khandesh and the Gwalior and Kotah States, are now being extended to Bhopal and further developments depend upon the erection of a distillery at some suitable centre.

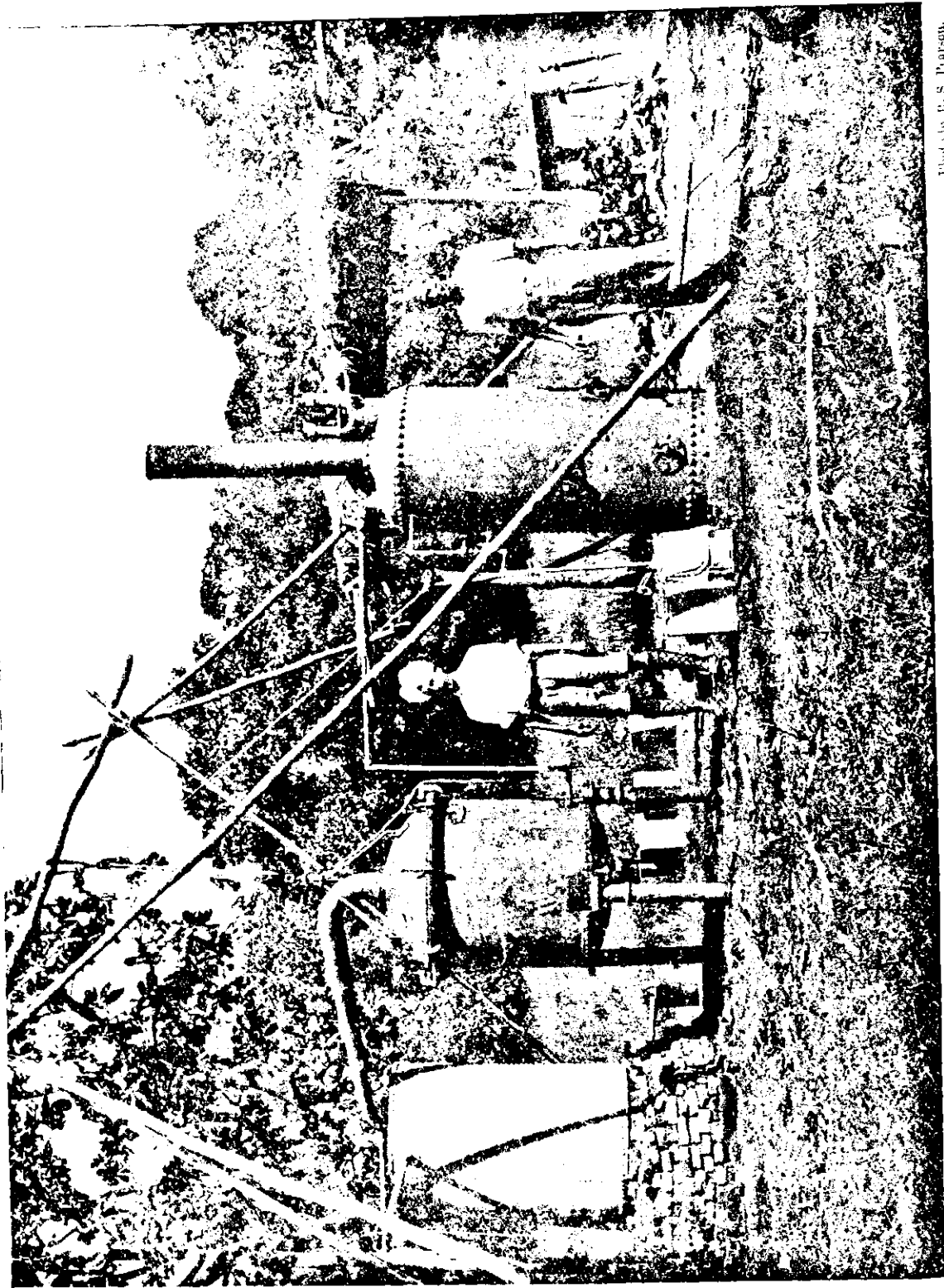
Rosha Grass Oil:—The object of improved methods of distillation continues to elicit numerous enquiries. The question is being investigated on a commercial scale in the Central Provinces and Bombay and it is understood that the possibility of increasing the outturn of grass in the Central Provinces is a question which is now engaging the attention of the local officers.

Wood Suitable for:—(i) Wood paving Blocks.—This subject is under observation in Bombay and the experimental pavements of Xylia blocks have been considerably extended.

(ii) Bobbins, Skuttles and Picking sticks for Cotton and Jute Mills.—Experiments on a commercial scale on various Indian timbers are now being undertaken by the Utilisation Circle of the United Provinces. The leading firm of bobbin manufacturers in England has been approached with a view to starting a branch business in India.

(iii) Rifle Stocks.—Since it has been found impossible to find any really suitable substitute for walnut timber, operations are now being concentrated on the supplies of properly kiln-dried walnut half wroughts to the Ishapore Rifle Factory from the N.-W. Frontier Province and from Kashmir.

(iv) Three-ply.—The manufacture of three-ply has now passed beyond the experimental stage in Assam where ply boxes for tea are now being manufactured from a wide variety of timber species. Difficulties have, however, lately been encountered in the matter of a tendency to 'cheesiness' in certain timbers, such as *Endospermum chinense* and *Tetrameles nudiflora*, when used for this purpose. This matter is one of vital importance to the industry and the possible solution of the difficulty is now being made a subject for detailed investigation. The possibilities of three-ply for tea and rubber boxes are also being considered by several firms in South India as it is now becoming increasingly difficult to obtain adequate supplies of



suitable timbers at a price which will permit of the ordinary box industry being run at a profit.

(v) *Cooperage*.—The general question is being investigated on a semi-commercial scale by the Utilisation Circle, Bareilly. The problem of finding a suitable timber or timbers for cocoanut oil casks in South India in addition to White Cedar (*Dysoxylum* spp.), which is the only timber now being used for the purpose, remains to be solved. The subject was opened by Messrs. Tata's Limited, who have erected a large oil mill at Ernakulam and intend to use imported Douglas Fir for the manufacture of oil casks, it being considered that this procedure is likely to prove more economical and satisfactory than that of depending upon a supply of the locally made casks. On the analogy that Douglas Fir has been found suitable for the purpose in the Philippines and elsewhere sample casks and shooks of the chief Himalayan conifers have been supplied by the Utilisation Circle, Bareilly, to the Tata Oil Mills, Ernakulam, for testing and four casks have also been sent to this branch in Dehra.

Steps have also been taken to purchase an experimental stove cutting and barrel making plant for the Economic workshops of the Research Institute so that there is every hope that a solution to the problem of a suitable timber for oil casks will be found reasonably soon.

Charcoal Briquettes:—An experimental briquetting press was purchased and erected during the year and the first series of experiments on charcoal dust with a binder of *Bauhinia retusa* gum have been carried out. The problem of an entirely suitable binding medium is as yet unsolved but valuable data on this subject have been collected during the Economist's tour in America which may be expected to indicate new lines for investigation.

A serious difficulty which was represented to the Forest Economist in America was the question of grinding charcoal to a fine dust preparatory to pressing it into briquettes. It appears that it is extremely dangerous to grind charcoal as it is liable to explode, and it was stated on good authority in Chicago, where ground charcoal is in great demand, that they write down their machinery at one year's life. To overcome this trouble the Madison Forest Products Laboratory are carrying out experiments in which they press up sawdust into briquettes and then carbonise them under pressure.

Other Enquiries :—Miscellaneous enquiries from firms and individuals, private and official, continue to increase in number and variety of subject, a sure proof of the need for special officers to deal with the various subjects. Such a need has been realised for a long time and steps have now been taken for the recruitment from America and Canada of specialists in timber technology and seasoning.

A number of interesting additions were made to both the Timber and Economic museums during the year.

UNITED PROVINCES.

Apart from what is mentioned in the Central Institute report concerning the work of these Provinces, the following details deserve notice. All the work has been done at Bareilly except the chir tar distillation.

Experimental.—A great deal of valuable pioneer work was done by the United Provinces Wood Technologist (Mr. Kinns) which included the investigation of the best methods of conversion and the most suitable timbers for implements, containers and articles of various other economic kinds.

Seasoning.—Owing to the delay in the arrival of various instruments from the United States of America the seasoning kiln which is a two battery Tiemann kiln of the water spray type, thermostatically regulated, did not commence its career of usefulness during 1919-20. The problems to be dealt with are numerous and will necessitate long and careful study but the ultimate results from the experiments of this and similar plants will have a far reaching effect on the timber trade of India.

New Markets and Uses.—At present investigations are being concentrated on *Pinus longifolia*, *Picea Morinda*, and *Abies Pindrow*. The necessity for obtaining new markets for these has long been appreciated and the results obtained show the possibilities of future development. Interior wood-work for buildings such as match boarding, cornice moulding, door and window bars, is being made from these timbers with good results. They are also being tried by one of the railway companies in the construction of railway carriages. It is hoped that in future they will replace the large quantities of

imported deal and fir which meanwhile command a ready sale on the Indian markets.

A plant for the manufacture of wood-wool has been laid down and it is proposed to utilise small sawn ends and wood waste for this purpose. The product is used for packing china and glassware. The price obtained for imported wood-wool before the war was 12 annas per pound.

A wood bending machine is also being laid down and it is intended to test the suitability of various timbers for the manufacture of felloes for carts and carriage wheels. The steaming and bending of blanks from small Shisham poles for the manufacture of spade-handles finds a ready use for what has hitherto been unmarketable timber in the United Provinces. Other small articles for which local timbers have been tried successfully during the year are picking sticks for calico looms and laggings for jute mill rollers, golf and hockey sticks, boot-trees, railway keys, cutter blocks.

Gums, Resins and Oleo-resins.—Experimental work in chir-tar distillation was continued in the West Almora Division of the Kumaon Circle. The old plant was dismantled and in its place two batteries of the new retorts, each of two units or double retorts, have been erected at the old site and one on a new site a few miles distant. The distillation was not well done and the yields reported are disappointingly low. The reason is that it was not possible to arrange for the same skilled supervision as last year and in an infant industry this makes the difference between success and failure.

Woods suitable for Various Purposes.—For hobbins eight timbers have been tried of the more valuable miscellaneous species of the Bhabar and plains forests. The best results have been obtained from *Adina cordifolia* and *Holoptelea integrifolia*. For handles of various patterns the timbers used are *Terminalia tomentosa*, *Anogeissus latifolia* and *Dalbergia Sissoo*. There is now a good demand for these handles. Half a dozen timbers have been tried in casks. Chir (*Pinus longifolia*) is used in large quantities for slack casks but for the fuller investigation into the possibilities of tight cooperage the advent of an expert cooper is awaited. In the manufacture of brushes the wood of ash (*Fraxinus floribunda*), holly (*Ilex dipyrrena*) and *Adina cordifolia* are very favourably reported on by brush-making firms.

BIHAR AND ORISSA.

Seasoning of Timber.—A considerable number of seasoning experiments are in hand in accordance with the suggestions of the Forest Economist; the species under trial are *Soymida febrifuga*, *Eugenia Jambolana*, *Odina Wodier*, *Anogeissus acuminata* and *Boswellia serrata*.

Experiments are also in hand to ascertain the best type of kiln to produce first class charcoal in an economical manner but are not sufficiently advanced to furnish useful information.

BURMA.

Museum.—The collections, mainly economic, in the forest museum at Rangoon were considerably added to and improved. They attract an ever increasing number of visitors, many of whom are actuated by motives other than mere curiosity and whose visits lead to inquiries for commercial products.

General Development.—In general, the year was spent as at the Central Institute in making plans for the future. The experimental seasoning plant at Insein was closed in view of the impending arrival of the dry kiln now *en route* from America which is to be erected at the Government Depôt, Rangoon. Plans for portable saw-mills are also under way, as well as for the erection of a workshop and laboratory for timber research, and for the building of dry kilns and testing machines and putting up a small saw-mill plant, for veneer cutting and making plywood barrels, articles of turnery, and shingles, for all of which there should be a great scope among the numerous little-known timbers of Burma.

CENTRAL PROVINCES.

Seasoning of Timber.—In common with other provinces further seasoning experiments are in hand in accordance with instructions received from Dehra Dun. They were started at Allapilli in 1918-19 and will be completed in 1920-21. Ten species are being dealt with, including *Chloroxylon Swietenia*, *Grewia tiliæfolia*, *Anogeissus latifolia*, *Soymida febrifuga*, *Hardwickia binata*.

Suitability of Timbers.—From the same Division (South Chanda) timber of *Saccopetalum tomentosum* is being supplied to a Bombay firm to test its suitability for billiard cues as a substitute for ash (*Fraxinus floribunda*).

BOMBAY.

Fibres.—Large samples of the fibre of the Talipot palm (*Corypha umbraculifera*) were sent, among others, to the Fibre Expert to the Government of Bengal and to interested firms from the South Kanara Division. Though somewhat brittle the fibre is of extraordinary length and tensile strength and might be very useful for cordage of good quality when prepared with the proper oils.

CHAPTER V. FOREST ZOOLOGY.

CENTRAL INSTITUTE.

The following items of the sanctioned programme were dealt with:—

Insects of the Sal.—Borers. (a) *Field work.*—Observations were continued in the two permanent incidence plots established in the borer-attacked parts of Thano forest, Dehra Dun, and a third plot of 60 acres in the peripheral zone was surveyed and enumerated. Analyses of trees showing different degrees of attack were made to determine (a) the number of successful emergencies, the proportion of failures due to parasitism, disease, etc., and (b) the conditions governing the survival of slightly attacked trees. Control measures devised in 1918, involving the removal of borer infested trees within the year of attack, were tested over about 250 acres, in which area no subsequent damage has occurred.

To determine the seasonal succession of sal borers and its connection with felling dates, an experiment has been started in which 12 sal trees are felled, one in each month throughout the year, and from each tree a log is removed monthly and caged.

(b) *Insectary work.*—Experimental rearing of larvæ from the prepupal stage in sealed tubes under varying conditions of moisture was continued with the object of determining the mortality due to parasitic fungi, bacteria, and diseases of unknown origin. The fungi were identified by Dr. E. J. Butler, Imperial Mycologist, who isolated a series of species of the genera *Acladium*, *Aspergillus*, *Botrytis*, *Cephalosporium*, *Dendryphium*, *Harpoglyphium*, *Helminthosporium*, *Hormodendron*, *Penicillium*, *Stysanus*, (*Melanospora*) and *Verticillium*. The mixed nature of the fungus flora (which contains hyperparasites) and the variation in the morbid symptoms indicate that several factors cause the death of *Hoplocerambyx spinicornis* larvæ and that the prevalence of a specific parasitic fungus is less probable than was supposed.

Other pests.—Insectary records have been obtained of pests of sal seed and the young seedling. The species primarily concerned are *Dichochrosis leptalis*, *Laspeyresia pulverula* and *Calandra* sp.

Insects of the Teak.—An illustrated note on the Beehole Borer of teak, with suggestions for its control, has been prepared, and is now in the press as a Forest Record. No field work was carried out by the Forest Zoologist's staff, but observations are being continued in sample plot areas by divisional officers.

Insects of the Toon.—The chalcidoid parasites of *Hypsipyla robusta* have been described by Captain the Revd. Waterston, Bureau of Entomology, in a paper that will shortly appear as a Forest Record. Work has been started on the biology of the hymenopterous parasites and the predators of the caterpillars of this borer.

Lac.—A microscopic examination of the internal morphology of lac insects was carried out under the direction of the late Mr. F. M. Howlett, with the object of discriminating specific differences in the form of lac insects from different kinds of host trees.

Miscellaneous Pests.—During the year under report 186 consignments of specimens (including 1,362 insects) were received for investigation. In collaboration with the Forest Economist the borer fauna of timbers laid down under different methods of seasoning is being worked out. A total number of 2,614 pieces of timbers laid down under different methods of seasoning is being worked out. A total number of 2,614 pieces of timber has been received from divisions in which seasoning experiments are in progress and from this material, numerous species of borers (amounting to some 7,000 specimens) have been bred out, adding considerably to our information on the food trees and distribution of timber pests. The more important of the new records are:—*Aeolesthes holosericea*, Fab. ex *Drimycarpus racemosus*; *Batocera titana*, Th. ex *Sterculia villosa*; *Ceresium leucosticticum*, White ex *Anogeissus latifolia* and *Grewia tiliaefolia*; *Coptops aedificator*, ex *Aegle Marmelos*, *Careya arborea* and *Holoptelea integrifolia*; *Dialeges pauper*, ex *Cassia fistula*; *Diorthis cinereus*, Fab. ex *Hardwickia binata*; *Epipedocera affinis*, Chev. ex *Grewia tiliaefolia*; *Gnatholea simplex*, Gah. ex *Hardwickia binata*; *Margetes modicus*, Gah. ex *Anogeissus acuminata* and *Anogeissus latifolia*; *Nyphasia apicalis*, Gah. ex *Anogeissus acuminata*; *Ploccederus ferrugineus*, Linne ex *Boswellia serrata*, and *Hardwickia binata*; *Xylotrechus quadripes*, Chev. ex *Hymenodictyum excelsum*; *Xylotrechus renominatus*, Beeson ex *Shorea robusta* and *Amoora Rohituka*; *Xylotrechus smeii*, L. et G. ex *Careya arborea*; *Xystrocera globosa*, Oliv. ex *Acacia modesta*; *Platypus solidus*, Wat. ex *Acrocarpus fraxinifolia*.

Insect collections.—Small batches of insects have been identified and returned by the following specialists :—

Siricidae and *Tenthredinidae* by Dr. S. A. Rohwer; *Syrphidae*, *Stratiomyidae* and other *Diptera* by Mr. E. Brunetti; *Asilidae* by Miss G. Richardo; *Odonata* by Major Fraser; *Aphidae* by the Government Entomologist, Madras; *Microlepidoptera* by Mr. E. Meyrick; *Carabidae* by Mr. H. E. Andrews; *Bostrychidae* by Mr. M. P. Lesne; *Tenebrionidae* by Mr. K. Blair; *Lamellicornia* by Mr. G. Arrow; *Curculionidae* by Dr. G. Marshall; *Scolytidae* and *Platypodidae* by Col. Winn-Sampson; *Cerambycidae* and *Lamiidae* by Dr. G. Gahan. While on leave the Forest Zoologist visited specialists in England and France and distributed 5,000 specimens of *Coleoptera* and *Hymenoptera*.

Museum.—The principal additions to the museum comprise 529 specimens of timber showing the work of borers, skins of palm squirrels, bats, bamboo-rats, etc. A consignment of 86 specimens of damage by borers to the principal Indian forest trees was presented to the School of Forestry, Oxford.

Staff.—Consequent on the sanction by the Secretary of State for the recruitment of four forest entomologists arrangements were made for the post-graduate training of certain I.F.S. probationers in entomology. The new post of Systematic Entomologist has been filled by the appointment of Surgeon Commander M. Cameron, M.B., R.N.

Mr. Beeson was deputed to attend the Imperial Conference of Entomology held in London, June 1920, as the representative of the Government of India.

Zoologist's Library.—105 new books in addition to periodicals were added.

Tours.—No tour was made during the year except by a field party which was more or less continuously in the Thano forest, Dehra Dun Division, United Provinces, chiefly in connection with the *Hoplocerambyx* epidemic.

BURMA.

Insects of the Teak.—There is nothing definite to report about the study of the beehole borer (*Duomitus ceramicus*). At the suggestion of Mr. Mackenzie a number of nesting boxes were put up in teak plantations in the Prome Division with the view of inducing insect-eating birds to make their nests in them. As the eggs of *D. ceramicus* are

laid on the bark of teak and as two of the most persistent insect-hunters, the nuthatch and the grey tit, nest readily in suitable boxes the experiment is one well worth trying.

Another point already under investigation and which appears to deserve very close and careful attention is the influence which fire has on the prevalence of this borer. The evidence on this point so far is very conflicting in some cases appearing to lead to the conclusion that fire destroys the insect in one or more of its metamorphoses, in others that it directly assists the pest.

CHAPTER VI.
FOREST CHEMISTRY.
CENTRAL INSTITUTE.

Research work was resumed with the advent of Dr. J. L. Simonsen to fill the vacancy caused by the absence of Mr. Puran Singh on leave. The latter has since gone on a medical pension.

Gums, Resins, Oleo-resins and essential Oils.—Work has been done on the following trees, shrubs and products.

Skimmia Laureola.—The leaves of this evergreen under-shrub have been distilled and the essential oil isolated. The results of an examination of the oil are approaching completion.

Note.—The shrub is common in the Oak and Fir forests throughout the Himalayas and frequently interferes with the regeneration of trees of valuable species. If a regular supply of the oil can be made at the most productive season the product might well have a considerable market value.

Zanthoxylum alatum.—The seeds have been distilled and the oil is under examination.

Camphor and Camphor Oil.—The results obtained in past years have been subject to analysis and it has been found that the leaves of coppiced trees yield about 4 per cent of camphor and camphor oil. Further experiments are being made to determine the acreage yield of camphor and camphor oil. The oil from the leaves after the removal of the camphor is likely to be of little value since it contains no Safrol. A detailed investigation of the constituents of the oil from the leaves, twigs and wood has been made and the results will shortly be published.

Indian Turpentine.—A detailed study of the turpentines obtained by the steam distillation of the oleo-resin from the various species of *Pinus* occurring in India has been commenced.

The oil from *Pinus longifolia* has been examined and has been shown to consist of 1- α -pinene, β -pinene, *d*-carene and *d*-longifolene.

Two of these terpenes, *d*-carene and *d*-longifolene, are new. The constitution of *d*-carene, which is the cause of the ready oxidation of the turpentine from *Pinus longifolia*, has been determined with some

certainty whilst *d*-longifolene has been shown to be a tricyclic terpene. The results of this investigation have been published in the Transactions Chemical Society, 1920. 117, 570.

The turpentine from the oleo-resin of *Pinus Khasya* from Burma has been examined, a sample of the oleo-resin having been distilled at Jallo for this purpose. Nearly 90 per cent of oil distilled below 170°/700 mm. and consists of a mixture of *d*- α -pinene and β -pinene. The turpentine is of a very high quality and is equal to the American oil. The high boiling fractions contain a sesquiterpene identical with *d*-longifolene present in the oil from *Pinus longifolia*.

Medical Research.—A number of specimens of the flower heads of *Artemisia maritima* have been examined, but no Santonin has been isolated.

Dyes.—The root bark of *Morinda citrifolia* has been shown to contain in addition to morindone, rubiadin, monomethyl ether and alizarine α -methyl ether. Experiments on the synthesis of morindone are in progress.

Miscellaneous inquiries.—As usual a number of analyses of samples submitted by forest officers have been made whilst the usual moisture determinations have been carried out for the Forest Economist.

Publications.—

1. The constituents of Indian Turpentine from *Pinus longifolia*, Roxb. Part I, by J. L. Simonsen (Trans. Chem. Soc., 1920. 117, 569.)
2. Note on the Constituents of *Morinda citrifolia*, by J. L. Simonsen. (Trans. Chem. Soc. 1920. 117, 561).
3. The distillation of Camphor in India, by J. L. Simonsen and T. P. Ghose (in the press).

PUNJAB.

Standardisation of Indian Turpentine from Pinus longifolia.—Large quantities of turpentine are now distilled annually from the oleo-resin of *Pinus longifolia*, and attempts have been made to produce a standard turpentine of uniform composition at Jallo, but although progress had been made, a standard turpentine had not been produced prior to an investigation made by the Manager, Captain Guest, during the year. The following description is taken *in extenso* from the latter's report.

The first step in attempting to produce a standard oil is to decide on the standard of oil desired; the second step is to arrange the distillation so as to produce the maximum amount of oil of this standard.

There is a considerable literature on the subject of turpentine specifications, but, from the economic stand-point, as Indian turpentine will have to compete with American turpentine it was decided to accept the specifications recently drawn up by the U. S. Bureau of Chemistry with a view to general adoption in that country. The specifications are detailed below :—

Specification for Turpentine.

	Max.	Min.
Specific gravity @ 15.5°/15.5°C.	0.8720	0.862
Refractive index 20° C.	1.478-7	1.468
Initial boiling point at 760 mm. pressure	160°C.	150°C.
Distilling below 170°C. @ 760 mm. pressure ... ..	...	90%
Colour—"Standard" or better.		
Appearance—Shall be clear and free from suspended matter and water.		

The distillation process consists of a primary distillation to separate the solid residue (rosin) from the liquid distillate. The latter is separated into the bulk oil and inferior oil, each of which is subject to re-distillation in order to separate the quality I oil from that of quality II and III. It was considered that the three physical qualities which could be usefully employed for control tests are :—

(a) Refractive index.

(b) Specific gravity.

(c) Percentage distilling over below 170°C.

(a) Refractive Index is probably the best property to rely on but was ruled out owing to lack of the necessary refractometer.

(b) Specific Gravity at first sight appeared suitable. In general the specific gravity increases with the boiling point of turpentine and eventually a certain specific gravity is reached beyond which the turpentine could not conform to the specifications. Experiments were carried out with a view to finding this maximum gravity, the intention being to procure a ball which would just float at this particular density and put it in the turpentine issuing from the condenser. The ball would rise to the surface when the maximum density allowed was attained and at this point the distillation would be stopped.

Unfortunately for the idea the experiments showed that the variation of density with the boiling point was not regular. It was found that the density decreased to a certain point and then began to increase. There were also other difficulties and so this idea was dropped.

(c) Percentage distilling over below 170°C.

This property was then considered and after a few preliminary trials a method of control was framed and has been used with great success.

The method in operation is as follows:—

The bulk oil obtained in the primary distillation together with 15% from the re-distillation of inferior oil is collected into one 400 gallons tank until the tank is full; this tank will contain 400 gallons of oil having definite properties. A first charge of 50 gallons from the tank is re-distilled and a definite volume (42 gallons or 84%) of quality I oil is distilled over and condensed. An average sample of this quality I oil so obtained is tested in the laboratory and the volume distilling over below 170°C. is found. If the volume is found to be below (or above) 90% (see specification) then it follows that re-distillation was carried too far (or not far enough) by the distiller and orders are given that in the subsequent charges from the particular bulk oil tank the amount distilled over as quality I oil must be less (or more) than the amount obtained from the first charge of 50 gallons.

Great care is taken that the control test is carried out under identical conditions each time. This is of paramount importance, for by varying the conditions almost any result can be obtained.

It is intended to pass the quality I oil obtained from several bulk oil tanks into one 1,200 or 1,600 gallons tank and so average out the slight individual variations.

The benefits resulting from this method are—

- (i) The turpentine conforms to the proposed American specifications, in fact its limits are much narrower than those allowed in the American specifications, and this standard is continuously obtained.
- (ii) The yield of quality I oil is slightly higher than with the old process, (1.57 gallons per maund of crude resin as compared with 1.45). On a yearly distillation of 36,000 maunds a still, quality I oil is increased by 4,300 gallons with a corresponding profit of Re. 1 a gallon.
- (iii) A certificate of physical properties can be issued with every drum of turpentine sold. It is hoped that free issue of this certificate will go a long way towards stopping that practice of adulteration of turpentine which is so prevalent.

The utilisation of waste resinous matter.—An investigation has been made at Jallo to convert the waste resinous matter consisting of earth, pine needles, bark and wood chippings which have generally been disposed of by being burnt in the open into saleable lamp-black by consuming it in a lamp-black chamber made of unserviceable resin-tins. Crude resin contains 5% of such waste matter. It is expected that with a proper chamber 1 lb. of lamp-black will be obtained from each maund of waste material. The prices of two well known grades of lamp-black in Bombay are Re. 1-8-0 and 10 annas a lb. Turpentine of quality III and resin oil are expected to produce a very good grade of lamp-black and if this is so a new outlet for the former and for surplus resin is found.

BURMA.

Tannins.—The Government Tannin Expert Mr. Pilgrim was engaged in an investigation of the tan-stuffs of the Sunderbans between June 1919 and February 1920. It was, therefore, in the main an inquiry into the products of the mangroves. For this work Mr. Pilgrim was deputed to the Board of Industries, Bengal, and his report is being published through the latter.

He was subsequently released from his work in India to take up the duties for which he was first engaged, namely the examination of the tan possibilities of Burma. He is now busy with an examination of the oaks and chestnuts indigenous to Maymyo and its vicinity. The preliminary tests have given promising results, and considering the wealth of species and individuals of the Cupuliferæ in certain parts of Burma it may be hoped that commercial development will follow these investigations.

Mr. Pilgrim writes that it will be regarded as somewhat surprising that in the Burma oaks, as a whole, the wood shows infinitely more promising results than the bark. Such are the woods of *Quercus Lindleyana*, one of the commonest oaks on the Maymyo plateau which yields an infusion which is free from any black colour, and of *Quercus spicata* var. *microcalyx*. The outer layers of the bark of the latter two and of *Quercus Griffithi* are capable of giving useful extracts with good tanning properties but much inferior in colour to those of English oaks. Another oak *Q. serrata* has given promising results from its leaves and galls. Lastly remarkably good preliminary results have been obtained from the wood of one of the commonest local trees, the chestnut *Castanopsis tribuloides*.

The Tannin Expert makes the following interesting remarks in comparing the Burma oaks with those of other countries.

" *Difference between Burma Oaks and those of Europe.*—This consists mainly in a tendency, on the part of the tannin in the former, rather to resemble that of the oak *bark* of Europe than that of European oak *wood*, in that it veers towards catechol-tannin reactions with a corresponding redder infusion than that obtained from the European wood. The tendency is quite strongly marked even in the best of these woods, *vis.*, that of *Quercus Lindleyana*, which however seems nevertheless to possess the valuable weight-giving property usually associated with oak-tannage.

" Most strongly marked of all is the catechol-tannin tendency, in the case of *Quercus fenestrata* bole-wood which indeed seems to contain at least a very large *preponderance* of tannin of the catechol class. On the other hand the wood of *Quercus Griffithii* is the one which most closely resembles English oak wood and seems to contain almost entirely *pyrogallol tannin*. It, however, does not by itself seem to be giving nearly as good-coloured a leather as the pinky-buff of the *Quercus Lindleyana*. As for its weight-giving properties I am, at the moment, unable to quote them as the tanning experiment with *Quercus Griffithii* is not yet completed. It may be mentioned, in passing, that *Quercus spicata* wood, which appears to contain equally pyrogallol and catechol-tannins, has in my small tests given the best weight so far obtained from these woods.

" It is unfortunate that, owing to the objectionable harsh leathers obtained from a number of tan-stuffs including for instance many mangroves, any tendency towards redness of even good leather is apt to be objected to by European tanners. The pink-buffs however produced by these local oaks are no worse than that which has proved acceptable in the case of the well-known and much used quebracho wood and the leather appears to have the superiority usually associated with oak. In any case a slight treatment with the local galls of *Quercus serrata* appears successfully to eliminate the pink colour and it would be open to the manufacturer, as I have stated earlier in this paper, to admix a small quantity of the galls into his Burma oak extract if he thought well. An alternative would be to prepare and sell a certain quantity of a separate galls-extract along with the oak wood extract, for use in small preparations, at the end of the tanning process.

“ *Comparison with some Indian oaks:—*

“ *Quercus incana* bole-wood (sample from the Inspector-General of Forests, Simla,) gave a theoretical yield of 8·7% of ‘crystal’ extract, with a theoretical-maximum-possible percentage of tannin of 50%. The tan is somewhat on the red side. The bark of the same species showed a yield of 20%, with a maximum possible percentage of tannin therein of 64%. This bark gave nearly as good a result as the bark of the local Maymyo chestnut *Castanopsis tribuloides* and better than any of the local Burma oak barks so far examined.

“Oaks from the Darjeeling neighbourhood showed, as a rule, comparatively low possible percentages of tannin in the bark extract although there was one notable exception, that being the Himalayan Oak *Quercus fenestrata*, whose bark gave a 25% yield of 62% crystals (calculated theoretical figures). I have obtained no such result from the local *Quercus fenestrata*, but I do not believe that the two species are entirely identical; and in any case locality is always likely to prove an important factor and the Darjeeling trees grow at an elevation of about double that of Maymyo. There is a similar difference, but in favour of Burma, in the case of *Castanopsis tribuloides* wood.”

CHAPTER VIII.

FOREST PUBLICATIONS.

Although this branch is not yet organised it forms an integral part of a research institute.

For reasons given elsewhere in this report the output of literary effort, memoirs, records, bulletins and leaflets of the central Institute, which alone are dealt with in this chapter, was much less than usual.

The following publications were either issued during the year or are in the Press :—

Serial No.	Name of publication.	Author.	Branch of research.
FOREST RECORDS.			
<i>Issued.</i>			
1.	Note on <i>Hopea canarensis</i> , Hole ...	R. S. Hole ...	Botany.
2.	Note on <i>Ixora Butterwickii</i> , Hole ...	Do. ...	Do.
3.	Notes on the Larvæ and Life-histories of Prionine Beetles. Coleoptera, Cerambycidae, Prionine.	C. F. C. Beeson...	Zoology.
4.	The Life History of the Toon Shoot and Fruit Borer, <i>Hypsipyla robusta</i> , with suggestions for its control.	Do. ...	Do.
5.	Note on the Mechanical Strength and Seasoning Properties of <i>Shorea robusta</i> timber.	R. S. Pearson ...	Economy.
<i>In Press.</i>			
6.	Note on Afforestation of Ravine Lands in the Etawah District, United Provinces.	E. A. Smythies ...	Silviculture.
7.	Note on the Bee Hole Borer of Teak ...	C. F. C. Beeson ..	Zoology.
8.	Note on Lac and Shellac ...	H. A. F. Lindsay and C. M. Harlow.	Economy.
9.	Note on the Regeneration of Sal Forests	R. S. Hole ...	Botany.
FOREST BULLETINS.			
<i>Issued.</i>			
10.	The Construction of Calcareous Opercula by longicorn Larvæ of the Group Cerambycini (Coleoptera, Cerambycidae).	C. F. C. Beeson...	Zoology.
11.	Note on Hollong Timber <i>Dipterocarpus pilosus</i> , Roxb.	R. S. Pearson ...	Economy.
<i>In Press.</i>			
12.	Note on Pynima, Ajbar or Jarul Wood (<i>Lagerstrœmia Flos-Reginæ</i> , Retz.)	Do. ...	Do.
13.	Note on Weights of Seeds ...	S. H. Howard ...	Silviculture.
14.	Note on <i>Adina cordifolia</i> ...	C. E. C. Cox ...	Economy.
15.	Note on <i>Odina Wodier</i> ...	Do. ...	Do.
16.	Note on <i>Bombax malabaricum</i> ...	Do. ...	Do.

APPENDIX I.

ADMINISTRATION REPORT OF THE FOREST RESEARCH INSTITUTE,
DEHRA DUN, FOR THE YEAR 1919-1920.

Administration.—The post of Conservator of Forests which was held by the President of this Institute was converted into one of Chief Conservator with effect from 1st March 1920.

Mr. W. F. Perrée, C.I.E., held this post from 1st July 1919 to 17th April 1920 and the writer of this report from 23rd April 1920 to the end of the year while Mr. J. E. Macpherson, Personal Assistant, held charge of the current duties in the *interim*.

The names of the officers who held charge of the various branches are given below :—

Branch of Forest Research Institute.	MONTH AND DATE.		Name of officer in charge of branch.
	From	To	
Silviculture ...	1st July 1919...	20th October 1919.	Mr. W. F. Perrée, C.I.E., Conservator of Forests and President, Forest Research Institute and College.
	21st October 1919.	30th June 1920	
Forest Botany ...	1st July 1919...	25th November 1919.	Mr. S. H. Howard, B.A., Deputy Conservator of Forests United Provinces. Mr. C. F. C. Beeson, M.A., Deputy Conservator of Forests, (Punjab) and Forest Zoologist.
	26th November 1919.	30th June 1920	
Forest Economy	1st July 1919...	26th August 1919.	Mr. S. H. Howard, B.A., Deputy Conservator of Forests, United Provinces. Mr. R. S. Pearson, F.L.S., Deputy Conservator of Forests, (Bombay). Mr. C. E. C. Cox, Deputy Conservator of Forests, Central Provinces.
	27th August 1919.	6th November 1919.	
	7th November 1919.	11th March 1920	
	12th March 1920	30th June 1920	
Forest Zoology...	1st July 1919...	25th November 1919.	Mr. A. J. Gibson, F.L.S., F.C.H., Deputy Conservator of Forests, (Punjab). Mr. C. E. C. Cox, Deputy Conservator of Forests, Central Provinces. Mr. C. F. C. Beeson, M.A., Deputy Conservator of Forests (Punjab).
	26th November 1919.	6th February 1920.	
	7th February 1920.	30th June 1920	
Forest Chemistry	1st July 1919 ...	14th November 1919.	Mr. J. E. Macpherson, Personal Assistant to President, Forest Research Institute and College. Mr. F. M. Howlett, Imperial Pathological Entomologist of Pusa. Dr. J. L. Simonsen, D.Sc., F.I.C. Mr. A. J. Gibson, F.L.S., F.C.H., Officiating Conservator of Forests (Punjab).
	15th November 1919.	7th March 1920	
	8th March 1920	30th June 1920	

Establishment.—The absence of Mr. R. S. Hole (Forest Botanist) throughout the year, and of Messrs. R. S. Pearson (Forest Economist), C. F. C. Beeson (Forest Zoologist) and of Dr. J. L. Simonsen (Forest Chemist) during parts of the year was the cause of these numerous changes and necessitated the President and certain of the Research Officers holding charge of other offices in addition to their own. With the return of the heads of branches from leave the position will improve in 1920-21 and the work of all the branches be in full swing by the end of it.

The post of Personal Assistant to the President was created during the year and Mr. J. E. Macpherson, on relief from military service, was appointed Personal Assistant with effect from the 16th October 1919.

Under the new reorganisation, five members of the Institute who as assistants in various branches have done some years of honourable work, were given gazetted rank, the promotion dating from 1st March 1920. Messrs. B. L. Gupta, Abdul Hafiz Khan (Botany), Gurdit Singh (Silviculture) and Nivaran Chandra Chatterjee (Zoology), were put in the new grade of Rs. 250—20—550 and Mr. Tarak Prashad Ghose (Chemistry) in the grade of Rs. 210—10—400.

Sanction to the revision of the major portion of the clerical and the menial service was received during the year, but in consequence of the continued high costs of living and the rise in salaries which have recently been granted to corresponding establishments in the Punjab and the United Provinces the question of further increase of pay of the clerical, subordinate and menial establishments is under consideration.

Buildings.—No new work was undertaken during the year but existing buildings were kept in repair. Much time was spent by the senior officers of the Institute in considering the acquisition of the new site, the lay out and, in a few cases, the plans of buildings for the new Research Institute.

Fittings and Furniture.—Little expenditure on this head was incurred during the year except that the equipment of the chemical laboratory has been improved very considerably. The students of the Provincial Forest Service and Ranger classes are at present badly equipped for the practical study of Chemistry, Physics and Engineering.

Research Offices.—The standard of work in all the offices was well maintained. Work tends to grow, especially in the President's office, and with the large amount of organising work looming ahead, particularly in the Economic branch, some increase of clerical staff appears inevitable. As regards the President's office the situation will be clearer if, as is hoped, the Ranger classes and College are handed over to the United Provinces on 1st April 1921.

Grounds.—The labelling of the trees and shrubs in the Forest Park and College grounds requires and is receiving attention.

Library.—Further additions have been made to the central as well as to sectional libraries. Steps are being taken to provide the Chemical Branch with an up-to-date library. The number of books and periodicals on the registers of all the libraries on 30th June last stood at 6,848 and 7,764 respectively.

Work of Officers.—In spite of the temporary paucity of staff all the officers on duty, both the heads of branches and their assistants, have done their very best to keep up the standard of work and to give all the assistance which was asked in lecturing to and even taking charge of classes of students. Mr. C. E. C. Cox severed his long connection with the Institute and took back to the Central Provinces the good-wishes of his fellow-workers. Messrs. Pearson and Beeson spent much of their time out of India in furthering the work of their branches, namely in purchasing plant and improving the connection of this Institute with other similar bodies and with experts and specialists in Europe and America. The importance of such connection and co-operation cannot be over-estimated.

APPENDIX II.

FINANCIAL.

The expenditure of the past two years is compared below:—

		Expenditure during the year.		Difference + or —
		1918-19.	1919-20.	
AVI.	Stores, Tools and Plant	Rs. 5,081	Rs. 8,328	Rs. +3,247
AVII.	Buildings, etc.	3,163	3,820	+657
AIX.	Miscellaneous	13,677	35,972	+22,295
BIa.	Conservators	11,307	18,996	+7,689
BIb.	Superior Officers	71,757	58,866	-12,891
BIc.	Subordinate Forest and Depôt Establish- ment.	13,776	12,736	-1,040
BI d.	Office Establishment	28,781	32,518	+3,737
BIe.	Deputation and special allowances	13,802	9,524	-4,278
BIf.	Compensation for dearness of provisions	1,640	1,606	-34
BII.	Travelling allowances	15,522	16,558	+1,036
BIII.	Contingencies	11,555	17,346	+5,791
Total		1,90,061	2,16,270	+26,209

The increase under AVI is due to the purchase of machinery for the Economic Branch.

The increase under AVII is due to high rates being paid for labour.

The increase under AIX is mainly due to the cost of the illustrations of Mr. Leete's report on Lumbering and Wood Working Industries of the United States of America and Canada being charged to this head and in a less degree to the purchase of more chemicals for the Forest Chemist and to a larger expenditure having been incurred on experiments by the Forest Economist and Tannin Expert and as well as to the entertainment of a surveyor on daily labour for survey of the new Research Institute site.

The increase under BIa is due to the elevation of the President's post to that of a Chief Conservator of Forests and to the appointment of Mr. A. J. Gibson, officiating Forest Economist as officiating Conservator of Forests.

The decrease under BIb is due to the absence on leave of Messrs. R. S. Hole and C. F. C. Beeson and to no other officers having been appointed from outside to fill their places.

The increase under BId is due to the reorganisation of the Clerical, Miscellaneous and Menial Establishments having been brought into force with effect from 15th July 1919.

The decrease under BIe is due to the departure of Messrs Hole and Beeson on leave and to no retaining fee having been paid to Mr. W. Raitt, Paper Pulp Expert.

The increase under BII is due to extensive tours having been undertaken by the President and the Silviculturist.

The increase under BIII is due to the purchase of a large number of books for the Forest Chemist and to the binding of more books than usual.

APPENDIX III.

List of Forest Publications issued since the creation of
the Forest Research Institute.

I.—BULLETINS (OLD SERIES).		PRICE (exclusive of packing, postage, etc.) Rs. a. p.
1.—Note on the Bee-Hole Borer of Teak in Burma, by E. P. Stebbing. (<i>Out of print</i>)	... ..	0 4 0
2.—Note on the Quetta Borer (<i>Aeolesthes sartus</i>), by the same author. (<i>Out of print</i>)	... ..	0 8 0
3.—Note on the Chilgoza (<i>Pinus Gerardiana</i>) Bark-Boring Beetles of Zhob, Baluchistan, by the same author. (<i>Out of print</i>)	... ..	0 8 0
4.— <i>Ficus elastica</i> : its natural growth and artificial propagation, with a description of the method of tapping the tree and of the preparation of its rubber for the market, by E. M. Coventry	... ..	0 12 0
5.—Notes on a Visit to some European Schools of Forestry, by E. P. Stebbing	... ..	2 0 0
6.—Memorandum on Mechanical Tests of some Indian Timbers, by W. H. Everett	... ..	0 2 0
7.—Note on the Chilgoza Forests of Zhob and the Takht-i-Suliman, by E. P. Stebbing (<i>Out of print</i>)	... ..	0 12 0
8.—Note on the Life-History of <i>Hoplocerambyx spinicornis</i> (The Singbhum Sal Borer), by the same author	... ..	0 9 0
9.—Note on the Influence of Forests on the Storage and Regulation of the Water-Supply, by S. Eardley-Wilmot	... ..	1 0 0
10.—Note on the Duki Fig-Tree Borer of Baluchistan (<i>Batocera rubus</i>), by E. P. Stebbing	... ..	0 7 0
11.—On Some Assam Sal (<i>Shorea robusta</i>) Insect Pests, by the same author	... ..	1 10 0
II.—LEAFLETS.		
1.—The Sal Bark-Borer (<i>Sphaerotrypes sivalikensis</i> , Steb.), by E. P. Stebbing. (<i>Out of print</i>)	... ..	0 4 0
2.—The Teak Defoliator (<i>Hyblaea puera</i> , Cram.), by the same author. (<i>Out of print</i>)	... ..	0 2 0
3.—The Teak Leaf Skeletoniser (<i>Pyrausta macharalis</i> , Wlk.), by the same author. (<i>Out of print</i>)	... ..	0 2 0
4.—The Larger Deodar Bark-Borer (<i>Scolytus major</i> , Steb.), by the same author. (<i>Out of print</i>)	... ..	0 4 0
5.—The Blue Pine "Polygraphus" Bark-Borer (<i>Polygraphus major</i> , Steb.), by the same author. (<i>Out of print</i>)	... ..	0 3 0

III.—PAMPHLETS.

	PRICE (exclusive of packing, postage, etc.) Rs. a. p.
1.—Note on Utilization of Khair Forests in Eastern Beogal and Assam, by Puran Singh. (<i>Out of print</i>)	0 4 0
2.—The Attack of the Bark-Boring Beetle in the Coniferous Forests in Simla Catchment Area, by E. P. Stebbing	0 8 0
3.—A Glossary of Forest Technical Terms for Use in Indian Forestry, by A. M. F. Caccia. (<i>Revised and issued as Bulletin No 4, New Series</i>) (<i>Out of print</i>)	0 4 0
4.—Note on Lac and Lac Cultivation, by D. N. Avasia	0 2 0
5.—Notes on Sal in Beogal, by A. L. McIntire. (<i>Out of print</i>)... ..	0 4 0
6.—Note on Forest Reservation in Burma in the Interests of an Endangered Water-Supply, by A. Rodger	1 0 0
7.—Note on Andaman Marble Wood or Zebra Wood (<i>Diospyros Kursii</i> , Hiern.), by R. S. Troup	0 4 0
8.—Note on the Collection of Statistical Data relating to the Principal Indian Species, by A. M. F. Caccia	0 10 0
9.—Tables showing the Progress in Working-Plans in the Provinces outside the Madras and Bombay Presidencies up to 31st December 1908, by the same author	0 10 0
10.—Note on Burmese Leza Wood (<i>Lagerstrœmia tomentosa</i> , Presl.), by R. S. Troup	0 2 0
11.—Note on Carallia Wood (<i>Carallia integerrima</i> , DC.), by the same author	0 2 6
12.—Note on Petwun or Trincomali Wood (<i>Berrya Ammonilla</i> , Roxb.), by the same author	0 4 0
13.—Note on Burmese In Wood (<i>Dipterocarpus tuberculatus</i> , Roxb.), by the same author	1 0 0
14.—Note on Burma Padouk (<i>Pterocarpus macrocarpus</i> , Kurz.), by the same author	1 0 0
15.—Note on the Preservation of Bamboos from the Attacks of the Bamboo Beetle or "Shot-Borer," by E. P. Stebbing	0 7 0
16.—Note on the Best Season for Coppice Fellings of Teak (<i>Tectona grandis</i>), by R. S. Hole	0 4 0

IV.—BULLETINS (NEW SERIES).

1.—Note on Calorimetric Tests of Some Indian Woods, by Puran Singh	0 2 0
2.—Memorandum on Teak Plantations in Burma, by F. A. Leete	0 10 0
3.—Note on the Relative Strength of Natural and Plantation-Grown Teak in Burma, by R. S. Pearson	0 4 0
4.—Second Edition of the Glossary of Technical Terms for Use in Indian Forestry, by A. M. F. Caccia, revised by R. S. Troup	0 6 0
5.—The Blue Pine Tomicus Bark-Borer (<i>Tomicus Ribbentropfi</i>), by E. P. Stebbing	0 2 0
6.—Memorandum on the Oil-Value of Sandalwood, by Puran Singh	0 2 0
7.—Note on the Chemistry and Trade Forms of Lac, by the same author	0 3 0
8.—Note on some Germination Tests with Sal Seed (<i>Shorea robusta</i>), by R. S. Troup	0 2 0

IV.—BULLETINS (NEW SERIES)—(contd.).

PRICE
(exclusive of
packing
postage,
Rs. a. p.

9.—Note on Resin Value of <i>Podophyllum Emodi</i> and the best season for collecting it, by Puran Singh	0 1 3
10.—Note on the Bark-Boring Beetle Attack in the Coniferous Forests of the Simla Catchment Area, 1907—1911, by R. S. Hole...	0 3 0
11.—A Further Note on some Casuarina Insect Pests of Madras, by V. Subramania Iyer	0 14 0
12.—Note on the Bark-Eating and Root-Boring Beetles of Babul (<i>Acacia arabica</i>), by E. P. Stebbing	0 4 0
13.—Note on <i>Ligno Protector</i> as a possible means of preventing timber from splitting while seasoning, by R. S. Pearson	0 5 0
14.—A Further Note on the Relative Strength of Natural and Plantation-Grown Teak in Burma, by the same author	0 3 0
15.—Note on the Technical Properties of Timber with special reference to <i>Cedrela Toona</i> wood while seasoning, by the same author	0 3 0
16.—Note on Gumbar (<i>Gmelina arborea</i> , Roxb.), by A. Rodger	0 3 0
17.—Note on Bija Saf or Vengai (<i>Pterocarpus Marsupium</i> , Roxb.), by the same author	0 4 0
18.—Note on Sain or Saj (<i>Terminalia tomentosa</i> , W. and A.), by the same author	0 5 0
19.—Note on Benteak or Nana Wood (<i>Lagerstræmia lanceolata</i> , Wall.), by the same author	0 3 0
20.—Note on Sandan (<i>Ougeinia dalbergioides</i> , Benth.), by the same author	0 3 0
21.—Note on Dhaura or Bakli (<i>Anogeissus latifolia</i> , Wall.), by the same author	0 4 0
22.—Note on the Causes and Effects of the Drought of 1907 and 1908 on the Saf Forests of the United Provinces, by R. S. Troup	0 5 0
23.—Note on the Preparation of Indian Forest Floras and Descriptive Lists, by R. S. Hole	0 4 0
24.—Note on Turpentine of <i>Pinus Khasya</i> , <i>Pinus Merkusii</i> and <i>Pinus excelsa</i> , by Puran Singh	0 2 0
25.—Development of the Culms of Grasses, by R. S. Hole	0 2 0
26.—Note on the Resin Industry in Kumaun, by E. A. Smythies... ..	1 4 0
27.—Note on Blackwood (<i>Dalbergia latifolia</i> , Roxb.), by E. Benskin	0 4 0
28.—Note on Dhauri (<i>Lagerstræmia parviflora</i> , Roxb.), by the same author	0 4 0
29.—Note on Sundri Timber (<i>Heritiera minor</i> , Lam.), by R. S. Pearson	0 3 0
30.—The Compilation of Girth Increments from Sample Plot Measurements, by R. S. Troup	0 2 0
31.—Note on Indian Sumach (<i>Rhus Cotinus</i> , Linn.), by Puran Singh	0 2 0
32.—Note on the Burma Myrabolans or "Panga fruits" as a Tanning Material, by Puran Singh	0 1 0
33.—Note on an Enquiry by the Government of India into the Relation between Forests and Atmospheric and Soil Moisture in India, by M. Hill	1 0 0
34.—Note on Red Sanders (<i>Pterocarpus santalinus</i> , Linn. f.), by T. A. Whitehead	0 9 0
35.—Note on Babul (<i>Acacia arabica</i> , Willd.), by J. D. Maitland-Kirwan	0 5 0
36.—Note on Kokan or Lampatia Timber (<i>Duabanga sonneratioides</i> , Ham.), by R. S. Pearson	0 3 0

IV.—BULLETINS (NEW SERIES)—(contd.).		Price
		(exclusive of packing, postage, etc.)
		Rs. a. p.
37.—	Note on the Contraction and Warping which takes place in <i>Pinus longifolia</i> timber while seasoning, by the same author ...	0 11 0
38.—	The Construction of Calcarous Opercula by Longicorn Larvæ of the Group <i>Cerambycini</i> (Coleoptera, Cerambycidae), by C. F. C. Beeson	0 3 0
39.—	Note on Hollong Timber (<i>Dipterocarpus pilosus</i> , Roxb.), by R. S. Pearson ...	0 4 0

V.—FOREST RECORDS.

Vol I, Part	I.—A Note on the Lac Insect (<i>Tachardia lacca</i>), its Life-History, Propagation and Collection, by E. P. Stebbing. (<i>Out of print</i>)	1 4 0
„ Part	II.—A Preliminary Note on the Development of the Sat in Volume and in Money Value, by A. M. F. Caccia. (<i>Out of print</i>)	1 4 0
„ Part	III.—1. <i>Pterocarpus dalbergioides</i> , Roxb. Andaman Padouk, by B. B. Osmaston	1 4 0
„	2. A Further Note on the Chilgoza Bark-Boring-Beetles of Zhob, by E. P. Stebbing and Captain E. H. S. James	
„	3. A Note on the Present Position and Future Prospects of the Cutch Trade in Burma, by R. S. Troup	
„	4. Note on the Manufacture of Ngai Camphor, by Puran Singh. (<i>Out of print</i>)	
„ Part	IV.—1. A Chemical Investigation of the Constituents of Burmese Varnish (<i>Melanorrhæa usitata</i> , Sap.), by Puran Singh	1 4 0
„	2. The Selection System in Indian Forests as exemplified in Working Plans based on this system with a short description of some Continental Methods, by A. M. F. Caccia	
Vol. II, Part	I.—Note on some Insect Pests of the Himalayan Oaks (<i>Quercus dilatata</i> and <i>Q. incana</i>), by E. P. Stebbing. (<i>Out of print</i>)	0 6 0
„ Part	II.—Note on the Fissibility of Some Indian Woods, by R. S. Troup. (<i>Out of print</i>)	1 6 0
„ Part	III.—1. Monograph on the Sylviculture of <i>Hardwickia binata</i> (Anjan), by D. O. Witt	3 4 0
„	2. Notes on Sandal (Germination and Growth of Sandal Seedlings) by M. Rama Rao	
„ Part	IV.—Note on Host Plants of the Sandal Tree, by the same author	2 0 0
Vol. III, Part	I.—Note on some Statistical and other Information regarding the Teak Forests of Burma, by R. S. Troup	2 12 0
„ Part	II.—Preliminary Note on the Antiseptic Treatment of Timber in India with special reference to Railway Sleepers, by R. S. Pearson	0 14 0
„ Part	III.—Report on the Investigation of Bamboos as Material for Production of Paper-pulp, by W. Raitt	0 6 0

V.—FOREST RECORDS—(contd.).		PRICE
		(exclusive of packing, postage, etc.)
		Rs. a. p.
Vol. III, Part IV.—Note on the Preparation of Tannin Extracts with special reference to those prepared from the Bark of Mangrove (<i>Rhizophora mucronata</i>), by Puran Singh ...		0 7 0
Vol. IV, Part I.—Note on the Distillation and Composition of Turpentine Oil from the Chir Resin and the Clarification of Indian Rosin, by the same author ...		0 9 0
„ Part II.—Note on some new and other Species of Hymenoptera in the collections of the Zoological Branch of the Forest Research Institute, Dehra Dun, by P. Cameron ...		0 4 0
„ Part III.—Note on Useful Exotics in Indian Forests (No. 1 <i>Prosopis juliflora</i> , DC.), by R. S. Hole ...		0 4 0
„ Part IV.—Note on <i>Albizzia Lathamii</i> , by the same author ...		0 3 0
„ Part V.—Note on the Utilization of Bamboo for the Manufacture of Paper-pulp, by R. S. Pearson (2nd Edition) ...		2 0 0
Vol. V, Part I.—Note on the Tea-box Industry in Assam, by the same author ...		0 4 0
„ Part II.—Note on Blue Gum Plantations of the Nilgiris (<i>Eucalyptus Globulus</i>), by R. S. Troup ...		1 6 0
„ Part III.—Report on the Investigation of Savannah Grasses as Material for Production of Paper-pulp, by W. Raitt. (Out of print) ...		0 4 0
„ Part IV.—1. Note on Ecology of Sal (<i>Shorea robusta</i>), Part I, Soil-composition, Soil-moisture, Soil-aeration, by R. S. Hole ...		0 8 0
„ „ 2. Note on Ecology of Sal (<i>Shorea robusta</i>), Part II, Seedling Reproduction in Natural Forests and its Improvement, by the same author ...		1 1 0
„ „ 3. Note on Ecology of Sal (<i>Shorea robusta</i>), Part III, Soil-aeration and Water-cultures, by the same author ...		0 8 0
„ Part V.—Note on <i>Trametes Fini</i> , by the same author ...		1 0 0
„ Part VI.—Note on a New Species of Forest Grass (<i>Spodiopogon Laceyi</i> , Hole), by the same author ...		0 8 0
„ Part VII.—Note on the Economic Uses of Roshia Grass (<i>Cymbopogon Martini</i> , Stapf.), by R. S. Pearson (Out of print) and ...		1 8 0
„ „ Note on the Constants of Indian Geranium Oil (Motia), by Puran Singh. (Out of print) ...		...
„ Part VIII.—1. Note on the Eucalyptus Oil Industry in the Nilgiris ...		...
„ „ 2. Note on the Distillation of Geranium oil in the Nilgiris ...		...
„ „ 3. Note on the Manufacture of Wintergreen Oil in India ...		...
	By Puran Singh.	1 0 0
Vol. VI, Part I.—The Life History of <i>Diapus furivorus</i> , Sampson, by C. F. C. Beeson ...		0 10 0
„ Part II.—Statistics compiled in the Office of the Sylviculturist, Forest Research Institute, Dehra Dun, during 1915-16 ...		1 6 0

V.—FOREST RECORDS—(cont'd.).

Price
(exclusive of
packing,
postage, etc)

Rs. a. p.

Vol. VI, Part III.—A Note on Thitsi (<i>Melanorrhæa usitata</i> , Wall.), with special reference to the Oleo-resin obtained from it, by E. Benskin and A. Rodger... ..	1	2	0
„ Part IV.—A Further Note on the Antiseptic Treatment of Timber, recording results obtained from past experiments, by R. S. Pearson	3	0	0
„ Part V.—Statistics compiled in the Office of the Sylviculturist, Forest Research Institute, Dehra Duu, during 1916-17	0	10	0
„ Part VI.—Note on Preparation of Turpentine, Rosin and Gum, from <i>Boswellia serrata</i> (Roxb.) gum-oleo-resin, by R. S. Pearson and Puran Singh	0	13	0
Vol. VII, Part I.—Preliminary Note on the Seasoning of some Indian Timbers by Natural Methods, by R. S. Pearson... ..	1	0	0
„ Part II.—A Further Note on Thitsi (<i>Melanorrhæa usitata</i> , Wall.), with special reference to the oleo-resin obtained from it in the Lawksawk and Myelat States, Southern Shan States, Forest Division, by F. A. Wright	0	4	0
„ Part III.—Note on <i>Hopea canurensis</i> , Hole, by R. S. Hole	0	3	0
„ Part IV.—Note on <i>Ixora Butterwickii</i> , Hole, by the same author	0	3	0
Vol. VII, Part V.—Notes on the Larvæ and Life-Histories of Prionine Beetles, Coleoptera, Cerambycidæ, Prionine, by C. F. C. Beeson	0	8	0
„ Part VI.—Note on the Mechanical Strength and Seasoning Properties of <i>Shorea robusta</i> (Sal Timber), by R. S. Pearson	0	8	0
„ Part VII.—The Life History of the Toon Shoot and Fruit Borer, <i>Hypsipyla robusta</i> , Moore, (<i>Lepidoptera</i> ; <i>Pyralidæ</i> ; <i>Phycitina</i> with suggestions for its control, by C. F. C. Beeson	2	4	0

VI.—MEMOIRS.

Note on the Analysis of Cutch and the Preparation of Pure Catechin, Vol. I, Part I, Chemistry Series, by Puran Singh. (<i>Out of print</i>)	1	4	0
Note on the Manufacture of Pure Shellac, Vol. I, Part II, Chemistry Series, by the same author. (<i>Out of print</i>)	0	8	0
On some Undescribed Scolytidæ of Economic Importance from the Indian Region I, Vol. I, Part I, Zoology Series, by E. P. Stebbing	0	4	0
On some Undescribed Scolytidæ of Economic Importance from the Indian Region II, Vol. I, Part II, Zoology Series, by the same author. (<i>Out of print</i>)	0	4	0
Indian Woods and their Uses, Vol. I, Part I, Economy Series, by R. S. Troup	2	12	0
Note on the Prospects of the Match Industry in the Indian Empire, Vol. II, Part I, Economy Series, by the same author	1	10	0
Second Edition of the Monograph on "Lac Insect" (<i>Tachardia lacca</i>), Vol. I, Part III, Zoology Series, by E. P. Stebbing	1	0	0
Note on some Important Insect Pests of the Himalayan Coniferæ (Treating of Deodar), Vol. II, Part I, Zoology Series, by E. P. Stebbing. (<i>Out of print</i>)	4	10	0
Note on the Insect Pests of the Chir Pine (<i>Pinus longifolia</i>), Vol. II, Part II, Zoology Series, by the same author	1	14	0

VI.—MEMOIRS—(contd.).

	PRICE (exclusive of packing, postage, etc.)
	Rs. a. p.
Memoir on some Indian Forest Grasses and their Ecology, by R. S. Hole	5 8 0
Note on the Life-History of <i>Chermus Himalayensis</i> , Steb., on the Spruce (<i>Picea Morinda</i>) and Silver Fir (<i>Abies Webbiana</i>), Vol. II, Part III, Zoology Series, by E. P. Stebbing. (Out of print)	1 12 0
Note on the Economic Value of <i>Shorea robusta</i> (Sal), Vol. II, Part II, Economy Series, by R. S. Pearson	1 12 0
On the Structure and Biology of <i>Tachardia lacca</i> , Kerr, with observations on certain insects predaceous or parasitic upon it, Vol. III, Part I, Zoology Series, by A. D. Imms and N. C. Chatterjee	2 2 0
<i>Pinus longifolia</i> , Roxb., Vol. I, Part I, Sylviculture Series, by R. S. Troup	5 0 0

VII.—MANUALS.

Forest Zoology Manual, by E. P. Stebbing. (Out of print)	*10 0 0
Manual of Botany, by R. S. Hole. (Out of print)	3 8 0
Indian Forest Utilization (Second Edition), by R. S. Troup. (Out of print)	2 12 0
Explanatory Notes on Forest Law (a new Edition of the Forest Law Manual). (Out of print)	1 2 0
Preparation of Forest Working-Plans in India, by W. E. D'Arcy. Revised by A. M. F. Caccia. (Fourth Edition)	0 14 0
Second Edition of Manual of Sylviculture. (Out of print)	1 0 0
Manual of Forest Mensuration, by R. S. Troup. (Out of print)	1 4 0
Surveying and Drawing Manual, by F. A. Brining and D. N. Avasia. (Out of print)	3 12 0

VIII.—OTHER PUBLICATIONS.

† Index to the <i>Indian Forester</i> , Vols. I to XXX, by E. P. Stebbing	1 0 0
† The Utilization of Bamboo for the Manufacture of Paper Pulp, by R. S. Pearson. Reprinted from "The Indian Forester," 1920	0 8 0
Practical Determination of the Girth Increment of Trees, by R. S. Troup. (Out of print)	0 4 0
Forest Flora of Chhota Nagpur, by H. H. Haines (Out of print)	9 0 0
Translation of M. Jacquot's "Incendies en Forêt," by C. E. C. Fischer. (Out of print)	0 14 0
Forest Flora of the Siwalik and Jaunsar Forest Division, U. P. (Revised edition, by U. N. Kanjilal. (Out of print)	1 14 0
Commercial Guide to the Economic Forest Products of India, by R. S. Pearson	1 0 0
Catalogue of the Photographic Collection at the Forest Research Institute, Dehra Dun	1 4 0
Forest Research Institute and College Calendar, 1916	0 14 0
Progress Report of the Forest Research Institute for the year 1918-19	0 9 0

* N.B.—Rupees 5 for Officers below Extra Deputy Conservators.

† Obtainable from the Manager, Pioneer Press, Allahabad.

VIII.—OTHER PUBLICATIONS—(contd.).

PRICE
(exclusive of
packing,
postage, etc.)
Rs. a. p.

Progress Report of the Imperial Forest College, Dehra Dun, for the year 1918-19	1	6	0
Note on the Forests of Java and Madoera of the Dutch East Indies, by R. C. Milward	0	13	0
A Note on some European Sylvicultural Systems, with Suggestions for Improvements in Indian Forest Management, by R. S. Troup. (<i>Out of print</i>)	3	4	0
Note entitled "Among the Eucalypts," by R. C. Milward	3	4	0
The Work of the Forest Department in India, by R. S. Troup	0	4	0

Progress Report of Forest Research Work in India

For the Year 1920-21

(July 1st, 1920—March 31st, 1921)

Including the Administration Report of the
Forest Research Institute, Dehra Dun



CALCUTTA
SUPERINTENDENT GOVERNMENT PRINTING, INDIA
1922

Price, Rs. 2.

Agents for the Sale of Books Published by the Superintendent of Government Printing, India, Calcutta.

IN EUROPE.

Constable & Co., 10, Orange Street, Leicester Square, London, W.C.
Kegan Paul, Trench, Trübner & Co., 68-74, Carter Lane, E.C., and 39, New Oxford Street, London, W.C.
Bernard Quaritch, 11, Grafton Street, New Bond Street, London, W.
F. S. King & Sons, 2 & 4, Great Smith Street, Westminster, London, S.W.
H. S. King & Co., 65, Cornhill, E.C., and 9, Pall Mall, London, W.
Grindley & Co., 64, Parliament Street, London, E.W.

Luzac & Co., 46, Great Russell Street, London, W.C.
W. Thacker & Co., 2, Creed Lane, London, E.C.
T. Fisher Unwin, Ltd., 1, Adelphi Terrace, London, W.C.
Wheldon & Wesley, Ltd., 23, Essex Street, London, W.C.
B. H. Blackwell, 50 & 51, Broad Street, Oxford.
Deighton Bell & Co., Ltd., Cambridge.
Oliver and Boyd, Tweeddale Court, Edinburgh.
E. Pousonby, Ltd., 116, Grafton Street, Dublin.
Ernest Leroux, 28, Rue Bonaparte, Paris.
Martinus Nijhoff, The Hague, Holland.

ON THE CONTINENT.

Otto Harrassowitz, Leipzig.
Friedländer & Sohn, Berlin.

IN INDIA AND CEYLON.

Thacker, Spink & Co., Calcutta and Simla.
Newman & Co., Calcutta.
B. Cambray & Co., Calcutta.
S. K. Lahiri & Co., Calcutta.
B. Banerjee & Co., Calcutta.
The Indian School Supply Depot, 309, Bow Bazar Street, Calcutta, and 228, Nawabpur, Dacca.
Butterworth & Co. (India), Ltd., Calcutta.
Bai M. C. Sarcar Bahadur & Sons, 90-2-A, Harrison Road, Calcutta.
The Weldon Library, 57, Park Street, West, Calcutta.
Standard Literature Company, Limited, Calcutta.
Lal Chand & Sons, Calcutta.
The Association Press, Calcutta.
Higginbotham & Co., Madras.
V. Kalpanarama Iyer & Co., Madras.
G. A. Natesan & Co., Madras.
S. Murthy & Co., Madras.
Thompson & Co., Madras.
Temple & Co., Madras.
A. R. Sams Iyer & Co., Madras.
Vas & Co., Madras.
E. M. Gopalakrishna Kona, Madura.
Thacker & Co., Ltd., Bombay.
D. B. Taraporevala, Sons & Co., Bombay.
Mrs Radhabai Anaram Segoon, Bombay.
Sunder Padurang, Bombay.
Sengal Narayan & Co., Bombay.

Ram Chandra Govind & (Son, Kalbadevi, Bombay.
Proprietor, New Kitabkhana, Poona.
The Standard Bookstall, Karachi.
Mangaldas Harkissandas, Surat.
Karnandas Narandas and Sons, Surat.
A. H. Wheeler & Co., Allahabad, Calcutta and Bombay.
N. B. Mathur, Supt., Nazir Kanun-i-Hind Press, Allahabad.
Munshi Seeta Ram, Managing Proprietor Indian Army Book Depot, Juhl, Cawnpore.
Bai Sahib M. Gulab Singh & Sons, Muft-i-Am Press, Lahore and Allahabad.
Bama Krishna & Sons, Lahore.
Supt., American Baptist Mission Press, Rangoon.
Manager, the "Hitavada," Nagpur.
S. C. Talukdar, Proprietor, Students & Co., Cooch Behar.
A. M. & J. Ferguson, Colombo, Ceylon.
Manager, Educational Book Depots, Nagpur and Jubbulpore.*
Manager of the Imperial Book Depot, 63, Chandney Chauk Street, Delhi.*
Manager, "The Agra Medical Hall and Co-operative Association, Ltd." (Successors to A. John & Co., Agra).
Supt., Basel Mission Book and Tract Depository, Mangalore.*
P. Varadachary & Co., Madras.*
Bam Dayal Agarwala, 184, Katra, Allahabad.*
D. C. Anand & Sons, Peshawar.*
Manager, Newal Kishore Press, Lucknow.*
Maung Lu Gals, Proprietor, Law Book Depot, Mandalay.*

*Agents for the sale of Legislative Department publications only.

CONTENTS.

	Page
INTRODUCTION	
CHAPTER	
I.—General	1
II.—Silviculture and Working Plans	2
III.—Forest Botany	39
IV.—Forest Economy	43
V.—Forest Zoology	53
VI.—Forest Chemistry	58
VII.—Forest Publications	61
APPENDICES	65



Photo by H. B. Blunfer.

INTRODUCTION.

In the second year of its existence in this form the report has increased in bulk but its faults have at the same time become more apparent. It is obvious that in future issues the mass of information collected must be arranged according to some system and that parallel investigations in different provinces should be correlated.

It is hoped to find time for the discussion of this question at the Silvicultural and Utilisation Conferences which are being held in the present year and that an arrangement will be come to as to the form to be adopted by Provinces in compiling their reports. As examples of possible arrangements attention is drawn in this issue to the silviculture reports of the United Provinces and Burma.

It is also recognised that in future an index will become a necessity and if possible it will be arranged for in the next report.

It will be noted that owing to the change in the forest year the report covers a period of only nine months, namely, July 1920—March 1921.

It is regretted that in some chapters certain provinces have had to be omitted altogether as their reports were either not received at all or, as in the case of Coorg, were received too late for insertion.

Progress of Forest Research in India 1920-21

CHAPTER I.

GENERAL.

The development of forest research and its organisation in India has progressed considerably in the period under review.

The preliminaries to the enlargement of the Research Institute at Dehra Dun are now well in hand. The land has been acquired for the purpose and it is hoped that building operations will be commenced in a few months.

The first buildings to be undertaken are the workshops for the Economic Branch which will include a sawmill and wood workshop, a timber testing workshop, seasoning kilns and a pulp and paper plant with the necessary offices and store godown. Most of the machinery required is already in India.

The following information is communicated by Burma:—

“The project for the building of a Forest Research Institute at Maymyo is unfortunately not much further advanced now than it was a year ago. Drastic curtailment of the Public Works Department Budget for 1921-22 meant that the project had to be cut out altogether and it still remains to be seen whether anything will be done before the latter part of 1922.

Lack of suitable buildings, bad as it is, does not mean that nothing has been done. Mr. H. R. Blanford, O.B.E., returned from leave at the end of December 1920, and was gazetted as provincial Silviculturist. Mr. Blanford's report speaks volumes for his grasp of and enthusiasm for his subject.

It is very much to be regretted that the year has closed without a special officer being appointed to study the bee-hole borer. This pest is far and away the most serious one that has hitherto come to notice either in India or Burma.

Plans for the experimental workshop and laboratory at Rangoon are gradually being evolved. The dry kilns are under construction.”

CHAPTER II.

SILVICULTURE AND WORKING PLANS.

Central Institute.

During the year no new sample plots have been laid out by the Central Institute but 34 plots have been remeasured and 17 experimental plots visited. There was a large amount of remeasurement due but as the greater part of this was taken over by the United Provinces Silviculturist it left the Central Silviculturist free to visit various provinces and assist in the formulation of their future research policies.

The Silviculturist spent 102 days on tour, visiting Kurseong, Darjeeling, and the Sundarbans in Bengal; Haldwani and Dehra Dun Forests in the United Provinces; and various parts of Burma. The principal work has been the discussion of the future research policies for these provinces with explanations of the Dehra system of recording results and compiling statistics, which it is difficult if not impossible to explain by correspondence. This has been the most important and it is hoped the most productive work during the year.

In accordance with the decentralisation policy 119 sample plots have been handed over to provincial silviculturists, with complete copies of results to date—the originals being retained at the Central Institute. These comprise 40 plots to Bengal, 13 to Madras and 66 to the United Provinces. Further plots will be handed over early in the coming year.

The following actual experiments may be mentioned and reference is invited to last year's report in connection with several of them:—

- (a) The Thano clear felling of sal has been badly damaged by frost. It is now evident, however, that a large number of the plants have not been killed but it is too early to express any opinion as to the success or otherwise of the method.
- (b) The experiment in storing sal seed was hampered by the fact that the rains were exceptionally unfavourable. Up to date there are good grounds for believing that this problem may be solved, and in any case experiments on a much larger scale will be undertaken in the coming year.
- (c) Regarding the Zaberkhel experiments, again the almost entire failure of winter rains has made conditions more than usually unfavourable. The winter *Dalbergia Sissoo* sowings, the bamboo seedlings, and the sowings of *Butea*

frondosa have failed entirely—the last owing to damage by porcupines. These experiments will not be repeated. The chir sowings, unweeded and untended, are at present very promising and will be extended during the coming year. As few nursery plants were ready the winter root and shoot cuttings of Sissoo were almost entirely composed of plants dug from the Song river bed and were therefore not favourable for experiment. They were out of the ground many hours and had to be transported many miles, they were not ideal in size, were badly grazed and were transplanted to an entirely different type of soil and lastly the winter rain failed almost completely. Despite this a large number are throwing out shoots and more will do so. Of 250 odd plants obtained from a local nursery almost every plant has sent up a shoot. The experiment will be continued this year with nursery plants, which are now available, and though definite conclusions cannot yet be drawn there is every reason to believe that this method is an easy way of solving the regeneration of the blanks without any attention during the rains.

- (d) The Camphor experiments have yielded complete enough results to render a tentative publication possible in the near future.
- (e) A taungya experiment of 10 acres in Thanu has been commenced.

The photographic branch now contains 3,736 photographs and 3,568 negatives. No additions have been made to the lantern slides and colour transparencies.

A Note on Afforestation of Ravine Lands in the Etawah District, United Provinces, by Mr. E. A. Smythies appeared as a Forest Record.

Owing to press difficulties no other publications have appeared during the year but the following have issued since the close of the year:—

- (1) Note on the weights of seeds.
- (2) Note on the rate of growth of Bengal Sal.
- (3) A code for the collection and tabulation of statistical data.
- (4) An article on Sal taper curves, in collaboration with Mr. E. A. Smythies. (*Indian Forester*, April 1921).
- (5) Notes on Artificial Regeneration in Bengal, by Messrs. E. O. Shebbeare, A. K. Glasson, L.E.S. Teague and P. T. Russell.
- (6) Note on the Miscellaneous Forests of the Kumaon Bhabar, by Mr. E. A. Smythies.

The arrears mentioned in last year's report have been cleared off so far as the actual routine work is concerned, but during the whole year the branch has suffered considerably from shortage in the assistants' staff and office. The ledger files are becoming a mass of undigested knowledge very sadly in need of arrangement.

What is much more serious is that the shortage of staff has caused great neglect of the programme. It is true that experimental silviculture cannot be done as well from the Central Institute as in the Provinces themselves and the need for decentralisation is admitted, but there will always be certain experiments to be conducted at Dehra if the branch is to remain a living entity, and moreover decentralisation, though agreed to, is not by any means complete. Except in four provinces the progress of silvicultural knowledge for all India depends largely on the Central Institute.

United Provinces.

The work carried out in the Silviculture Division has followed as closely as possible the printed programme of research for the Working Plans and Silvicultural Research Circle. The shortage of staff in the province has however resulted in the Silviculturist's having to hold charge of the Haldwani Division in addition to his own duties from the commencement of the working season, so that it was impossible to deal with problems which could not be studied near Haldwani—in fact, except for the measurement of a few sample plots near Dehra Dun, and the work done on two flying visits to the Kumaun Hills, nothing could be done elsewhere.

The several heads of the research programme mentioned are followed as far as convenient in the following report:—

I. SAL:—*Natural Regeneration.*—A series of large scale experiments from which it is hoped to get important results, has been initiated in Haldwani Division, in Lakhmanmandi, Compartment 4. This is a good quality Bhabar sal forest which has been placed in Periodic Block 1 of the Conversion Working Circle, and which already contains abundant small regeneration believed to date mostly from the 1913 seed year: this regeneration has been dying back annually in the usual fashion, after attaining a height of 1—2 feet. Four plots each of 25 acres were laid out: in the first, a clear felling of sal was made, and the small admixture of miscellaneous species left to form a light soil cover; the area was naturally subjected to a maximum of trampling, etc., during conversion and extraction, and it was burnt over on 11th and 15th February 1921, to remove the smaller debris. The second plot was felled over to remove all the lower canopy, leaving only a high and open cover of mature sal trees; this also was burnt over as soon as conversion was completed, on 25th March 1921. In the fourth plot nothing was done except to burn it over on 26th March. The third plot was made as a control

and nothing was done. A fifth plot of the same size has been demarcated, and will be dealt with under Mr. Hole's strip system, markings being made in August, 1921, under the Forest Botanist's personal directions. Small observation plots 15 feet square have been laid out in each area for the record of the history of individual seedlings, each of the latter being mapped, measured and described. It is to be emphasised that this research is directed towards a study of the conditions of development of a seedling crop already on the ground, and not a study of requirements for getting such a crop. It may also be noted that, in the Conversion Working Circle of the Haldwani Division, the real problem is this one of getting up a new crop from existing seedlings, as these are abundant almost everywhere.

Two similar experiments in clear felling and shelterwood felling were also carried out in Dehra Dun Division, at Lachiwala, in quality II sal forest, and above the Hathiwala line at Timli, in a quality IV crop. The object is to see the development of the new crop obtained from seedling and suppressed advance growth under these conditions of felling with burning of the slash. Each area is ten acres in extent. Control plots, in which the growth of seedlings of known age under these conditions can be examined, have also been laid out by Mr. Hole. The shoots in the area at Lachiwala are already (July) 7 feet high. In this area the actual seasons of growth are also being observed.

The data obtained to date from the small sal regeneration plots laid out all over the province after the 1913 seed year have been collated, but nothing conclusive can be deduced from them beyond the fact that during the 7 years which have elapsed, the seedling plants have all failed to commence vigorous height growth; some of these plots have been already abandoned, and for the remainder, proposals have been made and in part carried out by the Divisional Forest Officers concerned, for trying the effect of burning and removing overhead cover.

The results of past fellings under existing working plans have been studied, and memoranda recorded wherever possible.

It was found impossible this year to make any special studies of the natural regeneration of Sain (*Terminalia tomentosa*) with sal.

In Horai Block of Haldwani Division, in an area thrown out of the Working Plan on account of heavy damage from the drought of 1907, experiments are in progress aiming at replacing the dense growth of Ruini (*Mallotus philippinensis*) and other worthless species by *Terminalia tomentosa*, sal, or other trees of economic value; various methods of dealing with the understorey of weeds, which has occupied the gaps caused by the death of the standards and now prevents regeneration, have been tried and mound sowings are being done.

Statistical.—The bulk of the records of sample plots of the Forest Research Institute have been taken over during the year, and the remainder are to follow. The maintenance of these plots will henceforth remain in the hands of the Silviculture Division, though the Imperial Silviculturist will probably remeasure the plots near Dehra Dun. The following Forest Research Institute sample plots have been remeasured during the year :—

Species.	DIVISION.	
	Haldwani.	Dehra Dun.
Sal	7	2
Sain	—	—

The number of sample trees felled for analysis has been considerably increased as the numbers taken at past measurements are altogether inadequate; a change has also been made in accordance with the recommendations of the Board of Forestry, from the volume curve method to the form factor curve method for calculating the volumes of the crops. The back checking of sample tree measurements has demonstrated only too clearly the reason for the anomalous results obtained in the past.

In addition to those plots eight new ones have been laid out during the year in Haldwani Division to fill in the gaps left in the series of diameter and quality classes, and to include the varying conditions of Hills, Bhabar, and Tarai. The plots have in all cases been made as large as possible.

This brings the total of sal plots measured during the year to 17.

The data for all the plots have been worked up in the standard form. It proved impossible to lay out *Terminalia tomentosa* plots as intended.

Besides the figures required for the compilation of yield tables, the measurements of these plots have also been used for preparing tables showing taper curves, spacing of trees in well-thinned plots, thickness of bark, etc.

Endeavours were made to obtain ring countings for sal wherever possible, and the results tend to indicate that at least a fair approximation of the age of a plot can be obtained by this method.

Artificial Regeneration.—Sal sowings in irrigated lines, and on unirrigated mounds formed part of the experiments tried in the Dolpohra Plantation in Haldwani Division. The plants in the lines all died back during the cold weather, and except in the more favourable parts have failed altogether; this, as well as the complete

failure of the mound sowings, is primarily to be ascribed to the drought. The small plot of sal and Haldu (*Adina cordifolia*) in the Chorgallia garden continues its good development and in the cold weather 1920-21 the tallest stem measured 22 feet, being then 6 seasons old. Broadcast sowings under *Dalbergia Sissoo* are being tried this year at Dolpokhra.

No conclusive results have been obtained with Sain during the past year and, owing to the poor quality and quantity of seed available, but little will be done in the coming year.

The artificial reproduction of sal both by sowing and planting of root and shoot cuttings was continued in Gorakhpur. It has now been established that the planting of root and shoot cuttings is useless; the plants live if carefully tended but show no inclination to grow even after 5 years. Strip sowings both in the open and under cover are being investigated.

The ordinary attempts with artificial regeneration of sal by sowing in patches, without adequate tending in the rainy season, are utterly useless and should be given up altogether.

II. MISCELLANEOUS SPECIES.—The large scale work on the regeneration and general improvement of the miscellaneous forests of the Bhabar could not be initiated owing to pressure of other work, but arrangements were made for the coming year, the first step necessary being the closure to grazing of the selected area in Kalaga block of Haldwani Division. Sites have been selected for the experiment of diverting small streams to obtain regeneration of Khair (*Acacia Catechu*) and *Dalbergia Sissoo*, which will be tried out as soon as the closure can be effected.

At the instance of the local Silviculturist, the Special Forest Officer, Tarai and Bhabar, enclosed a portion of the dry bed of the Nandhaur River, near Chorgallia, to see the effect of protection from the intense grazing and trampling there prevalent, on the seedling crop of Haldu, Sissoo and Khair which already existed on the ground; the Haldu in particular is unusually abundant, but every year the new shoots are browsed down and a fresh start has to be made. A series of observation plots 15 feet square were selected and mapped for collection of precise records; these will be inspected as often as feasible until the new crop becomes established.

A commencement was made with sample plot work by laying out in Haldwani Division 8 plots in Sissoo crops. A fair range of diameter classes having been obtained the data are being worked up in the same way as for the sal.

III. AFFORESTATION.—A considerable amount of work on the Bhabar species has been done in the neighbourhood of Haldwani by the local territorial officers under the advice and co-operation of the Silviculturist. Thus sowings, etc., were made in Dolpokhra, an abandoned village site, probably cleared originally in Bhabar sal

forest, and in 5 acres of miscellaneous forests in Kalaga, both in Haldwani Division; in Talli Haldwani Plantation in the Tarai and Bhabar Estate, and a start was made in a typical Tarai area near Lalkua, also in the Tarai and Bhabar Estate. Some work was also done in Boxar and Phulai of Kalagarh Division. Small scale experiments have also been made in the Haldwani Experimental Garden belonging to the Silviculture Division.

Sissoo shoot and root cuttings have already proved a simple and effective method and further areas were afforested in this way where irrigation was possible; shortage of water has held back development a good deal in many parts, but appearances indicate that this may only be a temporary check; water must, however, be freely supplied during the first season if satisfactory results are to be obtained. In Dolpokhra the shoots of almost every plant were killed back by frost in the cold weather, and there was a great deal of grazing, but the new shoots are mostly vigorous despite a minimum of irrigation.

Of the numerous other species tried by the same method, it was found that Siris (*Albizia procera*) and Mulberry were successful and Lessora (*Cordia Myxa*) to a less extent, whilst all the rest were a failure.

Mound sowings of the following species were tried:—

Haldu (*Adina cordifolia*), Dhauri (*Lagerstroemia parviflora*), Bakli (*Anogeissus latifolia*), Semal (*Bombax malabaricum*), Sain (*Terminalia tomentosa*), Babul, Khair (*Acacia Catechu*), Dalbergia Sissoo, Gmelina and Bhaurang (*Hymenodictyon*).

Very poor germination was obtained with Haldu and Bakli, but on the whole, during the rains and early cold weather appearances were promising; the early cessation of the monsoon, followed by severe drought later on, has resulted in the death of a very large proportion of the young plants, only the Khair and babul having withstood it at all, except under exceptionally favourable circumstances, and even these species shew extremely poor development. This is disappointing, but can only be expected in drought years.

In the experimental garden, the Bakli regeneration both natural and from mound sowings made in 1919 is still apparent, but no start on vigorous height growth is yet to be recorded. Further experiments with bamboos are required but lack of seed has prevented their being done.

It becomes ever more apparent that for this class of work weeding is essential, at least during the first rains. Dolpokhra, which is the largest area dealt with, has been particularly unfortunate, having been submitted to every possible form of damage except fire.

The experimental sowings made in Lalwala of Saharanpur Division in 1920 were inspected by the Silviculturist in August 1920. Here three methods of cultivation are being tried, *i.e.*, complete ploughing, strip ploughing, and mounds. As regards the species best suited to afforestation work in the Bhabar the results are completely in accordance with those detailed above for Dolphokra—Khair and babul being the easiest to get established, Kanju (*Holoptelea integrifolia*) and Semal (*Bombax malabaricum*) fairly satisfactory, and all remaining species difficult. Of the three methods, the strip ploughing was most successful.

Several Divisional Forest Officers as well as the Forest Botanist have assisted with supplies of seed.

The question of Lantana eradication has been a good deal discussed; there is little question now but that the replacement of Lantana by Sissoo can be effected without difficulty wherever water is available for irrigation, but over much of the area water is probably better employed on agricultural crops.

The Benaik plantation of Naini Tal Division was inspected during the year and proposals made to the Divisional Forest Officer as to improvements in methods of afforestation with Kail (*Pinus excelsa*); no results have been recorded to date.

Research in ravine reclamation work was chiefly confined to the investigation of the causes responsible for the continued failure to get babul to grow in the Kalpi plantation. A pan caused by the flocculation of sodium carbonate and containing a higher percentage of this salt than babul will stand was discovered. The past failures are therefore easily explained. As a result of this discovery the proposal to extend afforestation in this neighbourhood has therefore been abandoned.

Experiments continued with many exotic trees in the Etawah ravines. *Terminalia Arjuna* germinated well but was killed by drought, *Hardwickia binata* promised well and its cultivation is being extended.

The question of soil cultivation has now been solved and reduced to a routine operation but finality as regards the best species of tree has not yet been obtained.

An investigation into the question of the inherited characteristics of babul seed is in hand.

The afforestation of the *chandas* of South Kheri and Pilibhit and the *phantas* of North Kheri is being investigated.

IV. HILL CONIFERS:—*Twisted Fibre in Chir.*—Mr. Champion initiated a further series of experiments during 1920, mainly directed to the investigation of the effect of various kinds of injury to seedlings of known parentage; new sowings were also made on a limestone soil to confirm the conclusion previously reached that the chemical composition of soil has no influence, and to check

general results hitherto obtained. In any case a further series of sowings will be made in 1921 in Kaligadh Block near Ranikhet, as the existing areas are too inaccessible under present conditions of transport in Kumaun. Until the proposed inspection can be made, nothing further can be deduced from these experiments.

Statistics.—Six new Chir (*Pinus longifolia*) sample plots have been laid out in Chakrata Division to fill up the gaps of the Forest Research Institute plots which are particularly deficient in the more mature crops of the poorer quality classes.

The Almora plantations will be very useful for sample plots of all but Quality I, for ages up to 45 years and are about to be inspected to this end. Divisional plots are being examined and wherever possible adopted or adapted to present requirements; some of them as well as of the Forest Research Institute plots have not been considered worth maintaining, and in some cases two adjoining plots have been amalgamated to give a single plot of more reasonable size. By the end of 1921, it is hoped that sufficient plots will have been measured up to allow of the compilation of a tentative yield table for this species; though data will still be wanting for intermediate yields. The former measurements of the Forest Research Institute plots will be back checked as for sal.

V. MISCELLANEOUS.—Experiments with Atlas "A" preservative and sodium arsenite solution in order to discover a sufficiently cheap solution for killing climbers and undesirable shrubs like *Mallotus* and *Clerodendron* have been carried out in many divisions and also by the Silviculturist. North Kheri reports that a 50 per cent. solution of Atlas gives as good results as the pure solution and that painting a girdle is more effective than a clean-cut surface. It is certain that Atlas solution will kill a large proportion of climbers treated but it is too expensive for employment on a large scale. The results with sodium arsenite have not yet been worked out.

A stump-pulling machine has been purchased for experimental purposes in the treatment of areas under regeneration infested with *Mallotus*.

The experiment of clearing undergrowth in Chir pine woods to see the effect, if any, on the yield of resin showed that the yield per 100 channels in two similar plots with and without the normal undergrowth was 5 maunds in the cleared plot as against 3 maunds in the control plot. The experiment is being continued until absolutely conclusive results are obtained.

Peridermium corticola still gives cause for anxiety in the Almora plantations and the investigation of the usual mortality of young Chir in these plantations has not proceeded any further.

VI. WORKING PLANS.—Silvicultural research, statistical work and forest working plans are intimately bound up with each other

and have rightly been included in the same charge. The Working Plans and Research Circle has now been fully organised in close co-operation with the territorial charges and is fulfilling its functions in a satisfactory manner. The divisions of the work inside the circle has been settled and once a whole-time staff is available progress should be rapid.

An undoubted improvement in the quality of working plans has been brought about and an increased interest in silviculture is being developed among the executive staff.

VII. PUBLICATIONS.—The staff of the Research Circle have devoted part of their time to the preparation of scientific papers and newspaper articles for various publications. The correspondence in the “Indian Forester” on silvicultural systems for sal has been productive of much good. Mr. Smythies brought out his Afforestation of the Jumna ravines in Etawah (Indian Forest Records, Vol. VII, Part VIII) which has been widely distributed and is now being published in Urdu and Hindi. Mr. Benskin’s book “Afforestation in the United Provinces” was also sent to press.

The Forest Pocket Book is in the press and should be found useful by every forester in Northern India. Besides much hitherto unpublished information regarding the artificial reproduction of the commoner species, a series of useful tables, including volume tables, for sal have been included. It is hoped that this little book will fill a long-felt want.

Punjab.

In the Kulu Division experiments to ascertain the best method of regenerating the high level spruce and silver fir forests were commenced just before the close of the year and will be dealt with in detail in next year’s report.

Experiments are in progress in the Hoshiarpur Division to ascertain :—

- (a) The correct cutting rotation of *Dendrocalamus strictus*.
- (b) Whether the clearing of the clumps of the above bamboo affects the number and quality of new shoots.
- (c) Whether a complete cleaning in one operation does not tend to the sub-division or splitting of the clumps.

The experiments are still in progress but as the results have probably been affected by the two abnormal years of drought in which they have been so far carried out; further observations are necessary before useful conclusions can be drawn.

An insect which bores from the tip of the shoots downwards is reported to cause the death of the culms.

In the Kalesar Range of the Simla Forest Division and the Nurpur Range of the Kangra Forest Division attempts at the

propagation of *Dendrocalamus strictus* by cuttings have brought the following points into prominence:—

1. Cuttings should not be planted on flat ground.
2. Cuttings under 4" in girth are liable to result in failure.
3. Cuttings from culms of less than 2 and more than 4 years of age should be avoided.

Bihar and Orissa.

The sowing of sal in cleared lines in Samta Range, Singhbhum Division, in experimental areas 1, 2 and 3 in Compartments 16 and 17 has yielded very poor results. If the lines be cleared in valley type areas close to water they become paths for sambhar on their way to drink, and plants of Tun (*Cedrela Toona*) and Gamhar (*Gmelina arborea*) are invariably grazed back. Where the lines are not cleared as in Tirilposi Block, these species do much better and appear to escape the attention of game.

Fifteen per cent. of the sal have died and more are expected to die during the remaining dry months.

In two years a few sal seedlings have reached a height of 18", Piasal (*Pterocarpus Marsupium*) seedlings 12", Tun and Gamhar 36". Weeding and loosening of the soil was carried out at a cost of Rs. 38-11.

Teak areas.—As the season was far advanced when teak seed was received only one seer was sown on an experimental scale; 119 seedling resulted and 17 were found dead after the rains. They were weeded twice, and a strong fence was put round them to prevent damage by wild animals. The total cost including fencing was Rs. 87-6-6. 70 seedlings are still alive. Experiments on this scale are obviously not profitable.

In Tirilposi Range. Area No. 1.—Sal sown on mounds in 1915. Some failed and some died back but threw up good shoots. They are partly under cover, and look healthy. Present height 8" to 16".

Toon of 1918. Sown on raised lines, doing remarkably well, tallest 13' high, average height of others 11' 6" in the open.

Toon of 1918 transplanted.—Free from cover, average height 7' 6". Toon sown in January 1919 in nursery. The seed was bad, those which came up have reached 17" in height.

Pterocarpus Marsupium.—Sown (a) on nursery beds in 1919, doing well, present height 7" to 8".

(b) On mounds and in lines. Those on mounds are more vigorous than those in lines, present height 5" to 7".

Sal.—Sown on mounds in 1919, mostly died owing to drip of a Pipal tree.

Sal.—Sowing in lines failed owing to lack of drainage.

Area No. 2.—Toon sown on raised mounds and lines in 1918, very successful in the open, height 7' to 11' 3".

Toon transplants of 1918.—Damaged by sambhar but have thrown up healthy shoots 5' to 7' high.

Toon transplants of 1919.—Many died, height of survivors 3' to 5' 3".

Sal sowing of 1918-19.—Failed entirely.

Area No. 3.—Sal sown in 1918 and 1919 in lines. Lines which are free from cover contain healthy seedlings. Lines under cover, very few. Rats are doing much damage.

Area No. 4.—(a) Sal sown in nursery beds in 1918. Condition good, overhead cover has been removed.

(b) Sal sown on mounds in 1918. Most died, rats killing many of them. Condition of survivors fair.

(c) Sal sown in line 1919. Area water-logged and under heavy cover. Lines which are free from cover contain healthy seedlings.

(d) Toon sown in 1918, transplanted in 1918. Most killed by sambhar, survivors 3' to 3' 6".

Area No. 5.—Sal sown in lines 20' apart with paddy in between 1918. Owing to the damage by wild animals the crops failed and were abandoned. Such areas must be fenced. Sal in water-logged soil turned yellow. Sal on slopes fairly healthy.

Area No. 6.—Natural reproduction of sal under cover. All seedlings died owing to water-logging and too much cover.

Area No. 7.—Well stocked with healthy natural seedlings, on low ground fewer but sufficient to stock. Weeding has been done and was necessary.

Blank Area.—Sowing of sal in August 1918, a failure owing to bad seed. There has been no seed since.

Group Area.—The sowing of sal and Piasal seedlings in 1919. A fair number of survivors, condition good.

Strip Area.—Sowing of sal, Piasal and Toon in 1919. The first two species are doing well. Ground appears unfavourable to Toon which have turned yellow and are dying.

Afforestation.—Eleven half acre plots were laid out in Khandata block, Sambalpur Division, one of a number of blocks which were reserved in 1916 and contain no forest growth. The soil is a sandy loam of moderate depth and the situation flat. Of the eight species sown teak, *Pterocarpus Marsupium*, and *Gmelina arborea* are likely to prove most useful for afforestation purposes but the experiment is not far enough advanced to allow of definite conclusions being drawn.

A series of experiments was carried out in the Angul Division to determine the best method to regenerate sal and teak in this Division. The experimental areas were not kept under proper observation and consequently no authentic written records exist, especially in the case of sal, which could convey reliable and accurate information.

Information given below, though not so accurate as it should be in such an important case, is, however, sufficient to draw conclusions from, which would not be far off the mark.

SAL.—Five plots, each about 2 acres in extent were selected in Purnakote Range.

Plot A.—Left to be naturally regenerated.

Nothing whatsoever was done here except the burning of undergrowth. It was a failure, attributable perhaps to the flames having risen so high as to destroy the vitality of seeds.

Plot B.—Soil was hoed up after burning the undergrowth. Result same as above.

Plots C. and D.—Were treated alike. Seeds were dibbled in after hoeing up the soil, undergrowth having been first burnt.

Plot E.—Soil was treated as in C and D but seeds were sown broadcast.

All the above operations were carried out towards the end of March 1919. Germination except in Plots A and B was quite satisfactory. Seedlings did not come up thick as grass, and it was at that time thought that further operations were not warranted by the degree of success attained.

Weeding was carried out in August and was half-heartedly done. Still there are enough seedlings on the area to make a fair crop. All the seedlings which survived are healthy and strong.

No records exist to give cost of carrying out the above experiments.

TEAK.—Sixty lines 10' wide and 20' apart were prepared. All the growth, mostly consisting of evergreen species and bamboos, was cut and burnt.

Pits about 8' apart were dug on cleared lines and filled with humus and ashes and mounds made in March 1920. The mounds were 6" in height and 1' in diameter.

Seeds were obtained from Burma and Madras and were dibbled in the first week of June. Those from Burma showed the better results, germination having taken place in the middle of July.

Unfortunately 20 lines were entirely destroyed in Purnakote Range by wild elephants during the drive in the last Khedda Operations. The rest of the lines show promising results. Watering was done during October and November twice a week. Weeding was done in September and mounds were loosened in January except in four lines. The loosened mounds showed much better results than those not loosened. About 200 seedlings were transplanted. The transplants do not show any marked advantage over the seedlings while a considerable number of them have already died. Transplantation involves a certain amount of risk because if not properly done roots are exposed. Some expenditure is also involved in the operation. No transplanting will be done in future.

Watering will also be dispensed with because it has been noticed that only a very few of those plants which were not watered failed to survive.

Results obtained warrant a continuation of this work.

The experiment of destroying climbers by applying creosote oil to the stumps has not proved as successful as was anticipated, several of the treated stumps having again thrown out shoots.

In the Puri Division an area of mixed forest was selected containing an upper-storey of sal with underwood and undergrowth of dense evergreen forest, and little or no sal regeneration on the ground. All the evergreen growth was cut, and a thinning made in the sal crop. The area was then divided into 3 plots; in the first of which all the cut material was burnt and the soil ploughed up. In the second only burning was done, and in the third plot neither burning nor ploughing was undertaken. All three plots were then densely sown up with sal seed collected from the adjoining forests. All these experiments were completed in June 1920. The area was last inspected in February 1921, and it was recorded that the experiments were giving satisfactory results. The whole area (especially plot No. 1, burnt and ploughed) was covered with sufficient seedlings to establish a dense stock. The seedlings varied in height from 6" to 1 foot and appeared very healthy. It will now be interesting to note what effect the dry season has on the growth of these seedlings, and if they will show signs of dying back, a possibility which is hardly expected in this moist climate. In this connection it will be possible to record more definite results next year.

Further experiments on a more extensive scale are to be undertaken this year with a view to ascertaining the cheapest method by which effectively to regenerate large areas with sal, and to establishing regeneration by natural means as far as possible, aided by cutting and burning of the dense evergreen underwood and undergrowth which has such a deleterious effect on the young sal.

A peculiar phenomenon noticed in connection with last year's experiments in the adjacent forests where the fire had spread and burnt the smaller undergrowth and leaves, consisted in observing that although the ground was covered with a mass of sal seedlings which had sprung from seed given by parent trees, all these seedlings were in a most unhealthy condition and many of them had already died. The cause of death was attributed to one or other of the following factors, excessive dampness and "drip" caused by the shade of the evergreen and accentuated by "sourness" and lack of aeration in the soil. In peculiar contrast to this, under exactly similar conditions of shade and cover, it was observed that in areas *not burnt* the seedlings were all surviving, and in appearance much more healthy and vigorous.

This condition of affairs is so contrary and so radically opposed to all established beliefs and opinions that further research is essential before advancing any theories on the subject. It, however, tends to show that burning alone without opening of the cover is harmful.

Casuarina.—Investigations carried out in the *Casuarina* plantation distinctly prove that the *Casuarina* seedling is highly susceptible to any mal-treatment of the main taproot. If the main root is damaged, very long lateral roots are developed which do not reach the lower layers of moisture-laden sand with the result that the growth of the plant is very much retarded, and in many cases ends fatally. Even partial damage to the roots causes the tree to assume a bushy growth.

Teak.—Teak seed buried in the soil, covered with alternate layers of straw, and watered regularly for a fortnight produced much healthier and stronger seedlings than seed treated by the old method of soaking in water for 48 hours prior to sowing.

Bengal.

Natural reproduction of valuable species in the hills is exceedingly scarce, or altogether absent.

Kawla (*Machilus odoratissima*) produces a fair quantity of seedlings, but the growth of this species is so slow that it cannot be considered one of our economic species.

Buk (*Quercus lamellosa*) and Phalat (*Q. lineata*) seeded profusely this year, but very few natural seedlings appeared on the ground; bears and insects, especially the latter, probably consume most of the seed before it can germinate.

Pipli (*Bucklandia populnea*) produced a fair quantity of seed, but large seed-bearing trees are very scarce in the forests, having mostly been cut out in accessible places, and we cannot expect much natural reproduction of this species, as such trees as remain are usually found in dense forest where the conditions are not favourable for germination of the seed.

Cryptomeria japonica promises to produce excellent natural reproduction where there are mature seed-bearing trees and sufficient light; but we have no large areas of mature *Cryptomeria* and the possibilities in this direction can only be seen at the Cinchona Department's plantation at Mungpoo. In any case it is probable that artificial planting of this species will prove the quickest and most effective way of restocking an area, as it transplants easily, and is easily raised in a nursery.

Champ (*Michelia excelsa*) seeded very badly again, and there is scarcely any natural regeneration.

Walnut (*Juglans regia*) produced a fair quantity of seed, but natural seedlings are seldom found.

Kimbu (*Morus laevigata*) and Panisaj (*Terminalia myriocarpa*) produced plentiful seed but scarcely any natural seedlings and these few are almost certain to be destroyed by game.

Utis (*Alnus nepalensis*) as usual seeded well, but it only seems to reproduce itself naturally on landslips and places where the soil is exposed and there is plenty of light.

Of less valuable hill species, Kapasi (*Acer Campbellii*), Arupati (*Prunus nepalensis*), Maya (*Eriobotrya petiolata*), Saur (*Betula cylindrostachys*) together with Kharani (*Symplocos theaeifolia*), Kanakpa and a species of Hill Mallatta (*Macaranga spp.*) reproduce themselves fairly well, especially the three latter.

In the sal forests of the plains, natural regeneration of valuable species is also very scanty; in the dense forests, because of the unfavourable condition of the soil as a seed bed, and owing to insufficient light for development of seedlings; and in more open ground owing to prevalence of heavy grass, fires and game, which seem to do more damage in such places.

Of the more valuable species Lattar or Cham (*Artocarpus Chaplasha*) and Champ (*Michelia Champaca*) produce a certain amount of natural regeneration and seem to be gradually coming in among the sal, especially in the moister parts. Seedlings of *Artocarpus* have frequently been observed when there was no sign of the parent trees, and which must have been sown by birds or monkeys; but it is very seldom that such seedlings get through, as they are nearly always eaten down by game.

Cham seedlings are also badly damaged by game, and recently at Panchnai a great quantity of Cham seed under a fair sized tree was found to have been destroyed by mice; parrots and birds also devour the seed on the trees just when they are getting ripe; so that at the best only a small amount of natural regeneration occurs.

Of the less valuable species Pitraj (*Amoora Rohituka*) produces plenty of natural seedlings; and in the more open ground Simul (*Bombax malabaricum*) and in the sandy river bed forests Tun (*Cedrela Toona*) produce good regeneration. This natural growth of Tun seedlings is particularly noticeable in the neighbourhood of the Hiapatha coupe in the Jalpaiguri District. Kadam (*Anthocephalus Cadamba*) reproduces itself plentifully in old taungyas and cultivated areas. Khair (*Acacia Catechu*) and Sissu (*Dalbergia Sissoo*) produce good natural regeneration along river banks at the foot of the hills, but they are terribly damaged by grazing of cattle, deer, elephants, etc.

Mandani (*Acrocarpus fraxinifolius*) produces splendid natural regeneration in clear-felled and cultivated areas along the foot of the hills, generally associated with Kadam, and a certain sprinkling of Lampati (*Duabanga sonneratioides*). Examples of this can be seen at Pundig in the Kurseong Division, and most noticeably in

the Meanglass coupe in the Kalimpong Division 1920 area. Gamhari (*Gmetina arborea*) has also produced large numbers of natural seedlings in similar areas in the Chittagong Hill Tracts, probably due to the proximity of forest villagers preventing bear and game from eating the fruits.

Sal.—It has been a really bad seed year, though at first everything promised well, but two exceptionally severe hailstorms on April 14th and May 27th, stripped nearly all the fertile seed from the trees.

Mahogany (*Swietenia macrophylla*) in the plantation at Kaptai, in the Chittagong Hill Tracts Division produces abundant natural seedlings, and judicious thinnings amongst the useless species immediately to the north of the plantation, together with timber cutting, will certainly lead to a gradual extension of the plantation by natural means. This was suggested to the D. F. O. in June last and when the plantations were again visited in November, there was a great improvement in the growth of these natural mahogany seedlings. They were coming up in thick patches with perfectly straight stems, some of them already over 25 ft. high. They reach this height in 3—4 years under favourable conditions.

Garjan (*Dipterocarpus sp.*) and Tali (*Dichopsis polyantha*), two of the most important indigenous species in the Chittagong Hill Tracts Division, produce abundant natural seedlings but the problem of how to regenerate these forests by natural regeneration has never been solved. The seedlings may be on the ground in thousands, but they will not develop under the dense shade. Immediately light is let in, the whole area is invaded by a tremendous growth of creepers, with which no seedlings can compete, and as the creepers would have to be cut several times in a year, probably for several years, to do any good; the expense would be prohibitive.

Artocarpus Chaplashu. another of the economic species of the Hill Tracts (very high prices are paid for large dugouts made from these trees, in which most of the trade of the district is carried on) also produces plentiful natural seedlings, but they are almost invariably destroyed by game.

The following is a brief account of *Artificial Regeneration* in the Hills and Plains with some account of the principal species which it is attempted to reproduce.

Pipli (*Bucklandia populnea*) and Utis (*Alnus nepalensis*). In Darjeeling and Kurseong Divisions small group fellings and blanks are planted up with the more valuable species such as Pipli and Utis which make an excellent mixture, the Utis being a fast growing light demander and the Pipli a shade bearer, which benefits by the presence of the Utis, as the latter protects it from frost and at the same time draws it up. In the Darjeeling Division

Pipli plants are kept 2 years in the nursery, and put out in the forest at the beginning of the 3rd rains, while in Kurseong Division at lower altitudes, the plants are only kept one year in the nursery. One year old plants of Utis are used, that is they are kept in the nursery through the first cold weather. Unfortunately Utis is rather too big to plant, sometimes being 3 or 4 ft. high by the 2nd rains which causes a great check to the growth when put out, while it is thought to be too small to put out in the first rains. It is thought however that if the shades are removed from the pricking out beds early, plants could be put out quite well in the first year without being kept through the cold weather in the nursery.

Saur (*Betula cylindrostachys*) is not in favour with the local people, though it gives an excellent fuel. It is usually planted pure and plants should be put out from the nursery when five months old. If kept in the nursery for a year, they are much too big to give good results; Saur does not transplant well, and for that reason not much of it has been tried this year.

Mandani (*Acrocarpus fraxinifolius*) is only now being experimented with by the Forest Department in artificial regeneration. It germinates readily when sown in a nursery bed, and transplants well; good results can be seen in the Kurseong Division, in the Taungya at Kadma and also at Mohurgong plantations where plants put out last June from the nursery are now 12 to 15 ft. high. Mr. Russell of the Cinchona Department however had excellent results by direct sowing with this species on a dry exposure in the hills, sowing in April and May. It is likely that wherever the soil is cultivated in the foothill country and up to 2,000—3,000 feet good results can be obtained by direct sowing. The growth is very fast and straight, 12—20 feet in 2½ years from seed, and it is an excellent constructional timber growing to a very large size in the Kalimpong Division. The difficulty is to get range officers to collect sufficient quantities of seed.

Cryptomeria japonica is planted pure in taungyas or at any rate in pure groups, two year old plants being used in the Darjeeling Division, and one year old plants in the Kurseong Division. It germinates readily in the nursery in shaded beds, and seedlings can be pricked out in July, and put out in the forest the following June or July. The wood is very light and excellent for battens, rafters, planking, tea boxes, etc., and does not appear to be eaten by white-ants.

Hill Champ (*Michelia excelsa*) is usually planted in small groups pure, or in mixture with Pipli, Utis, Oaks, etc., and most excellent results have been obtained where villagers can be induced to cultivate potatoes.

If cultivation of the soil is obtained, Champ puts on a shoot of 3' to 3' 6" and even 3' 8" in its second year planted out. Again

it is not definitely settled whether one year old or two year plants are the best. Also cold weather planting, after stripping the leaves, gives as good results as rains planting; Walnut is sown in a nursery about February or March, and planted out the following cold weather in jhoras. A curious fact about this species is that we have found the seed germinates much better in beds without any leaf mould.

Kimbu (*Morus laevigata*) is still in the experimental stage as far as the Forest Department is concerned; it is not common everywhere except in the Tista valley. The practice has been to keep it in the nursery through the cold weather, and put it out in the forest at the beginning of the 2nd rains after root and shoot pruning. Last year it was noticed that most of the young Kimbu at Mangpoo from about the 6th year or so are attacked by a large borer; and specimens of the larvæ were sent to Dehra Dun for identification. The entomologist says that it is probably the same longicorn beetle which does so much damage to the Mulberry trees in Japan, but which had not been reported from India before. Plate II shows Kimbu in the plains planted out some 14 months.

Panisaj (*Terminalia myriocarpa*) in former years was greatly cut out for furniture and cabinet work and now large trees are rare. It is difficult to obtain good germination of the seed; it should be lined out in a nursery and planted out in its first rains in July. It is much damaged by game in unfenced areas. In Kalimpong it is also sown direct in lines in Taungyas with success. Its growth is rapid, and fencing and planting in moisture localities is all that is required for good results.

Oaks and Chestnuts are difficult to grow on account of the uncertainty in obtaining sufficient good seed. The seed should always be tested by floating in water, when the good seed sinks and the floaters are thrown away. It is stored in a pit at least 4 feet deep during the cold weather to guard against insects. It can be either sown direct, two or three selected seeds in a thali (or planting hole) or seedlings kept in the nursery for 3-4 years and put out root and shoot pruned.

Arupati (*Prunus nepalensis*) has been sown direct in the Darjeeling District in prepared thalis; and is considered a good species from 7,000'—8,000' being frost hardy and not attacked by game. It does not transplant well.

Before leaving the question of artificial regeneration in the hills it is necessary to say something about the Taungya system.

Briefly, as applied to Bengal it consists in clear felling an area, burning it in the dry season, after removal of the timber and firewood, and raising field crops with cultivation for at least one, and if possible two years in succession, and at the same time sowing or



Photo.-Mech. Dept., Thomason College, Roorkee.

Photo. by L. Teague.

Kimbu (*Morus levigata*) one year in the Nursery and 14 months planted out in the Taungya after root and shoot pruning.

planting up the area from the first year with valuable species of trees.

The success of the system depends upon three main points—

- (1) Sufficiency of labour.
- (2) Fencing against game and cattle.
- (3) Good nursery work.

If sufficient labour is available, conditions 2 and 3 are absolutely essential to success. Everywhere, more especially in the plains, the hopelessness of the task of trying to raise young plantations without good fencing is apparent. Money must be spent without stint on game-proof fencing. Given the necessary labour and good fencing, the final basis of success is undoubtedly good nursery work.

Without a good nursery of adequate size, and stocked with a large reserve of good healthy seedling plants, blanks in direct sowing cannot be filled up, fully stocked young plantations could not possibly be obtained, and many of our most valuable species which are very small and delicate in the seedling stage could not be grown at all.

The secret of success is to obtain a fully stocked area from the start, as this means that after the 2nd or 3rd year, the fully stocked area begins to close up, and weeds and creepers are kept down by the shade of the young trees, after the villagers have left the area; so that further expenses of creeper cutting and cleaning are largely reduced.

The principal species in our plains forest is of course sal. In Kurseong Division it is raised by direct sowings in lines 6 or 8 feet apart together with the cultivation of crops on the Taungya system. In Buxa and Jalpaiguri Divisions, it is raised on the Taungya system and also by sowing hoed lines 3 feet wide and 6 feet between the lines of seedlings, leaving 3 feet between the hoed strips. This gives quite good results provided the jungle can be kept down between the lines.

The plants should be 3 feet high by the end of the 2nd rains, and 6 feet to 8 feet high by the end of the 3rd rains, by which time they can be considered fairly established. No attempt has so far been made to grow Khair by artificial means.

Dalbergia Sissoo is one of our most neglected valuable species, it grows very well throughout the Jalpaiguri and Buxa Divisions especially in Buxa, where trees of 7 ft. to 8 ft. girth are frequently met with. The chief difficulty is to obtain labour for cultivation in the shallow river bed areas, where the species grows well naturally; and also it must be fenced against game.

Satisal (*Dalbergia latifolia*).—Not much success has been obtained with this species. Seed was obtained again this year and sown in nurseries in Kurseong Division, but it did not germinate well, and a few plants put out last year seemed to show a slow rate of growth.

Kainjal (*Bischofia javanica*) which grows very successfully in moist depressions in the plains, was again largely sown this year. Six months' old seedling transplants from a nursery are used. Fencing against game is again essential, otherwise every plant is eaten.

Lali (*Amoora Wallichii*) is still in the experimental stage. Some plants put out at Panchanai, late last rains, survived the drought of the cold weather well, but seem to show a rather slow rate of growth. They are not more than 18 inches high now, when a year old.

With Chapalish or Cham (*Artocarpus Chaplasha*) excellent results have been obtained in the Chittagong Hill Tracts by direct sowing at stake in prepared thalis in Taungyas. During the period under report, thousands of young Chapalish trees were established in the large 1920 Taungya of 120 acres in the Chittagong Hill Tracts in this way. In North Bengal Divisional Officers have as yet only tried it in nurseries, with a view to transplanting it at the beginning of the 2nd rains. It appears then to be too big, and direct sowing in Taungyas with cultivation is the best way to grow it. It is an important tree of rapid growth, and should be 6 feet to 7 feet high when 18 months old, and 10—12 feet high in 2 years.

Toon (*Cedrela Toona*) can either be put out by direct sowing in lines of thalis in taungyas, or seedlings can be transplanted in the first cold weather from the nursery or one year old plants be cut back root and shoot pruned.

Chickrassi (*Chickrassia tabularis*) is planted out from a nursery when 6 months old, but it can also be planted out in the first cold weather. Seedlings are then ready for transplanting into the taungya. This year it was tried in the Chittagong Hill Tracts with great success at Kapti in the 1920 area and thousands of plants were successfully put out. It can also be sown direct in the same manner as Toon, but the plants are not so large in the same time as they are where nursery plants are used. This was very noticeable in the Hiapatha coupe of the Jalpaiguri Division.

Simul (*Bombax malabaricum*) is best sown at stake in taungyas, and 9' x 9' planting is close enough. It germinates well but several seeds are best sown at stake, to obviate the necessity of transplanting which it does not stand very well.

Gamhar (*Gmelina arborea*) is usually sown pure, direct in taungya after removing the pulp from the seed. If not sown

pure it outgrows everything else, which it suppresses, and then itself becomes branchy. Great quantities of seed were sown this year in the 1921 Taungya in the Chittagong Hill Tracts, and it has been most successful.

Plains Champ (*Michelia Champaca*) seed is ripe in August, a most awkward month, and there is always difficulty in obtaining sufficient seed. Seedlings cannot be put out and established before the first cold weather drought comes on, and many seeds do not start germinating till January and February. Seed therefore has to be sown in a nursery, in shaded beds, and seedlings kept in the beds till the following June when they are too big for satisfactory planting. However, it can be successfully pricked out into bamboo chungas. This retards the growth to some extent but makes transplanting it a practical certainty.

Mahogany (*Swietenia macrophylla*) is being tried on a very small scale in the Chittagong Hill Tracts Division where it shows great promise, and reproduces itself naturally, producing abundant seedlings. It reaches 10—12 feet high in 2 years and 20 feet in 3 years. As the "Tub" method of germinating the seed (soaking in a tub and drying for 15 days) has given very good results, the prospects seem quite promising. It is thought the best method would be to plant it in mixture with some suitable shade bearing species, if any can be found which nearly approximates to its rate of growth. Mahogany in the Chittagong Hill Tracts Division and Toon and Chikrassi elsewhere seem promising in this direction.

Jarul (*Lagerstræmia Flos-Reginae*) has only been tried on a small scale in the Chittagong Hill Tracts. The seed germinates well but its growth is slow, and it needs to be planted close, as it tends to be very branchy.

In September, nine temporary sample plots were laid out and measured by the writer in the plantations at Mangpoo, the species being Pipli, *Cryptomeria*, Saur and Utis, and the figures are being sent to Dehra Dun for working out the calculations, the idea being to obtain figures for the rates of growth of these species.

Of experiments tried the following may be mentioned:—

- (1) The planting of Champ (*Michelia Champaca*) in bamboo chungas at Kurseong. Result successful.
- (2) The planting of *Artocarpus Chaplasha* root and shoot pruned in Buxa, when too large for ordinary transplanting. Result successful.
- (3) Winter planting of Toon, Chickrassi, Kimboo and Champ (*M. Champaca*) stripping the leaves. Result—The three former successful, the latter a failure.
- (4) Planting of Pipli and Utis stripping the leaves; successful (Kurseong Division).

- (5) Planting of Utis (*Alnus nepalensis*) first year seedlings without pricking out (Kurseong Division) result very successful. This adds 4 feet in height growth to our plantation by the end of the 3rd year.
- (6) Seed percentage of germination test of Gurjan in Cox's Bazar Division. Result not yet reported.

The most important Silvicultural publication completed during the period under report, was the "*Nursery Notes for Bengal*" which was written by Mr. Shebbeare and Mr. Teague from these officer's notes and those of Mr. Russell when he was at the Cinchona plantations at Mangpoo. These notes are now being published as a handbook of convenient size for the use of rangers, foresters, and such others of the Department as may choose to avail themselves of it.

Up to date there has been no book of reference in Bengal which gave the seeding and fruiting times of the principal species; and with many new men filling up the Department who have had little experience of the work, it is hoped that the handbook will be really useful.

Assam.

The evergreen forests of Assam offer difficult problems in that they are composed of a large variety of trees, only a few of which are of economic importance. Exploitation under the selection system does not result in the reproduction of the valuable kinds and experiments have been undertaken to ascertain the best method of cultivation. Three distinct types have to be dealt with:—

(1) *Forests in which there is a sufficient number of mother trees of the more valuable species.*—Of the various experiments carried out in this type of forest the most successful are those in the Nambor and Diphu Reserves. Plate III gives a good idea of the natural regeneration of Hollock (*Terminalia myriocarpa*), *Phoebe attenuata* and Khokan (*Duabanga sonneratioides*) that has sprung up all over plot No. 1 (7 acres) Nambor Reserve and a recent enumeration of seedlings gives the following results:—

<i>Duabanga sonneratioides</i>	. . . . .	200
<i>Terminalia myriocarpa</i>	. . . . .	100
<i>Phoebe attenuata</i>	. . . . .	200
<i>Artocarpus Chaplasha</i>	. . . . .	60
<i>Bischofia javanica</i>	. . . . .	62
<i>Cinnamomum cecicodaphne</i>	. . . . .	4
<i>Gmelina arborea</i>	. . . . .	1
<i>Tetrameles nudiflora</i>	. . . . .	60

This was obtained by merely removing everything except the mother trees and by cutting and burning the undergrowth. The seeds fell in 1919. The crop of *Phoebe attenuata* seedlings which



Photo-Mech. Dept., Thomason College, Gooch.

Photo. by A. K. Adhikari.

Natural Regeneration of Khokan & Hollock. Nambor Reserve Plot No. 1, one year old seedlings—after burning.

has resulted from the 1920 fall is too large to enumerate. The greatest height of *Duabanga sonneratioides* is 16 feet and of *Terminalia myriocarpa* 8 feet.

Good results were also obtained from other plots and it is considered that the work is proceeding on right lines so that it should be possible within the next two years to prepare a reliable working plan for this type of forest based on these experiments.

(2) *Forest where there is an insufficient number of mother trees of the more valuable species.*—In this type intensive climber cutting is first carried out followed by clearing of the jungle under the seed bearers. Fire has also been used to burn the slash but encouraging results have been obtained both with and without its use in the case of *Phoebe attenuata*.

This operation obviously would not restock the ground completely and an experiment has been commenced over 5 acres in which the whole of the woody growth has been removed and burnt, in part of the area, while in the remainder only large trees have been left standing. The object is to join up the groups artificially which have been established under the parent trees. *Phoebe attenuata* has been sown and has thrived best in the shade where weed growth is less luxuriant but it is recognised that two weedings in the first year and again in the second year are essential to success.

(3) *Forest where valuable trees are absent.*—Here the experiments have so far not given very definite results although *Amoora Wallichii* has done well. This type is composed of a mass of soft woods and climbers which are usually the result of a secondary growth following upon temporary cultivation. The type covers large areas. At the outset the climbers are cut and the area sown or planted at intervals of 6' x 6', the overhead cover being removed when the plants have reached the sapling stage. A similar problem is being investigated in the large areas covered with *Dendrocalamus Hamiltonii*, the bamboos being felled and burnt and seeds dibbled in at intervals of 6' x 6'.

Observations have been recorded of the silvicultural requirements of the principal timber trees and of the injuries from natural causes to which they are subjected.

Attempts are being made to induce the hill tribes to sow the seeds of fast growing trees in their temporary cultivation. *Betula alnoides* is used in the Naga Hills and *Grewia multiflora* in the Mikir Hills. The Nagas however seem to prefer to allow the exotic *Eupatorium* to invade their land as the rotation is said to be as low as two years with this plant and to result in excellent crops even after this short interval.

The value of "Atlas Compound" to kill trees has been definitely proved in the Lakhimpur Division the matter resolving itself into one of the cost of the compound.

Central Provinces.

In the Melghat Division experiments are being carried out to find (a) the effect of removal of shade on teak seedling growth, (b) the best method of obtaining germination of teak seeds and (c) the suitability of planting teak seedlings in a clear felled area; but definite conclusions have not yet been reached.

One thousand coffee plants were planted at Bairat in shade on a south slope in June 1920 and when last counted 850 were still in leaf and a number more should revive when the rains break.

Regeneration.—Four sal regeneration plots, each of three-quarters of an acre, were permanently demarcated in South Raipur Division near Sitanadi Forest Bungalow. The seedlings of the year (an excellent one) were counted and were respectively 19,000, 18,000, 16,000, 15,000 in plots I, II, III, IV. The plots were treated as follows:—

- Plot I.—Untreated for comparison purposes.
- ” II.—In March 1920 all low cover was felled and the upper canopy opened by a “light” thinning.
- ” III.—In June 1920 treated as plot II but the “light” thinning was heavier.
- ” IV.—In March 1920 treated as plot II but clear felled in June 1920.

In order to make the results clear it may be stated that the South Raipur forests are situated in a frost-free tract, the soil is apparently well aerated and natural regeneration usually excellent. It is too early to draw any conclusive results from the experiment but plot IV (clear felled) looked extremely encouraging in March 1921. The ground is thickly carpeted with seedlings a few inches high and apparently very healthy; though the number enumerated is undoubtedly much reduced yet those surviving are more than sufficient to restock the area and have a very promising appearance. In addition to the above all the cut back advance growth of sal has coppiced magnificently and several shoots were measured eleven feet high, the majority being 3' 6". The area has every hope of successful and complete regeneration. Plots II and III are similar but the results not nearly so good. They appear to prove the theory that sal regeneration requires complete removal of top cover.

The sample plot created in Khairi Range, Jubbulpore-Narsinghpur Division in 1906 to ascertain the reproduction of frost-bitten teak trees was measured in January 1921 and the results show very slow growth.

In Saugor Division measurements of thinned and unthinned coppice shoots are being carried out.

Bombay.

Growing *Casuarina* without water has been tried in three places. In one place where the ground is hard and low the result has been failure but in the other two places the experiment is expected to be successful.

The experiment of applying green leaf manure to *Casuarina* plants to minimise watering expenses was tried in January. About half a head load of green *soppu* was spread around each plant over about an acre. The plants are in good condition and further results will be given in next year's report.

Madras.

During the year the following sample plots were transferred by the Imperial Silviculturist:—

(I) *South Malabar District*.—Eight sample plots in Nedun-gayam to ascertain volume increment and development of teak plantations at different ages, on different soils, and under different conditions of treatment. They were laid out originally in 1916-17.

(II) *Tinnevelly District*.—Near Mundanthorai, two sample plots dealing with volume increment and development of teak copice with standards, and two sample plots dealing similarly with the teak plantation near Kariar. These four plots were laid out in 1916-17.

(III) *South Cuddapah District*.—One volume increment sample plot of *Pterocarpus santalinus*.

The second series of measurements in all the above Dehra Dun plots should be recorded in 1922, five years after the first.

(IV) *North and South Mangalore Districts*.—One sample plot in Parappa to record the periodical girth and height increment of *Hopea parviflora* was taken over from the District Forest Officer, South Mangalore.

Besides the above, five sample plots were opened during the year, of which two, in the Devechala Reserve, are to record the girth and height increment, and the number of stems and volume increment of *Hopea parviflora*. The remaining three sample plots comprise two in the Nalkur reserve, to ascertain the periodical girth and height increment of *Hopea parviflora*, and one in the Pilarkan reserved forest, dealing with the number of stems and volume increment in a pure crop of *Hopea*.

There are 17 experimental plots in the deciduous forests at Dhoni, which have for their object the following:—

(a) Twelve plots for the study of the method of converting the existing deciduous forest into evergreen by the sowing of *Hopea parviflora* (five plots), *Artocarpus hirsuta* (five plots), *Vateria indica* (one plot) and *Mangifera indica*, the wild variety (one plot).

To come to any definite conclusion from the above experiments would be premature, as certain factors should be considered, such as the poor fertility of seed of any particular year, unusually severe drought, possible carelessness and apathy on the part of subordinates and so on. So the same experiment in the same plots will be carried out in 1921-22 with slight check-modifications. For the present it may be assumed that:—

- (1) To establish a crop of *Hopea parviflora*, *Artocarpus hirsuta*, *Vateria indica* or *Mangifera* in a clear-felled area of deciduous forest is very difficult if not impossible.
- (2) That for these plants to survive the scorching days of summer they must have overhead shelter, and be protected from the afternoon sun.
- (3) That consequently, in a purely deciduous forest thinly stocked with trees, all of which are completely deciduous, and whose stems and branches alone are insufficient to throw an appreciable amount of shade on the ground, it would be impracticable to raise directly a crop of the evergreen species enumerated above in localities where drought is severe and long in the hot weather.
- (4) That the condition that every tree is completely leafless in the summer months is not normal, at least in the deciduous forest near the locality experimented with, where *Schleichera trijuga*, *Trema orientalis*, *Dalbergia sissoides*, *Albizia Lebbek* and *procera*, and *Swietenia macrophylla* are in full leaf even in March, the hottest month. The last-named species, though in reality an exotic, is now reproducing itself naturally here. So by a preliminary step of increasing the proportion of such hardy light-demanding evergreen species in a typically deciduous forest, if attended with success, there is every reason to expect good results from the subsequent introduction of valuable shade-bearing and shade-demanding evergreen species in localities where the rainfall is sufficient.
- (5) That the weeding of plants in their infancy tends to lessen the number of casualties.

The remaining five experimental plots in the Dhoni deciduous forests have for their object the establishment of a pure crop of deciduous species in deciduous forest of mixed species.

Nursery work.—Experiments have been and are being carried out in the nursery at Dhoni with special reference to the determination of:—

- (1) The best method of sowing.



Photo. by W. Hart (April 1921).

Photo. Mech. Dept., Thomason College, Roorkee.

Natural regeneration of *Switenia macrophylla* under Teak at Dhoni, Malabar.

- (2) The general factors relating to the time of collection of seeds such as season of sowing, age of seed, source of seed, etc.
- (3) The storage of seed.
- (4) Method of transplanting and at what age.
- (5) Factors affecting development in early youth, such as overhead and side shelter from sun, direct rain as opposed to drip, etc.
- (6) Method of stimulating germination.

In South Malabar District (Nilambur and Nedungayam, from 50 to 100 feet above mean sea level. Annual rainfall from 120" to 140") investigations being undertaken are:—

- (a) To ascertain whether *Hopea parviflora* and *Artocarpus hirsuta* can be successfully introduced as an underwood for teak in the teak plantations at Nilambur and Nedungayam, and if so, at what age of the teak plantation could each of the two species be most successfully introduced.
- (b) The best means of converting the deciduous natural forest near Pulimunda into an evergreen forest by sowing or planting.
- (c) The introduction of box-wood species such as *Tetrameles nudiflora*, *Cedrela Toona*, *Bombax malabaricum*, etc., into the above forest.

To express the results with *Hopea* in percentage of surviving healthy plants, sowings and plantings under one year old teak showed no surviving plants at the end of a year. Sowings and plantings under teak after the first thinnings resulted in fourteen per cent. of healthy plants at the end of a year; sowings and plantings under teak after the second thinning resulted in 2.6 per cent. of healthy plants at the end of a year—or rather at the end of the following month of March.

There are no survivals of *Artocarpus* in any of the plots.

The evergreen species being tried in the Pulimunda forests this year for the second series of experiments are:—

Calophyllum tomentosum, *Hardwickia pinnata*, *Dipterocarpus turbinatus*, *Dysoxylum malabaricum*, *Mesua ferrea*, *Bischofia javanica*, *Gluta travencorica*, *Artocarpus hirsuta* and *Hopea parviflora*.—Details of results regarding these and the boxwood species can only be recorded in the next report.

North and South Mangalore Division. (Parappa, Malkur, Subladi, etc. Elevation from 50 to 150 feet above mean sea level. Annual rainfall from 120 to 160 inches.)

The experiments carried out in these Divisions aim at (a) Determining the best method of uncovering a young crop of *Hopea parviflora* both in a deciduous and in an evergreen or semi-ever-

green type of forest. Some years must elapse before any conclusive results are arrived at.

(b) Ascertaining the best way of inducing natural regeneration of *Hopea parviflora* in an area where *Hopea* seed-bearers exist but regeneration is absent; also to find out the best method of artificially regenerating an area apparently suitable for growing *Hopea* but where no *Hopea* seed-bearers exist.

(c) Determining the age at which *Hopea* seedlings can be most successfully transplanted and to what extent if any, root pruning and weeding would be beneficial.

(d) Investigation into the coppicing powers of *Hopea parviflora* in areas under regeneration.

(e) Investigating the cause and effect of good and bad seed years with reference to the more important species, deciduous and evergreen.

Burma.

On the return of Mr. Blanford from leave on the 23rd December 1920 the new post of Silviculturist was formed. During the short period of the year remaining but little actual research work could be done and the Silviculturist has been occupied in getting in touch with the work going on in some of the more important Divisions. A commencement was made by touring throughout the Tharrawaddy Division where all regeneration areas were visited and results of work in the previous rains noted. During the latter part of this tour the Silviculturist was joined by Mr. S. H. Howard, Silviculturist, Dehra Dun, who gave much valuable information on research methods. During February a short visit was made to the Burma Mines Corporation's workings at Namtu and proposals were drawn up in connection with the supply of mining timber and fuel for the mines. The existing method of working these forests under coppice with standards cannot possibly supply the Corporation's requirements *in perpetuo* and there is likely to be great difficulty in obtaining the necessary timber, more especially for the temporary mine props and lagging that are required. The only possible solution of the problem is to commence plantations on a large scale of some rapid growing but suitable timber. Eucalyptus has been suggested and will be tried. The size of the timber required is mostly about 10" to 12" in diameter but a certain amount of somewhat larger timber to give planks for mine lagging is also necessary.

Collection and supply of seed.—The Silviculturist has taken over the arrangements for the collection of seed required by Divisional Forest Officers when it is not available in their own Divisions, and also the supply of seed of all sorts for silvicultural or botanical work for other Departments or outside Burma. The indents from other countries, especially for bamboo seed, are increasing greatly.

Collection of statistics.—Many of the older sample plots made in the Province have been lost sight of but as these were generally made with insufficient experience of the requirements of sample plots, their loss is not greatly to be deplored. Of late years several sample plots have been made in Bhamo, Katha and Mogok Divisions by Working Plans Officers mostly in connection with In (*Dipterocarpus tuberculatus*) and there are several plots in North Toungoo Division and in Divisions in the Hlaing Circle made by the Research Officer. A number of these were made in In forest to ascertain the rate of girth increment. Several of these plots have been remeasured during the past year and show that the girth increment of In is extremely slow and averages very considerably less than 0.5 inch per annum. In Mogok the average is only about 0.2 inch. The figures have not yet been analyzed but there are a number of plots from which it will be possible to get valuable figures in the near future.

The few figures for Kanyin (*Dipterocarpus turbinatus*) received so far show that the girth increment of this species is considerably faster.

Records of all permanent sample plots are being collected in the Silviculturist's Office. The work in experimental silviculture is so urgent that until assistants are available it is doubtful if much can be done to lay out permanent sample plots for the present. Efforts will, however, be made to train a sample plot party during the coming year.

The collection of rough volume data for teak and other important species is a matter of some urgency, more especially in view of the decision to fix a yield by volume. In Tharrawaddy Division considerable data have already been obtained, in the case of teak, by the timber extraction staff, thanks to the assistance given by Mr. A. E. Elmore, Extra Assistant Conservator of Forests, in the case of other species by subordinates entrusted with the revenue marking of timber in the clear felling in regeneration areas in that Division. Wherever possible timber is measured and marked for duty at stump and the volume of timber obtained from each tree is noted down in the original list of trees marked in which also the breast height girth before felling is noted. The data given in this way are necessarily rough but will allow of the compilation of volume tables years in advance of accurate tables made by more reliable methods.

Experimental silviculture.—At present this is mainly confined to regeneration and in particular to regeneration in bamboo forests. Notes of interest have been received from Divisional Forest Officers but this report will attempt rather to summarise progress in the principal problems that confront the forest officers in this province

and to note on the special points which require early confirmation. The areas undertaken and the cost have been dealt with elsewhere.

(2) One of the chief problems has been the late, uneven germination of teak seed resulting in a small and weakly seedling in the first year. It has been proved that teak seedlings resulting from early germination can attain 4' to 5' in the first rains, but as a general rule teak seedlings, especially when growing in paddy, are of uneven growth and often only 2 or 3 inches high when the paddy in the taungya is reaped. The paddy undoubtedly has a considerable effect on the growth of the teak seedlings as seedlings grown without paddy, provided they are well weeded, are always stronger and more vigorous. The reason in the past has usually been that most of the teak seed has not germinated until after the paddy was sown and the roots have been choked by the paddy. Paddy is however very shallow rooted and, if the teak can get a start on the paddy, a vigorous seedling with fairly large leaves usually results. Early germination of teak seed has therefore long been a subject for experiment. The difficulty seems to be a very much greater one in Upper Burma Divisions than in Lower Burma probably because the early rain in Lower Burma is more continuous and regular. As long ago as 1874 Mr. Gamble discovered that heaping teak seeds and watering them led to early germination and this method is still found, at any rate in Lower Burma, to give very excellent results provided the seeds are sown before they actually germinate in the heaps and at a time when the rain and moisture in the air can carry on the process of germination.

(3) Of late years burying the seed for a year before sowing has been found to give excellent results in Upper Burma but experiments in this method of treatment in Lower Burma have been generally unsuccessful as the seed, unless buried in dry ground under shelter from the rain, usually gets too wet and goes bad.

(4) In Tharrawaddy Division very successful results were obtained by broadcasting teak seed on level places, as soon after the taungyas were burnt as possible, and transplanting the early germinating seedlings to stake. The resulting plants were 2' to 3' high at the time the paddy was reaped. It is doubtful however if this method would prove successful in Upper Burma.

(5) A most interesting method of planting teak which has led to astonishing results is the planting of root and shoot cuttings of one-year-old nursery seedlings. This method of planting has no doubt been tried by many people with fair results but the credit of showing the best method of using these "stumps" belongs to U. Po Thin, Extra Assistant Conservator of Forests, K. S. M., A. T. M., Katha Division. The "stumps" should be taken from healthy seedlings with well-developed shoots and roots. The shoot is cut off 2 inches above the collar and the root 6 inches below the collar. No special



Photo-Mech. Dept., Thomason College, Roorkee. Photo by H. R. Blanford.
A 1920 Teak Taungya in Zigon Division planted 6' x 6'. Photographs taken 15th July, 1921.
The upper photo shows area before weeding : the lower shows the same area after weeding.

care is required in planting except that the collar must be level with the surface and not below it. To obtain the best results, the "stumps" (as they may for convenience be called), should be planted out before the new leaves show and in Katha the best time for planting was found to be in the first half of May. Stumps planted thus in a freshly burnt *ya* attained a height of 4' by August and 8' to 12' by the end of the growing season. In a taungya in which planting had failed in the previous year a height of 3' to 4' was attained. It is perhaps needless to note that planting up failures in the second year is always a very difficult and expensive operation and this method of planting stumps promises to be the most suitable method. In a taungya where paddy is sown the growth of stumps is so vigorous that the paddy does not get a chance but by delaying the planting until a little later a less vigorous growth is obtained which would not interfere with the paddy. In preparing seedlings for this method it would probably be best to prick the seedlings out into nursery lines in order to obtain strong healthy seedlings.

(6) The main idea in obtaining a strong and healthy growth in the first year is to reduce the cost and labour of weeding and, apart from the main consideration of obtaining healthy and well stocked plantations this is the direction to which our main efforts are directed. It must be remembered that in Burma the daily pay of a coolie has always been at least 8 annas. The rate has now risen to at least 12 annas and in many places, especially in Upper Burma north of the dry zone, to one rupee. One of the most fruitful methods of reducing the cost is to organise and train a permanent staff of labourers for forest work. There can be no doubt that the experienced labourer who understands the work can do at least half as much work again as the inexperienced labourer we have up to recently been contented to rely on. At the same time Burma is severely handicapped by the higher cost of labour. Nevertheless our costs compare favourably with similar work in India with cheaper labour. In Bengal for instance Mr. Shebbeare, in a record about to be published, placed the cost of establishing a plantation at about Rs. 20 per acre exclusive of fencing. The labour is paid at rates of from 3 to 6 annas per day, say average 5 annas. Even in the old days in Burma this would have amounted to Rs. 32 per acre at 8 annas per day and at present rates it would be Rs. 48 per acre. In Burma we may I think expect in general, at any rate in Lower Burma, the following expenditure per acre at a maximum for all species:—

	<i>Rs. a. p.</i>
Cost of seed	2 0 0
Cost of planting paid to taungya cutters	6 0 0
Weeding in the second year—	
1st weeding	3 0 0
2nd weeding	1 8 0
Third year	2 4 0

Ordinarily, at any rate in teak plantations, the crop should be established after the third year and a creeper cutting and possibly unremunerative thinning in the 5th or 6th year and again between the 12th and 18th years would be all that is necessary.

	<i>Rs. a. p.</i>
Fifth year. Cleaning, creeper cutting and possibly thinning	3 0 0
Unremunerative thinning 12th to 18th year	3 0 0
TOTAL .	20 12 0

In some Divisions it may not be found possible to reduce the cost of planting by taungya cutters below Rs. 12 or Re. 1 per 100 plants and the cost would then be Rs. 26-12 per acre. These rates are calculated on labour at 12 annas per day.

The above is considered an outside estimate and should be capable of very considerable reduction in the cost of weeding in the second and third year. More especially should this cost be reduced in the case of teak and faster growing species that can be established with greater ease. The above costs do not however include everything. Taxes are remitted to all taungya cutters and increase the cost of formation by Re. 1-4 per acre. Establishment and supervision charges are not included as these are annually recurring expenses and not capital cost. A small increase should also be made for such items as survey and inspection paths.

(7) One of the most promising methods of reducing the cost of weeding is the broadcast sowing of accessory species. This is analogous to the sowing of *Leucaena glauca* in the teak plantations in Java. The idea is to get up a dense crop of accessory species to assist in keeping down the weeds. The ideal mixture for a light-demander is for the accessory species to be slightly slower growing than the major species but to cover the soil rapidly. So far Binga (*Stephegyne diversifolia*) has proved by far the best for this purpose. It frequently comes in naturally in *yas* in a dense mass and it has a small seed suitable for broadcast sowing which is cheap and easy to collect. It also grows at any rate for the first 2 or 3 years a little slower than the teak in most *yas*. Hnaw (*Adina cordifolia*) has also proved very suitable for this broadcast sowing. Among others that are cheap and easy to broadcast and which have been found suitable are:—

Pynma (*Lagerstroemia Flos-Reginae*).

Leza (*Lagerstroemia tomentosa*).

Myaukchaw (*Homalium tomentosum*).

Thitpayaug (*Nauclea excelsa*).

Of the above Pynma germinates very readily and forms a useful stock in the event of failure of the major species. It also stands a lot of shade and can probably continue as an understorey with the more rapid growing and lighter crowned species. In teak

plantations where Binga or Hnaw have been broadcasted or have come in naturally the expense on weeding in the second year has often been more than halved and only one weeding has been found necessary.

(8) In connection with accessory species it may be mentioned that in many taungyas dense masses of Myaukngo (*Duabanga sonneratioides*) and Mau lettan (*Anthocephalus Cadamba*) have appeared from natural seed. At first these were welcomed but it has been found that they grow so fast that they rapidly suppress all other species unless thinned out heavily or cut back. The extraordinary rate of growth of these species has been shown in many places in the last year. Early in the rains when the first weedings were done in the second year plantations Myaukngo and Mau were interfering with the major species and were left. By the end of the rains they formed a dense thicket up to 18' high completely suppressing the major species. At the same time the areas on which Myaukngo had established itself were very free of weeds and creepers and where the growth was not too dense valuable shade bearing species had undoubtedly benefited by the shelter and protection given to the soil. Considerable use can therefore be made of Myaukngo as a nurse, especially with Pyinkado (*Xylocarpus dolabriformis*) provided care is taken to keep it well thinned and not allow it to suppress more valuable growth.

(9) Mr. Dawkins, Divisional Forest Officer, Zigon Division, has paid great attention to the question of early burning as compared with fire protection of young regeneration areas. The advantages of early burning in later stages of growth when the canopy has formed and the area is free of grass and weeds are probable, as much of the expense of fire protection can be saved but it has not yet been proved that early burning in young regeneration areas of 2 to 5 years of age is an adequate method of protection. For one thing early burning is not an easy operation. If it is to be done early enough to avoid a serious fire it must be done when the growth is still too moist for the fire to spread. This means efforts to burn small patches repeatedly and over large areas this is very difficult to do. Considerable further investigation into this question is necessary before a definite decision can be reached. It has, however, been proved that a burning of the paddy straw and weeds after the first year considerably reduces the weeds and encourages healthy shoots from the tree seedlings of the more valuable kinds. Indeed very few of the tree seedlings are killed by fire. Myaukngo, Mau, and Baing are however killed outright as are some of the more evergreen species such as Kanyin.

(10) Up to the present very little attention has been paid to nursery treatment. Nurseries, usually of a rough and ready kind, have been used for the supply of seedlings for the patching of

blanks and nurseries have frequently been used for transplanting Yemane (*Gmelina arborea*) seedlings which seem to thrive better than when seed is sown at stake. At the same time nurseries are assuming more importance in the regeneration of low-lying and swampy areas in the Plains Reserves. In Bengal, nursery treatment has received much more attention, thanks mainly to the assistance of Mr. P. T. Russell of the Cinchona Department, and considerable use is now made of nurseries for supplying transplants for taungya areas. While it is doubtful if we shall ever do much planting of such species as Pyinkado and Taukkyan which come up easily from seed and are rather difficult to transplant, planting of nursery seedlings might give better results than sowing in the case of teak, Yemane, Pyinma, Kokko (*Albizia Lebbek*) and many other kinds by ensuring a more early establishment of the crop by rapid early growth. The question of nursery treatment therefore merits more attention and the records on the taungyas of Bengal which contains much valuable information in this respect will be of great interest to Forest Officers in Burma.

(11) The Plains forests in Lower Burma offer a different problem. Generally these forests are the few remaining pieces of the old forests which not so very long ago covered a great portion of the extensive paddy plains of Lower Burma. In some cases the forest has survived because the ground is slightly higher than the rest of the plain and was not therefore suitable for permanent cultivation. Such areas are usually fairly well drained and regeneration by the taungya method can be adopted. Many of the reserves, especially near the railway line, were however cut out of the original forests and preserved when it was seen that the original forests would rapidly disappear with the increase of cultivation. In these cases permanent cultivation extends up to the Reserve boundary and has entirely altered the natural drainage of the country. The result is that the water cannot escape rapidly from the reserve and waterlogging results. The original forest was established under quite a different condition and it is exceedingly difficult to reproduce it. Some success has been obtained in allowing villagers to plant vegetables and sugar-cane on condition that they sow or plant tree species and tend the seedlings; but much of the area is too waterlogged even for sugar-cane. A fair amount of success has been gained with Andamans Pyinma (*Lagerstroemia hypoleuca*) and Andamans Padauk (*Pterocarpus dalbergioides*), while on slightly higher ground Pyinkado and Taukkyan (*Terminalia tomentosa*) promise well. Eucalypts have been tried in Tharrawaddy and North Pegu Divisions among other places and have failed. Experimental plantations of fuel-yielding species in the Kamase Reserve in South Pegu Division have not proved a success owing to waterlogging and it has been decided to

disafforest this area. The latest method of planting attempted was to transplant nursery seedlings on beds 2' 6" high. Owing to heavy floods nearly all the tree seedlings planted out in 1920 were killed, and it was found that the beds had sunk to a height of only 1 foot. The bamboos planted out in 1919 have done well.

(12) *Indaing*.—No experiments were recorded during the year of any attempt at inducing natural regeneration of *In* but Mr. Shirley (Bhamo Division) reports that an experiment of clearing over young *In* regeneration proved fairly successful. An experiment of making a seed felling for *Ingyin* proved a failure as a dense mass of *thekke* grass sprang up and the weeding carried out on a small portion of the area proved very expensive. Too much cover had been removed. A further experiment in cutting only undergrowth and low cover of valueless teak is being made.

General.—The following are general notes of interest on experiments reported by Divisional Forest Officers:—

(13) *Eucalypts*.—Mr. Clifford, Southern Shan States Division, reports that the attempt to fill up gaps in coppiced areas with *Eucalypts* failed. Seedlings of *E. Globulus* and *citriodora* were raised in the nursery but died off before the cold weather. In view of the proposal to experiment with *Eucalypts* for the supply of the requirements of mine timber for the Burma Corporation at Namtu, this is disappointing. There is no doubt that the nursery treatment and transplanting of *Eucalypts* is a matter of considerable difficulty and it would probably be as well to depute an officer to the Nilgiris to study methods used in connection with *Eucalypts* there. Members of the Burma Corporation who have made enquiries in Australia say that experts there advised that there should be no difficulty in growing *Eucalypts* at Namtu.

Experiments with *Eucalypts* in Lower Burma have mostly proved a failure though some few are surviving and thriving in a fairly swampy area in one of the Plains Reserves in Tharrawaddy Division.

(14) *Evergreen species*.—The Divisional Forest Officer, South Tenasserim Division (Mr. Mathews), reports that he is sowing several of the more important evergreen species in taungya. Experiments with regard to the regeneration of species growing in the heavy evergreen forests of Tavoy and Mergui is of great importance in view of the fact that these forests are among the best stocked and therefore most suited to commercial exploitation on a large scale in the Province. The result of these experiments must be awaited.

(15) *Reafforestation*.—Efforts are being made in the Bhamo Kachin Hills to reclaim land which, owing to repeated taungya cutting on a short rotation, has become devoid of all growth except

bracken fern and is now unfit even for temporary cultivation. An attempt is also being made to persuade the Kachins to plant rapid-growing species in their taungyas to reclothe the slopes with forest growth and thus to prevent further areas from being ruined.

Mr. Shirley writes as follows:—

“The experimental sowings of Maibu (*Alnus nepalensis*) were not very successful so far as can be seen at present, but the seedlings will probably come up again during the rains. They were mostly killed back by frost in the cold weather.

The seed was collected too late (April) and many of the cones were probably empty of seed. The Maibu does better where no weeding is done as the bracken protects it to a certain extent from frost, though the danger from fire is of course increased.

So far as can be seen sowing in lines in shallow pits gives better results than broadcast sowing though it is, of course, much harder to find the seedlings under the latter system. It is undoubtedly better to clean the seed and throw away the cones.

Silver Oak (*Grevillea robusta*) has come up well at Sinlum (6,000') Lepykha (6,000') and Lweje (3,500').

Ngu (*Cassia Fistula*) came up fairly well at Lweje (3,500') and a few Taungdama (*Cedrela Toona*) are also alive.

Other species Hnaw, Yemaue, Baing (*Tetrameles nudiflora*) and Yedema (*Cedrela species*) tried at Sinlum, Lepykka and Lweje all failed.

(16) *Miscellaneous*.—Plantations of Mulberry for silkworms at Sene and Namtu in the Mandalay Division have proved successful.

From Mandalay and Meiktila Divisions come reports of the entire failure of plantations of *Cassia Fistula* and *auriculata*. These were made with a view to the supply of bark for tanning. The sites for the plantations seem to have been badly chosen.

The Divisional Forest Officer, Lower Chindwin, reports on some experimental plots made with a view to clearing out *Strobilanthes* cheaply and regenerating teak. He also reports on some experiments made in regenerating Cutch. A certain amount of success was obtained by dibbling cutch seed 3' x 3' but otherwise the experiments have proved nothing and do not seem to have been given much supervision. The Conservator remarks that he can see no use in sporadic unregulated experiments.

5. *Publications*.—There were no publications on silvicultural matters during the year. Arrangements have been made for the issue of information of interest to the Burma Forest Officer in the form of Bulletins. The first three numbers of this series are already in the press. The series will include notes on other subjects such as Economics, Botany, Zoology, etc., a separate series being kept for each subject.

CHAPTER III.

FOREST BOTANY.

Central Institute.

The Forest Botanist was absent on leave, with the exception of the last three months only of the period under report. The work of the branch, in consequence, was chiefly confined to routine duties but some progress was made with research work under the items noted below:—

Ecology of Sal.—The result of the sowings made in June 1920 in the local Dehra Dun forests has supported the results obtained in previous years, viz., that sowings in small clearings are more successful than sowings under partial or complete overhead cover. The development of the older seedlings, also, has now clearly demonstrated the fact that, by artificial sowings in these clearings, seedlings can be raised in the local forests with little or no dying back and which attain a height of 6 feet in 6-7 years. A factor which has assumed some importance during the year with reference to the development of these older seedlings is the damage done by rats and porcupines which destroy a number of vigorous young seedlings by eating through the sappy tap-roots. It is believed that this kind of damage will be relatively unimportant when work is carried out on a large scale and the supply of vigorous young seedlings is greatly increased. A very similar state of things has been noticed in the case of damage to the seed. In bad seed years when very little seed is available in the local forests, porcupines and other animals destroy a large proportion of the seed in the artificially sown areas, whereas in good seed years practically no damage is done.

Based on the experimental work carried out under this head in recent years a group-cum-strip system of regeneration, which was outlined in a paper by the Forest Botanist in the *Indian Forester*, XLV, 1919, pp. 119-132, has been suggested for certain types of sal forest. Full details were necessarily omitted from this preliminary sketch and there has been some misunderstanding in consequence regarding the scope of the work which has already been done and of that which it is suggested should now be undertaken. An article dealing with the various criticisms which have been recently published regarding the suggested system was sent to the *Indian Forester* for publication towards the close of the year and the final proof of the Forest Record has been passed which contains the detailed account of the experimental work carried out up to date. What is now desired is that the work initiated by the Forest Botanist, working intensively on a small

scale, should be carried a stage further by getting local forest officers to test the suggested system on a larger scale than the Forest Botanist has been able to do. There is no doubt that work carried out on a large scale, in different localities, by forest officers themselves is most likely to carry the conviction which is necessary for the adoption and successful working of a practical system of forest management. On the other hand, by carrying out the preliminary work on a small scale, unnecessary expense and waste of labour and time are prevented.

It is satisfactory to note that the Conservator of Working Plans in the United Provinces has now agreed to test the proposed system experimentally on a large scale. The main principle which has emerged from the work done up to date on this subject is that, in order to accelerate the growth and establishment of sal seedlings, it is necessary to secure, as far as possible, the most favourable conditions of soil-moisture and soil-aeration throughout the year, and that these conditions can often be greatly improved by making small clearings, with a suitable arrangement and degree of side shade, and by raising the seedlings in these open areas instead of under the shade of the forest. In this way favourable conditions of moisture and soil-aeration can be secured, dense and vigorous weed growth is not produced, frost damage is prevented and the soil surface does not become injuriously hardened or compacted. Whatever the precise systems of management may be which are ultimately adopted to suit the local conditions prevailing in the various types of sal forest, it is probable that increasing attention will be paid to the importance of this principle in the Indian Working Plans of the future. Local officers in the United Provinces have initiated large scale experiments during the year for the purpose of determining the best way of applying the principle in question to sal managed under the uniform method of treatment.

Ecology of Teak.—In 1916 the Forest Botanist published the results of experiments which showed that clear felling had a decidedly favourable effect on the germination of the seed and on the development of the seedlings of teak (*Indian Forester* XLII, pp. 51-57). During the year this matter has again received attention in an interesting article by the Hon. J. W. Best in the *Indian Forester* XLVI, pp. 411-415, where the opinion is expressed with reference to teak plantations in Berar that "clear felling in strips is likely to lead to the best results." There is little doubt that the principles which have been found to apply to sal will also be found to apply to a considerable extent to teak, and it is believed that there is considerable scope now in India for ecologists working in co-operation with forest officers in devising improved methods of treatment for many of our important species,

the seedling growth of which is at present often unsatisfactory and very slow.

Root disease of sal caused by *Polyporus shoreae*.—In cooperation with Dr. Shaw of Pusa a number of healthy sal saplings at Dehra Dun were inoculated with *Polyporus shoreae* in 1916 by the Assistant Botanist, Mr. Abdul Hafiz Khan. During the year under report, several of these saplings were dug up and examined. The results so far obtained indicate that, while the fungus is unable to attack a healthy unwounded root, successful inoculations were invariably obtained when the mycelium was placed in contact with the wood in the interior of the root by means of a wound. It is interesting to note that Mr. W. E. Hiley, in his recent work on the larch in the United Kingdom, has come to the conclusion that good soil aeration is of great importance for that species and that the fungus *Fomes annosus* gains an entrance into this tree through roots which have been killed by bad soil aeration (*Fungal Diseases of the Common Larch* Oxford, 1919, p. 184). It is probable that the most effective means of controlling troublesome root diseases, such as that of the sal mentioned above and that of *Dalbergia Sisso* caused by *Fomes lucidus*, will consist in improved methods of treatment which will ensure a better condition of water-supply and soil aeration.

Spike Disease of Sandal.—In the annual report for 1917-18 the Forest Botanist drew attention to a line of inquiry which seemed to promise good results. There is a frequent connection between spike, both in *Zizyphus* and Sandal, and the widespread death of twigs caused by weak parasitic fungi and it is possible that spike is caused by a very dilute solution of an enzyme excreted by these fungi which may only be able to enter the main water and sap currents in the plant when the damage is unusually severe or prolonged, when the plant has been weakened by other factors or under other special conditions. Such a hypothesis would harmonize with practically all the theories which have as yet been advanced regarding this disease and it has received considerable support from the recent work of Mr. W. B. Brierley on *Botrytis cinerea* in England. While on leave in England recently, the Forest Botanist discussed this question with one of the leading mycologists at home who expressed the opinion that "a careful study of the enzymic relations of common tree fungi would I think be invaluable and might give the key to the whole problem." With the early addition of a Mycologist and a Biological Chemist to the staff of the Forest Research Institute it is hoped that this line of research will now be energetically developed.

Systematic Botany.—During the year 22 specimens were identified at Dehra Dun for inquirers and the Forest Botanist while on

leave studied the material in the Kew herbarium of the genus *Tamarix*. Mr. H. H. Haines is working at the Forest Flora of Bihar and Orissa, Mr. R. N. Parker is revising his Forest Flora for the Punjab, Rai Bahadur Kanjilal is working at the Forest Flora of Assam, Mr. C. E. Parkinson has completed his draft of the Forest Flora of the Andamans and Descriptive Lists are in preparation for the United Provinces by Messrs. A. E. Osmaston and P. C. Kanjilal.

Herbarium.—666 sheets were added to the herbarium during the year, the chief contributors being Messrs. A. E. Osmaston, R. N. Parker and W. J. Lambert.

Library.—19 volumes exclusive of periodicals were added.

Tours.—The Forest Botanist visited Pusa in February and gave an address on the Physiology of Disease at the Conference of Mycologists, which was also attended by the Assistant Botanist Mr. Abdul Hafiz Khan. The Assistant Systematic Botanist Mr. B. L. Gupta attended the Indian Science Congress in Calcutta in January 1921.

Indents.—A large number of indents for seeds were complied with and they were despatched to various places in India and to England, France, the United States, Egypt, Ceylon, Palestine, Abyssinia and Mesopotamia.

Burma.

An officer on special duty examined the oaks and chestnuts near Maymyo and in the Northern Shan States with reference to their usefulness as a source of tannin. He found several species which may be new and further specimens will be collected.

Many of the planted Padauk trees (*Pterocarpus indicus*) in Lower Burma have died recently, and it is believed that their death was due to a root fungus. Specimens were sent to Dehra Dun.

A few specimens were collected and named, but nothing was done in the Maymyo Herbarium during the year. A trained Superintendent was engaged in England to take charge of the Botanical Garden at Maymyo and of the Government House gardens at Mandalay and Rangoon: he took over charge before the end of the year.

Work in the Botanical Garden at Maymyo continued throughout the year. The results are already very good and, as noted last year, the Forest Department and the general public are very greatly indebted to Lady Cuffe for the splendid work she has done there.

CHAPTER IV.

FOREST ECONOMY.

Central Institute.

The year under report saw a definite step forward in the expansion of the Economic Branch. Up to the commencement of 1920, the staff consisted of the Forest Economist and his Assistant, the Tan Specialist, a Museum Assistant, and an office establishment barely sufficient to carry on the work. Since then the Secretary of State for India has sanctioned the addition of six new sections, namely:—Wood Technology, Seasoning, Timber Testing, Wood Preservation, Minor Forest Products, and Paper Pulp, and officers have been appointed to all sections except to the first and fourth. A number of Upper and Lower Grade assistants' posts have also been sanctioned for each section, which will gradually be filled up as each section develops.

The Forest Economist returned from deputation to America, Canada and England in August 1920 and at about the same time the experimental machinery purchased in the above countries arrived in Dehra Dun. A set of wood working machinery was purchased in India and was also received during the year.

In consequence of the above new development, the staff was chiefly engaged on organisation work in the several sections and little could be done with respect to new investigation, while much of their time was taken up in checking the experimental plant received and in outlining projects of work to be taken up in future.

1. Section of Wood Technology.

Until a wood technologist is appointed no work is possible on the purely technical side of this subject, such as the preparation of microtome slides to facilitate identification, and the examination of the physical properties of Indian timbers. The work was confined to finding new markets for timber and in this connection an extensive enquiry is in progress at this Institute, working in conjunction with the Utilization Circle, Bareilly, United Provinces, and a large oil factory in Madras, to test certain timbers for the manufacture of oil casks. Another enquiry is being carried out, also in conjunction with Bareilly and a well known English firm, to test Indian timbers for cotton bobbins. Similar enquiries are in hand in respect of whiskey kegs, boot lasts, tool handles and other wooden articles.

For the last ten or more years the publication of a series of bulletins has been in progress, each dealing with one of the more important Indian timbers. Up to date twenty such notes have

been published while three more are in the Press, one is under compilation and information on six others is being collected.

A complete experimental three-ply machine was purchased in America which has since been received in Dehra, and will be erected in the new laboratories. The scope for three-ply furniture and ornamental panelling is very considerable in India and as soon as the machines are working it is proposed to test our more ornamental timbers to determine their qualities and appearance when cut on a rotary section.

A saw-mill to feed the seasoning kilns and wood workshops has also been purchased, which will be one of the first plants to be erected on the new site.

A large number of enquiries from firms were dealt with, covering a variety of uses for which timber is used. A definite start was also made in collecting and publishing price lists of various Indian timbers.

2. Section of Seasoning.

Though extensive experiments to ascertain the best method of naturally seasoning timber have been in progress for some years, a separate section of seasoning was not started until a specialist from the United States Government Forest Products Laboratories, Madison, Wisc., was appointed last autumn. Soon after Mr. Sweet's arrival he carried out the final inspection of the seasoning experiments in Bengal and the Central Provinces, the results of which will be published in the near future. The development of this section is of the greatest importance and will undoubtedly lead to results of far-reaching importance. The apparatus for the four blower and three steam spray drying kilns is now coming to hand and it is hoped to erect the kilns in the cold weather.

3. Section of Timber Testing.

A new section of Timber Testing was brought into being during the year, and the services were secured of the Chief of that section in the Canadian Government Forest Laboratories, at the McGill University, Montreal. As some of the testing machines purchased in England and America have reached Dehra Dun, Major Seaman at once set to work to assemble the 100,000 lb., 30,000 lb., 10,000 lb., universal machines and the 250 lb., impact machine and it is hoped to get to work on the preliminary testing operations at once. One of the first series of tests to be carried out is on redwood of spruce to determine its value for sleepers after impregnation. A complete project according to which tests on the more important Indian timbers will be carried out is under preparation. The importance of this work cannot be over-estimated.

4. Section of Wood Preservation.

A complete experimental antiseptic pressure plant was received from England, but was not erected as the Forest Economist had not time to spare owing to the heavy calls made on his time in connection with the rapid expansion of his branch. The appointment of a Wood Preservation Specialist is sanctioned but a suitable officer has not yet been procured. The question of developing this section is of great urgency as the railways are now keenly interested in the matter, one having actually erected a treating plant while three others contemplate doing so.

The experimental sleepers laid from 7 to 10 years ago in open lines and treated by four different methods were inspected. Those laid in the lines 10 years ago and treated by the Powell process, show that *Terminalia tomentosa*, (Sain) are, with few exceptions, doing remarkably well. *Pinus longifolia* and *Pinus excelsa* are also still doing well in the dry localities, moderately so in damp, and have all been rejected after from 9 to 10 years service when placed in very damp localities. The two Dipterocarps, In and Kanyin (*D. tuberculatus* and *turbinatus*) have lasted 10 years, the cause of rejection being deterioration under the rail seat and around the spike hole. Had both the Pines and Dipterocarps been laid with bearing plates they would have lasted 2 or 3 years longer, bringing their life up to that of deodar or sal in similar localities. In the other experiments treatment with creosote and earth oil, introduced in fairly large quantities, have given better results than either treatment with a small quantity of high grade oil or treatment with chloride of zinc and creosote.

5. Section of Minor Forest Products.

At the end of the year an Imperial Forest Officer was appointed to this section, and it may now confidently be hoped that our knowledge of this subject will expand rapidly.

The question of utilising the gum-oleo-resin of *Boswellia serrata* was advanced a step further by the publication of Dr. Fowler's valuable note on the work he had carried out at the Indian Institute of Science, Bangalore. His process differs from that advocated by Mr. Puran Singh in that alcohol is not used as a solvent. The Gwalior State are about to erect a plant working by the solvent process, the results of which will be watched with great interest, while a Bombay company are applying for a lease in that Presidency; so that there is every hope of this industry developing in the near future.

The steam distillation of Rosha Grass Oil is now carried on as a commercial undertaking and is being carried out successfully by a company in the Central Provinces,

The investigation into the manufacture of charcoal briquettes has been continued. The points to be settled are whether charcoal can be ground without undue danger of spontaneous combustion but with the pressure necessary to produce a satisfactory briquette. The pressure question is shortly to be taken up at Dehra Dun, while a parallel line of enquiry is being followed by sending 500 lbs. of charcoal and 100 lbs. of binding material to a well known American briquetting firm, with which to carry out tests.

6. *Section of Paper Pulp.*

Mr. Raitt, who took over charge of this Section last December, was previous to his joining this Institute as a whole-time officer, on deputation in England in connection with the design and manufacture of an up-to-date experimental paper and pulp plant, which it is hoped will soon arrive at Dehra. Since the armistice the question of utilizing bamboo for paper pulp has received much attention both in this country and at home, with the result that one bamboo pulp factory has been erected and is running near Calcutta and another in Burma, while several similar schemes are well advanced in Burma and elsewhere. The preliminary work of carrying out new surveys of possible bamboo areas in Bihar and Orissa and Madras was undertaken during the year, while the officer in charge also paid a visit to Burma in connection with a grass pulp scheme.

As soon as the experimental pulp and paper machines are erected it is proposed to carry out a complete series of tests on Savannah grasses.

7. *Section of Tans.*

Mr. Pilgrim continued his investigations into the tan values of the chestnuts and oaks of the Shan States and of certain Dipterocarps and other kinds which occur locally. So far the results are extremely encouraging but it has not yet been possible to complete the survey by forest officers on which the possibility of utilisation on a commercial scale eventually depends.

The report of the above officer on the "Tanstuffs of the Sunderbans Forest Division" the investigations of which had been undertaken in the previous year was published by the Department of Industries, Bengal. In this case also the departmental survey has not yet been completed.

8. *Sub-section of Wood Working.*

To test the properties of timber in so far as they lend themselves to be worked up for turnery, furniture or carving, etc., a sub-section of wood working was formed towards the end of the year and a skilled wood worker appointed in charge. Not only

will these shops carry out investigation as detailed above but they will also attend to the requirements of other sections, such as preparing specimens for timber testing and the museums, making specimen boxes, office furniture, etc.

The number of enquiries on the strength, seasoning qualities and treatment of various timbers, substitutes for imported timbers, on pulp, tans, gums, resins, oils and other minor forest products, increases very materially from year to year. Formerly, when there was only a Forest Economist and his assistant to deal with such an enquiry, the answers given were often not satisfactory; with an enlarged staff of specialists, matters are now on a somewhat sounder footing, but it will not be until the laboratories and workshops are equipped and in full working that the entire benefit can be derived from this branch of the Institute.

A number of interesting exhibits, chiefly manufactured articles obtained from the Empire Forest Exhibition held in London, were added to the Wood Museums, while additions were also made to the wood collections and Minor Products Museum.

Punjab.

Seasoning of timber.—In the Kangra Division the Ohi (*Albizzia stipulata*) timber seasoning experiment undertaken at the request of the Forest Economist is still in progress.

Some 48 pieces of Bakain (*Melia azedarach*) scantlings already under experiment were sent to the Forest Economist at the Research Institute from Changa Manga during the year.

In the Jallo Resin and Turpentine Factory experiments in the closer regulation of distillation by means of the refractive index and investigation into the keeping qualities of Jallo Turpentine of grades I and II have been continued. The manager of the factory has also been carrying out an investigation as regards the colour of resin with a view to the production of a paler rosin which will command a better market.

Bihar and Orissa.

Seasoning Experiments.—The final inspection of the seasoning experiments on Jamun (*Eugenia Jambolana*) and Rohen (*Soyimida febrifuga*), which were commenced at Sambalpur in October, 1918, have been carried out and the results will be published in the Research Institute publication on natural seasoning now in course of preparation.

Charcoal experiments.—These are still in progress. Conclusions up to date are as follows:—

- (1) The ordinary paraboloidal shaped kiln of a diameter of about 15 or 16 feet gives the best results as the burning is easily controlled and the quality of charcoal produced is good.

- (2) Kilns of a larger diameter than 15 or 16 feet are much more difficult to control, are disliked by the local burners on account of their size and are no more economical to burn than the smaller kilns.
- (3) Lighting from the top gives better results than lighting from the bottom as the burning proceeds more regularly.
- (4) A kiln covering of dry or slightly moist earth is superior to a covering of mud plaster as (a) cracks are not formed, (b) the kiln can be more easily rammed as it settles, and (c) most important of all, it entails the use of the minimum quantity of *water*. The percentage yield of charcoal is the same. (No experience has yet been gained of burning dry covered kilns in a wind. Possibly they will burn too rapidly and the yield will be smaller).
- (5) Permanent paraboloidal shaped kilns of sundried bricks have proved a comparative failure as (a) the initial cost is high, (b) burning is difficult to control (c) and the extraction of the charcoal is difficult and expensive. Actually the outturn of charcoal from permanent kilns has been poor in quantity and quality.
- (6) Charcoal produced from green wood is lighter and smaller than that produced from dry wood. The volume percentage of outturn is the same.
- (7) It is not economical to split up wood into billets of regular size to obtain closer stacking as there is little gain in volume percentage and large sized charcoal fetches the best price.
- (8) The average percentage of outturn by volume of 120 tons of sal charcoal was 40 per cent. The average is steadily rising and for the last 3 kilns burnt was 50.6. Figures for percentage of outturn by weight are not available as the weighing machine was found to be unreliable.
- (9) The average cost of producing 120 tons charcoal and transporting it to the railway with a lead of 7 miles has been 11 annas per maund. For the last three tons, the work being very strictly supervised, the average was only 0.5-8 per maund. These figures exclude overhead charges which would not however amount to much.
- (10) Female labour is cheaper and better than male labour for the actual work of constructing and burning the kilns.
- (11) The health of labour engaged continuously on the work of burning and extraction suffers considerably. It has

thus been found necessary regularly to interchange the various tasks.

- (12) No definite results have yet been obtained in producing charcoal from species other than sal except in the case of *Eugenia Jambolana* which gives a good hard charcoal and which can be burnt in the same kiln as sal as the rate of combustion is the same.

Bengal.

The problem as to the best means of utilising as fully as possible all the produce of a fifty acre clear felling coupe of sal mixed with its usual associates and a considerable underwood of miscellaneous evergreen species was investigated at Sukna, Kurseong Divisions during the year. The coupe had to be cleared by the beginning of May in order to be sown up with sal and field crops.

The Darjeeling-Himalayan Railway Company were approached and they considered that the amount of timber and fuel to be transported justified them in running a siding of about half a mile into the coupe. The Forest Department provided the necessary sleepers free, the Railway found the rest of the material and bore the construction charges. Felling and dressing of timber and stacking of fuel was done by contractors under the Forest Department.

All sal timber that was fit to cut into really good logs *i.e.*, straight lengths of 20 ft. and over was so converted and dragged to the siding. Logs of any girth over 4 ft. of this length are too heavy for the local carts to manage, while shortening the length reduces the value per c.ft. very seriously, so a donkey engine was rigged up as a skidder which dragged the logs from all over the area by wire rope to the siding and also loaded them into the railway trucks. This timber was then taken to the big depôt at Siliguri, the junction of the Darjeeling narrow gauge railway with the Eastern Bengal Railway metre gauge line, and sold there.

Sal unfit to give long logs was sawn by Nepalese sawyers into B. G. and M. G. special sleepers in fulfilment of a large order; the rates paid for special sleepers are considerably higher per c.ft. than those for standard sleepers.

There is a good demand for $\frac{1}{2}$ inch planking of most of the other species for local use as tea chests and a small saw mill was under construction to use this material but did not actually start work during the year. A considerable quantity of Simul and other logs however were collected beside the saw which has since got to work and cuts about 2,000 square ft. of $\frac{1}{2}$ inch planking daily. The rest of the soft wood timber was sawn by hand into $\frac{1}{2}$ inch planks by sawyers employed by local tea gardens. Tops of sal and other species and most of the underwood was cut into stacked firewood and taken by local tea gardens as engine firewood. It

was also sold in small quantities to bazaar firewood dealers, and a new trade was opened in firewood by train to places in the hills, both for domestic use and for hill tea gardens. It was found cheaper to get this firewood from 20 miles away by train than to cut in the hill forests within 3 or 4 miles of the garden. It is expected that this trade will expand with the saw in full working order next season.

Assam.

The increasing value of 'Agar', a deposit only found in the wood of *Aquilaria Agallocha*, has led to experiments being initiated with a view to inducing the formation of the product in various forms of wounds, borings, etc.

Burma.

The remarks made about Burma in Chapter IV of the Progress Report for 1919-20 can, with a few additions, be held to apply to the year under report. A good deal of work has been done at Rangoon, but most of it is of a preparatory nature, and it would be premature at present to attempt to go into any great detail as to the developments in economic research which are likely to take place in the near future.

Proposals for timber research in Burma are taking the form of a sawmill, workshop and laboratory in the Government Timber Depôt, Rangoon. A good deal of the machinery has been purchased, but up to the present construction had been limited to (1) a temporary sawmill, (2) Office building and (3) Dry Kilns.

Mr. L. V. Teesdale, Timber Seasoning Expert from the Madison Laboratory, U. S. A., arrived in Burma in September 1920, but it was not until after the close of the year under report that a start could be made with actual construction of the experimental dry kilns, consisting of a battery of three chambers of the Tiemann type. Within a few months it is hoped that construction will be started on the permanent sawmill and the workshop.

One of the most urgent needs of the Province is an *economic survey* with a view to ascertaining the supplies available of various timbers. A few well known timbers such as Pyinkado (*Xylia dolabriformis*), Taukkyan (*Terminalia tomentosa*), In (*Dipterocarpus tuberculatus*), Kanyin (*Dipterocarpus turbinatus*) etc. are so widely distributed and are known to exist in such large quantities that there is no immediate fear of over-exploitation. But with a number of other species the case is very different. Their distribution is more localised and diffused. It is a matter of difficulty to extract any considerable quantity for experimental sale and it is impossible to say on what scale extraction can safely be conducted without risk of over cutting.' Under this head may be

mentioned Hnaw (*Adina cordifolia*), Thitkado (*Cedrela Toona*), Thitka (*Penatace burmanica*) and Tamalan (*Dalbergia Oliveri*). Some enquiries have already been started but progress in a general economic survey must naturally be extremely slow until the staff of officers for general duty and for research work in Burma has been very much strengthened. The time of the Conservator, Utilization Circle, is already so completely taken up with the multifarious duties which have devolved upon him that he has not been able to give much personal attention to the subject.

A very useful publication under the title of "A Handbook of the Forest Products of Burma" by Mr. Alexander Rodger, O.B.E., I.F.S., was published during the year by the Superintendent, Government Printing, Burma. The book contains a great deal of very useful information with regard to Burma timbers and other forest products.

Central Provinces.

Seasoning of Timber.—The seasoning experiments carried out under the direction of the Research Institute have now been completed and it is expected the results will be published shortly.

In connection with the determination of the practicability or otherwise of seasoning Allapilli teak by girdling, 133 teak trees were girdled in November 1918 of which 51 trees were felled in November 1920 and 5 in March 1921. The results so far obtained show that (a) even after 2 years and 4 months from girdling the timber at the centre of the log is still unseasoned and (b) the tendency to splitting and shattering on felling is such that girdling cannot be adopted as a practical method of seasoning in Allapilli as the loss thereby caused is enormous.

Suitability of timbers.—One hundred scantlings of log-seasoned Karai (*Saccopetalum tomentosum*) were sold at a cheap rate to a Bombay firm for trial in the form of billiard cues in March 1921. The firm will be asked later whether the cues made from them have proved satisfactory.

Lac experiments.—Lac experimental work on *Schleichera trijuga* (Kusum). It has been decided to introduce departmental lac work in South Raipur but as existing contracts have not yet expired, only preparatory measures have so far been possible. A casual inspection of the Kusum trees of this division growing in mixed and usually thick forest shows them to be tall, wide-branching trees and by no means resembling the low crowned, much-branched, gooseberry-bush-like typical Kusum tree on which lac is usually grown. Their form is such that it is physically impossible for any man to climb anywhere near to the tender twigs on which alone lac will grow. It is obvious therefore that the infection and subsequent

collection of lac from such trees would be difficult and hazardous. A number of trees have therefore been completely pollarded, the point of pollarding being dictated not so much by scientific principles as by the physical incapacity of even the most expert of jungle tribes to climb more than a certain distance along the wide spreading branches. Usually, however, branches were cut above and not below a fork. The time of the year for such pollarding had to be decided on theory only. It is generally believed that trees in this province have a period of rest in the cold weather (January-February) and this period was selected. As however lac is a bivoltine insect two pollardings are required each year, one in preparation for each brood. The cold weather pollarding is assumed to prepare the trees for the next cold weather infection about twelve months later. The June-July infection remains; and it was decided to pollard in July-August in preparation for this, for the following reasons. Observations in connection with the study of lac point to the fact that the growing season of trees in India (*i.e.*, the period of active metabolism) which commences usually in the hot weather and dies away sometime in the autumn, is divided by a period of almost complete cessation during the rains, induced firstly by the reduction of osmotic pressure of the sap to zero by the water-logging of the soil so that the sap cannot rise in the trees, and partly to the reduction of transpiration due to the water vapour saturation of the atmosphere. Though this theory was not proved, it was assumed, and trees were pollarded in July-August for infection with lac about 12 months later in June-July.

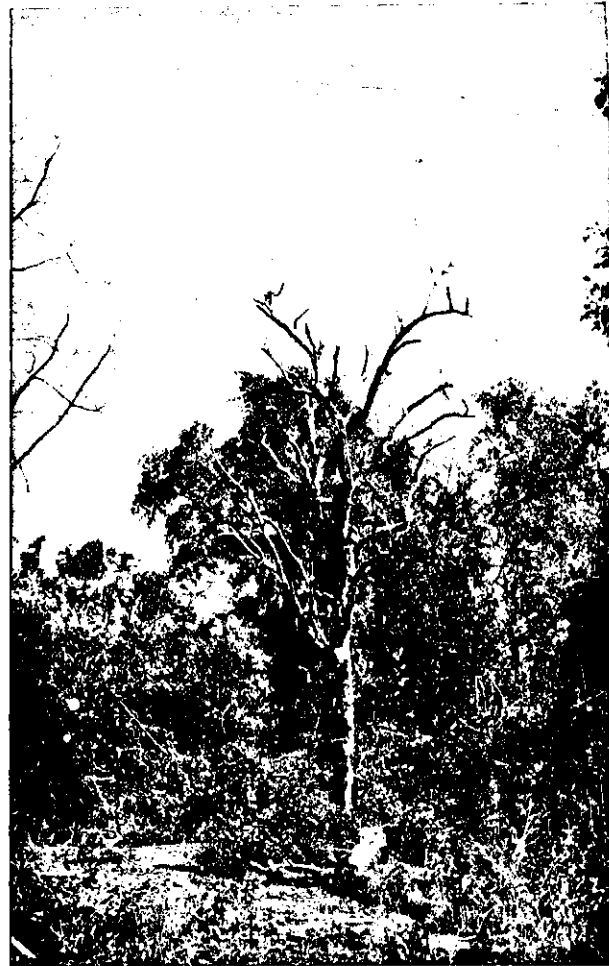
One hundred and thirty Kusum trees were completely pollarded in August 1920. It is uncertain when shoots first appeared but in February at each pollarding point there was a dense mass of shoots averaging 1' long and 2" girth at the base with a maximum of 3' long by 4" basal girth. One such tree at Gattasilli was pollarded in August 1920. It will undergo another period of growth in the hot weather 1921 before it is infected with lac. One curious result of this pollarding was noted. Pollarded trees retained their leaves fully one month longer than neighbouring unpollarded trees. By a mistake in the interpretation of orders, about 10 of the above trees were not completely pollarded and about a dozen vertical branches were left on each. These trees failed to produce pollard shoots; and it would appear that all the nourishment of the tree had passed into these dozen branches left.

About 5,000 Kusum trees were pollarded similarly in February-March 1921. March is a little late as this year some of the trees had already begun to produce new leaves and flowers. In early April many of these trees were already producing pollard shoots. At the same time as these trees were pollarded they were also freed from crown shade by felling adjacent trees, a procedure shown to be



Photo.-Mech. Dept., Thomason College, Roorkee.

Kusum tree pollarded in August 1920,
photographed in March 1921.



Kusum tree pollarded in February 1921
and photographed the same day.

necessary by the results of the work in the previous rains. A photograph of a tree pollarded in February and photographed on the same day is shown at Plate VI.

Bombay.

Fibre.—Tali Palm fibre obtained from the leaf stalks was sent to—

- (1) The Ganges Rope Co., Calcutta.
- (2) The Western India Rope Co., Bombay.
- (3) The Fibre Expert to the Government of Eastern Bengal and Assam, Dacca;

Report from (1) is as follows:—

“The Tali fibre sent to us for experimental purpose is of no use for rope making. The fibre is very brittle and cannot be softened even after batching the fibre for six months. We cannot say what other utility it has.”

Reports from (2) and (3) are awaited.

CHAPTER V.

FOREST ZOOLOGY.

Central Institute.

INSECTS OF THE SAL:—Borers.—In the area of the epidemic occurrence of *Hoplocerambyx spinicornis* in Thano forest, Dehra Dun, observations were continued on the plan of previous years, involving enumerations and plane-table surveys. Particular attention was paid to the effects of edaphic and climatic conditions on the incidence of the borer, which is now correlated with annual rainfall. The recognition of a connection between the periodic abundance of the borer, the resistance of the host-tree to attack, and rainfall during the flight period of the beetle has materially altered existing conceptions of the economic status of the pest. It is now apparent that in a series of years of high rainfall the increase of the borer is favoured and the resistance of the host-tree is lowered; in years of low rainfall the reverse effect occurs. If the monsoon fails during the course of a borer epidemic the proportion of trees fatally attacked is reduced (in spite of the relatively increased incidence of the borer) to such an extent that the pest receives a marked check. Control measures based on these results have been formulated and put into practice during the 1920-21 season, the first result being to reduce the yield of borer-infested timber to a degree much below that of any year since the detection of the epidemic in 1916. It is anticipated that, given a valuation of the growing stock and its increment, a safety-limit expressed in deaths per acre and a safety-period for control operations can be determined. A note on the

connection of *Hoplocerambyx* with the dying-off of sal was published in the *Indian Forester* for February 1921, pp. 69-76.

In tours carried out in Singhbhum and Porahat divisions, Bihar and Orissa, it was determined that *Hoplocerambyx* is rare or absent in dry and hill type sal forests, and that it is usually a secondary effect of *Polyporus shoreæ* in the moist and valley type sal, a condition suspected some years before in the Bengal Duars forests. The frequent mortality of sal without the assistance of borer attack leads one to consider that borers of the type of *Hoplocerambyx* are essentially secondary factors, which, however, under epidemic conditions may determine the death or survival of a weakened tree.

Further insectary records of the development of *Aeolesthes holosericea*, *Xylotrechus smei*, *Platypus* spp., *Diapus* sp., and *Xyleborus* spp. have contributed to the establishment of the economic status of these species, and revealed the extent to which their prevalence is affected by climber-cuttings and girdling or felling without removal of inferior species.

Other Pests.—The seed-weevil, which has been named *Calandra shoreæ* has been found to have a wide distribution and a variety of dipterocarp host-plants.

INSECTS OF THE TEAK.—Work on the beehole borer of teak has been in abeyance pending the appointment of a forest entomologist to continue the collection of statistical data. Further insectary records of the minor sapwood borers and the shot-hole beetles have been obtained.

Miscellaneous Pests.—During the period under report 125 consignments of specimens (including 903 insects) were received from enquirers for investigation. A total of 910 specimens of timbers was received from divisional seasoning depôts for examination of the borer fauna.

BORERS OF MISCELLANEOUS TIMBERS.—Of the subsidiary investigations the most important is that aimed at the determination of the borer fauna of timbers seasoned by various natural processes. Some 8,500 specimens have been bred out and are in process of classification and identification. It has been found possible to grade boring insects into classes according to their ability to attack (1) the living tree, (2) the girdled tree, (3) the felled log, and (4) converted timber. The recognition of the first and last classes, particularly, permits a correct appreciation of the success or failure of the natural methods of seasoning. Field-work in this connection was carried out in the Dun forests and in Bihar and Orissa.

A short survey was made in the Sunderbans, Bengal, of the borer fauna of swamp, slump and cyclone-killed trees and drift timber to obtain evidence on the survival or destruction of boring insects by immersion in brackish and salt-water.

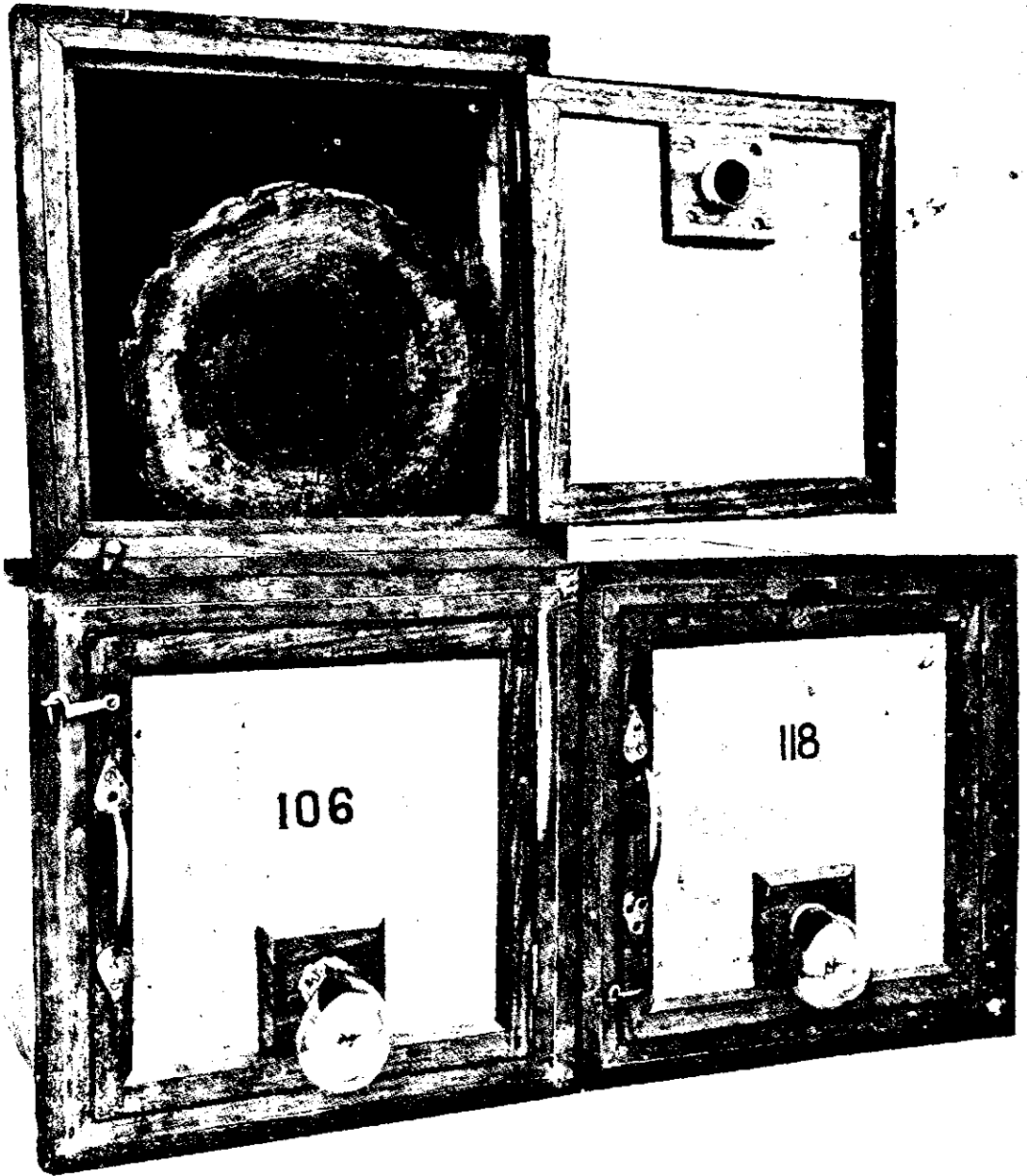


Photo-Mech. Dept., Thomason College, Roorkee.

Galvanized iron cages in which the air and wood humidity can be regulated.



Photo.-Mech. Dept., Thomason College, Roorkee.

Types of breeding cages used for wood-borers in the Forest Zoologist's Insectary.

The compilation of the food-plants of forest insects has been continued with the issue of the families Platypodidæ and Scarabæidæ.

The more important of the new records are:—

<i>Platypus solidus</i> , Wlk.	ex <i>Litsea polyantha</i> ; <i>Pterosperrum acerifolium</i> ;
<i>Xystrocera globosa</i> , Oliv.	ex <i>Albizzia stipulata</i> ;
<i>Xyleborus perforans</i> , Woll.	ex <i>Litsea polyantha</i> ;
<i>Calopepla leayana</i> , Latt.	ex <i>Gmelina arborea</i> ;
<i>Clania variegata</i> , Snell.	ex <i>Casuarina equisetifolia</i> ;
<i>Stromatium barbatum</i> , Fabr.	ex <i>Alnus nepalensis</i> ; <i>Sterculia alata</i> ; <i>Quercus lanuginosa</i> ; <i>Q. serrata</i> ; <i>Garcinia indica</i> ; <i>Dalbergia Sissoo</i> .
<i>Rhynchophorus ferrugineus</i> , Oliv.	ex <i>Oreodoxa regia</i> ;
<i>Oryctes rhinoceros</i> , Linn.	ex <i>Cocos nucifera</i> ;
<i>Xyleborus</i> sp.	ex <i>Xylia dolabriformis</i> ;
<i>Phloeocinus jubatus</i> ,	ex <i>Abies Webbiana</i> ;
<i>Heterobostrychus aequalis</i> ,	ex <i>Dipterocarpus turbinatus</i> ;
Waterh.	
<i>Epania</i> sp.	ex <i>Calophyllum Wightianum</i> ;
<i>Xylotrechus</i> sp.	ex <i>Dalbergia Sissoo</i> ; <i>Odina Wodier</i> ;
<i>Xylodectes ornatus</i> , Lesne.	ex <i>Bauhinia Vahlia</i> ;
<i>Aphrodisium cantori</i> , Hope.	ex <i>Mallotus philippinensis</i> ;
<i>Xylotrechus smeii</i> , C. & G.	ex <i>Kydia calycina</i> ;
<i>Phassus, signifer</i> , Wlk.	ex <i>Tectona grandis</i> ;
<i>Gelonaetha hirta</i> , Fairm.	ex <i>Heritiera Fomes</i> ;
<i>Platypus uncinatus</i> , Bldf.	ex " "
<i>Belinota prasina</i> , Themb.	ex <i>Sonneratia apetala</i> ;
<i>Xylothrips flavipes</i> , Ill.	ex <i>Vateria indica</i> ; <i>Odina Wodier</i> ;
<i>Olenecaniptus bilobus</i> , Fabr.	ex <i>Ficus religiosa</i> ;
<i>Glenia multiguttata</i> , Gahan,	ex <i>Shorea robusta</i> ;
<i>Sthenias grisator</i> , F.	ex <i>Morus alba</i> ;
<i>Poritia hewettsoni</i> ,	ex <i>Dipterocarpus pilosus</i> ;
<i>Xylocopa latipes</i> , Fabr.	ex <i>Amoora Wallichii</i> ;
<i>Adoretus</i> sp.	ex <i>Bombax malabaricum</i> ;
<i>Cerococcus hibisci</i> , Gr.	ex <i>Premna latifolia</i> ; <i>Anogeissus latifolia</i> ;
<i>Dactylopins</i> sp.	
<i>Eriococcus</i> sp.	ex <i>Mangifera indica</i> ;
<i>Ceroplastes</i> sp.	
<i>Ceresium zeylanicum</i> , Whit.	ex <i>Careya arborea</i> ;
<i>Arbella tetraonis</i> , Mo.	ex <i>Anogeissus latifolia</i> ;

Museum.—The principal additions include 243 specimens of timber, injurious insects, skins and shikar trophies, some of the latter loaned by Sir George Hart.

Records.—Card indices to the collections, pests of forest trees and current literature are up to date, but the interpretation and collation of insectary records and field observations has not made relative progress. There are about 15 subjects on various aspects of forest entomology for which material is available for publications, but the pressure of current work postpones the possibility of writing-up the data in Record or Bulletin form. As soon as the posts of forest entomologist are filled it is hoped that there will be opportunities for publishing these data.

Staff.—Messrs. D. Atkinson and J. C. M. Gardner who have been selected for appointment to two of the posts of forest entomologist will complete their training in forestry and entomology at the close of 1921. It is proposed to appoint Mr. Mackenzie, I.F.S., to a third post of forest entomologist to investigate the beehole borer in Burma.

In February 1921, the Forest Zoologist and Systematic Entomologist attended the 4th Entomological meeting held at Pusa. Papers were read by the former on the Imperial Entomological Conference in London, 1920, and on the progress of research in forest entomology.

Publications.—The following issued after the close of the year :—

- (1) Beehole Borer of Teak (*Duomitus ceramicus*, Wlk.) by C. F. C. Beeson.
- (2) Lac and Shellac by H. A. F. Lindsay and C. M. Harlow.
- (3) The Food Plants of Indian Forest Insects, part vi (family Scarabaeidae) by C. F. C. Beeson. (*Indian Forester*, June 1921.)

Library.—One hundred new books in addition to periodicals were added.

SYSTEMATIC ENTOMOLOGY.—The post of Systematic Entomologist has been filled by the appointment of Surgeon Commander M. Cameron, M.B., R.N., on the 4th December 1920.

The material awaiting classification and identification amounts to tens of thousands of specimens of insects and their early stages. Considerable progress has been made in the naming-up of monographed groups of Coleoptera by Dr. Cameron and in the distribution of material to specialists in other orders. In collaboration with Colonel Winn-Sampson, the Forest Zoologist has been working on the revision of the Indian Platypodidae and Scolytidae necessitated by the re-determination of Stebbing's types. Some 350 species new to the Research Institute collection have been added during the period under review. The following specialists are

engaged in the identification of forest insects (*D.* indicates the despatch and *R.* the receipt of material during the year):—

Dr. G. Arrow, *Lamellicornia*, *Endomychidæ*, *Erotylidæ* (*D. R.*); Mr. H. E. Andrews, *Carabidæ* (*D. R.*), *Adephaga* (*R.*); Mr. K. G. Blair, *Tenebrionidæ* (*D. R.*); Mr. E. Brunetti, *Diptera* (*D. R.*); Mr. J. Corporaal, *Cleridæ* (*D.*); Mr. St. J. Donisthorpe, *Formicidæ* (*D.*); Mr. T. B. Fletcher, *Odonta*, *Pyralidæ* (*D.*); Major Fraser, *Odonata* (*D. R.*); M. P. Lesne, *Bostrychidæ* (*D. R.*); Dr. G. A. K. Marshall, *Curculionidæ* (*D. R.*); Dr. E. Meyrick, *Microlepidoptera* (*D. R.*); Miss. G. Ricardo, *Asilidæ* (*D. R.*); Mr. Wasman, *Termitophila* (*D.*); Government Entomologist, Madras, *Apidæ* (*R.*).

The following families have been revised and expanded, but the permanent arrangement of the collection awaits the provision of suitable store-cabinets:—

Coleoptera; *Staphylinidæ*, *Scarabæidæ*, *Curculionidæ*, *Chrysomelidæ*; *Hymenoptera*; *Fossores*; *Lepidoptera*; *Lymantriidæ*, *Notodontidæ*.

Burma.

Little progress can be made in this subject until a special officer is appointed.

No result can be reported on the trial of nest boxes in plantations in Prome and Tharrawaddy. Unfortunately in Tharrawaddy Division young villagers are reported to have found some of the boxes first and the birds did not get a chance. Nevertheless birds did nest in a few of the boxes but were not seen by anyone with sufficient knowledge of ornithology to identify them. Results however cannot be expected immediately and it will require careful study over a number of years by an expert to record any definite results.

Mr. Forster reports that early burning of the reserves in the West Salween Division did not seem to effect the teak leaf defoliator in any way.

Larvæ of the following insects were found tunnelling in the stems of 3-year old teak trees in Thauingyin Division:—

1. *Phassus signifer* (*Hepiolidæ*).
2. *Haplohammus cervinus* (*Leemiidæ*).
3. *Sagra* sp.? (*Chrysomelidæ*).
4. Unknown *Lepidoptera*.

A new species of shot hole borer, *Xyleborus* sp., *Scolytidæ* was reported from North Pegu Division. It was found attacking some felled Pyinkado in the Aingdonkun Reserve. It was identified by the Forest Zoologist, Dehra Dun, who remarks:—"The borer is

new to the collection and no previous record of this insect or its attack on Pyinkado has been made."

Bombay.

Teak Pests.—Many of the 1919 teak plants in the Nisalnr and Taltot plantations S. D. Kanara Division were found to be damaged by the stem borer about the month of August. The insect has girdled the plants in many cases about a foot from the ground. The parts thus attacked appear to heal up soon by occlusion. In order to ascertain this 100 plants in each of the plantations have been marked and are under observation.

The same plantations 1½-year old were attacked by defoliators in September and October last. All the leaves macerated and fell by October. There was new foliage, a sort of epicormic growth by November; but this again dropped down in February. The plants are now looking like sticks except for the dormant terminal buds. This may be due to the defoliation.

Teak seed collected in 1919 when there was a general attack by the teak defoliator proved to be very poor in germinating powers.

CHAPTER VI.

FOREST CHEMISTRY.

Central Institute.

The following is a list of the subjects sanctioned for investigation in the Chemical Branch of the Forest Research Institute during the period under report:—

1. *Gums, Resins, Oleo-resins and Essential Oils.*—
 - (1) General study of essential oils.
2. *Miscellaneous Enquiries.*—
 - (1) Chemistry of Indian turpentine.
3. *General investigation into the nature and value of dyes obtainable from woods, barks, fruits, flowers and leaves.*

Essential Oils.—Experiments on Indian turpentine from *Pinus longifolia* have been continued during the year. The work has been mainly concerned (a) with the synthesis of the new bicyclic terpene *d-carene* and (b) with efforts to find some economic use for *d-longifolene*.

The experiments on the synthesis of *d-carene* are still in the preliminary stage and are not sufficiently advanced to determine whether they will be successful.

d-longifolene is in all probability a tricyclic sesquiterpene and in view of the frequent occurrence of sesquiterpenes in essential oils

it appears desirable to endeavour to find some use for them. At present they only find a small market as fixatives and turpentine substitutes. Up to the present owing to the great stability of longifolene all experiments have been negative but it is hoped that satisfactory results will be obtained when more light has been thrown on the constitution of longifolene. Experiments in this direction have been planned and will be commenced as soon as the necessary apparatus has been installed.

Some experiments were made on the standardisation of turpentine using the refractive index of the oil as a guide to its purity. These experiments showed promise and it is hoped that arrangements will be made either at Jallo or Bareilly for a complete investigation. A simple method of standardisation would be of great value in the factories.

Essential Oil from *Skimmia Laureola*.—The examination of this oil (from the leaves) has been completed and a paper on the subject is in the press. The oil consists of *d*-linalyl acetate (approximately 50 per cent.), *d*-linalol, a trace of terpene (possibly terpinene) and a mixture of sesquiterpenes and sesquiterpene alcohols. A sample of the oil is being valued.

Essential Oil from *Zanthoxylum alatum*.—The examination of this oil (from the seeds) is also complete. It has been found to contain *d*-linalol (approximately 50 per cent.), phellandrene dipentene and methyl cinnamate. There appears to be some reason to doubt whether the seeds were obtained from *Z. alatum* or *Z. acanthopodium* and this point will be definitely settled this year. At the same time it is proposed to investigate the essential oils derived from other species of *Zanthoxylum*s. The oil from *Z. alatum* is being valued in England.

Essential Oil from *Blumea Malcolmii*.—It had been hoped to arrange for the distillation of this grass in Belgaum but owing to the difficulty of obtaining a certificated boilerman the trip had to be abandoned. Two parcels of leaves were distilled at Dehra Dun but the yield of oil was very small.

Deodar Wood Oil.—The oil from *Cedrus Deodara* has been distilled from the saw dust of some logs supplied by the Silviculturist. The yield of oil is about 2.7 per cent. and its composition agrees with that found for previous samples of the oil examined at the Imperial Institute (See Roberts, Journ. Chem. Soc. (1916), 791). This oil is being valued in England.

Camphor.—The results of the chemical investigation of the camphor leaf oil from leaves grown in Dehra Dun have been published during the year. (Journ. Soc. Chem. Ind. 1920, 39, 296T). In collaboration with the officer-in-charge, Minor Forest Products, and the Silviculturist the acreage yield and the prospects of establishing the camphor industry in India are being examined. The

laboratory work has shown that the oil from the leaves is of little value apart from its camphor content since safrol is absent.

Fixed Oils.—The oils from the seeds of *Garcinia Morella*, *Garcinia Cambogia* and *Minusops Elengi* have been under investigation during the past year. The first two are fats and should apparently be of considerable value if they can be obtained in sufficient quantity. Further experiments on these three oils are in progress.

The oil from several samples of olive seeds grown near Rawalpindi was expressed at the request of the Forest Economist. The yield of oil was low but the oil obtained was of good quality.

A small sample of *Payena oleifera* oil was sent by the Forest Economist for examination. It was too small in quantity for any experiments of value to be made.

Vegetable Dyestuffs.—Work on the synthesis of morindone, the colouring matter present in *Morinda citrifolia* and *Morinda umbellata* has been continued. The experiments are approaching completion and do not lend themselves to summarisation.

A quantity of rottlerin has been extracted from the seeds of *Mallotus philippinensis*. Owing to the readiness with which it is attacked by reagents the determination of its constitution is likely to be a matter of considerable difficulty.

Medicinal Plant Products.—As the result of a careful analysis of a large number of samples of the flower heads of *Artemisia maritima*, gathered weekly during the growing season under the direction of the Conservator of Forests, Kashmir, Santonin has been found to be present in workable quantity. This discovery is one of considerable importance as Santonin is at the present time practically unobtainable and has the fancy price of £50 per kilo. The question of the commercial extraction of Santonin in Kashmir is now being considered.

Miscellaneous.—A very large number of moisture determinations in timber have been made for the Forest Economist. This work has taken up a large portion of the time of one of the assistants.

A sample of creosote oil was analysed and passed as suitable for use for creosoting timber. Subsequently the Government Test House, Calcutta, rejected a sample from the bulk. This rejection was shown to be unwarranted and was due to a wrong method of analysis having been adopted. A working standard for the analysis of creosotes based on American practice has been drawn up and approved by the Forest Economist.

The juice and the fruits of Cactus received from Jodhpur were shown not to contain a dye-stuff of any value. The colour is probably due to the presence of an insoluble anthocyanin dye.

A number of other analyses for Forest Officers were made, and an article on the distillation of camphor in India was published in the *Journ. Soc. Chem. Ind.* (1920, 39, 296T.).

A note is given of various other researches on Forest Products which have been made in India.

Fowler and Joshi (*Journ. Ind., Inst. of Sc., Vol. 3, page 39*) have studied the fermentation of cellulose. They consider that it should be possible under certain conditions to generate power gas (methane) by the fermentation of waste cellulose materials which are frequently available in quantity as for example on the West Coast.

Sudborough and Vridhachalam (*Journ. Ind., Inst. of Sc., Vol. 3, page 61*) have investigated the extraction of tartaric acid from tamarinds. They show that the acid is readily recovered and are of opinion that it should be a paying industry. (Results of a similar nature were communicated to the Indian Munitions Board by Dr. B. B. Dey of Calcutta during the war. These results have not been published.)

Fowler, Behram, Bhate, Hassan, Mahdihassan and Inuganti (*Journ. Ind., Inst. of Sc., Vol. 3, page 81*) have published a lengthy study of the bio-chemistry of the Mahua Flower. The results do not lend themselves to summarisation.

Sudborough and Watson with several collaborators (*Jour. Ind., Inst. of Sc., Vol. 3, page 281*) have published Part III of their researches on wood distillation. This Part of the research is concerned mainly with the distillation of certain Mysore and Baroda woods under conditions similar to those used in previous experiments. The results are given in a number of tables. They have also investigated the distillation of cocoanut shells and have confirmed the high acetic acid yield. The tar from the shells is of interest since it contains on appreciable quantity (6.2 per cent.) of ordinary phenol.

Fowler and Malandkar (*Journ. Ind., Inst. of Sc., Vol. 4, page 27*) have published details of their method for the separation of the turpentine, rosin and gum from the gum-oleo-resin from *Boswellia serrata*. The method advocated does not involve extraction with a solvent which was the basis of Pearson and Puran Singh's method of separation and should be much cheaper to work.

CHAPTER VIII.

FOREST PUBLICATIONS.

The necessity for an organised publication branch grows more apparent each year. Not only are scientific results being obtained

which to be useful must be made public at once, but it is obvious that in future the Department must consider the spreading of information concerning its work an integral part of its activity. A great deal of the prejudice which at present exists against the Department is due largely to ignorance of its work and its aims, and it must under the new conditions be part of the work of the Department to remove this ignorance.

A beginning has been made in this direction by having descriptive articles published in several of the newspapers showing what work is being carried on, but it is hoped that next year's report will contain a record of considerable progress in this direction.

The United Provinces are to be congratulated on having also made a beginning on similar lines.

The following publications were either issued during the year or were in the press at its close:—

Serial No.	Title.	Author.	Date of issue.
FOREST RECORDS.			
<i>Issued.</i>			
1	Note on the Afforestation of Ravine Lands in the Etawah District, United Provinces.	E. A. Smythies.	December 1920.
<i>In Press.</i>			
2	Note on the Beshole Borer of Teak	C. F. C. Beeson	(Issued in December 1921).
3	Report on Lac and Shellac . . .	H. A. F. Lindsay and C. M. Harlow	(Issued in May 1921).
4	Note on the Regeneration of Sal Forests	R. S. Hole . . .	(Issued in July 1921).
5	Notes on Artificial Regeneration in Bengal.	E. O. Shebbeare, A. K. Glasson, L. E. S. Teague and P. T. Russell.	(In final print.)
FOREST BULLETINS.			
<i>Issued.</i>			
6	Note on Pynna, Ajhar or Jarul Wood (<i>Lagerstroemia Flos-Reginæ</i> , Retz.)	R. S. Pearson	August 1920
<i>In Press.</i>			
7	Note on Weights of Seeds . . .	S. H. Howard	(Issued in April 1921).
8	Note on <i>Adina cordifolia</i> . . .	C. E. C. Cox . . .	(Issued in September 1921.)
9	Note on <i>Odina Wodier</i> . . .	„ . . .	Do.
10	Note on <i>Bombax malabaricum</i> . . .	„ . . .	Do.
11	Note on Rate of Growth of Bengal Sal	S. H. Howard	Do.
12	Note on the Miscellaneous Forests of the Kumaon Bhabar.	E. A. Smythies	Do.
OTHER PUBLICATIONS.			
<i>Issued.</i>			
13	Forest Research Institute and College, Calendar, 1919.	...	October 1920.
14	Progress Report of Forest Research Work in India for 1919-20.	...	January 1921.
15	Progress Report of the Forest College, Dehra Dun, for 1919-20.	...	Do.
<i>In Press.</i>			
16	Code for the Collection and Tabulation of Statistical Data.	S. H. Howard	(Issued in July 1921.)
17	Do. Do. Appendices .	Do.	Do.

The following publication is being issued by the Central Institute for the Conservator of Forests, Bengal :—

Nursery Notes for Bengal.

UNITED PROVINCES.

Issued.

1. Enumeration of miscellaneous species of the Haldwani Division.
2. Felling scheme of *Acacia Catechu* of the Haldwani-Ramnagar Bhabar.

In Press.

3. Afforestation in the United Provinces, by E. Benskin, I.F.S., (Issued in August 1921).

BURMA.

Issued.

1. A Handbook of the Forest Products of Burma, by A. Rodger.

In Press.

2. Bulletin No. 1.—Preparation of Teak seed for early germination, by H. R. Blanford, O.B.E., I.F.S.
3. Bulletin No. 2.—Early burning in Young Regeneration Areas, by C. G. E. Dawkins, I.F.S. (Issued in August 1921).
4. Bulletin No. 3.—Teak Stumps, by U. Po. Thin, K.S.M., A.T.M., Extra Assistant Conservator of Forests, Katha Division.

APPENDIX I.

Administration Report of the Forest Research Institute, Dehra Dun, for the year 1920-21 (1st July 1920 to 31st March 1921).

Administration.—The post of President, Forest Research Institute and College, was held by Mr. R. C. Milward, Officiating Chief Conservator of Forests, from 1st July to 16th November 1920, and for the rest of the year by the writer of the report (except for the period 17th to 27th November 1920 when Mr. J. E. Macpherson, Personal Assistant to the President, held charge of the current duties of the President's Office).

The names of the officers who held charge of the various branches are given below :—

Branch of Forest Research Institute.	MONTH AND DATE.		Name of Officer-in-Charge of branch.
	From	To	
Silviculture . . .	1st July 1920.	31st March 1921	Mr. S. H. Howard, B.A., Deputy Conservator of Forests, United Provinces.
Forest Botany .	1st July 1920	28th December 1920.	Do.
	29th December 1920.	31st March 1921	Mr. R. S. Hole, C.I.E., F.C.H., F.L.S., F.E.S., Conservator of Forests.
Forest Economy	1st July 1920	3rd July 1920	Mr. C. E. C. Cox, Deputy Conservator of Forests, Central Provinces.
	4th July 1920	26th August 1920.	Mr. R. C. Milward, Officiating President, Forest Research Insti- tute and College.
	27th August 1920.	31st March 1921	Mr. R. S. Pearson, C.I.E., F.L.S., Officiating Con- servator of Forests, Bombay Presidency.
Forest Zoology . . .	1st July 1920	8th July 1920	Mr. F. M. Howlett, M.A., Imperial Pathological Entomologist, Pusa.
	9th July 1920	31st March 1921	Mr. C. F. C. Beeson, M.A., I.F.S., F.E.S., Deputy Conservator of Forests, Punjab.
Forest Chemistry .	1st July 1920	18th September 1920.	Dr. J. L. Simonsen, D.Sc., F.I.C., F.A.S.B.
	19th September 1920.	24th January 1921.	Mr. C. F. C. Beeson, M.A., I.F.S., F.E.S., Deputy Conservator of Forests, Punjab.
	25th January 1921.	20th March 1921.	Mr. M. Gopal Rao, M.A., Assistant to Forest Chemist.
	21st March 1921.	31st March 1921.	Dr. J. L. Simonsen, D.Sc., F.I.C., F.A.S.B.

APPENDIX II.

Financial.

The expenditure of the past two years is compared below :—

	EXPENDITURE DURING THE YEAR.		Difference or
	1919-20 (12 months July 1919 to June 1920).	1920-21 (9 months July 1920 to March 1921).	
AVI Stores, Tools and Plant	8,328	26,906	+18,578
AVII Buildings, etc.	3,820	2,852	— 968
AIX Miscellaneous	35,972	31,526	— 4,446
BIa Conservators	18,996	15,641	— 3,355
BIb Superior Officers	58,866	99,245	+40,379
BIc Subordinate Forest and Depôt Establishment.	12,736	3,379	— 9,357
BI d Office Establishment	32,518	34,081	+ 1,563
BIe Deputation and Special Allowances	9,524	13,246	+ 3,722
BI f Compensation for dearness of provisions	1,606	995	— 611
BII Travelling Allowances	16,558	19,087	+ 2,529
BIII Contingencies	17,346	25,038	+ 7,692
TOTAL	2,16,270	2,71,996	+55,726

The increase under AVI is due to the purchase of machinery for the Economic Branch consequent on its expansion.

The decrease under AVII is due to less expenditure having been incurred on repairs during the year.

The decrease under AIX is due to less expenditure having been incurred on experiments.

The decrease under BIa is due to the figures for 1920-21 representing 9 months against 12 months for 1919-20.

The increase under BIb is due to the appointment of Experts in the Economic branch and to the pay of Assistants Upper Grade charged under this head.

The decrease under BIc is due to the pay of Upper Grade Assistants having been charged under BI d owing to the raising of their status.

The increase under BI d is due to the entertainment of extra establishment in the Economic branch and to the re-organization of clerical, miscellaneous and menial establishment having been brought into force with effect from the 1st October 1920.

The increase under B1e is due to the Upper Grade Assistants to Research Institute Officers having been allowed to draw a duty allowance of Rs. 75 per mensem each under the new scheme.

The decrease under B1f is due to the abolition of compensation for dearness of provisions with effect from 1st October 1920.

The increase under BII is due to extensive touring done by certain Research Institute Officers.

The increase under BIII is due to more expenditure having been incurred on the carriage of tents and records on tours by Research Officers and to the purchase of books and periodicals for the Forest Chemist.

APPENDIX III.
Annual Form No. 24.

FOREST DEPARTMENT, INDIA, FOREST RESEARCH INSTITUTE DIVISIONS.

Summary of Revenue of the different Divisions during 1920-21.

BUDGET HEADS.	President.	Sylviculturist.	Forest Botanist.	Forest Zoologist.	Forest Economist.	Forest Chemist.	TOTAL.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
REVENUE.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.
I.—TIMBER AND OTHER PRODUCE REMOVED FROM THE FORESTS BY GOVERNMENT AGENCY—							
(a) Timber . . . . .	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..
(b) Firewood and charcoal. . . . .	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..
(c) Bamboos . . . . .	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..
(d) Sandal-wood . . . . .	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..
(e) Grass and other minor produce.	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..
TOTAL I . . . . .	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..
II.—TIMBER AND OTHER PRODUCE REMOVED FROM THE FORESTS BY CONTRACTORS OR PURCHASERS—							
(a) Timber . . . . .	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..
(b) Firewood and charcoal. . . . .	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..
(c) Bamboos . . . . .	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..
(d) Grazing and fodder grass . . . . .	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..
(e) Other minor produce . . . . .	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..
(f) Other items . . . . .	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..
(g) Commutation fees . . . . .	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..
TOTAL II . . . . .	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..
III.—DRIFT AND WARP WOOD AND CONFISCATED FOREST PRODUCE.							
TOTAL III . . . . .	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..
IV.—REVENUE FROM FORESTS NOT MANAGED BY GOVERNMENT—							
(a) Duty on foreign timber and other forests produce. . . . .	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..
(b) Revenue from shared and private forests . . . . .	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..
TOTAL IV . . . . .	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..
V.—MISCELLANEOUS—							
(a) Fines and forfeitures . . . . .	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..
(b) Returns	54 1 0	.. ..	.. ..	57 4 4	9 11 8	.. ..	121 1 0
Other sources	6,258 5 2	76 8 0	80 15 9	0 13 4	126 9 0	64 13 6	6,608 0 9
TOTAL V	6,312 6 2	76 8 0	80 15 9	58 1 8	136 4 8	64 13 6	6,729 1 9
GRAND TOTAL REVENUE	6,312 6 2	76 8 0	80 15 9	58 1 8	136 4 8	64 13 6	6,729 1 9

APPENDIX III—contd.

Annual Form No. 24—contd.

FOREST DEPARTMENT, INDIA, FOREST RESEARCH INSTITUTE DIVISIONS.

Summary of Expenditure of the different Divisions during 1920-21.

BUDGET HEADS. (1)	President. (2)	Sylviculturist. (3)	Forest Botanist. (4)	Forest Zoologist. (5)	Forest Economist. (6)	Forest Chemist. (7)	TOTAL. (8)
	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.
VI.—LIVE-STOCK, STORES, TOOLS AND PLANT—							
(a) Purchase of cattle	..	..	..	..	..	..	..
(b) Feed and keep of cattle.	..	..	..	..	..	..	..
(c) Purchase of stores, tools and plant.	21,302 2 0	57 0 0	37 0 0	2,068 8 0	1,014 2 0	1,527 8 0	26,906 4 0
TOTAL A. VI .	21,302 2 0	57 0 0	37 0 0	2,068 8 0	1,014 2 0	1,527 8 0	26,906 4 0
VII.—COMMUNICA- TIONS AND BUILD- INGS—							
(a) Roads and bridges.	..	..	..	..	..	..	..
(b) Buildings	2,212 12 7	14 0 0	..	..	..	..	2,226 12 7
(c) Other works	619 14 3	3 4 0	..	2 8 0	..	..	625 10 3
TOTAL A. VII .	2,832 10 10	17 4 0	..	2 8 0	..	..	2,832 6 10
VIII.—ORGANIZATION, IMPROVEMENT AND EXTENSION OF FORESTS—							
(a) Demarcation	..	..	..	..	..	..	..
(b) Cost of Forest Settlements ; compensation for land and rights.	..	..	..	..	..	..	..
(c) Surveys	..	..	..	..	..	..	..
(d) Working plans	..	..	..	..	..	..	..
(e) Sowing and planting	..	..	..	..	..	..	..
(f) Protection from fire.	..	..	..	..	..	..	..
(g) Other Works	..	..	..	..	..	..	..
TOTAL A. VIII .	..	..	..	..	..	..	..
IX.—MISCELLANEOUS							
(a) Law charges	..	..	..	..	..	..	..
(c) Other charges	13,817 14 10	2,228 14 6	814 0 6	1,147 6 11	8,687 7 4	4,830 0 2	31,525 12 3
TOTAL A. IX .	13,817 14 10	2,228 14 6	814 0 6	1,147 6 11	8,687 7 4	4,830 0 2	31,525 12 3
TOTAL A.—CONSER- VANCY AND WORKS.	37,052 11 8	2,303 2 6	851 0 6	4,118 6 11	9,791 9 4	6,357 8 2	61,284 7 1
B.—ESTABLISH- MENTS.							
I.—SALARIES—							
(a) Conservators	12,129 10 6	..	3,511 4 8	..	..	..	15,640 15 2
(b) Superior Officers	6,300 0 0	10,408 5 4	4,491 4 7	15,431 12 3	54,254 2 9	8,359 3 11	99,244 12 10
(c) Subordinate forest and dept estab- lishments.	..	1,100 0 0	378 8 0	1,300 0 0	..	600 0 0	3,378 8 0
(d) Office establish- ments.	7,280 1 9	3,861 11 11	4,912 4 10	5,700 6 10	10,274 15 6	2,951 15 1	34,081 7 11

APPENDIX III—concl'd.

Annual Form No. 24—concl'd.

Summary of Expenditure of the different Divisions during 1920-21—concl'd.

BUDGET HEADS.	President.	Sylviculturist.	Forest Botanist.	Forest Zoologist.	Forest Economist.	Forest Chemist.	TOTAL.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
D.—ESTABLISHMENT—cont'd.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.
SALARIES—cont'd.							
(e) Deputation and special allowances.	916 10 8	2,250 0 0	2,500 10 10	2,670 15 4	4,229 15 2	668 11 4	13,245 15 4
(f) Grain compensation allowance.	307 0 0	129 10 11	171 8 2	240 15 11	87 7 9	58 3 2	994 13 11
TOTAL E. I.	26,933 6 11	17,749 12 2	15,074 9 1	25,344 2 4	63,846 9 2	12,638 1 6	1,66,586 9 2
II.—TRAVELLING ALLOWANCES—							
(a) Conservators	222 5 6	..	336 13 0	..	..	..	559 2 6
(b) Superior Officers	232 3 0	3,223 11 6	502 2 6	1,983 4 0	7,930 6 3	415 10 6	14,297 5 9
(c) Subordinate forest and depot establishments.	..	155 5 4	12 0 0	..	..	..	.67 5 4
(d) Office establishments.	144 15 10	842 1 11	151 2 3	520 11 1	2,363 9 1	50 5 2	4,072 13 4
TOTAL B. II.	599 8 4	4,221 2 9	1,002 1 9	2,503 15 1	10,293 15 4	465 15 8	19,086 10 11
III.—CONTINGENCIES							
(a) Stationery	4 2 0	18 1 0	39 12 0	71 9 0	13 14 0	10 1 0	157 7 0
(b) Carriage of tents and records	..	715 0 2	1 3 0	85 7 0	1,562 2 1	..	2,364 1 3
(c) Rents, rates and taxes	1,500 7 1	..	60 0 0	..	..	..	1,560 7 1
(d) Pay of police guards	..	..	..	..	..	..	..
(e) Official postage	303 1 0	94 1 6	240 3 6	101 6 0	368 12 6	150 10 0	1,348 2 6
(f) Sundries and Telegraph charges.	6,828 8 10	430 15 6	868 8 2	1,208 8 2	8,653 11 5	1,617 8 4	19,807 12 5
Compensation for dearness of provisions.	..	..	..	..	..	..	..
TOTAL B. III.	8,636 2 11	1,258 2 2	1,209 15 8	1,556 14 2	10,598 8 0	1,778 3 4	25,037 14 3
TOTAL B.—ESTABLISHMENT.	36,160 2 2	23,229 1 1	17,236 19 6	29,404 15 7	89,739 0 6	14,882 4 6	2,10,711 2 4
GRAND TOTAL OF EXPENDITURE.	74,121 13 10	25,532 3 7	18,137 11 0	33,523 6 6	99,440 9 10	21,239 12 8	2,71,995 9 5
SURPLUS OR DEFICIT.	-67,809 7 8	-25,455 11 7	-18,056 11 3	-33,465 4 10	-99,304 5 2	-21,174 15 2	-2,65,266 7 8

CALCUTTA,
The 16th September 1920-21.

M. N. GUPTA,
Assistant Accounts Officer.

Certified that the totals of this form as printed in Forest College and Forest Research Institute Reports for 1920-21 when added together agree with those entered in the forms for the combined offices as supplied by the Accountant General, Central Revenues, under Article 78 (ii) of the Forest Department Code.

W. F. PERRÉE,
President, Forest Research Institute and College.

FOREST DEPARTMENT, INDIA,

Account current for

RECEIPTS.

	President.			Sylviculturist.			Botanist.			Zoologist.			Economist.			Forest Chemist.			TOTAL.		
	Rs.	A.	P.	Rs.	A.	P.	Rs.	A.	P.	Rs.	A.	P.	Rs.	A.	P.	Rs.	A.	P.	Rs.	A.	P.
CASH BALANCE	..			..			..			..			..			..			..
VIII--ASSESSED TAXES																					
Income Tax - deductions from salaries	..			509	5	0	379	7	0	537	0	9	2,535	8	3	317	9	7	4,278	14	7
REVENUE DURING THE YEAR.	6,312	6	1	76	8	0	80	15	9	58	1	8	136	4	8	64	13	6	6,729	1	8
FOREST DEPOSITS	..			..			..			..			..			..			..
FOREST ADVANCES	..			12,572	1	5	3,076	15	11	3,236	2	7	7,063	9	6	3,624	11	3	29,573	8	8
SUSPENSE ACCOUNT	..			..			..			..			..			..			..
SERVICE FUNDS—																					
Unencumbered Service Family Pension Fund, Bengal	..			..			3	4	3	..			..			..			3	4	3
SAVINGS BANK DEPOSITS—																					
Bank Account—																					
Miscellaneous, Provident Fund.	..			..			..			250	0	0	..			..			250	0	0
General Provident Fund.	..			2,012	0	0	747	2	7	1,536	0	0	1,857	3	10	494	5	4	6,446	11	9
Special Account—																					
General Family Pension Fund.	..			..			..			..			..			..			..
House building advances	..			..			..			202	8	0	..			..			202	8	0
Motor car advances	..			1,777	10	8	40	0	0	83	5	4	1,598	10	0	..			3,199	10	0
Objection book advances	..			..			..			..			300	0	0	..			300	0	0
CASH REMITTANCES—LOCAL—																					
FOREST REMITTANCES.																					
Forest cheques drawn.	11,035	11	2	..			261	8	9	2,011	4	9	..			1,223	2	10	14,531	11	7
Revenue Remittances written back.	..			..			..			20	0	0	..			..			20	0	0
Inter-divisional Transfers.	..			..			..			..			..			..			..
ACCOUNT CURRENT WITH FOREIGN STATES																					
His Majesty's Colonial Government, Ceylon.	..			..			..			..			..			..			..
Carried over	17,348	1	4	16,947	9	1	4,569	6	3	7,334	7	1	13,291	4	3	5,724	10	6	65,835	6	6

IV.

—[Prescribed.]

FOREST RESEARCH INSTITUTE, FOREST DIVISION.

the Forest year 1920-21.

PAYMENTS.

—	President.			Sylviculturist.			Botanist.			Zoologist.			Economist.			Forest Chemist.			TOTAL.			
	Rs.	A.	P.	Rs.	A.	P.	Rs.	A.	P.	Rs.	A.	P.	Rs.	A.	P.	Rs.	A.	P.	Rs.	A.	P.	
I.—REFUNDS AND DRAWBACKS.																						
EXPENDITURE DURING THE YEAR.	74,121	13	10	25,532	3	7	18,137	11	0	33,523	6	6	99,440	9	10	21,239	12	8	2,71,995	9	5	
FOREST DEPOSITS	..			..			..			..			..			..			..
FOREST ADVANCES	..			13,368	6	5	4,333	9	6	3,368	8	7	10,299	14	9	3,595	1	3	34,965	8	6	
House building advances	..			..			..			..			..			320	0	0	320	0	0
SUSPENSE ACCOUNT SAVINGS BANK DEPOSITS	..			..			..			..			..			..			..
Motor Car Advances	..			..			..			3,000	0	0	11,300	0	0	..			14,300	0	0
Objection book advances.	..			..			450	0	0	..			1,050	0	0	..			1,500	0	0
Bank account—																						
General Provident Fund.	..			1,000	0	0	149	11	4	..			..			..			1,149	11	4
Forest Officers' Provident Fund.	..			..			..			..			..			..			..
CASH REMITTANCES —LOCAL--FOREST REMITTANCES.																						
Remittances to Treasuries	..			..			..			..			..			..			..
Unpaid cheques written back.	..			..			..			..			..			..			..
Inter-divisional Transfers.	..			..			..			..			..			..			..
ACCOUNT CURRENT WITH FOREIGN STATES																						
His Majesty's Colonial Government, London.	..			..			55	9	0	..			..			..			55	9	0
EXCHANGE ACCOUNT WITH OTHER GOVERNMENTS—																						
Account between India and Central Provinces—																						
III.—Items adjustable by India.	..			..			..			..			..			..			..
Carried over	74,121	13	10	39,900	10	0	23,126	8	10	39,891	15	1	1,22,590	8	7	25,154	13	11	3,24,780	6	3	

APPENDIX
Form No.
FOREST DEPARTMENT, INDIA
Account current

RECEIPTS.

	President.	Sylviculturist.	Botanist.	Zoologist.	Economist.	Forest Chemist.	TOTAL.
	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A.
Brought forward . . .	17,348 1 4	16,947 9 1	4,389 6 3	7,934 7 1	13,291 4 3	5,721 10 6	65,835 6
EXCHANGE ACCOUNT WITH OTHER GOVERNMENTS—							
Account between India and Central Provinces—							
III.—Items adjustable by India.	..	..	..	..	..	..	..
IV.—Items adjustable by Central Provinces.	..	..	..	..	140 0 0	..	140 0 0
Account between India and Burma—							
III.—Items adjustable by India.	..	..	..	..	3,290 15 7	..	3,290 15 7
IV.—Items adjustable by Burma.	..	..	..	..	4,750 5 4	..	4,750 5 4
Account between India and Behar and Orissa—							
III.—Items adjustable by India.	..	..	..	..	..	..	..
IV.—Items adjustable by Behar and Orissa.	..	..	50 6 0	..	..	..	50 6 0
Account between India and Bengal—							
III.—Items adjustable by India.	..	..	..	..	..	..	..
IV.—Items adjustable by Bengal.	..	..	..	..	373 3 6	..	373 3 6
Account between India and United Provinces of Agra and Oudh—							
III.—Items adjustable by India.	61,379 4 7	23,815 2 11	18,019 12 10	29,968 12 2	63,746 14 1	19,154 10 6	2,22,084 8 1
IV.—Items adjustable by United Provinces.	..	..	..	..	..	..	..
Account between India and Assam—							
III.—Items adjustable by India.	..	..	..	..	..	..	..
Carried over . . .	78,727 5 11	40,762 12 0	23,659 9 1	37,903 2 3	91,592 10 9	24,879 5 0	2,56,524 13 0

IV.—(contd.)

— [Prescribed.]

FOREST RESEARCH INSTITUTE, FOREST DIVISION.

the Forest year 1920-21.

PAYMENTS.

—	President.	Sylviculturist.	Botanist.	Zoologist.	Economist.	Forest Chemist.	TOTAL.
	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.
Brought forward .	74,121 13 10	39,900 10 0	23,126 8 10	39,891 15 1	1,22,590 8 7	25,154 13 11	3,24,786 6 3
IV.—Items ad-justable by Central Provinces.	..	..	..	..	355 10 1	..	355 10 1
Account between India and Burma							
III.—Items ad-justable by India.	..	..	..	..	..	..	..
IV.—Items ad-justable by Burma.	..	..	..	..	..	..	..
Account between India and Assam—							
II.—Items ad-justable by India.	..	..	..	..	..	..	..
IV.—Items ad-justable by Assam.	..	..	..	..	..	..	..
Account between India and Bengal—							
III.—Items ad-justable by India.	..	..	..	..	..	..	..
IV.—Items ad-justable by Bengal.	..	..	..	..	..	..	..
Account between India and United Provinces of Agra and Oudh—							
III.—Items ad-justable by India.	6,312 6 1	76 8 0	..	78 1 8	126 9 0	62 15 0	6,656 8 8
IV.—Items ad-justable by United Provinces.	..	1,000 0 0	..	..	..	..	1,000 0 0
Account between India and Punjab—							
III.—Items ad-justable by India.	..	..	..	..	..	..	..
IV.—Items ad-justable by Punjab.	..	..	..	..	..	..	..
Account between India and Madras—							
III.—Items ad-justable by India.	..	..	..	..	..	..	..
IV.—Items ad-justable by Madras.	..	..	..	..	..	..	..
Carried over .	80,484 8 11	40,977 2 0	23,126 8 10	39,970 0 9	1,23,072 11 8	25,217 13 5	3,32,798 8 7

APPENDIX

Form No. 25

FOREST DEPARTMENT, INDIA,

Account current for

RECEIPTS.

	President.	Sylviculturist.	Botanist.	Zoologist.	Economist.	Forest Chemist.	TOTAL.
	RS. A. P.	RS. A. P.	RS. A. P.	RS. A. P.	RS. A. P.	RS. A. P.	RS. A. P.
Brought forward .	78,727 5 11	40,762 12 0	22,659 9 1	37,903 2 3	01,592 10 9	24,870 5 0	2,90,524 13 0
IV. - Items adjust- able by Assam.	..	..	..	..	..	..	..
Account between India and Madras—							
III. -Items adjust- able by India.	..	..	..	..	..	..	..
IV. -Items adjust- able by Madras.	..	..	..	..	..	..	..
Account between India and Bombay—							
III.--Items adjust- able by India.	..	..	145 1 5	..	79 14 7	..	225 0 0
IV. -Items adjust- able by Bombay.	..	..	25 3 0	..	..	..	25 3 0
INTER-DEPART- MENTAL TRANS- FERS.							
P. W. Department, Ordinary Branches.	..	..	..	..	..	..	..
P. W. Department, Railway Branch.	..	..	..	..	..	..	..
Military Department, Supply Circle.	..	..	..	..	..	..	..
Military Department, Western Command.	..	..	..	..	1,125 3 6	..	1,125 3 6
Military Department, Account between India and N. W. Railway.	..	..	..	..	..	..	..
Military Department, Secunderabad Divi- sion.	..	..	..	..	..	..	..
Telegraph Depart- ment.	..	..	..	..	..	..	..
Post Office Depart- ment Miscellaneous (War Loan).	..	..	..	..	..	..	..
Post Office Depart- ment P. I. Fund.	..	..	13 2 0	67 0 6	..	..	80 2 6
Marine Department .	..	..	..	..	..	..	..
Account with N.W. Railway.	..	..	..	..	..	..	..
Civil Departments .	1,706 14 0	214 6 0	284 11 4	1,999 14 0	30,541 2 8	338 8 6	35,085 8 6
GRAND TOTAL .	80,434 3 11	40,977 2 0	24,127 10 10	39,970 0 9	1,23,338 15 6	25,217 13 5	3,33,065 14 5

IV—concl'd.

—[Prescribed.]

FOREST RESEARCH INSTITUTE, FOREST DIVISION.

the Forest year 1920-21.

PAYMENTS.

—	President.			Sylviculturist.			Botanist.			Zoologist.			Economist.			Forest Chemist.			TOTAL.					
	RS.	A.	P.	RS.	A.	P.	RS.	A.	P.	RS.	A.	P.	RS.	A.	P.	RS.	A.	P.	RS.	A.	P.			
Brought forward .	80,434	3	11	40,977	2	0	23,126	8	10	39,970	0	9	1,23,072	11	8	25,217	13	5	3,32,798	8	7			
Account between India and Bombay—																								
III.—Items adjustable by India.	..			..			..			..			..			..			..			..
IV.—Items adjustable by Bombay.	..			..			..			..			..			..			..			..
INTER-DEPARTMENTAL TRANSFERS—																								
Public Works Department, Ordinary Branches.	..			..			..			..			..			..			..			..
Public Works Department, Railway Branch	..			..			..			..			..			..			..			..
Military Supply Department.	..			..			..			..			..			..			..			..
Military Department, Northern Command.	..			..			..			..			..			..			..			..
Military Department, Western Command.	..			..			..			..			..			..			..			..
Military Department, Secunderabad Division.	..			..			..			..			..			..			..			..
Telegraph Department.	..			..			..			..			..			..			..			..
Post Office Department.	..			..			..			..			..			..			..			..
Marine Department.	..			..			..			..			..			..			..			..
Civil Departments.			1	2	0	..			266	3	10			267	5	10
Account between India and North Western Railway.																								
III.—Items adjustable by India.	..			..			..			..			..			..			..			..
CASH BALANCE .	..			..			..			..			..			..			..			..
GRAND TOTAL .	80,434	3	11	40,977	2	0	23,127	10	10	39,970	0	9	1,23,338	15	6	25,217	13	5	3,33,065	14	5			

CALCUTTA,

The 16th September 1921.

M. N. GUPTA,

Assistant Accounts Officer.

Certified that the totals of this form as printed in the Forest College and Forest Research Institute Reports for 1920-21 when added together agree with those entered in the forms for the combined office as supplied by the Accountant General, Central Revenues, under Article 78 (ii) of the Forest Department Code.

W. F. PERRÉE,

President, Forest Research Institute and College

APPENDIX V.

Annual Form No. 27.

FOREST DEPARTMENT, INDIA, FOREST RESEARCH INSTITUTE.

Outstandings and Liabilities on account of Contractors and Disbursers for the Forest year 1920-21.

Divisions.	DEPARTMENT DEBTOR.			DEPARTMENT CREDITOR.			BALANCE DUE.		REMARKS.
	Opening balance.	Recoveries in Cash and value of supplies and work done during the year.	Total.	Opening balance.	Payments made during year.	Total.	To Department (Outstandings).	By Department (Liabilities).	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	RS. A. P.	RS. A. P.	RS. A. P.	RS. A. P.	RS. A. P.	RS. A. P.	RS. A. P.	RS. A. P.	
Sylviculturist	..	12,572 1 5	12,572 1 5	190 2 9	13,368 6 5	13,558 9 2	986 7 9	..	
Forest Botanist	..	3,076 15 11	3,076 15 11	151 7 11	4,333 9 6	4,485 1 5	1,408 1 6	..	
Forest Zoologist	..	3,236 2 7	3,236 2 7	221 14 1	3,368 8 7	3,590 6 8	354 4 1	..	
Forest Economist.	..	7,063 9 6	7,063 9 6	196 14 10	10,299 14 9	10,496 13 7	3,433 4 1	..	
Forest Chemist	..	3,624 11 3	3,624 11 3	120 12 8	3,595 1 3	3,715 13 11	91 2 8	..	
TOTAL	..	29,573 8 8	29,573 8 8	881 4 3	34,965 8 6	35,846 12 9	6,273 4 1	..	

M. N. GUPTA,
Assistant Accounts Officer.

CALCUTTA,
The 16th September 1921.

Certified that the totals of this form as printed in the Forest College and Forest Research Institute reports for 1920-21 when added together agree with those entered in the Forms for the combined offices as supplied by the Accountant General, Central Revenues, under Article 78 (ii) of the Forest Department Code.

W. F. PERRÉE,
President, Forest Research Institute and College.

APPENDIX VI.

List of Forest Publications issued since the creation of the Forest Research Institute.

I.—BULLETINS (OLD SERIES).

	{ PRIOR (exclusive of pack- ing, postage, etc.). Rs. s. p.
1.—Note on the Bee-hole Borer of Teak in Burma, by E. P. Stebbing. (<i>Out of print</i>)	0 4 0
2. Note on the Quetta Borer (<i>Aeolesthes sartus</i>), by the same author. (<i>Out of print</i>)	0 8 0
3.—Note on the Chilgoza (<i>Pinus Gerardiana</i>) Bark-Boring Beetles of Zhob, Baluchistan, by the same author. (<i>Out of print</i>)	0 8 0
4.— <i>Ficus elastica</i> : its natural growth and artificial propagation, with a description of the method of tapping the tree and of the preparation of its rubber for the market, by E. M. Coventry	0 12 0
5.—Notes on a Visit to some European Schools of Forestry, by E. P. Stebbing. (<i>Out of print</i>)	2 0 0
6.—Memorandum on Mechanical Tests of some Indian Timbers, by W. H. Everett	0 2 0
7.—Note on the Chilgoza Forests of Zhob and the Takht-i-Suliman, by E. P. Stebbing. (<i>Out of print</i>)	0 12 0
8.—Note on the Life-History of <i>Hoplocerambyx spinicornis</i> (The Singbhum Sal Borer), by the same author	0 9 0
9.—Note on the influence of Forests on the Storage and Regulation of the Water-Supply, by S. Eardley-Wilmot	1 0 0
10.—Note on the Duki Fig-Tree Borer of Baluchistan (<i>Batocera rubus</i>), by E. P. Stebbing. (<i>Out of print</i>)	0 7 0
11.—On Some Assam Sal (<i>Shorea robusta</i>) Insect Pests, by the same author	1 10 0

II.—LEAFLETS.

1.—The Sal Bark-Borer (<i>Sphærotypes siwalikensis</i> , Steb.), by E. P. Stebbing. (<i>Out of print</i>)	3 4 0
2.—The Teak Defoliator (<i>Hyblæa puera</i> , Cram.), by the same author. (<i>Out of print</i>)	0 2 0
3.—The Teak Leaf Skeletoniser (<i>Pyrausta machæralis</i> , Wlk.), by the same author. (<i>Out of print</i>)	0 2 0
4.—The Larger Deodar Bark-Borer (<i>Scolytus major</i> , Steb.), by the same author. (<i>Out of print</i>)	0 4 0
5.—The Blue Pine "Polygraphus" Bark-Borer (<i>Polygraphus major</i> , Steb.), by the same author. (<i>Out of print</i>)	0 3 0

III.—PAMPHLETS.

1.—Note on Utilization of Khair Forests in Eastern Bengal and Assam, by Puran Singh. (<i>Out of print</i>)	0 4 0
2.—The Attack of the Bark-Boring Beetle in the Coniferous Forests in the Simla Catchment Area, by E. P. Stebbing	0 8 0
3.—A Glossary of Forest Technical Terms for Use in Indian Forestry, by A. M. F. Caccia. (<i>Revised and issued as Bulletin No. 4, New Series</i>). (<i>Out of print</i>)	0 4 0
4.—Note on Lac and Lac Cultivation, by D. N. Avasia	0 2 0
5.—Notes on Sal in Bengal, by A. L. McIntire. (<i>Out of print</i>):	0 4 0
6.—Note on Forest Reservation in Burma in the Interests of an Endangered Water-Supply by A. Rodger	1 0 0
7.—Note on Andaman Marble Wood or Zebra Wood (<i>Diospyros Kurzii</i> , Hiern.), by R. S. Troup	0 4 0
8.—Note on the Collection of Statistical Data relating to the principal Indian Species, by A. M. F. Caccia	0 10 0
9.—Tables showing the Progress in Working-Plans in the Provinces outside the Madras and Bombay Presidencies up to 31st December 1908, by the same author	0 10 0

	PRICE (exclusive of pack- ing, postage, etc.). Rs. a. p.
10.—Note on Burmese Leza Wood (<i>Lagerstræmia tomentosa</i> , Presl.), by R. S. Troup	0 2 0
11.—Note on Carallia Wood (<i>Carallia integerrima</i> , DC.), by the same author	0 2 6
12.—Note on Petwun or Trincomali Wood (<i>Berryu Ammonilla</i> , Roxb.), by the same author	0 4 0
13.—Note on Burmese In Wood (<i>Dipterocarpus tuberculatus</i> , Roxb.), by the same author	1 0 0
14.—Note on Burma Padouk (<i>Pterocarpus macrocarpus</i> , Kurz.), by the same author	1 0 0
15.—Note on the Preservation of Bamboos from the Attacks of the Bamboo Beetle or "Shot-Borer," by E. P. Stebbing	0 7 0
16.—Note on the Best Season for Coppice Fellings of Teak (<i>Tectona grandis</i>), by R. S. Hole	0 1 0

IV.—BULLETINS (NEW SERIES).

1.—Note on Calorimetric Tests of Some Indian Woods, by Puran Singh	0 2 0
2.—Memorandum on Teak Plantations in Burma, by F. A. Leete	0 10 0
3.—Note on the Relative Strength of Natural and Plantation-Grown Teak in Burma, by R. S. Pearson	0 4 0
4.—Second Edition of the Glossary of Technical Terms for Use in Indian Forestry, by A. M. F. Caccia, revised by R. S. Troup	0 6 0
5.—The Blue Pine Tomicus Bark-Borer (<i>Tomicus Ribbentropi</i>), by E. P. Stebbing	0 2 0
6.—Memorandum on the Oil-Value of Sandalwood, by Puran Singh	0 2 0
7.—Note on the Chemistry and Trade Forms of Lac, by the same author	0 3 0
8.—Note on some Germination Tests with Sal Seed (<i>Shorea robusta</i>), by R. S. Troup	0 2 0
9.—Note on Resin-Value of <i>Podophyllum Emodi</i> and the best season for collecting it, by Puran Singh	0 1 3
10.—Note on the Bark-Boring Beetle Attack in the Coniferous Forests of the Simla Catchment Area, 1907—1911, by R. S. Hole	0 3 0
11.—A Further Note on some Casuarina Insect Pests of Madras, by V. Subramania Iyer	0 14 0
12.—Note on the Bark-Eating and Root-Boring Beetles of Babul (<i>Acacia arabica</i>), by E. P. Stebbing	0 4 0
13.—Note on <i>Ligna Protector</i> as a possible means of preventing timber from splitting while seasoning, by R. S. Pearson	0 5 0
14.—A Further Note on the Relative Strength of Natural and Plantation-Grown Teak in Burma, by the same author	0 3 0
15.—Note on the Technical Properties of Timber with special reference to <i>Cedrela Toona</i> wood while seasoning, by the same author	0 3 0
16.—Note on Gumhar (<i>Gmelina arborea</i> , Roxb.), by A. Rodger	0 3 0
17.—Note on Bija Sal or Vengai (<i>Pterocarpus Marsupium</i> , Roxb.), by the same author	0 4 0
18.—Note on Sain or Saj (<i>Terrivalia tomentosa</i> , W. and A.), by the same author	0 5 0
19.—Note on Benteak or Nana Wood (<i>Lagerstræmia lanceolata</i> , Wall.), by the same author	0 3 0
20.—Note on Sandan (<i>Ougeinia dalbergioides</i> , Benth.), by the same author	0 3 0
21.—Note on Dhaura Bakli (<i>Anogeissus latifolia</i> , Wall.), by the same author	0 4 0
22.—Note on the Causes and Effects of the Drought of 1907 and 1908 on the Sal Forests of the United Provinces, by R. S. Troup	0 5 0
23.—Note on the Preparation of Indian Forest Floras and Descriptive Lists, by R. S. Hole	0 4 0
24.—Note on Turpentine of <i>Pinus Khasya</i> , <i>Pinus Merkusii</i> and <i>Pinus excelsa</i> , by Puran Singh	0 2 0
25.—Development of the Culms of Grasses, by R. S. Hole	0 2 0
26.—Note on the Resin Industry in Kumaun, by E. A. Smythies	1 4 0
27.—Note on Blackwood (<i>Dalbergia latifolia</i> , Roxb.), by E. Benskin	0 4 0
28.—Note on Dhauri (<i>Lagerstræmia, parviflora</i> , Roxb.), by the same author	0 4 0
29.—Note on Sundri Timber (<i>Heritiera minor</i> , Lam.), by R. S. Pearson	0 3 0
30.—The Compilation of Girth Increments from Sample Plot Measurements, by R. S. Troup	0 2 0

	PRICE (exclusive of pack- ing, postage, etc.). Rs. a. p.
31.—Note on Indian Sumach (<i>Rhus Cotinus</i> , Linn.), by Puran Singh	0 2 0
32.—Note on the Burma Myrabolans or "Panga fruits" as a Tanning Material, by Puran Singh	0 1 0
33.—Note on an Enquiry by the Government of India into the Relation between Forests and Atmospheric and Soil Moisture in India, by M. Hill	1 0 0
34.—Note on Red Sanders (<i>Pterocarpus santalinus</i> , Linn. f.), by T. A. Whitehead	0 9 0
35.—Note on Babul (<i>Acacia arabica</i> , Willd.), by J. D. Maitland-Kirwan	0 5 0
36.—Note on Kokan or Lampatia Timber (<i>Duabanga sonneratioides</i> , Ham.), by R. S. Pearson	0 3 0
37.—Note on the Contraction and Warping which takes place in <i>Pinus longifolia</i> timber while seasoning, by the same author	0 11 0
38.—The Construction of Calcareous Opercula by Longicorn Larvæ of the Group <i>Cerambycini</i> (Coleoptera, Cerambycidae), by C. F. C. Beeson	0 3 0
39.—Note on Hollong Timber (<i>Dipterocarpus pilosus</i> , Roxb.), by R. S. Pearson	0 4 0
40.—Note on Pyinma, Ajhar or Jarul Wood (<i>Lagerstrœmia Flos-Reginæ</i> , Retz.), by the same author	0 6 0
41.—Note on Weights of Seeds, by S. H. Howard	0 3 0

V.—FOREST RECORDS.

Vol. I, Part I.—A Note on the Lac Insect (<i>Tachardia lacca</i>), its Life-History, Propagation and Collection, by E. P. Stebbing. (<i>Out of print</i>)	1 4 0
„ Part II.—A Preliminary Note on the Development of the Sal in Volume and in Money Value, by A. M. F. Caccia. (<i>Out of print</i>)	1 4 0
„ Part III.—1. <i>Pterocarpus dalbergioides</i> , Roxb. (Andaman Padouk), by B. B. Osmaston	1 4 0
„ „ 2. A Further Note on the Chilgoza Bark-Boring Beetles of Zhob, by E. P. Stebbing and Captain E. H. S. James	
„ „ 3. A Note on the Present Position and Future Prospects of the Cutch Trade in Burma, by R. S. Troup	
„ „ 4. Note on the Manufacture of Ngai Camphor, by Puran Singh. (<i>Out of print</i>)	
Vol. I, Part IV.—1. A Chemical Investigation of the Constituents of Burmese Varnish (<i>Melanorrhœa usitata</i> , Sap.), by Puran Singh	1 4 0
„ „ 2. The Selection System in Indian Forests as exemplified in Working-Plans based on this system with a short description of some Continental Methods, by A. M. F. Caccia (<i>Out of print</i>)	
Vol. II, Part I.—Note on some Insect Pests of the Himalayan Oaks (<i>Quercus dilatata</i> and <i>Q. incana</i>), by E. P. Stebbing. (<i>Out of print</i>)	0 6 0
„ Part II.—Note on the Fissibility of some Indian Woods, by R. S. Troup. (<i>Out of print</i>)	1 6 0
„ Part III.—1. Monograph on the Sylviculture of <i>Hardwickia binata</i> (Anjan), by D. O. Witt	3 4 0
„ „ 2. Notes on Sandal (Germination and Growth of Sandal Seedlings), by M. Rama Rao	
„ Part IV.—Note on Host Plants of the Sandal Tree, by the same author	2 0 0
Vol. III, Part I.—Note on some Statistical and other Information regarding the Teak Forests of Burma, by R. S. Troup	2 12 0
„ Part II.—Preliminary Note on the Antiseptic Treatment of Timber in India with special reference to Railway Sleepers, by R. S. Pearson	0 14 0
„ Part III.—Report on the Investigation of Bamboos as Material for Production of Paper-pulp, by W. Raitt	0 6 0

PRICE
(exclusive of pack-
ing, postage, etc.).
Rs. a. p.

Vol. III, Part IV.—Note on the Preparation of Tannin Extracts with special reference to those prepared from the Bark of Mangrove (<i>Rhizophora mucronata</i>), by Puran Singh	0 7 0
Vol. IV, Part I.—Note on the Distillation and Composition of Turpentine Oil from the Chir Resin and the Clarification of Indian Rosin, by the same author	0 9 0
„ Part II.—Note on some new and other Species of Hymenoptera in the Collections of the Zoological Branch of the Forest Research Institute, Dehra Dun, by P. Cameron	0 4 0
„ Part III.—Note on Useful Exotics in Indian Forests, (No. 1 <i>Prosopis juliflora</i> DC.), by R. S. Hole	0 4 0
„ Part IV.—Note on <i>Albizzia Lathamii</i> , by the same author	0 3 0
„ Part V.—Note on the Utilization of Bamboo for the Manufacture of Paper-pulp, by R. S. Pearson. (2nd Edition)	2 0 0
Vol. V, Part I.—Note on Tea-box Industry in Assam, by the same author	0 4 0
„ Part II.—Note on Blue Gum Plantations of the Nilgiris (<i>Eucalyptus Globulus</i>), by R. S. Troup	1 6 0
„ Part III.—Report on the Investigation of Savannah Grasses as Material for Production of Paper-pulp, by W. Raitt. (Out of print)	0 4 0
„ Part IV.—1. Note on Ecology of Sal (<i>Shorea robusta</i>) Part I, Soil-composition, Soil-moisture, Soil-aeration, by R. S. Hole	0 8 0
„ „ 2. Note on Ecology of Sal (<i>Shorea robusta</i>), Part II, Seedling Reproduction in Natural Forests and its Improvement, by the same author	1 1 0
„ „ 3. Note on Ecology of Sal (<i>Shorea robusta</i>), Part III, Soil-aeration and Water-cultures, by the same author	0 8 0
„ Part V.—Note on <i>Trameetes Pini</i> , by the same author	1 0 0
„ Part VI.—Note on a New Species of Forest Grass (<i>Spodiopogon Laceri</i> , Hole), by the same author	0 8 0
„ Part VII.—Note on the Economic Uses of Roshia Grass (<i>Cymbopogon Martini</i> , Stapf.), by R. S. Pearson and	1 8 0
„ „ Note on the Constants of Indian Geranium Oil Motia, by Puran Singh. (Out of print)	
„ Part VIII.—1. Note on the Eucalyptus Oil Industry in } By	
„ „ 2. Note on the Distillation of Geranium } Puran	1 0 0
„ „ 3. Note on the Manufacture of Wintergreen } Singh.	
Oil in India.	
Vol. VI, Part I.—The Life-History of <i>Diapus furtivus</i> , Sampson, by C. F. C. Beeson	0 10 0
„ Part II.—Statistics compiled in the Office of the Sylviculturist, Forest Research Institute, Dehra Dun, during 1915-16	1 6 0
„ Part III.—A Note on Thitsi (<i>Melanorrhæa usitata</i> , Wall.), with special reference to the Oleo-resin obtained from it by E. Benskin and A. Rodger	1 2 0
„ Part IV.—A Further Note on the Antiseptic Treatment of Timber, recording results obtained from past experiments, by R. S. Pearson	3 0 0
„ Part V.—Statistics compiled in the Office of the Sylviculturist, Forest Research Institute, Dehra Dun, during 1916-17	0 10 0
„ Part VI.—Note on Preparation of Turpentine, Rosin and Gum, from <i>Boswellia serrata</i> (Roxb.) gum-oleo-resin, by R. S. Pearson and Puran Singh	0 13

PRICE
(exclusive of pack-
ing, postage, etc).
Rs. A. P.

Vol. VII, Part	I.—Preliminary Note on the Seasoning of some Indian Timbers by Natural Methods, by R. S. Pearson	1 0 0
.. Part	II.—A Further Note on Thitsi (<i>Melanorrhæa usitata</i> , Wall.), with special reference to the oleo-resin obtained from it in the Lawksawk and Myelat States, Southern Shan States Forest Division, by F. A. Wright	0 4 0
.. Part	III.—Note on <i>Hopea canarensis</i> , Hole, by R. S. Hole	0 3 0
.. Part	IV.—Note on <i>Izora Butterwickii</i> , Hole, by the same author	0 3 0
.. Part	V.—Notes on the Larvæ and Life-Histories of Prionine Beetles, Coleoptera, Cerambycidae, Prionine, by C. F. C. Beeson	0 8 0
.. Part	VI.—Note on the Mechanical Strength and Seasoning Properties of <i>Shorea robusta</i> (Sal Timber), by R. S. Pearson	0 8 0
.. Part	VII.—The Life History of the Toon Shoot and Fruit Borer, <i>Hypsiopyla robusta</i> , Moore, (<i>Lepidoptera</i> ; <i>Pyralidae</i> ; <i>Phycitinae</i>) with suggestions for its control, by C. F. C. Beeson	2 4 0
.. Part	VIII.—Afforestation of Ravine Lands in the Etawah District, U. P., by E. A. Symthies	2 0 0
Vol. VIII. Part	I.—Report on Lac and Shellac, by H. A. F. Lindsay & C. M. Harlow	2 12 0
.. Part	II.—The Regeneration of Sal (<i>Shorea robusta</i>) Forests, by R. S. Hole	2 2 0

VI.—MEMOIRS.

Note on the Analysis of Cutch and the Preparation of Pure Catechin, Vol. I, Part I, Chemistry Series, by Puran Singh. (<i>Out of print</i>)	1 4 0
Note on the Manufacture of Pure Shellac, Vol. I, Part II, Chemistry Series, by the same author. (<i>Out of print</i>)	0 8 0
On Some Undescribed Scolytidae of Economic Importance from the Indian Region I, Vol. I, Part I, Zoology Series, by E. P. Stebbing	0 4 0
On Some Undescribed Scolytidae of Economic Importance from the Indian Region II, Vol. I, Part II, Zoology Series, by the same author. (<i>Out of print</i>)	0 4 0
Indian Woods and their Uses, Vol. I, Part I, Economy Series, by R. S. Troup	2 12 0
Note on the Prospects of the Match Industry in the Indian Empire, Vol. II, Part I, Economy Series, by the same author	1 12 0
Second Edition of the Monograph on "Lac Insect" (<i>Tachardia lacca</i>), Vol. I, Part III, Zoology Series, by E. P. Stebbing.	1 0 0
Note on Some Important Insect Pests of the Himalayan Coniferæ (Treating of Deodar), Vol. II, Part I, Zoology Series by E. P. Stebbing. (<i>Out of print</i>)	4 10 0
Note on the Insect Pests of the Chir Pine (<i>Pinus longifolia</i>), Vol. II, Part II, Zoology Series, by the same author	1 14 0
Memoir on Some Indian Forest Grasses and their Ecology, Vol. I, Part I, Botany Series, by R. S. Hole	5 8 0
Note on the Life-History of <i>Chermes Himalayensis</i> , Steb., on the Spuce (<i>Picea Morinda</i>) and Silver Fir (<i>Abies Webbiana</i>), Vol. II, Part III, Zoology Series, by E. P. Stebbing. (<i>Out of print</i>)	1 12 0
Note on the Economic Value of <i>Shorea robusta</i> (Sal), Vol. II, Part II, Economy Series, by R. S. Pearson	1 12 0
On the Structure and Biology of <i>Tachardia lacca</i> , Kerr, with observations on certain insects predaceous or parasitic upon it, Vol. III, Part I, Zoology Series, by A. D. Imms and N. C. Chatterjee	2 2 0
<i>Pinus longifolia</i> , Roxb., Vol. I, Part I, Sylviculture Series, by R. S. Troup	5 0 0

VII.—MANUALS.

Forest Zoology Manual by E. P. Stebbing. (<i>Out of print</i>)	10 0 0
Manual of Botany, by R. S. Hole. (<i>Out of print</i>)	3 8 0
Indian Forest Utilization (Second Edition), by R. S. Troup. (<i>Out of print</i>)	2 12 0

PRICES
(exclusive of packing, postage, etc.).
Rs. a. p.

Explanatory Notes on Forest Law (a new Edition of the Forest Law Manual). (<i>Out of print</i>)	1 2 0
Preparation of Forest Working Plans in India, by W. E. D'Arcy. Revised by A. M. F. Caccia. (Fourth Edition)	0 14 0
Second Edition of Manual of Sylviculture. (<i>Out of print</i>)	1 0 0
Manual of Forest Mensuration, by R. S. Troup. (<i>Out of print</i>).	1 4 0
Surveying and Drawing Manual, by F. A. Brining and D. N. Avasia. (<i>Out of print</i>)	3 12 0

VIII.—OTHER PUBLICATIONS.

Index to the <i>Indian Forester</i> , Vols. I to XXX, by E. P. Stebbing	1 0 0
"The Utilization of Bamboo for the Manufacture of Paper Pulp," by R. S. Pearson, Reprinted from "The Indian Forester," 1920	0 8 0
Practical Determination of the Girth Increment of Trees, by R. S. Troup. (<i>Out of print</i>)	0 4 0
Forest Flora of Chhota Nagpur, by H. H. Haines. (<i>Out of print</i>)	9 0 0
Translation of M. Jacquots. "Incendies en Forêt," by C. E. C. Fischer. (<i>Out of print</i>)	0 14 0
Forest Flora of the Siwalik and Jaunsar Forest Divisions, U. P. (Revised Edition), by U. N. Kanjilal. (<i>Out of print</i>)	1 14 0
Commercial Guide to the Economic Forest Products of India, by R. S. Pearson	1 0 0
Catalogue of the Photographic Collection at the Forest Research Institute, Dehra Dun	1 4 0
Forest Research Institute and College Calendar, 1919	1 0 0
Progress Report of Forest Research Work in India for the year 1919-20	...
Progress Report of the Imperial Forest College, Dehra Dun, for the year 1919-20	1 6 0
Note on the Forests of Java and Madoera of the Dutch East Indies, by R. C. Milward	0 13 0
A Note on some European Sylvicultural Systems, with Suggestions for Improvements in Indian Forest Management, by R. S. Troup. (<i>Out of print</i>)	3 4 0
Note entitled "Among the Eucalypts," by R. C. Milward	3 4 0
The Work of the Forest Department in India, by R. S. Troup	0 4 0
Code for the Collection and Tabulation of Statistical Data, by S. H. Howard	2 0 0
Code for the Collection and Tabulation of Statistical Data (Appendices), by the same author	3 8 0

Progress Report of Forest Research Work in India

For the Year 1921-22.

Including the Administration Report of the
Forest Research Institute, Dehra Dun.



SIMLA
SUPERINTENDENT, GOVERNMENT CENTRAL PRESS
1923

Price Rs. 2.

Agents for the Sale of Books Published by the Superintendent, Government Printing, India, Calcutta.

EUROPE.

Constable & Co., 10, Orange Street, Leicester Square, London, W.C.
 Kegan Paul, Trench, Trübner & Co., 68-74, Carter Lane, E.C., and 39, New Oxford Street, London, W.C.
 Bernard Quaritch, 11, Grafton Street, New Bond Street, London, W.
 P. S. King & Sons, 2 & 4, Great Smith Street, Westminster, London, S.W.
 H. S. King & Co., 65, Cornhill E.C., and 9, Pall Mall, London, W.
 Grindley & Co., 54, Parliament Street, London, S.W.
 Luzac & Co., 46, Great Russell Street, London, W.C.

W. Thacker & Co., 2, Creed Lane, London, E. C.
 T. Fisher Unwin, Limited, 1, Adelphi Terrace, London, W. C.
 Wheldon & Wesley, Ltd., 28, Essex St., London, W. C.
 B. H. Blackwell, 50 & 51, Broad Street, Oxford.
 Deighton Bell & Co., Ltd., Cambridge.
 Oliver & Boyd, Tweeddale Court, Edinburgh.
 E. Ponsonby, Ltd., 116, Grafton Street, Dublin.
 Ernest Leroux, 28, Rue Bonaparte, Paris.
 Martinus Nijhoff, The Hague, Holland.
 Otto Harrassowitz, Leipzig.
 Friedländer and Sohn, Berlin.

INDIA AND CEYLON.

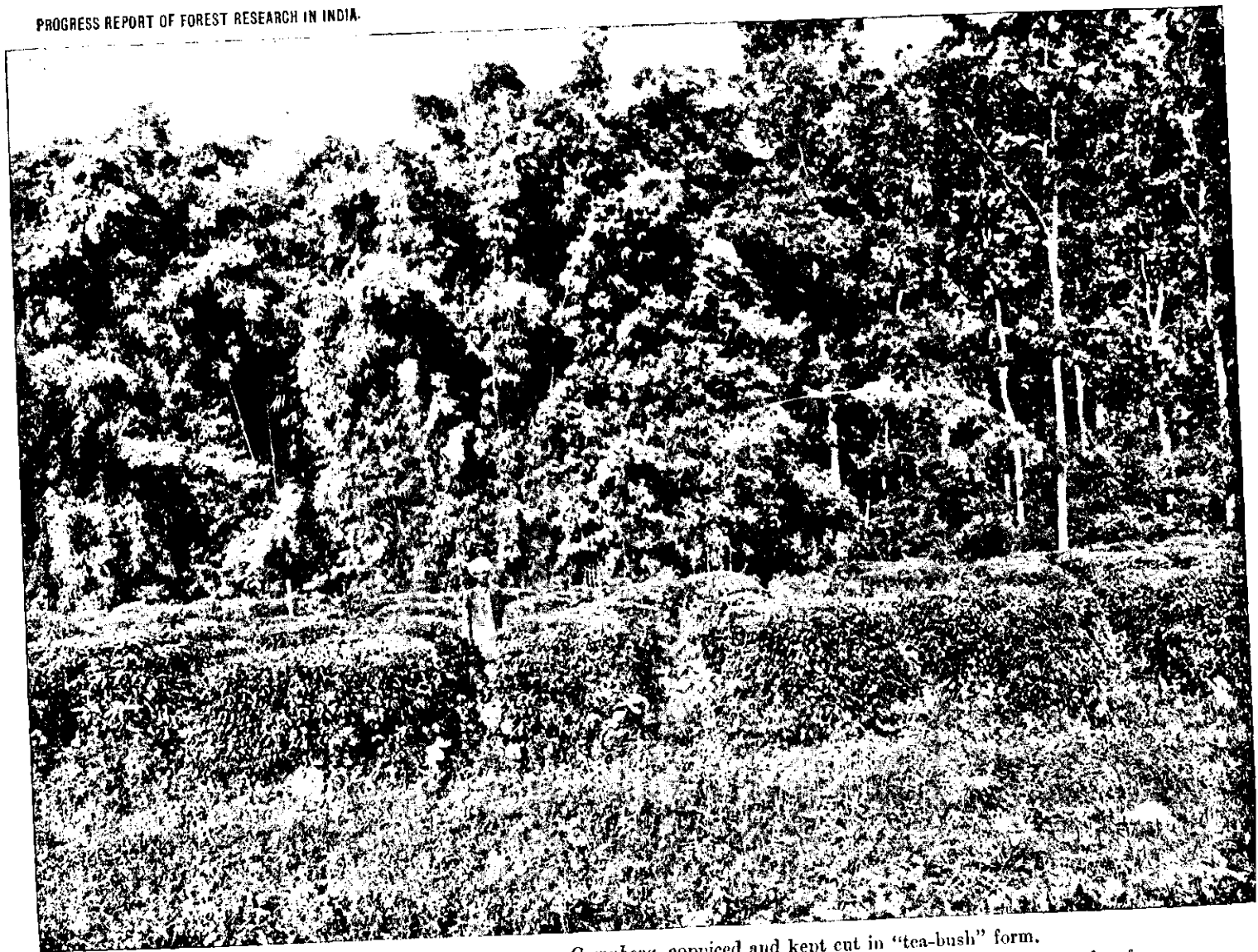
Thacker, Spink & Co., Calcutta and Simla.
 Newman & Co., Calcutta.
 R. Cambay & Co., Calcutta.
 S. K. Ishari & Co., Calcutta.
 B. Banerjee & Co., Calcutta.
 The Indian School Supply Depot, 509, Bow Bazar Street, Calcutta, and 226, Nawabpur, Dacca.
 Butterworth & Co., (India), Ltd., Calcutta.
 Bai M. C. Sarear Bahadur & Sons., 90-2A, Harrison Road, Calcutta.
 The Weldon Library, 57, Park Street, West, Calcutta.
 Standard Literature Company, Limited, Calcutta.
 Lal Chand & Sons, Calcutta.
 Association Press, Calcutta.
 Bigginbotham & Co., Madras.
 V. Kalyanarama Iyar & Co., Madras.
 G. A. Natesan & Co., Madras.
 S. Murthy & Co., Madras.
 Thompson & Co., Madras.
 Temple & Co., Madras.
 P. R. Bama Iyar & Co., Madras.
 Vas & Co., Madras.
 E. M. Gopalakrishna Kone, Madras.
 Thacker & Co., Ltd., Bombay.
 D. B. Taraporewala, Sons & Co., Bombay.
 Mrs. Radhabai Atmaram Sagoo, Bombay.
 Sunder Pandurang, Bombay.
 Gopal Narayan & Co., Bombay.
 Ram Chandra Govind & Son, Kalbadevi, Bombay.
 Proprietor, New Kitabkhana, Poona.

The Standard Bookstall, Karachi.
 Mangaldas Harkisandas, Surat.
 Karsandas Narandas & Sons, Surat.
 A. H. Wheeler & Co., Allahabad, Calcutta and Bombay.
 N. B. Mather, Supt. Nazir Kanun Hind' Press, Allahabad.
 Munshi Seeta Ram, Managing Proprietor, Indian Army Book Depot, Juhl, Cawnpore.
 Rai Sahib M. Gulab Singh & Sons, Mufid-i-Am Press, Lahore and Allahabad.
 Rama Krishna & Sons, Lahore.
 Supt., American Baptist Mission Press, Rangoon.
 Proprietor, Rangoon Times Press, Rangoon.
 Manager, the "Hitavada," Nagpur.
 E. C. Talukdar, Proprietor, Students & Co., Kocch Behar.
 A. M. & J. Ferguson, Ceylon.
 Manager, Educational Book Depots, Nagpur and Jabulpore.*
 Manager of the Imperial Book Depot, 63, Chandnee Chawk Street, Delhi.*
 Manager, "The Agra Medical Hall and Co. operative Association, Ltd." (successors to A. John & Co., Agra).
 Supt., Basel Mission Book and Tract Depository, Mangalore.*
 P. Varadachary & Co., Madras.*
 Ram Dayal Agarwala, 184, Katra, Allahabad.*
 D. C. Anand & Sons, Peshawar.*
 Manager, Newal Kishore Press, Lucknow.*
 Maung Lu Gale, Proprietor, Law Book Depot Mandalay.*

*Agents for the sale of Legislative Department publications only.

CONTENTS.

	PAGE.
INTRODUCTION—	
CHAPTER	
I. General	1
II. Silviculture and Working Plans	2
III. Forest Botany	47
IV. Forest Economy	53
V. Forest Entomology	71
VI. Forest Chemistry	79
VII. Forest Publications	81
APPENDICES	84



Photograph showing *Cinnamomum Camphora*, coppiced and kept cut in "tea-bush" form. One bush of camphor leaves has just been cut. The object of this experiment is to find out the yield of camphor from the experimental Garden, Dehra Dun, December 1921.

INTRODUCTION.

This report deals with the period from the 1st April 1921 to the 31st March 1922 and is therefore the first dealing with the full period of 12 months since the abolition of the Forest Year (1st July to 30th June).

At the Silvicultural Conference held at Dehra Dun in January the question of the most suitable headings came under discussion and these now adopted were recommended in Resolution No. IX of that Conference's Proceedings. It is hoped that this will be considered an improvement. At all events it is now easier to compile the information under appropriate heads, but there is still room for clearer correlation of the work within provinces. In some cases the provincial reports can be embodied without alteration, in others it is necessary to curtail the information considerably. It is sometimes difficult to follow up experimental work which has already been referred to in previous reports and to distinguish between important and other matter. Until research officers are appointed in all provinces this condition will obtain but it would add considerably to the value of the report if the material could be supplied in a form suitable for direct incorporation. This report is intended to represent the progress of forest research work in India and includes the administration report of the Central Institute. It is not intended to be merely the compilation by this institution of matter which it considers of general interest.

It is to be hoped that the provinces will all co-operate in making the report fulfil its purpose and this, it is thought, can best be achieved by local preparation of the material. Eventually this may necessitate the allotment and perhaps curtailment of space but until the provinces are all equally equipped it is felt that too rigid a form is inadvisable.

The general impression conveyed by a perusal of the material forwarded is that an awakening is taking place in the department generally in all scientific and economic directions. This is particularly the case in experimental silviculture in every province but the interest of the public in all questions of utilization is equally gratifying. The combination of research into problems of production and utilization, if continued and encouraged, must result in a fuller realisation of our forest resources which, after all, is the main object in view.

* * * * *

Some contributions from the United Provinces, Assam and North-West Frontier Province were received too late for insertion.

Progress of Forest Research in India 1921-22

CHAPTER I.

GENERAL.

Progress in the appointment of staff for research work and in the provision of appliances (buildings, equipment, etc.) has been retarded owing to the financial stringency. In some provinces the shortage of officers has precluded the filling of vacant posts. The following extract from the Burma report explains the position in that province :—

“ It may be mentioned that it is hoped to start construction of the quarters for Research offices connected with the proposed Research Institute at Maymyo within a few weeks and to have the Institute well under way by 1923.

The most important event of the year, so far as Economic Research is concerned, was the visit to Rangoon of the Forest Economist, Mr. Pearson, and a conference of senior officers who met him and decided finally the scope of the operations desired by the Forest Department. The recommendations of this Conference, have been sent up to the Local Government for approval and it is hoped that they will be sanctioned in full.”

At the Central Institute at Dehra Dun good progress was made in the construction of workshops and laboratories and the complete transfer should be effected before the end of March 1923.

The method of dealing with the general scheme¹ of extension received careful consideration and orders were passed, after the close of the year, to proceed with the transfer of the Economic and Entomological branches to the new site. This is as much as can be expected in present circumstances and will have the desirable effect of clearing part of the existing Research Institute building for education. Both education and research will benefit greatly from this decision.

The sections of Wood Technology and of Systematic Botany were instituted during the year but it was not possible to organise the section of Wood Preservation owing to the difficult financial

position. This is to be regretted as it is probably more in this direction than in any other that a study of Indian problems is required. The experimental plant has been in Dehra for some time and it only awaits an expert to erect and work it in order to extend the use of Indian timbers and to replace the creosoted railway sleepers imported from other countries.

Allusion has been made to the Silvicultural Conference held during the year. An Utilization Conference was held concurrently ; both were well attended and should prove of great value. The discussions dealt with general problems of organization of forest research rather than with specific problems and also aimed at the definition of the respective spheres of the central and local research organizations. The Proceedings have issued in print since the close of the year.

CHAPTER II.

SILVICULTURE AND WORKING PLANS.

Central Institute.

I.—*Experimental Silviculture.*

General.—The bulk of experimental silviculture in those provinces where local silviculturists have already been appointed, is done by them. The Central Institute has been passing through a transition period during the year and the sub-division of labour between it and the local silviculturists is only now becoming defined. It has been proposed and approved by the Silvicultural Association that, as a result of past experience, in the realm of pure experimental silviculture, the Central Institute should confine itself to recording and ledgering all experimental work in provinces and that its actual experimental researches should be confined to the seeds and seedling stage only. Once the plants get beyond this stage the local officer is the only person who has the facilities for carrying out the work, but where possible, the Central Institute should conduct such check experiments as provinces may ask for.

Natural Regeneration.—None of the natural regeneration experiments in the hills, dealing with hill types, have been visited during this year. It is not possible for the Silviculturist to visit all the plots yearly and it is partly for this reason that it is proving better for such work to be done by local officers.

Sal (*Shorea robusta*).—An attempt is being made to regenerate sal on the Gorakhpur method in Thano forest, which is subject to frost. The shoots were killed back early in 1921 but during the rains it looked as if they would get through. Grazing by deer and cattle proved so bad however, that when last seen, almost every plant was nibbled down to a height of about 3 feet. As grazing

incidence is not being tested, the area was fenced early in March 1922. The only other natural regeneration experiments on this species were in coppice experimental plots. These are being classified and the results obtained will be available shortly. From measurements made it appears again that the "coppice with standards" method is a poor one if anything much is expected from the coppice. Either simple coppice or high forest appear preferable, in the localities dealt with, with the exception perhaps of forests where severe damage from frost is expected.

Dalbergia Sissoo.—For some years an attempt has been made to regenerate *sissoo* by means of an ordinary seeding felling. The experiments on this subject only confirm what was already known, *viz.*, that *sissoo* cannot be naturally regenerated in this way. An even heavier felling has now been made but it is not expected that any regeneration will appear.

Dalbergia latifolia.—Stems thinned in a local plot have all sent up vigorous coppice shoots.

Seeds.—The results of investigations into the weight of seeds have been published during the year.

The following results on plant per cents (by this is meant the percentage of seedlings to seeds sown) have been observed during the year. It was an exceptional year however in Dehra Dun, as there was an abnormal hot weather, and no regular rain till July 7th. The beds were watered but the nursery was not provided with shades so that a large number of failures of species sown in May occurred which would not have happened in a normal year. In most cases the sowings were not made to test the plant per cent. and as it is merely an incidental and single observation it is not inserted as a final result. Sowings of *Anogeissus latifolia*, *Cedrela Toona*, *Chickrassia tabularis*, *Ficus infectoria*, *Odina Wodier*, *Quercus incana* and *serrata*, *Sapindus emarginatus*, *Swietenia Mahagoni* and *Terminalia Chebula*, made between the 15th and end of May, failed completely or produced only an odd plant or two.

The following were the observed results on other species. In many cases the reason of the low plant per cent. was that too many seeds were sown and there was no room for all the plants to come up.

Species.	Germination per cent.	Plant per cent. in bed.	Time to germinate in bed.	REMARKS.
<i>Acacia Catechu</i> ...	Not tested ...	27%	10 days to 7 weeks.	The bed was full. Sown May 22nd.
<i>Acacia arabica</i> ...	" " ...	26%	3 to 4 weeks	Sown May 22nd. The bed was absolutely full. There was no room for more.

Species.	Germination per cent.	Plant per cent. in bed.	Time to germinate in bed.	REMARKS.
<i>Albizia odoratissima</i>	Not tested ...	20%	6 days to 5 weeks.	Sown 26th May.
<i>Bombax malabaricum</i>	" " ...	32%	One month ...	Sown 26th May.
<i>Buchanania latifolia</i>	" " ...	16%	6 to 9 weeks	Sown end May.
<i>Cinnamomum Camphora.</i>	Not finished...	...	4 to 6 months	Sown in November. Germination still going on.
<i>Dalbergia Sissoo</i> ...	Not tested	10%	1 to 2 months	Sown 26th May. The plant per cent. conveys little as the bed was absolutely full of plants.
<i>Dichopsis elliptica</i> ...	" " ...	87%	One month.	
<i>Eugenia operculata</i>	" " ...	13%	10 days to 7 weeks.	Sown 13th August.
<i>Garuga pinnata</i> ...	" " ...	3½%	10 days to 2 months.	Sown 24th July.
<i>Gmelina arborea</i> ...	" " ...	40%	3 weeks to one month.	Sown 24th June.
<i>Melia indica</i> ...	" " ...	Good not worked out.	10 to 15 days	Sown 21st July. Plant per cent. was probably 100.
<i>Piptadenia oudhensis</i>	" " ...	17%	8 days to one month.	Sown 24th June.
<i>Podocarpus nerifolia</i>	" " ...	37%	6 days to 1 month.	Sown 19th August.
<i>Prosopis juliflora</i> ...	" " ...	10%	3 weeks to 3 months.	Sown May 25th. The plant per cent. conveys really nothing here. The bed was absolutely full of plants.
<i>Sapindus detergens</i> ..	" " ...	13%	6 weeks to 6 months.	Sown May. Soaked in cold water for 2 days before sowing.
<i>Schleichera trijuga</i> ...	" " ...	6%	15 days.	
<i>Shorea robusta</i> ...	100%	Not observed.	Abnormal this year.	The plant per cent. of sal is usually 30—50.
<i>Terminalia belerica</i>	Not tested ...	Good not worked out.	6 weeks to 2 months.	Sown 21st May.
<i>Terminalis tomentosa</i>	" " ...	8%	20 days to 6 weeks.	Sown 4th June. Seeds not covered.
<i>Vateria indica</i> ...	" " ...	28%	2 to 3 weeks	Sown too late end of August.

Nursery work.—There is nothing to report this year except that the abnormal hot weather of 1921 showed the necessity of providing shades over a permanent nursery such as the Kaunli one. A very large number of the sowings to raise plants for various experiments or for the new Institute failed completely and it is probable that these could have been saved with shades. Shades similar to those used in Bengal have now been erected and it is hoped that the young plants will now be immune from the results of abnormal weather.

Artificial regeneration.—A large amount of work has been done in this section during the last few years and observations filed as the experiments were finished. The result is a mass of detail out of which it is impossible to get any tangible results without first reducing the observations to definite essentials. This work has been commenced and it is hoped that it will be completed during the coming year when it will be possible to regulate the future work better.

It was, however, abundantly clear that in the matter of transplanting, etc., the experiments had practically always been made with too few plants, often only 5 or 6, and that there seems to have been no definite plan of work; experiments appear to have been haphazard and desultory. As a result it was decided this year to start a series of transplanting experiments with the following variations :—

- (1) Transplanting entire plants at the beginning of the monsoon.
 - (a) weeded round the plants.
 - (b) unweeded.
- (2) Root and shoot cuttings, transplanting at the beginning of the monsoon.
 - (a) weeded round the plants.
 - (b) unweeded.
- (3) Transplanting entire plants after the monsoon (usually November).
 - (a) weeded round the plants.
 - (b) unweeded.
- (4) Root and shoot cuttings, transplanting after the end of the monsoon.
 - (a) weeded round the plants.
 - (b) unweeded.

In every variation 50 plants will be used which, it is thought, is sufficient to give a reliable percentage of survivals. Five species have already been taken in hand and four more are being raised for the purpose.

The only one which has reached a definite stage is *Cinnamomum Camphora*, of which the following is the result to date.

Entire transplants July 1921, weeded, show now	80 per cent. survivals.
Entire transplants July 1921, unweeded, show now	48 per cent. survivals.
Root and shoot cuttings July 1921, weeded, show now	100 per cent. survivals.
Root and shoot cuttings July 1921, un- weeded, show now	94 per cent. survivals.

No other results can be given till the files have been sorted or till the new work is further advanced.

Dendrocalamus strictus.—A series of experiments with seeds, offsets from various aged culms, stem cuttings, etc., have been commenced but it is as yet too early to report. It appears that monsoon sowings, if weeded, or offsets from either one or two year old culms are an easy and successful method of propagation.

Reclamation and Afforestation.—The experiments in Zabarkhet grass land where there is great liability to heavy frost, foreshadowed last year, have been continued. The year 1921 was a particularly bad year for all winter sowings and plantings owing to the complete failure of winter rains, the severe drought in the hot weather, and a late monsoon. Consequently in a normal year much better results can be hoped for.

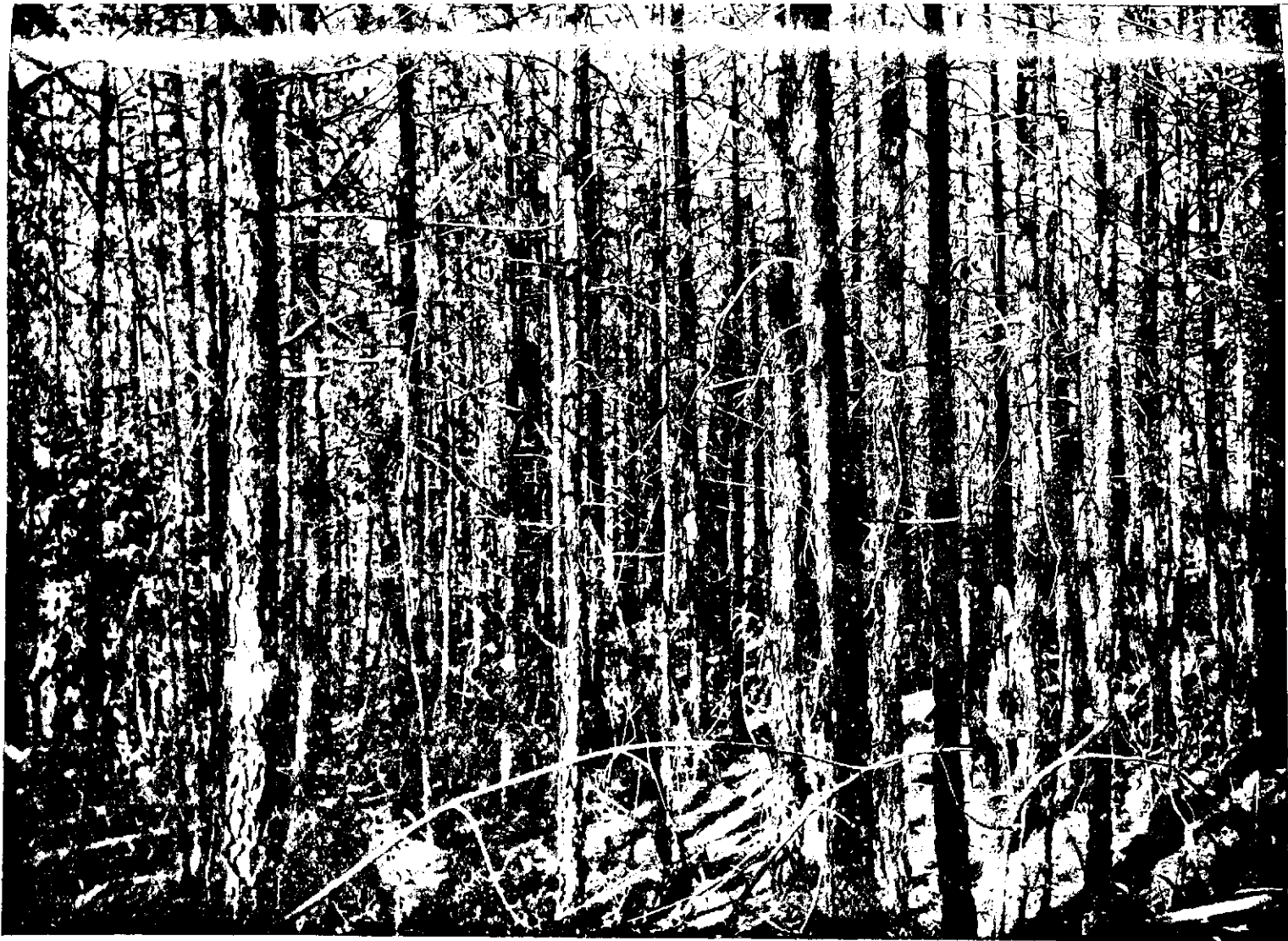
The following summarises the results.

Plot A.—Half acre, line sowing of *Pinus longifolia* on ploughed land in July 1920. No attention since. At present quite promising. A sufficiency of plants survive in the grass from 6 inches to 2 feet high. They are beginning to show new growth for this year. Pigs have done a great deal of damage.

Plot B.—Half acre, line sowing of *Pinus longifolia* in uncleared grass land in July 1920. Grass is very heavy but there are plenty of fine plants at present now showing new growth and slightly better than those in Plot A. Pigs have done damage in this plot also.

Plot C.—Half acre, sowing of *Pinus longifolia* on ploughed and cleared grass land in December 1920. No germination till the end of June (owing to winter rains failing) when the plants came up copiously. No weeding or attention in the rains. By November 1921 plants were 6" to 18" high. The grass was then cut as labour is available in that month and grass cutting pays for itself. Pigs have done damage but plants are numerous all over the plot.

Plot D.—(i) About 1½ acres burnt clear of grass in November and root and shoot cuttings of sissoo put out in pits at 5' x 5' interval in December. No further attention till November 1921 when the grass was cut. These cuttings were taken from the Song river bed and were guarded and hardly expected to succeed. Only 7 per cent. alive now but these are 3' to 4' high and there was no need



Photograph showing *unthinned* Sample Plot of *Pinus longifolia*, 29 years old, 1760 stems per acre, mean girth 13.3", mean height 31 feet, volume per acre 1592 cubic feet.



Photograph showing a typical sample plot laid out by the Silviculturist, Forest Research Institute, Dehra Dun.

Pinus longifolia 36 years old, thinned. 1208 stems per acre, mean girth 13.7",
mean height 35 feet, volume per acre 2022 cubic feet.

to cut the grass. In a normal year a better percentage could have been got but these river bed plants will not be used again.

Plot D.—(ii) Exactly as in D (i) but 225 cuttings from the nursery were used, which was all that were available. Now 47 per cent., alive are 3 feet to 4 feet high and very healthy. In a normal year a far better result would be obtained. Pigs have done a great deal of damage in this plot and have destroyed 10—15 per cent. of the plants.

Plot E.—As in Plot B but sown in June and July 1921.

Too early to report. Part of the area failed owing to bad seed but the rest looks promising and there are a good many plants to be seen on examination. Pigs have done damage.

Plot F.—About $1\frac{1}{2}$ acres root and shoot cuttings of *Dalbergia Sissoo* exactly as in Plot D, but all plants obtained from a nursery and transplanted December 1921. A good percentage are shooting already but it is too early to give a definite percentage of success yet.

In addition, Plot D was redone and all new cuttings are sprouting. A record of originals and replacements has been kept. The root and shoot cuttings of *Dalbergia Sissoo* are as far as possible about as thick as the little finger or the thumb and with a root cut down to 6" and a stem to 2".

Thinnings and cleanings.—Nothing is being done except with reference to the ordinary statistical work or as reported, under artificial regeneration.

Mixtures.—Nothing to report.

Underplanting.—Nothing to report. The experiment in underplanting *Pinus longifolia* with *Quercus incana* is being continued.

Silvicultural systems.—The only matter to report is the experiment in natural regeneration of sal under the Gorakhpur method mentioned under "Natural Regeneration." An attempt was made to try a sal taungya but it was so badly carried out that it was foredoomed to failure before it was sown and was therefore abandoned.

II.—Working Plans and Statistics.

(i) *Working Plans.*—The following working plans have been received during the year.

1. Revised Working Plan of the Casuarina Plantations, Alibag Range, Kolaba Division, for 1919-20.
2. Working Plan for the Satpura Forests.
3. Revised Working Plan for Kulu Forests.
4. Working Plan for Forahat Division, Bihar and Orissa.
5. Working Plan for the Reserved Forests in the Buxa Division of the Bengal Forest Circle, for 1920-21 to 1925-26.

6. Working Plan for Jaunsar Bawar Forests.
7. Revised Working Plan for the Upper Hill Forest of the Darjeeling Forest Division, 1921.
8. Working Plan for the Yinke Working Circle, Upper Burma, Volumes I and II.
9. Working Plan for the Reserved Forests in the Jalpaiguri Division.
10. Working Plan for the Central Almora Division for 1920-21 to 1931-32.

A working scheme for the 250 acres of the New Research Institute was prepared and approved, but could not be commenced until administrative sanction to the scheme had been given.

(ii) *Yield Tables*.—The Central Institute has remeasured 18 plots this year on behalf of the United Provinces but the ordinary seasonal work does not fall within the year under report owing to the change in date. A great deal of spade work has been done in bringing old records up to date, all of which have to be converted from the old to the new methods and, though this work is not by any means finished, the greater part of it has now been done and the Bengal sample plots have all been worked out for the Bengal Silviculturist. No yield table has been published during the year. On the whole the new system of measurement and calculation is working well. It has already brought to light a large number of errors in former measurements (which is one of its principal merits) and results have now so progressed that it is believed that the compilation of proper crop yield tables for *Shorea robusta* and *Pinus longifolia* will be started early next cold weather, when Mr. Howard returns from leave, thanks, principally, due to the very excellent work done by the United Provinces on both these species. A hot weather tour was arranged for in the Punjab and it was hoped that sufficient data would be obtained to get out a Yield Table for *Cedrus Deodara*. Unfortunately the tour had to be abandoned owing to the unsettled condition of the Province. Certain difficulties have arisen with regard to calculations but in future these will be remedied by the Central Institute taking over all calculations so soon as the necessary staff is supplied.

As a result of experience gained, the Silvicultural Association recommended that, in future, all ordinary field work should be done by provinces and that all calculations should be done by the Central Institute staff; an arrangement which should tend to much greater speed and efficiency. It is impossible to obtain the necessary accuracy without having a staff continually employed on this rather special line of work.

(iii) *Volume and Form Factor Tables*.—Two volume tables have been compiled during the year, both for sal. One concerns I Quality Bengal sal only, the other is a general sal volume table.

The recording of all measured trees for this work continues and the rate at which results are coming in, is now so rapid that it is hoped revision of this year's sal volume tables can be got out in the coming year. Possibly also a volume table for *Pinus longifolia* and *Cedrus Deodara* can be issued.

(iv) *Bark Measurements, Heartwood Measurements, etc.*—These matters are recorded when possible and when data are collected for volumes and form factor. Information on these points and on lengths of marketable boles has been issued during the year.

III.—Publications (See Chapter VII).

IV.—Miscellaneous.

The Silviculturist toured in Madras in connection with the handing over of sample plots and discussed the future policy with the Madras Silviculturist.

The photographic collection now contains 4195 prints, 4108 negatives, 456 lantern slides, 6 colour positives and 3 cinema films. This represents an addition of some 540 negatives and 460 prints made during the year.

Assam.

General.—The enumeration and stock mapping commenced in 1911, with a view to ascertaining the contents of the evergreen forests of Assam has been continued. The results so far obtained would appear to indicate that approximately only 25 per cent. of the evergreen forests contain timber of marketable value. The remainder appears to consist chiefly of cane-brakes and worthless scrub jungle or forest in which trees of the more valuable kind are too scattered to render their extraction a paying proposition. There are practically no trees in these evergreen forests of outstanding value, such as the teak or sal, and none of the more valuable species is floatable so that export to the distant markets in Bengal cannot be done by floating, with the result that the high railway and steamer freights preclude the placing of Assam timbers on the markets of lower Bengal in competition with timbers of similar class imported from Burma or the Andamans. The local market is principally for tea-box timbers which is not capable of very great expansion. These facts must naturally affect the progress of Silviculture and of Working Plans and no great development can be expected until local markets have expanded and a demand arises for exploitation on a larger scale.

Natural regeneration.—In the Western Circle the experiments which were initiated in 1919 and referred to in the Progress Report of Forest Research Work in India for 1919-20, under Bengal and Assam, have been continued. These aim at the reduction of the evergreen undergrowth in the sal forests of the Goalpara Division by cutting and burning and at the same time reducing the overhead cover to 3—15 trees per acre. It has now been proved that a

grass undergrowth can be substituted for evergreen shrubs by these measures and, in the year under report, it is stated that there are a large number of healthy sal seedlings on the ground. These and modifications of the original experiments are in progress but it is as yet too soon to form any conclusions.

The effect of burning areas containing heavy *sao* grass (*Pollinia*) in the high level forests were observed with a view to ascertain whether any change in the character of the grass would result thereby. So far the experiment is hopeful.

In the Eastern Circle the experiments reported in last year's Report dealing with the following types of forests were continued:

- (1) Forests in which there is sufficient number of mother trees of the more valuable species.
- (2) Forests where there is an insufficient number of mother trees of the more valuable species.
- (3) Forests where valuable trees are absent.

In the first of this class the results have been fairly satisfactory but unfortunately the revelation that this type of forest occurs only over a very small area renders these experiments less hopeful than was originally expected. The necessity of weeding has become apparent, specially in those areas where insufficient overhead cover has been maintained, and it would appear that the success of these experiments from the financial standpoint must depend on a careful reduction of overhead light to that in which the seedlings best thrive. The report shows that the species enumerated in last year's Report have continued to give satisfactory results although it is not clear whether *Phoebe attenuata* has developed as quickly as its associates. The above results show that the clearing of the undergrowth and the reduction of the overhead cover, followed by burning of the slash, does undoubtedly produce successful re-generation, and it will be necessary to systematise the work in order to reduce the cost of soil preparation and subsequent tending.

Seeds, etc.—Experiments to test the germination of the seeds of different species have been carried out in the Lakhimpur and Sadiya Divisions. In the former the seed of *Albizia lucida* and *Bischofia javanica* gave cent. per cent. germination. The results in the Sadiya Division on the other hand vary greatly, although in some instances the seed is supposed to have been collected unripe, in others the cause of failure is as yet unknown.

Artificial regeneration.—The Taungya plantations for the production of *Bombax* for the tea-box industry, which were commenced a few years ago in the Lakhimpur and Sadiya Divisions, have been continued but it is a question whether this tree is of much value now that the utilization of other kinds in the form of 3-ply boxes has been undertaken on a large scale. Other and more valuable kinds have therefore been substituted for *Bombax* during the year under report: but it does not appear as if these would be as easy to cultivate successfully in temporary cultivation as *Bombax*.

Underplanting.—This is considered one of the most important experiments, for, as explained above, about 25 per cent. of the total area of the evergreen forests will have to be regenerated artificially and it is believed that this can best be achieved by underplanting. Most of the valuable species are shade bearers and this attribute is valuable in order to avoid the mass of weeds, including *Eupatorium*, which invariably appear in clearings. Success has been attained with *Bischofia javanica*, *Lagerstroemia Flos-Reginae*, *Amoora Wallichii*, *Dysoxylum procerum*, *Phoebe attenuata*, and *Artocarpus Chaplasha*.

The plantation of *Aquilaria Agallocha*, which is the source of the valuable product known as *agar*, was continued. Other valuable species have also been taken in hand and the observations made in the forests of *Terminalia myriocarpa* in the Frontier Tract, in which heavy fellings have been carried out, would appear to indicate that this species also can be regenerated by sowing or planting and that it is not essential to burn the undergrowth provided that the mineral soil is sufficiently exposed. The relative growth and development of the different species under this method of treatment is being observed and it would appear that *Cedrela febrifuga* produces the quickest growth, reaching a height of 10 feet in three years.

Silvicultural systems.—The fact that so much of the evergreen forests is worthless precludes the adoption of any but the system of artificial regeneration for the bulk of the forests and present indications point to some such simple system as the *quartier bleu* as the most suitable.

Volume and form factor tables.—Volume and form factor tables are in course of preparation.

The report on research work carried out in the Cachar Division was received too late for insertion.

Bengal.

Natural regeneration.—In north Bengal, in the moist forests of the hills and plains, natural regeneration of the species of some value is practically absent. In the plains forests of the Kurseong Division, on areas which are not clear felled, regeneration of three evergreen shade bearers is found, *viz.*, *Amoora Rohituka*, *Amoora Wallichii*, *Dysoxylum binectariferum* and in the ungrazed hill forests *Acer Campbelii* and *Evodia frazinifolia*. In the plains on clear felled areas *Anthocephalus Cadamba* and *Trema orientalis* come in by seed, *Sterculia villosa* and *Callicarpa arborea* by coppice shoots; in the clear felled areas of the hills *Macaranga* spp. and *Evodia frazinifolia* come in by seed, *Symplocos theaeifolia* and *Eurya* spp. by coppice shoots.

Natural regeneration of *Heritiera minor* and many other species is prolific in the Sundarbans.

Nurseries.—Nursery work in Bengal received special attention as usual, the object being to produce strong healthy plants, which will have every chance of success when put out into the forest and thus cheapen the cost of formation and tending plantations. The nurseries in the Darjeeling Division are especially well organised and cared for. Attention is drawn to the difficulty of assessing the area needed for nurseries if early and complete success is to be obtained in filling up blanks.

Artificial regeneration.—Of the work which has been done up to date in northern Bengal, Bulletin No. 5 by the Silviculturist, Burma, gives a very good idea. Wherever possible the taungya system is used, the crops being grown by the taungya cutters. Where taungya cutters are not available, plantations are made and the crops grown by departmental agency, as at Panchanai in the Kurseong Division, or the plantations are made departmentally and no crops are grown, as at Rajabhatkhawa in the Buxa Division. With regard to the system of departmental crops, the following figures given for Panchanai show that this is expensive :—

				Rs.	A.	P.	
1st year	...	...	...	34	9	0	per acre.
2nd year	...	...	...	9	10	0	„
3rd year	...	...	...	7	0	0	„
			Total	51	3	0	
			Cost of fencing	63	0	0	„
			Total	114	3	0	per acre.

Two conclusions may be drawn from these figures—

- (a) That departmental crops must be made to pay.
- (b) That unless a cheaper form of fencing can be devised, the injurious game will have to be dealt with.

At Rajabhatkhawa as yet it has not been possible to put in departmental crops or to get outside cultivators to come in, but a start has been made in the present year with small areas under cotton and maize, the former by an ex-forest guard and the latter by the department. If these experiments are successful it is hoped that cultivators will sow all the crops in future. The cost per acre excluding fencing and special staff amounts to Rs. 36. As the areas to be restocked are large and compact, being the areas cleared by the Buxa Trading Company, the cost of fencing is far less than at Panchanai.

A new development at Rajabhatkhawa is the direct sowing of species other than sal which for the most part had previously been transplanted from the nurseries, notably *Lagerstroemia Flos-Reginae*, *Cedrela Toona*, *Acrocarpus fraxinifolius*, *Bombax malabricum*, *Bischofia javanica*, *Chickrassia tabularis*, *Morus laevigata*. All these species are being sown in lines six feet apart and results are hopeful

so far. Up to the present, mixtures of *Bombax malabaricum* with *Bischofia javanica* and again of these with *Michelia Champaca*, and *Cinamomum cecicodaphne* and *Gmelina arborea* as pure crops have done best.

In the Darjeeling Division winter planting has been carried out and complete success has been obtained with *Acer Campbellii* and *Prunus nepalensis*. *Quercus lamellosa*, *Bucklandia populnea*, *Alnus nepalensis*, *Eriobotrya petiolata* and *Machilus* spp. have been tried for one year. Of these the first two are alive and healthy, the third is alive but sickly and the other two have died. No definite conclusions can be drawn yet. If winter planting can be carried out successfully the cost of making plantations will be diminished materially, for the seedlings will get a better start in the spring and get further ahead of the weed growth and in this way casualties will be reduced.

Silvicultural systems.—Those prescribed by the latest Working Plans are still under observation. Progress in placing the full areas under clear fellings, especially in the moist forests of the plains and hills, is greatly retarded by the difficulty which is experienced in obtaining labour to restock the cleared areas. As a result only the better localities are being planted or sown. The remaining areas are being allowed to come up in coppice, together with any natural regeneration that may be present. This is considered to be a good system and in the northern Bengal Divisions it will provide fuel and box-planking which is greatly in demand. Sixteen acres of the Hateswar coupe in the Kurseong Division have been allowed to grow up in this way, and it is now nearly fully stocked principally with seedlings of *Trema orientalis*; with a little climber cutting this will be established at a very low cost and should provide good firewood in 15—20 years and fair box-planking in 30 years.

Working Plans and Statistics.

1. *Sample plot work, etc.*—The work of remeasuring sample plots was continued throughout the year. The following figures have been made available by the Silviculturist, Dehra Dun :—

Species.	Age.	Av. height.	Av. diam.	Av. volume. Stem. Small-wood.	Av. volume. Stem. Timber.	Av. annual increment.	Locality.
	Yrs.	Feet.	Inches.	Cu. ft.	Cu. ft.	Cu. ft.	
<i>Bucklandia populnea.</i>	12	38.3	5.66	1474.2	...	122.86	Mungpoo Cinchona Plantations—Hill Forests
<i>Bucklandia populnea.</i>	10	33.5	3.65	839.0	...	86.90	
<i>Betula cylindrostachys.</i>	6	48.0	4.0	1629.0	...	271.50	
<i>Betula cylindrostachys.</i>	7	63.0	5.40	2079.0	...	297.00	
<i>Cryptomeria japonica</i>	27	73.0	13.50	752.0	3663.0	163.5	

2. *Volume and yield tables, etc.*—From measurements taken in the Toong taungya, Kurseong, elevation about 5,500—7,000', the following figures for height growth have been obtained :—

Species.	1st year.	2nd year.	3rd year.
<i>Alnus nepalensis</i> ...	2'—3'	5'—9'	12'—14'
<i>Cryptomeria japonica</i> ...	1'	2'—3'	4'—5'
<i>Bucklandia populnea</i> ...	8"—1'	2'	4'—5'
<i>Juglans regia</i> ...	1'	4'	8'—10'
<i>Eriobotrya petiolata</i> ...	1'	2'—3'	4'—5'

Bihar and Orissa.

Again no research officer could be appointed owing to the shortage of gazetted officers. The Divisional officers could devote very little time to research work after doing their routine duties. The following is a resumé of such research and experiments as could be carried out by the Divisional Forest Officers, Hazaribhum, Hazaribagh, Puri and Angul in their respective divisions.

1. An experiment in the cultivation of field crops with sal in Valley Type areas was attempted, the field crops (rice) were wiped out by wild elephants so that the result was a failure.

2. An experiment in the propagation of *Vitex peduncularis* by cuttings proved only partially successful. Seed of this species sent to the Malay States and Assam did not germinate.

The experiments in connection with the regeneration of sal in the mixed evergreen forests of the Banpur Mals in Puri Division are still being continued. The experiment which was inaugurated in 1920, consisting of entirely clearing away the underwood and undergrowth and at the same time opening the over head cover of sal trees, has given very satisfactory results. The ground is covered with sal seedlings which may be counted on as fully established. They have passed through the vicissitudes of two comparatively dry seasons and have shown no tendency to die back, but on the contrary are pushing ahead with a rapidity that will soon place them out of danger of the rank growth of grass and weeds which springs up with the advent of the monsoons. The time has now come to remove the mother trees which were left scattered over the area.

In continuation of the above, four other experiments were undertaken during 1921, also in connection with sal. This consisted of opening the canopy (both above and below) to varying degrees of density, keeping the plot of 1920 as the extreme case. The results clearly show that the regeneration varies from place to place according to the degree of light admitted, and has established the fact that sal

regeneration can be obtained to best advantage in this climate by complete exposure. These experiments give a definite indication of the method of treatment to be adopted in the sal areas.

Casuarina.—It was noticed that *Casuarina* seedlings contained a peculiar nodular growth on their root systems which somewhat resembled the nodules which occur on plants belonging to *Leguminosae*. Specimens were sent to the Forest Botanist at Dehra Dun for examination and he now reports that the plants contain numbers of bacteria which help to fix nitrogen from the air. Investigations are now in hand to ascertain at what depth in the soil the nodules are usually found, and what factors appear to encourage the formation of nodules.

Teak seed buried in the soil close to white-ant heaps for a period of 4 months prior to sowing gave germination within one week of sowing and produced healthy seedlings. The seed which will be sown this year has now been buried for nearly one year, and the results of germination will be reported in due course.

Experiments are in progress in Angul Division in order to ascertain the dying back phenomenon of sal seedlings. Two plots each 15' square have been selected. One of them is in shade while the other is in the open. Both of them have been fenced round with a bamboo fence. Every other growth except 1 year old sal seedlings has been removed. A sal seedling with two leaves has been taken as 1 year old seedling. All these seedlings were counted and entered. Countings are done every fortnight and the results noted. As this experiment was started in January 1922 it is too early to say anything definitely.

Experiment was started in order to ascertain the height increment of coppice shoots, before and after the rains. Unfortunately the area selected was not fenced with the result that deer destroyed the young shoots. This experiment will be started again during 1922-23.

Bombay.

No information forthcoming.

Burma.

General.—At the commencement of the year the Silviculturist was engaged on a tour in Katha Division where work under the Mohnyin Working Plan was inspected. This work has not progressed as satisfactorily as might have been hoped. From the end of May until the early part of August tours were made throughout Tharrawaddy, Zigon and the southern end of Prome Division, followed by a short tour in the Delta forests on which a note was drawn up in collaboration with Mr. A. W. Moodie, O.B.E. Early in September the writer proceeded to Dehra Dun in order to become

acquainted with the methods of Ledger filing and Record keeping as practised at the Forest Research Institute. A short visit was also paid to Naini Tal where research and working plan methods in the United Provinces were studied. The writer returned to Burma at the end of October.

In the middle of November the cold weather tour commenced with a visit to the Pyinyaung forests in Meiktila Division in order to advise on the best methods of regenerating the forests there in view of the commencement of a jungle wood lease. The teak plantations at Pyonchaung in North Toungoo were then visited followed by a visit to the regeneration area in the Saing Yene forests which are being worked by clear felling under a jungle wood lease. The regeneration area at Putkya was also visited. The greater part of December was spent in the Tharrawaddy Division. The results of experiments carried out at Nyaungbinzin were first inspected and then a commencement was made in laying out permanent sample plots in teak plantations in Minhla Reserve and in the training of the sample plot party under Ranger Maung Kaw Wun. During January and the early part of February the Silviculturist was absent in India, first attending the Silvicultural and Utilization Conferences at Dehra Dun and then on a most interesting tour in North Bengal, mainly with a view to seeing the Bengal nursery methods. The latter part of February and the first half of March were spent in Tharrawaddy and Zigon Divisions, first in inspecting sample plot work done and making thinnings in the sample plots and then in organising a series of experimental plots and a small sample nursery on Bengal lines. At the close of the year a commencement was made with a tour in Katha Division.

Owing to there being no satisfactory office available and to the absence of the Silviculturist on tour or on deputation to India, little progress has been made with the important branch of record keeping and Ledger filing. Since the close of the year however a more satisfactory arrangement for a temporary office has been made and it is hoped to make a start during the coming year in the organisation of a Library and Ledger files.

Mr. H. S. Single, Assistant Conservator of Forests, on appointment in December, was attached to the Silviculturist and towards the end of the year was employed in laying out a series of experimental plots in regeneration areas in Nyaungbinzin Reserve, Tharrawaddy Division.

Maung Kaw Wun, Ranger, was attached to the Silviculturist from August until the close of the year. He accompanied the Silviculturist to Dehra Dun in September and studied the latest sample plot methods at the Research Institute for a month. From December to the close of the year he has been in charge of the party engaged on the laying out of sample plots and has shown that he can now be thoroughly relied on to select and lay out sample plots by himself. In future, progress in sample plot work should be more

rapid now a sample plot party has been organised. As soon as another reliable Ranger can be obtained it is hoped to form another party. Eventually it is hoped to have at least 4 parties working.

The position of the Burma Silviculturist is in some ways a difficult one. In the first place the area to be covered is enormous, the problems to be tackled are numerous and it is quite impossible to see more than a small portion of the work that is being carried on. This would not matter so much if he were free to concentrate on definite problems and devote himself entirely to experimental and statistical work instituted and carried on by himself. Unfortunately he is also expected to act as a general adviser and to keep in touch with and advise on practically all regeneration and silvicultural work being carried out in the Province. The result is that while it is quite impossible to inspect all the areas that should be inspected, the necessity of covering as much ground as possible seriously interferes with his more legitimate experimental and statistical research. Under the present circumstances therefore the sum total of actual experimental and statistical research carried on must be somewhat disappointing, as most of the Conservators consulted agree that touring and inspecting work in the Divisions and advising thereon must for the present form an important part of the duties of the post. Eventually the Branch must expand and the actual experimental and statistical research must be carried on by assistants under the guidance and supervision of the Silviculturist who will also be free to inspect and advise on silvicultural work generally.

I.—*Experimental Silviculture.*

General.—Some progress has been made in the methods of laying out experimental plots in young crops. The necessity of obtaining results which were not dependant entirely on observation but could definitely be reduced to figures was early discovered. As a result the method now adopted is to lay out small one chain square plots in pairs or threes under as similar conditions of soil, aspect, slope, etc., as possible. Each plot is treated so that the plots will show clearly the results of one particular operation only. The best method of reducing these results to definite figures in the case of regeneration has been found to be by enumeration and measurement of the height growth of all seedlings on the plots before, and again at intervals after, the operation, with which the investigation is concerned, has been carried out. A comparison between the rate of survival and the height growth in the different plots gives a very good indication of the benefit or otherwise of each operation. A number of plots have been laid out on these lines during the year and it is hoped that definite results on many questions affecting the earlier stages of regeneration will be forthcoming.

Natural regeneration (including coppice, rootsuckers, etc.)—Little work has been done in connection with natural regeneration during the year. Natural regeneration is not at present of

much importance in the main bamboo forests in Burma and during the year it was not found possible to do any work in connection with *Dipterocarps*. Since the close of the year the natural regeneration of *D. turbinatus* (*kanyin*) and *D. tuberculatus* (*in*) has been studied and experimental plots are being made.

The year 1921 was an excellent seed year for *Pentacme suavis* (*ingyin*) in Katha Division. Seedlings germinated in thousands in many parts of the Division owing to favourable early rains. Examination late in the rains however showed that nearly all these seedlings had died back. A further examination since the close of the year under report would seem to show that considerable light is essential for the successful regeneration of *ingyin*. Wherever reproduction had sprung up under shade the seedlings had not been able to grow vigorously or to form the carrot like taproot that is so essential for survival. In the absence of direct overhead cover, but where the gap in the cover was not big enough to encourage the vigorous growth of weeds, the *ingyin* seedlings had survived and were healthy. They had all developed carrot-like taproots and the majority of them had not died back. Where weeds had been encouraged by the opening out of the cover to a greater extent the *ingyin* had invariably been smothered and killed.

Seeds.—The distribution of seed has again been arranged for in all cases where seed of any particular species was unobtainable in the Division in which it was required.

The supply of seed to countries outside Burma was also arranged for where possible.

A useful method of separating *Adina cordifolia* (*hnaw*) seed from the husk has been found by Mr. Dawkins. After the heads of seed have been collected and dried the heads are broken up and immersed in water. After stirring up and allowing to settle it is found that the seed all sinks to the bottom leaving the husk floating. The husk and water are then poured off and the residue, which is almost pure seed, can be dried. The same result can be attained by winnowing. In the past sowing of *hnaw* seed has frequently been unsuccessful and the probability is that the empty husks were sown.

Nursery work.—As a result of the Silviculturist's visit to Northern Bengal sample nurseries on the Bengal lines have been started in Zigon Division and in Maymyo. Since the close of the year a nursery has also been made to supply plants for the regeneration area under the Mohnyin Working Circle. While there seems to be a great future for nursery work in the evergreen forests of Upper Burma and especially in connection with the planting of Eucalyptus in Maymyo it seems doubtful if there is much scope for it in connection with the deciduous teak forests of Lower Burma.

Artificial regeneration. Teak.—The method of broadcast sowing in the taungyas soon after burning and the later transplanting of

early germinated seedlings to stake has continued to give good results and has proved to be a most popular method with the taungya cutters in Tharrawaddy Division, as it does not entail a race against time to complete the staking and sowing at an early date. Mr. Dawkins has introduced another method in his taungyas in Zigon. A small furrow about 1' long is dug up to the depth of 6" and the soil thoroughly loosened and replaced. The seeds are then pressed into the loosened soil. On the level or on easy slopes this method has been found to give most excellent results both in germination and growth, but on the steeper slopes there is danger of the loosened soil being washed out of the pits and other methods are necessary. At the same time it must be admitted that this method adds considerably to the work that has to be done by the taungya cutters even though in the case of Zigon Division an increased spacing of 9' x 9' has reduced the number of stakes per acre by over 50 per cent.

Further experience of the use of buried seed shows that the results are extremely uncertain. The majority of buried seed examined during the year was found to be bad. While no doubt buried seed which has kept good does germinate very rapidly, the loss of the thick corky covering of the fruit is not altogether an advantage. The two essential preliminaries to successful germination are heat and moisture. In the case of buried seed that has had its corky covering eaten by white ants the fruit is instantly dried up by the heat of the sun as soon as rain is over. In the case of seeds with the corky cover intact, this retains the moisture which is further acted upon by the heat of the sun, producing conditions suitable to germination.

Further experience has shown that the use of teak stumps requires considerable care in order to give satisfactory results. Experiments are now being undertaken to ascertain the best size to plant and the best time of planting. The previous directions given in Burma Forest Bulletin No. 3 have proved that the season given as the best time for planting teak stumps, *i.e.*, early May, is wrong as the rain after planting is too uncertain. Generally speaking stumps should not be put in until continued rain for 2 or 3 days is fairly certain. Stumps have been planted out in the late cold weather but have not proved very successful. It has also been found that when cutting the root care must be taken not to damage the carrot-like taproot.

The use of broadcast sowing of accessory species to complete the stocking with a view to reducing the cost of weeding is gradually extending. Apart from the reduction in costs it appears probable that the early formation of a dense stocking also leads to a very much more vigorous growth of the major species. The reason of this is undoubtedly that the clean soil produced by a heavy shade and absence of weeds and grass has a very beneficial effect both on the free development of the root system and by retain-

ing the moisture in the soil. Mr. Davis in his Annual Report for Tharravaddy notes that small leaved and slender stemmed species like *Xylia dolabriformis* (*pyinkado*), *Lagerstroemia Flos Reginae* (*pyinma*) and *Terminalia tomentosa* (*taukkyan*) ought to be grown closer than 6' x 6'. He contends that a pure close crop is easier to tend than a crop with the major species at regular intervals and a dense stock between of accessory species. The writer does not agree with this view. It is surely easier to tend a crop in which one species only is to be favoured and whenever necessary the other species can be cut out.

Reclamation and afforestation.—The only important work of this kind in Burma is in the Bhamo Kachin Hills. Here excessive taungya cutting combined with uncontrolled burning has converted a comparatively well wooded country into a waste of bracken covered hills. The elevation is between 4,000' and 6,000'. In 1921 an area of some 200 acres was sown up after burning with *Alnus nepalensis* (*maibau*) which is sown by some of the neighbouring tribes in their taungyas in order to re-cover the areas rapidly with forest growth. Besides growing very rapidly the humus produced by this species is said to improve the soil better than any other species. Part of the area was sown at a spacing of 6' x 6' in small pits and part was sown broadcast. Of the two the broadcast sowing was much cheaper and equally successful. Unfortunately the frost early in 1922 was exceptionally severe and all the seedlings on the lower slopes were killed back. On the higher slopes where the frost was not so severe, the seedlings mostly survived and appeared to be quite healthy under the dense shade of the bracken. Fire protection of the sown areas is essential as portions of the area sown in 1921 have been burnt with complete loss of all regeneration. The most urgent problem that remains is to discover a good rapid growing frost hardy species for sowing on the lower slopes where frost damage is bad.

Thinnings and cleanings.—Research into the best time to commence thinnings in young crops is extremely urgent. In Burma we have been finding that our older teak plantations show on the whole a disappointing growth and the individual trees do not seem capable of taking advantage of thinnings to increase the size of their crowns. In fact we find a condition of growth in the older plantations similar to that so ably described by Mr. Bourne in his Working Plan for the Nilambur plantations. The remedy is undoubtedly the same as Mr. Bourne lays down, *i.e.*, early and repeated thinnings to allow the full development of the crown. Mr. Dawkins is instituting experiments in young teak plantations 4 to 8 years old to ascertain the effect of early thinning. In a 7 year old plantation over a small plot, trees were thinned down to 150 trees to the acre. The trees in this plantation averaged 37' in height and 15½ in girth. In a year they had increased over 2 inches in girth and had extended their crown appreciably. Trees

in unthinned plantation adjacent had only put on half this girth increment.

Miscellaneous.—Burning and fire protection.—This subject is of very great importance at present. It is not a question so much of the damage done by fire as the use that can be made of fire in reducing the cost of establishment of the crop. Mr. Dawkins has been investigating this question for the past two years and besides being a keen protagonist of early burning as against fire protection as a means of preventing damage, has also investigated the question of burning back the young crop of teak with a view to reducing the expense of weeding and establishment. This he is doing both before the 2nd and 3rd rains of the crop. A series of experimental plots has been laid out to compare the results of burning alone and of cutting back all weeds and shoots and burning, with fire protection. No results are yet available for areas cut back before the 3rd rains but some interesting results from plots laid out before the 2nd rains are available. They show the following results.

(1) As a result of burning the crop late only one weeding was required in the 2nd rains instead of twice as in unburnt areas or in early burnt areas. The cost of weeding was therefore halved.

(2) Although the percentage of survival in the area burnt late was slightly less than in the unburnt area, 86 per cent. as compared with 95 per cent., the average height of the teak seedlings was 49.8", as compared with 27.5" in the unburnt area.

(3) The burnt area showed fewer weakly seedlings at the end of the rains as compared with the unburnt plot.

(4) There was not much difference between the area burnt late and the area that had been cut earlier and then burnt at the same time as the uncut area.

The height growth even in the burnt plot is far below what can be attained by teak in two years' growth but the plantations were not of the best quality. The *taungyas* had been very badly weeded and the teak seedlings were weakly. It is however just in these conditions that burning seems to be most beneficial. Where vigorous teak seedlings with big leaves are obtained as the result of the first year's work, they are quite capable of looking after themselves and, whether they are burnt or not, shoot up rapidly in the second rains. It is the small seedlings with small leaves that cannot get a good start in the second rains and are rapidly suppressed by the weeds. Burning however gives them a good start and while checking the growth of the weeds causes the teak to send up strong shoots with big leaves.

From experience gained the writer has no doubt whatever that in the case of teak plantations that have not been given a good start in the first year burning is undoubtedly a great help and should always be done. In the case of plantations in which the seedlings are vigorous an early burning might kill off the weeds without

damaging the more vigorous seedlings, but for weakly seedlings a late thorough burning is probably preferable.

Mr. Dawkins' theory is that plantations burnt over before the 2nd rains need only be weeded sufficiently to prevent the seedlings being suppressed by weeds. The area is then either cut over and burnt or simply burnt in the following hot weather. It is too soon to say yet whether this method will result in a saving of expense or not but the results so far promise well. The result of burning is an early and vigorous growth of coppice shoots of teak which can keep ahead of the weeds and thus render any great expense of weeding unnecessary.

II.—Working Plans and Statistics.

(Sample plots.)

Yield tables.—Reports of all the older existing sample plots have now been received from the Divisional Forest Officers. With few exceptions they have mostly been discarded as useless. Only those made by the Forest Research Officer between 1914 and 1917 and a few, chiefly for girth increment only, made by Working Plans Officers, are of any use.

During the year 11 new sample plots have been made in teak plantations in Tharrawaddy and Zigon Divisions and 6 old plots have been remeasured and reorganised on the latest methods. One sample plot for ascertaining the girth increment of *Dipterocarpus alatus* was also remeasured. Progress was extremely slow owing to the difficulty of obtaining labour at any price. Most of the new sample plots made are in plantations of from 15 to 30 years old. This coincides with the period during which the area planted annually was at its maximum. Owing to the way in which taungya plantations were stopped from 1906 until the revival of planting in 1918 it is extremely hard to get sample plots in plantations between the age of 5 and 15 years. On the other hand, with the exception of one or two plots in really old plantations such as those at Myodwin and Kangyi, started by Sir Dietrich Brandis, it has so far been found impossible to obtain suitable plots in plantations made in the seventies or early eighties. Even the sample plots made are far from satisfactory in regard to stocking as it is almost impossible to find even half an acre of fully stocked plantation. The probable reason of this is that the older plantations were not sufficiently tended during youth and thinning has been started so late that the crowns have lost their vigour and are unable to develop and fill up gaps.

The following figures for girth increment, though based on only a limited number of trees in the natural forest and sometimes over only a limited period, may nevertheless be interesting.

Periodic mean annual girth increment (in inches and decimals).

Girth class.	<i>Cimelina arborescens</i> (Katha) 12 trees.	<i>Pyratium serratum</i> (Katha) 93 trees.	<i>Lagerstroemia Flos Reginae</i> (Katha) 13 trees.	<i>Aitona cordifolia</i> (Katha) 8 trees.	<i>Dipterocarpus alatus</i> (Tharawaddy) 68 trees.
1' 1" to 2' 0"	...	·3	·15	...	·57
2' 1" to 3' 0"	...	·49	·24	·54	·60
3' 1" to 4' 0"	...	·37	·47	...	·64
4' 1" to 5' 0"	...	·48	·43	·29	·81
5' 1" to 6' 0"	...	·71	·35	·47	1·3
Mean annual increment	·51	·46	·28	·82	·63
Rotation based on mean annual increment to attain 6' girth.	141 years	157 years	257 years	88 years	104 years

Girth class.	<i>D. tuberculatus.</i>			<i>Terminalia tomentosa</i> Shwegu Division 47 trees.	<i>Pentacme rupestris</i> Shwegu Division 51 trees.	<i>D. turbanatus</i> Shwegu Division 32 trees.	
	Mogok Division 50 trees.	N. Toungoo Division 104 trees.	Shwegu Division 127 trees.				
1' 1" to 2' 0"	...	·05	·53	·30	·26	·44	·23
2' 1" to 3' 0"	...	·30	·29	·24	·23	·39	·53
3' 1" to 4' 0"	...	·18	·31	·25	·37	·32	·57
4' 1" to 5' 0"	...	·16	·39	·21	·32	·24	·65
5' 1" to 6' 0"	...	·15	·32	·19	·31	·20	·45
6' 1" to 7' 0"	...	·21	·47	·24	...	·15	·27
7' 1" to 8' 0"	...	·14	·48	...	...	...	...
Mean annual increment	·17	·35	·23	·28	·27	·53	
Rotation based on mean annual increment to attain 6' 0" girth.	424 years.	203 years.	313 years.	257 years.	267 years.	136 years.	

Although these figures, especially for the species of which only a few trees are available, are far from reliable they do indicate roughly the relative rates of growth for each species. Unfortunately many of the old sample trees were badly chosen and were often dominated or suppressed.

Volume tables.—Data for rough outturn tables have been coming in from teak firms and from Divisional Forest Officers. Since the close of the year it has been found possible to issue a tentative volume table for teak in Tharrawaddy Division and it is hoped to work up further results later.

Central Provinces.

The outstanding feature of the year was the after-effects of the rain failure in 1920 and the exceptional and prolonged incidence of the hot weather of 1921. Over half a lakh of teak trees 1' in girth and upwards died in the Markhanda and Waingana Felling Series alone. Teak trees also suffered to a less extent in Dhaba, Ahiri Leased, and Sironeha Ranges. In the last range large numbers of *ain* (*Terminalia tomentosa*) and *dhaura* (*Anogeisus latifolia*) of all ages died off. A remarkable feature everywhere was the wholesale dying off of the pestilential Ironi creeper (*Zizyphus Oenopia*) owing to the sinking of the water table.

Natural Regeneration.—Teak, *ain* (*Terminalia tomentosa*) and *tendu* (*Diospyros Melanoxylon*) practically produced no seed. The *mohwa* flower crop was abundant and gave promise of good seed at the close of the year. Teak coppice was pretty good but was everywhere affected by the drought and in the six worked coupes of the Markhanda Felling Series nearly one half of the hitherto promising coppice died off.

Nursery Work.—Steps were taken at the close of the year to establish a seed nursery at Allapilli.

Artificial regeneration.—Steps were taken at the close of the year to sow up with teak one acre of an area cleared of bamboos in compartment 35 Working Circle I Allapilli Range.

Thinnings and Cleanings.—The usual cutting back operations were carried out throughout 13,214 acres of the Division in the interests of teak.

Working Plans and Statistics. Yield tables.—The existing sample plots were measured up.

No new research work was undertaken in any of the divisions of the Northern Circle with the exception of two sample plots opened recently at Sarastal in the North-Mandla Division to ascertain:—

- (1) The rate of girth increment and volume increment of sal trees under light and heavy thinnings,
- (2) The kind of thinnings required,
- (3) The rate of growth of coppice,
- (4) The condition of natural regeneration if overhead canopy is opened,
- (5) Damage to coppice and seedlings by frost,

(6) Damage by fire,

(7) Whether suppression has been the cause of the trees remaini-
ing below 3' in girth all these years,(8) Whether natural regeneration is lacking on account of there
being insufficient light on the ground.

The four sample plots of Jubbulpore-Narsinghpur mentioned in the last year's report were maintained. The rate of growth there appears to be slow.

In the Jubbulpore-Narsinghpur Division *tarwad Cassia auriculata* sowing was carried out on a small scale with unsatisfactory results.

Sal Regeneration.—Details of four sal regeneration plots laid out in May 1920 in South Raipur Division were given in last year's report. The regeneration has in each case improved but the progress is not yet sufficient to give any decisive results. Two new plots of $\frac{3}{4}$ acre each were laid out, Nos. V and VI with the object of testing the effect of burning on regeneration. Both plots were clear felled in May 1921 and plot No. V was burnt and VI unburnt. The result after the rains was a profuse growth of grass in both plots. In February and March attempts were again made to burn plot No. V but without success. The surrounding forest burnt easily early in March but this plot would not burn. The reason is by no means clear.

An experimental plot was opened in the Sarastal Range to see the result of light and heavy thinnings on sal crops.

A strip 20' wide and 103 yards long was cut in a sal area in the Sarastal Range to note the effect of light on regeneration.

Some teak coppice shoots were measured with a view to reduce the grazing closure of 10 years, the results are given below with an outline of the advantages of reducing the grazing closure from ten years to five years in the Dhanwahi Range at least.

1. Grazing after 5 years helps to weed the forest and thus helps the growth of the coppice shoots and also gives seeds a chance of falling to the ground.

2. Fire protection can be reduced and proper protection would only be necessary for 5 coupes in each Felling Series. The remainder could be burnt in November and December.

3. More cattle could be admitted in many places and the revenue increased on grazing and expenditure on fire protection reduced.

4. Perhaps also stop many illicit grazing cases and thus give more time both to subordinates and D. F. O. for forestry; 80 teak coppice shoots were measured in 4 different coupes of 4 different Felling Series (coupes No. 20) (Felling Series II, III, IV, and V).

The average of each Felling Series was :—

Girths.				Age 3 years.
II.	III.	V.	V.	
31 $\frac{1}{2}$ "	8 $\frac{1}{10}$ "	3 $\frac{1}{8}$ "	31 $\frac{1}{10}$ "	Average 41 $\frac{1}{10}$ "
Height from 4' to 15'			...	Average 9'.

80 teak coppice shoots were measured as above in coupes No. 17 of Felling Series II to V and the results are as follows :—

Girth.				—
II.	III.	IV.	V.	
8 $\frac{1}{2}$ "	10 $\frac{1}{10}$ "	7 $\frac{1}{2}$ "	8 $\frac{1}{10}$ "	Average 8 $\frac{8}{100}$ " and 17' high.
Height from 13' to 23'.				

45 teak coppice shoots in coupes No. 15 of Felling Series II and III gave the following results :—

9 $\frac{1}{2}$ "	12 $\frac{1}{10}$"	...	...	...	Average girth 10 $\frac{1}{2}$ ".
Height from 13' to 23'			...	...	Average height 18'.

From these data a 5 years old coppice shoot would be about 7" in girth and 15' high.

Coorg.

Killing Lantana with Sodium Arsenite.—Half a gallon of sodium arsenite, 25 per cent. solution, was handed over to the Somwarpet Range Officer and the same quantity to the Fraserpet Range Officer with instruction to dilute it to 10 per cent. solution and to treat dense lantana with the 10 per cent. solution (a) by cutting the stem near ground level and painting the cut surface and (b) by scraping the bark off the lantana stems in a ring near the base and painting the scraped surfaces.

The 25 per cent. solution was got from Messrs. Parry & Co., Madras, and cost Rs. 6 per gallon delivered in Coorg. The cost of 1 gallon of 10 per cent. solution therefore works out at Rs. 2-2-6 per gallon delivered in Coorg.

Plot A.—

The Somwarpet Range Officer used $\frac{1}{2}$ gallons of the 10 per cent. solution to treat as per (a) above and with this quantity was able to treat 8,850 sq. feet or about $\frac{1}{3}$ th acre. Therefore to treat 1 acre by this method costs $\frac{2}{3} \times \frac{5}{1} =$ Rs. 7-8-0. Labour employed for cutting lantana over 8,850 sq. feet, 7 men coolies at 6 annas and 5 women and boys at 4 annas = Rs. 3-14-0. Therefore cost of

labour per acre is Rs. 18-12-0. Total cost of solution *plus* labour per acre = Rs. 26-4-0.

Plot B.—

The remaining $\frac{3}{8}$ gallon of the 10 per cent. solution was used to treat as per (b) above and with this quantity was able to treat 3,720 sq. ft. or about $\frac{1}{2}$ acre. Therefore to treat 1 acre by this method costs $\frac{3}{8} \times \frac{12}{1} =$ Rs. 18-0-0. Labour employed for scraping lantana over 3,720 sq. ft., 6 men coolies at 6 annas and 6 women and boys at 4 annas = Rs. 3-12-0, therefore cost of labour per acre is Rs. 45. Total cost of solution *plus* labour per acre = Rs. 63.

The cutting and painting of lantana in Plot A was done on 22nd, 23rd, and 25th October 1921 and the scraping and painting of lantana in Plot B on 25th and 26th October 1921.

The area dealt with in Somwarpet Range lies about $\frac{1}{2}$ mile to the east of Somwarpet village.

Fraserpet Range.—

Plot A. (Cutting lantana close to the ground and painting the cut surface). 7,869 sq. ft. of dense lantana were treated. Labour employed 5 men at 6 annas each and 1 boy at 4 annas = Rs. 2-2-0 (for $\frac{2}{11}$ acre). Cost of $\frac{2}{8}$ gallon 10 per cent. solution is (for $\frac{2}{11}$ acre = Rs. 1-8-0. Total (for $\frac{2}{11}$ acre) Rs. 3-10-0.

therefore cost of labour <i>per acre</i>	Rs. 11-11-0
„ cost of solution <i>per acre</i>	8-4-0
	19-15-0
Total cost per acre	19-15-0

Plot B.—

(Scraping off the bark in a ring near the base and painting the scraped surfaces). 7,812 sq. ft. were treated.

Labour employed 9 men at 6 annas each (for $\frac{2}{11}$ acre)	Rs. 3-6-0
Cost of $\frac{2}{8}$ gallons 10 per cent. solution (for $\frac{2}{11}$ acre)	„ 1-8-0
	4-14-0
Total (for $\frac{2}{11}$ acre) Rs.	4-14-0

therefore cost of labour <i>per acre</i>	Rs. 18-9-0
Cost of $\frac{2}{8}$ gallons 10 per cent. solution <i>per acre</i>	„ 8-4-0
	26-13-0
Total	Rs. 26-13-0

The experiment was done in both plots A and B on 26th and 27th October 1921. On 20th November 1921 the Fraserpet Range Officer reports that of 100 stumps in plot A only 10 stumps were dead and the balance were sending up shoots from the base of the stump. In

Plot B on 20th November 1921 28 stumps were dead, the balance of 72 stumps were surviving.

The Somwarpet Range Officer reported that on 18th February 1922 shoots from cut stumps were coming up in *Plot A*. Seedlings also existed. In *Plot B* Root shoots had made an appearance and moreover the ringed lantana was not dead. A few seedlings were also noticed in this plot.

Mr. J. Prioris' Experiment on Spike in Sandal.—Mr. J. Prioris accompanied by the Deputy Conservator of Forests and Commissioner made some initial experiments into the effects of injecting a liquid antiseptic preparation, of his own compounding, with a hypodermic syringe into the stems of spiked sandal trees on 15th June 1922.

The trees were dealt with as follows:—

No. of tree.	Approximate girth.	Condition.	Nature of experiment.	Remarks. Dated 15th June 1922.
1	8 inches	Spike confined to two or three young branches.	Spiked branches removed; where branches had been cut off the cut surface smeared with a mixture of putty and an antiseptic.	To observe future development of spike. Forester to report when spike reappears.
2	11 "	About 20 per cent spiked.	Spiked branches not removed, a slab of bark removed. Injected 6 divisions (of syringe) of the trial preparation on each side of the stem at 3' height. In all about 10 divisions went in. Bark replaced.	To observe whether injection affects health of tree and whether spike diminishes.
3	7 "	Had been pollarded, presumably spiked top having been removed. The regrowth branches are slightly spiked.	Again removed the whole foliage by taking the top right off again.	Left as control tree vide experiment No. 5.
4	8 "	Far gone in spike	Merely injected as with No. 2.	
5	11 "	About 75 per cent spiked tree. Spiked parts low down.	Took top off as in No. 3. Into centre of top of stem injected 13 divisions (of syringe). Covered cut top with putty.	
6	10 "	Slim tall tree 50 per cent spiked.	Injected 13 divisions (of syringe) into each side of tree.	
7	15 "	Slightly spiked	Injected 13 divisions into each side.	
8	3 "	Healthy, but situated near spiked neighbours.	Injected 10 division dose.	With a view to see if tree remains free from disease.
9	11 "	Completely spiked	Injected 3 doses of 13 divisions each.	
10	7 "	Healthy situated close to No. 9.	Not injected.	To be observed with reference to No. 8 the presumption being that both 8 and 10 are likely to get spike owing to propinquity to spiked neighbours. To see if No. 8 gets off more lightly than No. 10.
11	12 "	Healthy tree situated about 40 yards to the Siddapur Side of new Dassavain bridge, beside road.	An attempt was made to inject the tree with disease. Cotton wool which had been kept about ½ hour in an incision under the bark of a diseased tree was placed similarly under the bark of the healthy tree.	

Madras.

The number of experimental plots under the control of this office was increased during the year from 42 to 62. Of the 62 plots, 27 are situated in the neighbourhood of the Chenai Nair Reserve, Dhoni, 10 in South Malabar and 25 in South Mangalore.

The chief problem under investigation is the regeneration of both evergreen and deciduous forests with evergreen species, the degree of shade under which seedlings can be best established and at what stage in their development further light should be admitted. Four evergreen species were experimented with in plots laid out in 1920 in the deciduous forests of the Dhoni valley. These have failed partly because too much shade was originally removed, as a result of which the first hot weather killed off large numbers of seedlings, and partly because the soil is so very light and porous that it will not retain sufficient moisture if exposed to give the seedlings a fair chance. An attempt to establish regeneration of *Hopea parviflora*, *Dichopsis elliptica*, *Mangifera indica* and *Artocarpus hirsuta* by sowing under varying degrees of evergreen shade in the Seppal valley was unsuccessful because the majority of the trees girdled in the upper and middle storey were not killed.

Although experiments in Dhoni and Seppal valleys have not as yet produced many positive results, a considerable amount of useful information on the regeneration of *Hopea* has been collected from South Canara and Coorg and by the end of another hot season there should be sufficient material at hand to justify the publication of a separate bulletin on this species.

In the Nilambur Teak Plantations *Hopea parviflora* and *Artocarpus hirsuta* were being experimented with as possible underwood for teak, but all work came to a standstill in August with the beginning of the Moplah rebellion, and has not yet been restarted.

Natural regeneration.—For investigation into the best method of uncovering natural seedlings 3 sets of plots have been laid out; but owing to the fact that many of the girdled trees did not die, no satisfactory results have yet been obtained.

Each set of plots was divided up into five sub-plots as follows:—

- (1) all weeds and shrubs of inferior species below 30' height cut out;
- (2) all weeds and shrubs cut out and trees forming the middle storey girdled;
- (3) all weeds and shrubs cut out and trees of inferior miscellaneous species forming the top storey girdled;
- (4) all weeds and shrubs cut and all but the valuable trees girdled;

(5) nothing done by way of weeding or girdling.

To discover what kind of opening has benefited the growth, results have to be observed after at least one or two growing seasons. As a result of similar uncovering carried out in Coorg, a marked increase in height growth was obtained.

With a view to discovering the effect of growth while young of some of the more important natural seedlings of evergreen species when they are fully exposed to sun in an evergreen type of forest one plot of 100 square yards was laid out in the Seppal valley, in May 1920, and the whole shade was removed in it and the seedlings were enumerated and staked. The age of the seedlings at the time of the experiment was believed to be 3 to 5 years, or more.

The following were the results noticed in December 1921 :—

---	Average ht. on 29th August 1921.	Average ht. on 3rd Decem- ber 1921.	Increase.
<i>Calophyllum tomentosum</i> ...	30·98"	31·1"	·12"
<i>Mesua ferrea</i> ...	23·35"	29·62"	1·27"
<i>Dishopsis elliptica</i> ...	18·34"	19·44"	1·10"
<i>Cullenia excelsa</i> ...	18·18"	19·42"	1·24"

In all the above cases of uncovering the letting in of light was sudden. Further experiments have to be made to see the effect of admitting more and more light in each growing season in one and the same plot so that the plot would be subjected to direct sunlight at the end of 4 or 5 years.

Seeds.—Experiments were carried out to ascertain the best method of collecting seed. In the case of *Artocarpus hirsuta* it was found that seeds extracted from perishing fruits dropped under mature trees and sown three days after collection germinated to the extent of 100 per cent. in one case and 88 per cent. in another, while of seeds of the same age but plucked off direct from branches of trees 78 per cent. have germinated. In the case of *Hopea parviflora* no material difference was noticed between seeds directly plucked from branches and those dropped on the ground, but it may be taken that collection from the ground is preferable.

As regards treatment of seeds the following conclusions were come to (1) removal of pericarp (*Artocarpus hirsuta*) had no effect on germination, (2) soaking did not appear to favour germination, (3) removal of wings (*Hopea parviflora*) did not affect germination, (4) seeds kept in mud pots with mouth hermetically closed and buried under ground for 30 to 56 days have germinated 5 per cent. (5) boiled and soaked seeds of *Terminalia tomentosa* give a large percentage of success (this experiment will be repeated).

Experiments were carried out to ascertain if possible the difference if any between the germinations of seed collected from different localities and also of seeds collected from different sizes or ages of trees. Certain results were obtained but to draw definite conclusions it requires further investigation to see if similar results are obtained in respect of seeds collected from different localities but from trees of the same size.

As the result of one experiment with *Artocarpus hirsuta* it was found that seeds collected from large trees germinate better than those collected from small trees.

Best conditions required for germination.—From the experiments so far made it appears that no special conditions are necessary to effect germination excepting the fact that the seeds should be fresh and should be from mature trees. But it may be noted that the percentage of germination of seeds sown in the open was always higher than those of seeds sown under shade.

The statement appended below shows the minimum time taken for each species of seed to germinate.

<i>Artocarpus hirsuta</i>	x	x	x	x	x	24 days.
<i>Gmelina arborea</i>	x	x	x	x	x	12 days.
<i>Vateria indica</i>	x	x	x	x	x	1½ months.
<i>Hopea parviflora</i>	x	x	x	x	x	11 days.
<i>Hardwickia pinnata</i>	.	.	.	.	.	2½ months.
<i>Terminalia tomentosa</i>	.	.	.	.	.	15 days.
<i>Dichopsis elliptica</i>	.	.	.	.	.	2½ months.
<i>Xylia xylocarpa</i>	.	.	.	.	.	10 days.
<i>Balanocarpus utilis</i>	.	.	.	.	.	9 days.

From the experiments carried out to see how long seeds retain their power of germination under ordinary conditions it has been recorded that seeds of—

<i>Xylia xylocarpa</i> keep vitality up to	.	.	.	.	15 days.
<i>Gmelina arborea</i>	do.	.	.	.	30 days.
<i>Artocarpus hirsuta</i>	do.	.	.	.	7 days.
• <i>Terminalia paniculata</i>	do.	.	.	.	5½ months.
<i>Hopea parviflora</i>	do.	.	.	.	7 days.
<i>Hardwickia pinnata</i>	do.	.	.	.	15 days.
<i>Terminalia tomentosa</i>	do.	.	.	.	3 months.
<i>Lagerstroemia Flos Reginae</i>	do.	.	.	.	210 days.
<i>Bischofia javanica</i>	do.	.	.	.	28 days.
<i>Bombax malabaricum</i>	do.	.	.	.	86 days.
<i>Balanocarpus utilis</i>	do.	.	.	.	11 days.
<i>Adina cordifolia</i>	do.	.	.	.	65 days.

As regards soil preparation no special conditions seem necessary to effect germination.

It might also be noted that the results of experiments show that seeds sown and protected from sun by a brushwood covering gave a larger percentage in all the cases.

Nursery Work was carried out in the year under report which started with 5 nurseries, one in Palghat Division, one in South Canara and 3 in South Malabar Divisions. Two more were laid out during the early part of the year, one at Mundakadavu in South Malabar, the other in Seppal valley of Palghat Division. The total cost of maintenance of these nurseries in the year amounted to Rs. 657-8-0.

Artificial regeneration.—(a) Experiments were carried out to discover if *Hopea* could be raised in a pure crop in a deciduous type of forest, 4 plots being laid out at Dhoni.

Plot I.—Was completely in the open. Seeds sown in May and June 1921.

Plot II.—Seeds sown in May and June 1921 under shade of the existing trees.

Plot III.—Seeds sown under light shade such as that afforded by the middle storey of an open mixed deciduous forest.

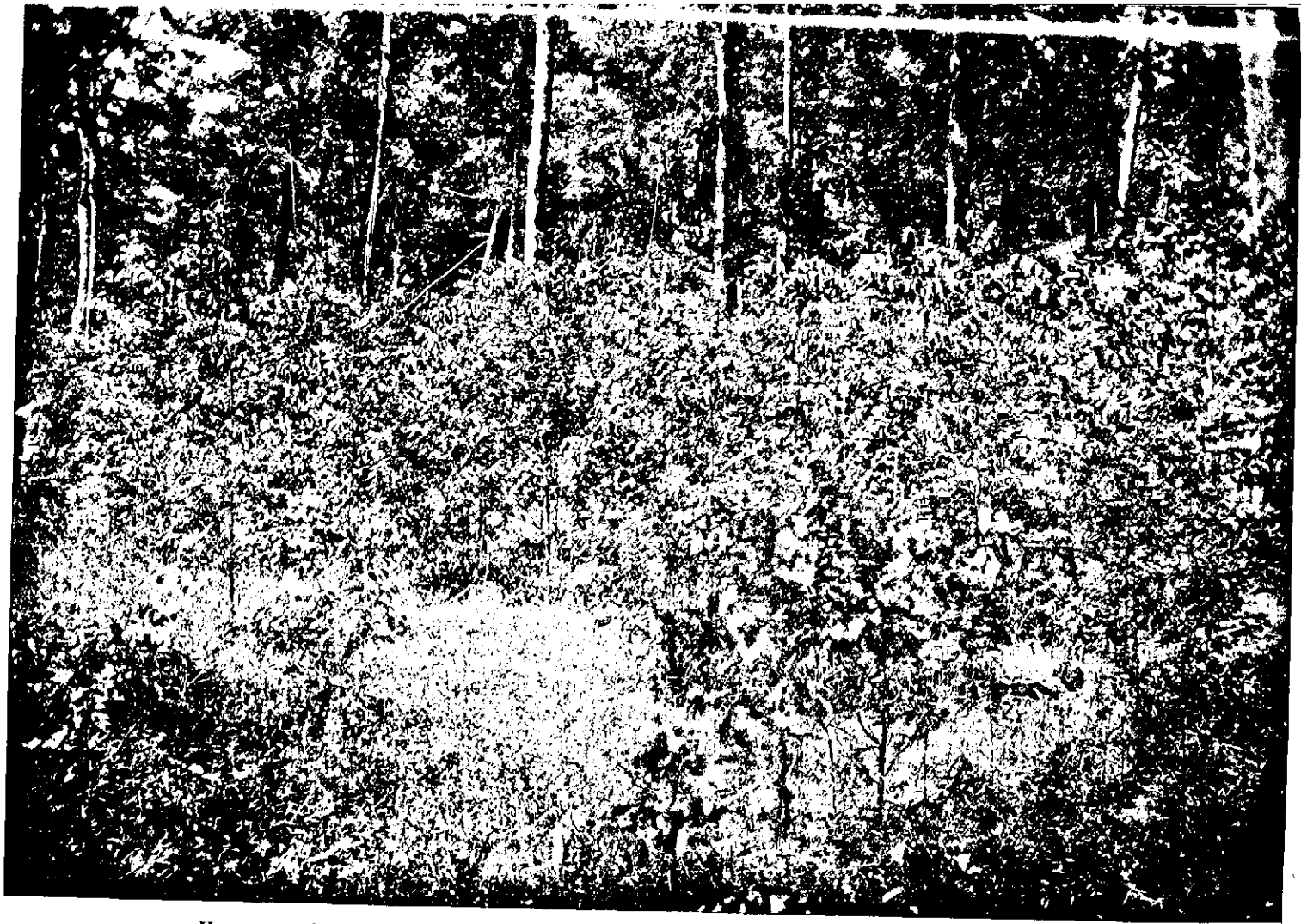
Plot IV.—Seeds sown under light shade formed by the top storey of deciduous species.

(b) To discover the degree of shade necessary to establish regeneration, by artificial means, of the more valuable evergreen species in an evergreen type of forest 5 contiguous plots were laid out in June 1921 in Seppal valley and seeds of the following species dibbled in, *Artocarpus hirsuta*, *Mangifera indica*, *Dichopsis elliptica*.

To come to any definite conclusion on the effect of various degrees of light let in, the growth requires observation for at least 2 hot weathers.

(c) To discover if pure crops of the following species could be raised by dibbling or planting 6 plots have been laid out at Dhoni and the growth in the several cases is noted below.

Species.	Nature of plot.	SEEDS SOWN IN MAY 1921.				SURVIVALS IN JANUARY 1922.		
		Weeded.	Unweeded.	Weeded.		Ht.	Unweeded.	Ht.
<i>Vateria indica</i> ...	Flat open ...	263	336	1920	4	1'	1	11"
				1921	4	6"	53	6"
<i>Mangifera indica</i>	Dibbled under a light overhead shade of standing deciduous trees.	434	467	1920	58	2½'	5	...
				1921	129	9"	74	6'1"



Hopca parviflora, from broadcast sowing of 1910 exposed to light in 1920, by removing middle storey, shrubs and weeds.

Species.	Nature of plot.	SEEDS SOWN IN MAY 1921.			SURVIVALS IN JANUARY 1922.		
		Weeded.	Unweeded.	Weeded.	Ht.	Unweeded.	Ht.
<i>Bombax malabaricum.</i>	Completely open ...	157	235	1920 40	8½'	65	9' 1"
<i>Bombax malabaricum.</i>	Dibbled under a light overhead shade of standing trees.	388	192	1920 104	4' 4"	32	3' 10"
<i>Gmelina arborea</i>	Fully exposed to sun.	728	538	1920 47	5'	83	7' 3"
				1921 98	1'	2	1'
<i>Terminalia paniculata.</i>	Dibbled under light shade.	692	...	1921 21	4"	...	...

NOTE.—All the above plots were resown in May 1921 when the sowings of 1920 failed.

(d) Three plots have been laid out in the compound of the Forest Rest house at Parappa to discover the most suitable age at which and the extent to which natural seedlings of *Hopea* can successfully be transplanted and also to see what the effect will be of pruning the root before transplanting seedlings. One to 5 years were planted, some with roots intact and an equal number with roots pruned. The following are the results recorded.

Plot No.	Date of planting.	No. and age of seedling.	SURVIVALS IN FEBRUARY 1922.			
			Of those planted with roots intact.		Of those with roots pruned.	
			No.	Ht.	No.	Ht.
I.	4-7-20	25 1 year	19	7½"	13	8½"
	"	25 2 years	17	12"	19	11"
	5-7-20	25 3 "	17	14"	19	11"
	19-7-20	25 4 "	14	17½"	14	17½"
II.	7-8-20	100 1 year	16	9½"	64	9½"
	"	100 2 years	14	7½"	23	8"
	8-8-20	100 3 "	48	11½"	50	11"
	"	100 4 "	45	11½"	50	12½"
	"	100 5 "	70	11"	65	12½"
III.	9-11-20	100 1 year	9	6"	25	6½"
	10-11-20	100 2 years	8	7"	4	7"
	"	100 3 "	20	6½"	8	7"
	"	100 4 "	29	9"	11	7"

(e) The last experimental plot laid out was to ascertain the coppicing power of some of the more valuable natural seedlings of evergreen species if they are cut back in the event of their being damaged during the felling and removal of the overwood in the general scheme of exploitation in the Chenat Nair evergreen forest.

Species.	No. of seedlings coppiced.		Coppice shoots counted on.
		24-8-21.	14-12-21.
<i>Dischopsis elliptica</i> ...	40	1	1
<i>Cullenia excelsa</i> ...	143	5	40
<i>Mesua ferrea</i> ...	19	7	13
<i>Calophyllum tomentosum</i> ...	3	nil	nil
Miscellaneous ...	311	41	111
Total ...	516	54	165

It is still too soon to draw any definite conclusion.

(f) As suggested by the Imperial Silviculturist in his inspection notes of May 1921, one plot half an acre in extent has been laid out in the Seppal valley of Chenat Nair R. F. to discover if evergreen species can be grown by direct sowing in the open on prepared soil.

The plot will be dibbled in May 1922.

Comparison between direct sowing and transplanting.—No experiment has yet been made in this direction. But all the experiments made in transplanting were with reference to :—

“ What species can bear transplanting ” and the following are the results carried out.

Name of species.	Age of seedlings transplanted.	Percentage of success.
<i>Hardwickia pinnata</i> ...	3 months.	54.05
<i>Hopea parviflora</i> ...	5 „	93.25
<i>Xylia xylocarpa</i> ...	3 „	18.33
<i>Vateria indica</i> ...	2½ „	75
<i>Terminalia tomentosa</i> ...	3 months and 3 weeks.	30.55
<i>Terminalia paniculata</i> ...	5 months.	87.50
<i>Artocarpus hirsuta</i> ...	1 year.	80
<i>Gmelina arborea</i> ...	7 months.	90

The above results go to show that in preference to dibbling of seeds transplanting could be resorted to, with every prospect of success. But the best age for transplanting remains to be ascertained.

Stump Planting.—At the instance of the Conservator of Forests, VI Circle, planting stumps of *Gmelina arborea* and *Bombax malabaricum* was attempted. Seedlings one year old (above 3' high), were cut leaving 3" root and 3" stem of each.

Of 20 stumps of *Gmelina arborea* planted on 2nd August 1921, 13 were found established and of 21 *Bombax* 20 had survived at the end of December 1921.

Working Plans and Statistics.

Yield Tables.—A number of plots are being maintained. In South Mangalore the periodical diameter and height increment of *Hopea* trees of known age, grown in an even-aged mixed forest condition, on a second class soil are being recorded in the Parappa teak plantations. An average diameter increment of .27" per annum was recorded for the five years ending 1916 and of .32" for the five years ending 1921.

Three plots were laid out in Pillarkhan in 1921 for comparative research with regard to volume increment and general development in height, form factor, diameter, etc., of *Hopea parviflora* grown in a pure crop in second class soil. The next measurements of these plots are due in 1927.

Four plots were laid down by the Central Institute in 1916-17 at Mundanthorai to ascertain the volume increment and development of teak coppice with standards. These were transferred to Madras in 1919-20.

The remeasurements due in January 1922 in the plots in South Malabar could not be carried out owing to the Moplah disturbances.

Punjab.

As mentioned in the previous year research work in the Kulu Division is being continued to ascertain the best method of regenerating the spruce and silver fir woods, but owing to the shortage of labour and the unsaleability of the outturn exploited from certain of the forests in which research is being carried out the work was retarded. A paper on this subject was written by Mr. H. L. Wright, Deputy Conservator of Forests, and Lala Parma Nand, Extra Assistant Conservator of Forests and read at the Punjab Forest Conference in February 1922. Similar research has been started in the Bashahr Division during the year.

In the Afforestation Division research work has been started in connection with the afforestation of the Pabbi Reserve.

The Khairimurat Olive Plantation was placed under the charge of a trained Supervisor towards the end of the year, but the success of the plantation seems rather doubtful as the fruit yield of the crop suffers badly in years when there is a shortage of rains. If the quantity of fruit produced during next year is not satisfactory the question of abandoning the experiment will have to be considered.

The propagation of lac which was started in the Hoshiarpur Division last year has made satisfactory progress during this year, although the larvae were attacked by a species of large black ant in August 1921. More than 1,100 trees have been definitely infected with lac and further extension is being made. The sale of the season's crop was frustrated by the local non-co-operators, who prevented the buyers from bidding.

The experiments in regard to the correct rotation for cutting over bamboos were continued in the Kangra and Hoshiarpur Divisions and final results will be available next year.

Experimental sowings of eucalyptus species were tried in Kangra and Simla Divisions but failed. The experiment is also being tried in the Kot Lakhpat Plantation, but no definite result has yet been attained.

Fomes annosus, the fungus which attacks young deodar, continued to be under observation in the Kulu and Bashahr Divisions, but no satisfactory remedy against its attacks has yet been found.

The experimental rearing of BeMadona was continued in the Nagkelo Reserved Forest, Simla Division, as reported last year, but no definite result has yet been arrived at.

Food and fodder crops are being raised experimentally in a number of deodar and *kail* forests in order to ascertain whether this affords a prompt or economical means of regeneration. In some patches of forest destroyed in last year's fires wheat crops were recently seen to be very promising, in others buckwheat and potatoes are being extensively grown. Figures at present available show that one crop will not as a rule pay for the labour of clearing the ground of burnt saplings.

UNITED PROVINCES.

Experimental Silviculture.

General.—Constant endeavours have been made to improve the standard of all silvicultural operations and some success has been obtained. In the best managed divisions there is a distinct improvement in all classes of markings but much remains to be done before this aspect of silviculture can be considered satisfactory. The

correct technique of regeneration markings, the proper treatment of regeneration areas, efficient thinnings and cleanings and the best methods of artificial reproduction have been matters to which the Conservator of Forests, Working Plans Circle, has repeatedly drawn attention and on which his advice is frequently sought by divisional officers. Notes on items of interest have been circulated and endeavours have been made to keep the Executive Staff informed of the progress of knowledge and to stimulate the interest of all in scientific forestry.

The work carried out in the Silviculture division has followed as closely as possible the printed programme of research for the Working Plans and Silvicultural Research Circle. For the first 6 months of the year, the shortage of staff in the Province necessitated the Silviculturist's holding charge of the Haldwani division in addition, but from the beginning of the working season, for almost the first time since the creation of the post, the Silviculturist was left untrammelled with other duties and was free to devote all his energies to pure Research. Thereby the programme of research work carried out received a great stimulus, and much useful and important work was taken in hand.

Natural Regeneration.—(1) (Sal). The natural regeneration of the sal remains by far the most important silvicultural problem of the province. Much has been learnt on the subject as the result of the researches of several officers and it can be said with some confidence that the problem is well on the way towards solution.

The series of important experiments in Lakhmandi C4 referred to in last year's report were continued and extended. It must again be emphasised that this research is directed towards a study of the conditions of development of a seedling crop already on the ground, and not a study of requirements for getting such a crop. The results obtained during the year may be briefly summarised.

A.—In the areas clear felled and heavily felled.

(1) The very heavy felling and intensive conversion results in considerable trampling and smashing of the young sal plants, and enormous accumulations of slash and debris. When this is burnt off, a fierce fire results, and after the fire the existing plants of all sorts are almost entirely cut back, flush with the ground, and are invisible. The ground is left bare, with a fertile deposit of ash.

(2) This trampling and burning was followed by the fiercest and driest hot weather on record. Despite this, the sal plants sent up healthy shoots in large numbers, which successfully persisted until the rains broke. This proves that there is no fear of drought killing the young plants on these good quality Bhabar soils.

(3) Throughout the rains and subsequent cold weather, the young sal plants preserved a very healthy appearance and showed no indications of wanting to die back (in marked contrast to the plants in the adjoining unfelled areas).

(4) At the beginning of the following hot weather a high per cent. of the young plants commenced new growth, putting out new shoots from the top of the previous years growth, and *not from the base or root stock*. In most cases the 12 months' growth equalled the growth of the previous 7 years !

(5) Weed growth and grass came up very vigorously in the felled areas, and in November appeared to be smothering the young plants, but by April it was evident that the young sal much prefers the conditions of open growth, with the inevitable severer competition of weeds, to the closed canopy with a layer of decaying sal leaves.

(6) The percentage of survival in the heavily felled and burnt areas amounted to 65 per cent.

In the adjoining unfelled and unburnt areas the percentage of survival was 49 per cent.

B.—In the unfelled and unburnt areas.

The condition of the young sal plants throughout the year was extremely poor. A large per cent. disappeared altogether, and the remainder showed very little upward growth.

These results conclusively show that even the most drastic treatment possible is better for the young sal plants than attempting to nurse them up under a heavy shelterwood, without removing the mat of dead sal leaves, which in the rains form an acid airless blanket, and have a most deleterious effect on the young plants.

It now remains to be seen to what extent the young sal plants will succeed in struggling up through the more vigorous weed growth, and how many years it will take. It is believed that in the heavily felled areas, the young plants (9" to 2' high at the time of felling), will be firmly established and free of the grass and weeds in from 6 to 8 years of the felling, without any further assistance.

During the year the series of experimental 25 acre plots was extended by the addition of 2 plots with strip fellings as advocated by Mr. Hole and one plot with shelterwood fellings, the idea being to compare the results between the two methods. Also the surrounding forest (except for a 25 acre control plot) was burnt early in April without felling, to remove the layer of dry sal leaves, to see what the effect of mere burning without felling will be.

In the course of a few years, it is hoped to obtain conclusive results from this series of large scale experiments which may have an important influence on the future management of the large areas (400,000 to 500,000 acres) of Bhabar, Plains and Tarai forests of the United Provinces. Similar large scale experiments of 25 acres were also commenced during the year in South Kheri and North Kheri, in different types of sal forests. The results will be noted next year.

Several divisional officers contributed to this investigation. In Dehra Dun Mr. Mathura Prasad Bhola continued his experiments at Lachiwala designed to show the simplicity of regenerating a sal forest containing a more or less profuse advance growth under circumstances which do not admit of a system of simple coppice as in Gorakhpur. The system resolves itself into—

- (1) Selecting the seed trees 20—25 to the acre.
- (2) Cutting everything else clean.
- (3) Burning what remains of the slash after more or less complete conversion.
- (4) Regenerating by coppice wherever available and elsewhere by seed.

Most excellent results have been obtained with the coppice both in the shelterwood and clear felling but the latter method will not be persisted in as the frost hazard is too great. Mr. Bhola writes as follows :—

Lachiwala plot.—(1) In the months of May and June 1921 almost all the new shoots were browsed by deer but they soon recovered and immediately made up the loss. No damage from frost was seen in either of the plots, only a few plants were slightly effected.

(2) The development of coppice shoots in both the plots was good. The average height growth in the clear felled and shelter wood plots was 79 and 103 inches respectively.

(3) No natural reproduction of 1921 was noticeable in the shelterwood area as the rains were late, though sal seed was abundant.

(4) The weed growth of *karoo*, *Clerodendron infortunatum*, *karaunda*, *Carissa spinarum* and *munj* grass was noticeable in both the areas but did not appear to be doing any damage at present.

(5) Half of each of these plots comprising an area of about 10 acres was thinned in the month of April 1922 at a cost of Rs. 12.

Timli Range.—(1) No damage from frost, some browsing by deer was seen in the clear felled area and a little in the shelterwood plot.

(2) The growth of coppice shoots in the clear felled area is more vigorous than in the other.

(3) Seedling crop of 1921 is very scanty in both the plots.

(4) The weed growth, especially that of *maljahan*, *Bauhinia Vahlia*, was enormous in the clear felled area while *Clerodendron infortunatum* appeared in the shelterwood plot. This weed growth does not appear to be doing any damage at present.

Two new shelterwood sample plots of 10 acres each were laid out in the Lachiwala and Timli Ranges close to the old ones, all material except the shelterwood was felled and removed and the areas burnt in April 1922. The results will appear in the next year's report.

Experiments with fire as a means of stimulating the reproduction of sal and reducing heavy evergreen undergrowth were carried out in Lansdowne, North Kheri, Bahraich and Gonda divisions and burning has invariably given good results. A complete carpet of sal seedlings was obtained in this way in C 41b of North Kheri whereas in the ordinary forest there was little or no reproduction.

Our above experiments have therefore shown us the way to obtain germination and the Haldwani ones the way to make these seedlings grow, so that we are well on the way to complete success. The Conservator has devoted considerable attention to the proper treatment of sal under coppice with standards and management has been much improved in revised working plans. The simple coppice system of Gorakhpur continues to give excellent results. A modification of the routine by substituting burning for unremunerative cleanings was suggested by the Conservator, Working Plans Circle, after his rains tour and at the next revision of the plan the rotation will be lengthened in accordance with the results exhibited by the new yield tables for sal.

(2) *Miscellaneous Species*.—Several important and interesting results have been established and will be noted on by species.

(a) *Haldu (Adina cordifolia)* (i) Following the fierce burning of the slash and felling debris in Lakhmanmandi C4; mentioned above, a magnificent and almost complete crop of natural *haldu* seedlings appeared in the rains wherever a smouldering log or a half burnt stem had effectively baked the soil, killed the weeds, and left a thick deposit of ash. Their development was remarkably good, and although many disappeared in the cold weather and all were grazed back by deer—sufficient seedlings have survived, and will it is believed, now continue to survive, to form a complete crop. (However, as this is primarily a sal regeneration area, the *haldu* plants will be kept back if found to interfere with sal plants). In the adjoining unburnt areas, not a single *haldu* seedling came up. The method of obtaining successful natural regeneration at a minimum of cost and trouble is now fairly evident for rich moist soils overlying the Bhabar gravels. The future development of these *haldu* seedlings will be carefully noted.

(ii) The 50 acre plot of natural *haldu* regeneration (mixed with khair, sissou and *Holoptelea* regeneration) in the Nandhaur old river bed which was fenced last year by the Special Forest Officer, Tarai and Bhabar Estates, was carefully noted, and the following points established :—

- (1) The *haldu* plants showed no material growth during the year, but remained in leaf to late in November, long after the plants in the surrounding tract open to grazing had become leafless.
- (2) The plants remained leafless and inconspicuous until April when new leaves were again formed, and the plants showed indications of shooting up.

- (3) The closure to grazing greatly improved the condition of the sissoo plants, which shot up vigorously during the year, and were most flourishing.
- (4) Generally speaking it is evident that closure to grazing had a most beneficent result on the experimental area, and in 6 or 8 years it appears certain that a well established crop of young trees will be established. It proves that it is only heavy grazing which prevents the natural afforestation of those bare old river beds.

(iii) Very similar results have been noted with natural *haldu* seedlings in the areas closed to grazing of the Haldwani lantana plantations (referred to below), which will in time contain a fair percentage of natural *haldu* trees. The plants are still affected by the grazing of Nilgai, but are gradually growing into safety.

It may be said with confidence that the problem of *haldu* regeneration, which for so many years was a perplexing conundrum to Forest Officers, is rapidly approaching satisfactory solution, and the secret of success appears to lie in careful attention to the following factors :—

1. The seed and the young seedlings must be protected from flooding and from being washed away.
2. The soil must be clean, loose, and preferably fairly porous.
3. Complete freedom from weeds.
4. Subsequent protection from grazing.

With these 4 factors assured, success is almost certain.

As regards the hill conifers, methods of natural regeneration of the *chir*, *kail* and deodar are well-known. The natural regeneration of *ban* oak under a shelterwood is being undertaken in Ranikhet.

Artificial regeneration.—**SAL** :—The feature of the year is the successful solution of the problem of the artificial regeneration of sal in the Gorakhpur coppice coupes.

These experiments have a history dating back to 1914, and it is mostly a history of failure in which much knowledge has been gained. The complete history of the Ramgarh-Tilkonia experiments has been written by Mr. Wood and published in the "Indian Forester" for February 1922 at pages 53 to 77 and this contains all the information up to August 1921. Since that time what has to be considered is the effect of one growing season which has been a favourable one, and it can be said that in all cases those plants which were not doing well are still not doing well, and that those which were doing well have continued to show every promise. At the same time the matter cannot be dismissed in this report at this point.

The clear felling system was adopted in Gorakhpur with confidence leavened with misgiving. It was known that when abundance of young poles existed, the response of the shoots on the clearfelled areas was extraordinary. At the same time the greatest optimist at that time could not say for certain what would happen where young poles did not exist. No one knew how to regenerate sal with certainty, and no true Forester could contemplate with equanimity the prospect of creating blanks, especially as there were not inconsiderable areas where young poles did not exist.

The following methods were successively tried in order to induce regeneration.

Leaving seed bearers on the clear fellings resulted in a complete failure and was soon given up.

Sowing under the old crop in prepared patches and wounding the soil and sowing. Failed.

Transplanting root and shoot cuttings of sal. A complete and final failure after prolonged careful trial.

Digging and sowing under the old canopy opened out. Has failed.

Digging and preparing the land and sowing and tending the sal in the open on the clear fellings. This has been a success.

This work was done in coupe 2, Tilkonia, under forest conditions. An unfenced area exposed to illicit grazing and fire. It has stood the test of a bad rains, a frosty cold weather for these parts, a bad hot weather and a fire. The plants have remained healthy and sound for 2 years and in the year under report they have come through and are now thoroughly established.

It can now be said therefore that when clear felling is adopted in this division that, barring causes over which we have no control, artificial regeneration of blanks created by clear felling can be successfully carried out with a confident expectation of success, and it is hardly possible for any one not in charge of the division to realise the relief which this knowledge gives. Costs are still high and the work has not yet reached the stage of definite routine, but that is a matter of detail which time will set right. The key discovery has been made and since the close of the period under report it has been possible to commence preparations for the cultivation of sal with field crops which should lead to the artificial regeneration of 80 acres at a cost amounting to practically nil. If that work succeeds then all difficulties, both silvicultural and financial, will have been removed and our regeneration operations will not appear on the debit side of our budget at all.

It is proper that the report which at last records success in this matter should contain the name of Pandit Ram Rattan, a vernacular Forest Ranger who has been in executive charge of the work from

the beginning and whose care and diligence, as well as his silvicultural sense has been beyond all praise.

Two small scale experiments were made in Dolpokhra plantation, (an area subject to severe frost) to examine the possibilities of artificial regeneration of sal, (a) in the open, (b) under a shelterwood of sissou. Results will be noted next year.

Experiments in artificial sal regeneration in the dry soils of Jaspur Range are under the Divisional Forest Officer, Ramnagar, but nothing can be done till a good seed year arrives.

Miscellaneous Species.—The sowing and planting of miscellaneous species was continued in the experimental garden at Haldwani ; in the Dolpokhra plantation and on an extensive scale by Mr. Murphy, Special Forest Officer, Tarai and Bhabar Government Estates. This officer has obtained very considerable success and much of the knowledge available is due to his efforts. *Haldu*. Successful results have been obtained in the Tarai plantations at Lalkua with transplanting small natural *haldu* seedling (2½ months old) in September. A good percentage survived the cold weather and started new growth in March and April.

Sain (Terminalia tomentosa).—The general bad quality and shortage of seed last year prevented very much being done with this species, but the experiments carried out in S. Kheri, Horai, Dolpokhra, etc., suggest :—

1. That a moist rich loam or fairly stiff clay loam is desirable for this species, which fails on gravelly or loose sandy soils.

2. That it is intensely liable to damage by grazing of deer, hares, cattle, etc.

3. That on favourable soils, and if adequately protected from grazing, its regeneration is a comparatively simple matter, and it grows up quickly without dying back. *Holoptelea integrifolia*. All experiments with artificial regeneration of this species in the open have failed, and it appears essentially to be a species to be regenerated under a shelterwood of sissou on loose sandy or gravelly soil.

Sissoo (Dalbergia Sissoo).—Very considerable success has been obtained with this species over a wide range of conditions, and it appears pre-eminently the chief species for afforestation on dry gravelly or sandy soils or loose fertile loams but not on stiff loams and clays. Its natural regeneration appears largely confined to new river beds and landslips.

A wide range of experiments with other important Bhabar species (amongst which should be mentioned *Acacia Catechu*, *Anogeissys latifolia*, *Bombax malabaricum*, *Lagerstroemia parviflora* *Gmelina arborea*, bamboos, etc.), have also been started, and results will be noted as they become available.

Afforestation.—The work in the Afforestation Division was continued and the plantations were extended by 2,000 acres. *Hardwickia binata*, *Albizia procera*, and *Acacia Catechu* were experimented with on a considerable scale. Babul would be an excellent species but for frost which causes great losses in all low lying areas. An experiment in connection with local races of babul seed is in hand. A scheme for the afforestation of the North Kheri phantas is under preparation but it is doubtful whether the expenditure can be justified at the present time.

The attempts to grow sissou as a shelter to the frost bitten sal shoots in the *chandars* of South Kheri and Pilibhit have not so far been attended with much success but this matter will be again taken up.

Thinnings and Cleanings.—These operations are prescribed in all new working plans both in high forest and coppice crops, the urgency of this work has been repeatedly pointed out and is at length being realised by the Executive Staff.

Silvicultural Systems.—The shelterwood system is now a standard system for the sal forests of the province wherever the locality and the growing stock justify this method of treatment. The essence of the system is as follows :—

- (1) Develop a good crop by constant thinning.
- (2) Obtain regeneration by burning.
- (3) Open the canopy somewhat heavily.
- (4) Cultivate the soil where this must be done to obtain seedling reproduction.
- (5) Cut back advance growth drastically.
- (6) Coppice to count as good as seedling reproduction.

A new system has been developed for the Nawadia forests of Pilibhit. A start is made with the ordinary coppice with standards, blanks in the coppice are filled up artificially, the standards are thinned out and finally removed within 10 years leaving the coppice to develop into high forest, where selection is retained ; a yield by volume has been substituted for a yield by area and good silviculture insisted on. It has been definitely established that simple sal coppice is not a suitable silvicultural system where frost damage is to be expected.

II.—Working Plans and Statistics.

The plans for the Dehra Dun, Saharanpur, Landsdowne, North Kheri, South Kheri and Pilibhit Divisions were under revision during the year. The plan for Chakrata Cantonment forests was finished and published and the preliminary report on the Gonda forests was prepared. All the above plans are on up to date lines and need not fear comparison with the plans of continental Europe. The position

as regards plans is now normal. Five to six important plans can be dealt with at one time and the organisation and supervision of the work enable plans to be prepared by officers too junior or inexperienced to be entrusted with this work under the old conditions, under which a man was sent to make a plan without any fixed policy having been settled as to the lines on which the work should be drawn up. The work in the Silviculture division is intimately bound up with the preparation of working plans, both as regards experimental forestry and statistical work. The working plans branch has now a complete knowledge of the forestry of the province and is in a position to keep the Executive staff in touch with the latest discoveries and developments and to give the best advice available on any subject. There can be no question that the creation of the Working Plans Circle has been of great benefit to the forestry of the United Provinces.

A large amount of work has been done during the year in the remeasurement of old sal plots and laying out of new plots. 30 old plots were remeasured, 20 new permanent plots laid out and measured, and 34 temporary plots were measured, totalling 84 plots. Simultaneously with the field work, the necessary calculations of the plots and measurements were made, involving much additional work (which should theoretically be done at the Forest Research Institute, Dehra Dun, but the authorities there indicated their shortage of staff rendered it quite impossible for them to do this work). The statistical staff (Pt. Bhawani Datt, E.A.C., and Ranger Raghubans Swarup) deserve great credit for the hard work undertaken and successfully carried through.

This great mass of additional statistical data rendered it possible to commence the compilation of Volume and Yield Tables for the United Provinces sal forests, and during the 3 months of the year under report, the writer was chiefly engaged in the preliminary calculations. These were completed, and the Volume and Yield Tables were finished in May, after the close of the year under report, and during the coming year it is hoped to bring out an interesting and useful publication on the results.

It will not be out of place here to mention that the results of research on sal carried out during the last 10 years by the Research Officers at the Forest Research Institute, Dehra Dun, and in the province justify a practical revolution in the systems of management of the United Provinces sal forests of the Plains and Bhabar by—

- (a) Enabling more scientific silvicultural system to take the place of the old " Selection with Improvement " method.
- (b) By reducing the rotation for sal by roughly 25 per cent.

and it is claimed that the money value of this research will be represented, on a low and conservative estimate, by an increase of at least Rs. 10 lakhs *per annum* in the Provincial Forest Revenues.

Owing to the pressure of statistical work in connection with sal, very little attention could be paid to the statistics of miscellaneous species, but during the year the following sample plots were re-measured or laid out—

Shisham	..	..	..	..	3
Semal	..	..	..	..	1
Jaman	..	..	..	..	1

Regeneration experiments in the Improvement Working Circle, Ramnagar Division.

Owing to the pressure of other works no experiments were taken in hand this year under this head, but the experiments on *bakli*, *khair*, *sain*, etc., in hand in other areas are supplying useful information. It appears advisable to transfer the experiments under this head to the Gonda Division.

Yield tables and sample plots.—During the year a number of old sample plots in *chir* and oak were re-measured and a number of new plots laid out, *viz.*,

Chir—

Old plots re-measured	..	..	..	15
New plots laid out	..	..	..	12
Temporary plots	..	..	..	2

Oak—

Old plots re-measured	18
-----------------------	----	----	----	----

Unfortunately several plots were severely damaged by the fires of 1921.

There are still too few plots of the larger diameter classes to take up the compilation of a yield table. Further plots will be laid out as opportunity occurs.

Various miscellaneous investigations are in hand. The experiment of cleaning undergrowth in *chir* pine woods to see the effect, if any, on the flow of resin was continued with the following results :—

Statement showing yield in Siuni Compartment 13, Experimental Area.

Month.	No. of Channels.	CLEARED OF UNDERGROWTH.			UNCLEARED OF UNDERGROWTH.			REMARKS.
		Mds.	Srs.	Per cent. Channels Mds.	Mds.	Srs.	Per cent. Channels Mds.	
April ...	1902	5	4½	0.25	4	3	0.21	Not tapped from June owing to fire.
May ...	..	14	6	0.66	4	19	0.23	
Total	..	19	10½	0.90	8	22	0.44	

The beneficial result of removing undergrowth on the yield of resin is again demonstrated. It should be noted in this connection that even if the flow of resin is not really affected the yield per acre is improved in practice and the cost of tapping and collection are likely to be reduced by clearing thick undergrowth, which is a great hindrance to resin tapping operations.

A severe attack of *Peridermium complanatum* on *chir* was noticed in the hot weather probably as the result of last year's fires. A paper on *P. corticola* was published by Mr. Champion in the "Indian Forester" for April and May 1922 and a paper on twist in *chir* by the same author is awaited. Experiments with "Atlas A" and sodium arsenite for the poisoning of shrubs and climbers were continued with varying results.

CHAPTER III.

BOTANY.

Central Institute.

Shortage of staff and equipment caused by financial stringency have materially restricted research work during the year but some progress has been made with the items noted below.

Oecology of Sal.—A summary of most of the experimental work carried out up to date on the factors influencing the development of sal seedlings was published during the year (*Indian Forest Records*, Volume VIII, Part II, 1921). Based on these results an experimental trial with a group-cum-strip system of regeneration was suggested for certain types of sal forest. This system possessed two features which rendered it troublesome to work on a large scale, viz. :—

- (1) the prescription that only alternate strips should be regenerated, the regeneration of the intervening strips not being undertaken until the second half of the rotation.
- (2) the prescription regarding a chess-board arrangement of patch fellings which are gradually extended in the form of strips.

The object of (1) was to insure as complete security as possible from drought and frost damage, by the provision of adequate side-shade both from the east and west, and of (2) to diminish damage by heavy weed growth. An inspection during the year of one of the Dehra experimental areas, 180 feet in diameter, which was clear felled in 1915 and sown with sal in patches revealed the fact that the seedling growth here now was much more satisfactory than appeared probable at first. The seedlings here suffered considerably from drought during the first few years but now, after 6½ years, several have become thoroughly established with a height growth attaining 5-8 feet. This, it is believed, justifies the conclusion that

the more convenient system of continuous strip fellings (which will always insure side-shade from at least one direction) can be safely adopted instead of that of alternate strips. In the second place, it is probable that, as suggested by Mr. C. G. Trevor, weed growth can be sufficiently controlled by varying the width of the strips instead of by a chess-board arrangement of felling. With the co-operation of local officers in the United Provinces large scale tests of strip fellings on these modified lines have been carried out during the year in the Dehra Dun and Haldwani Divisions.

The only factor which at present appears likely to militate against the success of the system is damage by rats. In the Dehra Dun experiments these animals have been responsible for very heavy mortality among the young sal plants by biting through the sappy tap roots of vigorous seedlings and saplings. As mentioned in last year's report, however, it is believed that this damage will be relatively unimportant when work is carried out on a larger scale. During the year, also, it was noticed that rat damage appears to be invariably worst where there is a heavy growth of grass especially of *Imperata* and large tufted species of *Saccharum*. The rats appear to be primarily attracted by the succulent rhizomes of the grasses on which they feed and incidentally they bite through the succulent sal roots which they come across in their burrowings in the grass. It is believed that grass growth and consequently rat damage can be adequately controlled by keeping the strips narrow, by allowing all good coppice growth to develop on the strips and form a part of the future crop and by sowing sal thickly and weeding during the early years, so that the seedlings may quickly form a close canopy.

The advantages of this strip system over the ordinary seeding felling method at present appear to be that it provides more suitable conditions of soil moisture for seedling growth, greater security against weeds, greater concentration and better control of artificial sowings and cultural work. It also avoids the damage to the young growth occasioned in seeding-felling areas by the felling and export of the mother trees. At the same time the strips get the benefit of most of the natural seed produced by the trees on the edges of the cleared strips. Whatever success is eventually obtained with the strip system will be mainly due to Mr. C. G. Trevor, Conservator of Working Plans in the United Provinces, to Mr. E. A. Smythies, Silviculturist, and to Messrs. H. G. Champion and M. P. Bhola, Divisional Forest Officers of Haldwani and Dehra Dun respectively, who have heartily co-operated in the work of testing this system experimentally.

Systematic.—A matter the importance of which has become increasingly evident during the year is that of disseminating widely through all ranks of the Department a good practical knowledge of our forest species. It is frequently not realized how much economic development is hindered by an insufficient knowledge of species

on the part of local officers, which makes it difficult to collect information regarding the local distribution and yield of commercial products and to obtain samples of them for research purposes. It is believed that two causes are chiefly responsible for this, *viz.*—

- (1) a tendency which has been somewhat prevalent in the past to think that a forest officer who studies and tries to know well the plants in his forest is gradually becoming “only a botanist” and is therefore decreasing in value as a practical forest officer;
- (2) the fact that the classical detailed floras now available in India, indispensable though these undoubtedly are, do not sufficiently facilitate the successful identification of species by the average forest officer.

As regards the first point, the idea appears to be due to a misunderstanding, on the one hand, regarding the lines of work which fall within the legitimate scope of the science of botany and on the other hand as to the kind of botany which an efficient forest officer ought to know. The decision as to the correct botanical name for any particular species or other group depends upon herbarium work and a study of the herbarium specimens, plates and original descriptions on which those groups are based and which are the authority for the various published specific and varietal names. Forest Officers, as a rule, have neither the time nor the opportunity for doing much work of this kind which should be done by the expert herbarium botanist. On the other hand, what is usually called field work which comprises a study of the living plants in the forest, of the characters which enable us to recognize them in the forest at different seasons of the year and of the range of variation which these exhibit forms a necessary part of forest botany and, to a more or less considerable extent, is an essential part of the equipment of every efficient forest officer in India. A great deal could be done by those local forest officers who know their plants well in the way of helping other forest officers to increase their knowledge in this respect while, if senior officers made it clear that they considered a good knowledge of local species necessary for efficiency, it is believed that a considerable improvement would result.

As regards the second point, efforts have been made for many years to encourage forest officers who have studied their plants in the forest to prepare small simple floras, each one of which dealing with a small area and therefore a restricted number of species and in which forest characters are utilized as far as possible in the keys and descriptions. With the object of accelerating this work a scheme for the systematic preparation of descriptive lists of species was drawn up by the Forest Botanist in 1913 which subsequently received the sanction of the Government of India (see *Forest Bulletin* No. 23, Calcutta, 1914). Descriptive lists of this kind, provided with useful keys, are really very efficient local forest floras

and it is believed that such pocket companions for the field dealing with restricted areas will always possess a permanent value of their own. The first lists issued under this scheme were those for the 3 Forest Circles of the Central Provinces by Messrs. H. H. Haines and D. O. Witt which were published at Allahabad in 1916. A striking testimony to the value of these lists is afforded by the fact that although the Bombay Presidency is provided with two excellent detailed regional floras yet a Divisional Forest Officer serving in a Bombay district adjoining the Central Provinces recently informed the writer that he found the list dealing with the adjacent area of the Central Provinces more generally useful to him in his work than the Bombay floras. Similar lists, but in a preliminary form, were under preparation during the year for the United Provinces by Mr. A. E. Osmaston and Mr. P. C. Kanjilal. This work has also been carried a definite stage further during the year by the completion of a local forest flora for the Andamans by Mr. C. E. Parkinson, a former forest student of Dehra Dun. Mr. Parkinson's work has materially increased our knowledge regarding the species of the Islands. Four new species have been discovered and more than 100 of the indigenous species described in his book either have not been mentioned at all or have not been reported as occurring in the Andamans in Brandis's *Indian Trees*. Mr. Parkinson's work has also indicated that several species which have been previously recorded for the Andamans probably do not occur in the Islands and that the well-known Andaman marblewood is not yielded by *Diospyros Kurzii*, Iliern, as has been hitherto thought to be the case. The following books were under preparation during the year : the *Flora of Bihar and Orissa* by Mr. H. H. Haines, a revised edition of the *Forest Flora of the Punjab* by Mr. R. N. Parker, a *Forest Flora and Descriptive Lists for Assam* by Rai Bahadur Upendranath Kanjilal. During the year 154 specimens were identified at Dehra Dun for inquirers and Mr. Parker, the systematic botanist, made a special study of *Dipterocarpus*, *Acacia* (groups *caesia* and *eburnea*), *Berberis* and exotic species cultivated in India.

Pathology.—A careful study has been carried out by the Assistant Forest Botanist Mr. Abdul Hafiz Khan in co-operation with forest officers in Madras with reference to the location and progressive accumulation of starch in the tissues of spiked sandal and the question as to whether spiked plants ever recover from the disease.

Publications.—*The Regeneration of Sal Forests* by R. S. Hole, Forest Records, Volume VIII, Part II was published during the year and work was continued on the *Botany Manual* by the Forest Botanist and his staff.

Herbarium.—2941 specimens were added to the herbarium during the year the chief contributors being Messrs. C. G. Rogers, Chief

Conservator of Burma, R. N. Parker, A. E. Osmaston, P. C. Kanjilal and Mr. B. L. Gupta, Assistant Forest Botanist.

Library.—86 volumes exclusive of periodicals were added at a cost of Rs. 823.

Tours.—The Forest Botanist toured in the United Provinces during the year visiting the Haldwani and Etawah Divisions in August and the Ramnagar Division in November.

126 consignments of seeds of 88 species were made in fulfilment of indents during the year.

Education.—Lectures were given as usual to the Provincial Classes during the rains by the Forest Botanist and by the Assistant Botanists Messrs. B. L. Gupta and Abdul Hafiz Khan; the Forest Botanist conducted the botanical examinations of the senior Provincial Class and Mr. R. N. Parker those of the Ranger Class in March. The botanical examinations at the Cawnpore Agricultural College were carried out by the Forest Botanist and the Assistant Forest Botanist Mr. B. L. Gupta in April 1921.

The Forest Botanist held charge of the branch throughout the year. Mr. R. N. Parker joined the branch as systematic botanist on December 6th, 1921.

Assam.

Oecology.—Observations made in the frontier tract on the requirements of *Terminalia myriocarpa* indicate that the species requires a good soil free from organic matter and plenty of light, any direct overhead shade appears to be fatal. Existing forests of this species have arisen chiefly on the heavy deposit of silt which is brought down by the rivers and causes the death of any existing vegetation. It is therefore necessary to reproduce in the forests as close a condition to that which exists in nature in order to ensure the regeneration of the species. *Kayea assamica* has been observed to thrive best on light soils, namely loams with a very high percentage of gravel in admixture and wherever these conditions obtain its germination and reproduction are excellent.

Burma.

A new edition of Mr. Lacey's "List of trees, shrubs and principal climbers, etc., recorded from Burma," containing much additional information, was prepared by Mr. A. Rodger and was in the Press at the end of the year.

Work in the Botanical Garden at Maymyo continued during the year, but on a small scale only, owing to want of funds and to the absence of Mr. Cooper, the Superintendent, for considerable periods at Rangoon.

Mr. Cooper who was in charge of the Herbarium at Maymyo, had little time to devote to it and practically no progress was made.

The following bamboos were found in flower in the Tenasserim Circle during the year and many specimens were collected :—

Oxytenanthera nigrociliata over considerable areas.

Oxytenanthera albociliata over considerable areas.

Oxytenanthera parvifolia one clump found in Thauangya.

Cephalostachyum pergracile here and there.

Dendrocalamus strictus here and there.

Dendrocalamus membranaceus here and there.

Dendrocalamus Brandisii here and there.

Bambusa arundinacea here and there.

Tabindaing (not yet identified) here and there.

Bambusa polymorpha occurs in the north of the Thaton district but was not found in flower. It has a curious form of growth, many of the culms being crooked.

A bamboo in flower called *wathabut* was collected in the Karen hills of Toungoo, and the same bamboo was sent from West Salween as *wanwe*. This was supposed to be *Teinostachyum Helferi*, Gamble, but the Forest Botanist reports that this name is incorrect and it may be a new genus. Good specimens were called for to settle the matter.

A large number of specimens were collected by forest officers in the Tenasserim Circle and the majority of these were verified at Calcutta, Dehra Dun or Maymyo. *Hura Crepitans*, L. was found at Mergui and had not previously been recorded from Burma.

Enquiries were made in various parts of Burma as to the abundance of oaks and chestnuts which could provide tanning materials. Although there are many species and these trees are widely distributed, it appears that they do not occur over large enough areas anywhere to make their commercial exploitation possible.

A botanical survey of the very valuable and almost unknown hardwood forests of Mergui was begun, sets of botanical specimens and corresponding timber specimens being collected.

The Divisional Forest Officer, North Toungoo, sent to Dehra Dun specimens of teak damaged by a fungus. The Forest Botanist reported that the specimen showed a sporophore of the common Saprophytic fungus *Schizophyllum commune* but no signs of any parasitic fungus attack.

“ A very useful ‘ Simple Key to One Hundred Common Trees of Burma ’ by Mr. C. B. Smales was published during the year, after having been delayed by the faulty printing of the first impression.”

CHAPTER IV.**FOREST ECONOMICS.***Central Institute.*

The year 1921-1922 saw a complete evolution in the Economic Branch due to the inauguration of several new sections, the work of which will be dealt with hereafter. At the close of last year specialists arrived in India to take charge of the Sections of Timber Seasoning, Timber Testing, and Paper Pulp. An officer of the Imperial Service started the Section of Minor Forest Products, while the post of Wood Technologist was filled at the end of the year under report. Of the Upper and Lower Grade Assistants' posts sanctioned, only an Upper Grade Assistant to the Officer in Charge, Timber Testing, was appointed, while Lower Grade Assistants to both Timber Testing, Seasoning and Paper Pulp were appointed. A certain number of computers, and machine operators were also engaged and a Wood Worker was appointed by the Secretary of State. The above staff by no means represents that required for all the Sections, and though it was fully realised that it was most necessary to fill the other appointments, the financial stringency rendered it impossible to do so.

With the exception of a portion of the Paper Pulp Plant, all machinery belonging to the various Sections, purchased in England and America, was received during the year under report. The work of checking and housing this experimental plant took up a great portion of the various officers' time, while further delay was caused by the housing accommodation being extremely limited. It was hoped that during the last cold season the laboratories and workshops on the new site would be ready for erecting the plant, but this was not the case, and therefore the greater part of the machinery had to be put in store. On the other hand it was thought advisable to erect as a temporary measure such machinery as was possible in the existing workshops and outhouses of the present Institute in order to carry on what work was possible in the limited space available and to train a nucleus of machine operators.

The major portion of the Forest Economist's time was taken up in organising the various Sections and making the necessary arrangements for erecting, as a temporary measure, what Testing and Wood Working machines it was possible to put in the existing buildings. The Forest Economist was also employed in preparing plans and lay-outs for the new laboratories and workshops which are now being erected and the only tours he made were a short trip to Delhi with the Officer in Charge, Seasoning, to advise on the seasoning of timber in New Delhi, a visit to the Utilization Workshops at Bareilly, a visit to attend a Conference of all the Railway Engineers

in Simla, a visit to Calcutta to give evidence before the Fiscal Commission and a more extended tour to Burma, at the request of the Local Government, to submit a report on their future policy in connection with Economic research.

A feature of the year's work was the first Utilization Conference held in India, which was largely attended by officers from all provinces. At this Conference the future policy of Utilization Circles and the development of Economic Research at the Central Institute were fully discussed. This meeting marks one of the most important advances in Forest Utilization in India.

There can be no doubt that though much has been done during the year under report to develop the Economic Branch, considerably better results could have been obtained had (1) the new laboratories and buildings been ready in which to erect the machinery and so allow the Sectional Officers to make the best of their opportunities and (2) had Imperial and Upper Grade Assistants been appointed to the various Sectional Officers and thus give the specialists more time to train their Assistants to undertake the work when the new laboratories and workshops are a running proposition.

It is gratifying to be able to record the great increase in the number of enquiries which have been received both from officials and from the commercial world, on subjects connected with all branches of our work.

In order to assist interested parties a Trade Supplement to the "Indian Forester" is now issued monthly, this supplement is the outcome of a quotation list formerly published at the end of the Indian Forester and which has been gradually amplified year by year. This new departure in issuing a supplement has been well received by the commercial community as is verified by the number of copies applied for.

The inadequacy of the clerical establishment has been a source of continued difficulty and has considerably hampered the correspondence work which has to be carried on with the commercial world.

II. EXPERIMENTAL AND COMMERCIAL ACTIVITIES.

1. *Section of Wood Technology.*

Dr. Brown, who recently joined the Forest Research Institute as Wood Technologist is about to prepare keys based on gross and microscopic features for the identification of our more common commercial timbers, and his laboratory is now being fitted up. It is hoped at the end of the forthcoming year that it will be possible to report substantial progress in this most important Section of our work. The only work in connection with Wood Technology that has been carried out in the absence of a Specialist has been the identification of timber as they have come to hand from various enquirers.

Semi-Portable Timber Seasoning Kiln for softwood boards—particularly tea box shooks. This class of timber ordinarily is damaged severely during natural seasoning because of decay, mould and insects, but may be kiln seasoned without damage in 3 to 5 days' time.



Photo I. A kiln similar to the above has a capacity of approximately 8 tons of box shooks or 2 tons output per day, and may be built for Rs. 5,000 exclusive of the power plant. Its greatest usefulness is probably in connection with small semi-portable saw mills operating in the jungle.



Photo II. Showing the internal arrangement as to piling, steam heating coils, and air ducts for the uniform circulation of air within the kiln. The temperature, humidity and circulation of air must be carefully controlled and regulated to obtain good results.

2. Section of Timber Seasoning.

The Officer in Charge, Timber Seasoning, was very fully occupied during the year in spite of the fact that his seven drying kilns are not yet sufficiently advanced in construction to permit of erecting the internal machinery connected with these plants. He spent three months at Bareilly, putting the seasoning kilns of the Wood Working Institute into working order, training two kiln operators and seasoning some 5,000 specimens of timber to be tested for cotton bobbins. In April 1921, he was sent, at the request of the Chief Engineer, New Delhi, to enquire into and submit a report on the seasoning of timber being used in the construction of the buildings at Raisina, and the result of this report is likely to have far reaching effects. As an outcome of an enquiry from Bengal concerning the seasoning of tea-box woods a temporary semi-portable kiln was erected at the Central Institute in which to carry out the necessary experiments. This kiln was also erected with a view of demonstrating the uses, possibilities and limitations of such kilns to the officers attending the Utilization Conference. The results obtained in this kiln with soft woods were highly satisfactory. Mr. Sweet made an extensive tour in the United Provinces, Madras and Coorg to check the results of the natural seasoning experiments which had been in progress during the last two years and has since been engaged in writing up the results, his report will shortly be submitted.

At the request of the Director of Ordnance Mr. Sweet paid a visit to the Jubbulpore Gun Carriage Factory and carried out a preliminary investigation in connection with the seasoning of their timbers which has resulted in a project being submitted to the military authorities making proposals for a more detailed enquiry into the subject.

The work already carried out by the Officer in Charge Seasoning has led to a number of enquiries being made both by officers of the Forest Department and by timber users, and it may be said that a very satisfactory start has been made with this most important branch of research.

3. Section of Timber Testing.

The Officer in Charge, Timber Testing, began his work during the year under report by the erection of four testing machines in the old workshops. This took up a considerable amount of time, as it was found that, due to the alternating form of electric current available in Dehra, new speed gears had to be designed and procured, while as soon as the machines were erected they had to be carefully calibrated and all the instruments connected with timber testing had also to be calibrated and verified. While this work was in progress the Officer in Charge also drew up a complete programme of work which laid down the exact lines on which all routine tests

should be carried out, and which, with minor modifications, eventually received the sanction of the Inspector General of Forests. This scheme of working will in future be known as Project I, of this branch of the Forest Research Institute. As soon as the machines were in running order the first series of tests were carried out on behalf of the Punjab Government to ascertain the relative value of the red and white wood of spruce which resulted in clearly demonstrating that the red wood was equally as strong as the white and could therefore be used, after treatment, for railway sleepers. The next set of tests carried out was for the Utilization Circle, Bareilly, who had prepared a number of hammer shaft woods of various species which it was hoped might be suitable substitutes for imported handles. The tests conclusively proved that the Indian substitutes were in every way suitable for the purpose. Conjointly with carrying out hammer shaft tests, routine tests according to Project I were carried out on green Malabar and Central Provinces teak, while the Burma variety will be taken up as soon as it comes to hand. The tests according to Project I on *Terminalia tomentosa* have also been started and will be continued until complete. The next series of tests carried out were for a firm in Calcutta on plugs for concrete sleepers in order to determine suitable woods for the purpose and *Acacia arabica* was found to answer the purpose fairly well. Following the spike pulling tests on plugs, similar tests were carried out on silver fir and deodar sleepers in order to compare the relative value of the former with a timber of standard species. Again, another series of spike pulling tests were carried out on *pyinkado*, *Xylia dolabriformis*, at the special request of the Agent of the Burma Railway. At the request of the Madras Government a series of strength tests were carried out on four species and the results will shortly be submitted. Towards the close of the year the Burma Oil Company asked for tests to be carried out with a view of finding substitutes for hickory used for Sucker Rods in oil wells, and an extensive enquiry is in progress.

The total number of tests carried out during the year were as follows—

Spike Pulling Tests on 7 species	159
Project O on 11 species—	
1. Mechanical Tests	1,545
2. Physical Tests	1,274
Project I on 4 species—	
1. Mechanical Tests	945
2. Physical Tests	1,031
Total Mechanical and Physical Tests	4,795
Spike Pulling Tests	159
GRAND TOTAL	4,954

It can briefly be said that the results of the tests carried out during the first year of working have more than justified the engagement of a specialist for timber testing and the purchase of several expensive testing machine. To take one example, the very first tests carried out on red and white wood of spruce proved that red wood could be used as well as white wood for sleepers, thus allowing the Punjab Government to supply nearly 50 per cent. more sleepers of that species for treatment to Indian Railways.

4. Section of Minor Forest Products.

Satisfactory progress was made in consolidating the work of this section and at the same time the preliminary detailed work in connection with the forthcoming Empire Exhibition was carried out. In order that the Officer in Charge, Minor Forest Products, when starting the section should have as wide a knowledge as possible of all conditions in various parts of India and also to enable him to make the preliminary arrangements with the local Forest Officers in the various provinces in connection with the Empire Exhibition, he proceeded on tour early in November and visited Bengal, Assam, Bihar and Orissa, Burma, the Andamans, Madras, Bombay and the Central Provinces.

The question of utilizing *Boswellia serrata* gum-oleo-resin has been under consideration and experiment for a number of years, and during his tour the Officer in Charge, Minor Forest Products, took steps to develop the industry in the various provinces and it is thought has succeeded in developing an export trade in the raw material until such time as a start may be made to refine it in India. As regards the progress of the enquiry it may be said that negotiations for a lease by a firm are in progress in the Bombay Presidency, while the erection of a solvent plant to deal with the separation of gum-rosin and turpentine is now being erected by the Gwalior Durbar, the results of which will be watched with interest.

Experiments are in progress for tapping gums of the *bossora* or *tragacanth* series and much attention has been paid to this subject during the year under review. Another enquiry which may lead to important results is in connection with the leaves and bark of *Vitex peduncularis*; correctly identified material has been distributed by the Medical Research Department with which the Minor Forest Products Officer is working in collaboration.

Other enquiries in connection with local fibres, as substitutes for imported material used by Indian brush factories, have been in progress, while the work on Copals, in which considerable interest is taken, has been much delayed due to want of staff both in the Minor Forest Products Section and the Chemical Branch.

A trade index is being prepared and is making satisfactory progress. Mr. Robertson, the Officer in Charge of this Section, has

rendered much assistance to the writer especially during the time when the Assistant Forest Economist had to be temporarily lent for instructional duties.

5. *Section of Wood Utilization.*

Owing to the workshops and testing laboratories not being in full working order the number of experiments carried out with the object of finding new uses for timbers, or substitutes for imported wood, were confined during the year under report to an extensive enquiry in connection with possible bobbin woods from Madras. The timber was sent in the log to the Utilization Circle, Barcilly, where it was converted into rough bobbin pieces and seasoned in steam kilns by the Officer in Charge, Seasoning, and then sent to England to one of the biggest bobbin factories to be tested. The report on these woods is now awaited. Similarly a number of Madras woods were sent to the Utilization Circle, United Provinces, where they were converted, seasoned and tested for casks of which, however, only one or two showed any promise at all.

A large number of enquiries were received from firms as to woods suitable for a variety of purposes and information was supplied wherever possible from experience gained from former experiments. Until we have our Sections of Wood Technology, Timber Testing, and Seasoning fully organised and their laboratories and workshops complete, we shall not be in a position to give the best information possible to enquirers who seek information as to suitable woods for special purposes.

6. *Section of Wood Preservation.*

In the absence of a Wood Preservation Specialist neither was the experimental pressure plant erected nor were any new experiments inaugurated. On the other hand the annual inspection was made of the experimental sleepers laid in open lines in order to determine the durability of various Indian timbers after treatment, and in this connection inspections of experimental sleepers were carried out in Burma, and near Lucknow, Hardwar, Quetta, Ferozepore and Sukkur. These experiments have now been in progress for ten years and may be said to have given very satisfactory results to date. The writer attended a meeting of all the Chief Engineers of Indian Railways at Simla, when the whole subject of treatment of sleepers was very fully discussed and, after the results of the above mentioned experiments had been fully explained, a resolution was passed by the conference advocating the erection of treating plants at all suitable centres in India. Results of the experiments may therefore be said to be gratifying. The North-Western Railway authorities, as a result of our experiments, are erecting a large creosoting plant, while

at least three other Railways in India have similar projects under consideration.

Two comprehensive notes on the results of these experiments have been prepared, one of which will be issued as a Forest Record and the other, drawn up at the request of the Chief Engineer of the Railway Board, will be published as a technical report by the Railways. The urgency of obtaining the services of a whole-time man to deal with this subject becomes daily more apparent.

7. Section of Paper Pulp.

The experimental pulp and paper plant which was ordered by Mr. Raitt, while on deputation in England, came to hand during the year, with the exception of a portion of the paper making machinery which is shortly expected to arrive in Dehra Dun. This plant has been checked and carefully housed.

Enquiries received on the subject of supposed deterioration of *sabai* grass for the manufacture of paper pulp have led to a series of laboratory experiments being carried out to verify these assumptions and also with the object of improving the present methods of treatment in order to increase the yield and to reduce the amount of bleach necessary.

An enquiry was carried out at the instigation of the Bihar and Orissa Government as to the possibilities of working bamboos for pulp in the Angul, Sambalpur and Singhbhum Divisions of that province and the Officer in Charge, Paper Pulp Section, carried out a tour in that locality with the object of determining the principal factors governing the possibility of starting such an industry. The enquiry is now pending a field survey as to outturn, which is being carried out by the local officers.

At the request of the Superintendent of Jails in the two provinces of Bihar and Orissa and Central Provinces, the Officer in Charge, Paper Pulp, carried out an enquiry as to improvement in the methods adopted in the manufacture of hand made paper in the Central Jails and a report with recommendations was submitted on the subject.

The year under report has been signalized by an increased number of enquiries as to possibilities of starting pulp and paper factories in various localities. Schemes are under contemplation in Western and Southern India, in Gujrat and the Nerbada territories, in Chittagong and in the United Provinces.

8. Section of Tans.

The Officer in Charge Tans has been working in Burma throughout the year and has carried out a survey of chestnut and oak barks leaves and woods in the neighbourhood of Maymyo and is about to

prepare an exhaustive report on the subject. He has also carried out a considerable number of tests on various *Dipterocarps* and *Terminalias*, and on completion of which work he will proceed to Mergui in the Tenasserim Circle to carry out a survey of the mangroves in that locality.

Mr. Pilgrim was on leave during a part of the year, which somewhat curtailed his activities, on the other hand he made arrangement for routine tests to be carried out by Mr. Pasupati, his assistant, and also has collected large samples of tan stuffs of a variety of species with which to tan specimen hides for the 1924 Empire Exhibition.

9. Sub-Section of Wood Working.

As soon as a Wood Worker was appointed from England, arrangements were made for the erection of some of the wood working machinery which had come to hand, but as the temporary sheds available were hardly sufficient even to take a portion of the machinery an extension had to be made of a quite temporary nature in order to allow any work at all to be carried out. It should be mentioned that the crection of these machines as they now stand is only a temporary measure, aiming at employing the available staff and especially directed towards training machinists before we move over into the new buildings.

In spite of the very cramped space available, a great deal of useful work has been carried out during the year as no less than 280 orders placed by the various Branch and Sectional Officers have been executed. At the same time a very good nucleus staff has been trained in handling the various machines.

Of the more important work carried out the following may be mentioned :—

Erection of a temporary seasoning kiln, of temporary godowns, shingling the existing workshops, partly as an experimental measure and partly to reduce the heat under the galvanized iron roofing.

Of articles prepared and which entailed considerable work the following may be mentioned :—

12 filing cabinets for various Branch and Sectional Officers.

3,000 specimens for Timber Testing.

450 air-tight insect specimen boxes for the Forest Entomologist.

4 book cases, two for the Forest Chemist and two for the Library.

Complete internal fittings for the Timber Testing shops including four large almirahs :—

4 special cabinets for the Botanist.

4½ dozen plotting boards for the Silviculturist.

6 special callipers for Working Plans Officer, Bihar and Orissa.

The above is sufficient to show the variety and extent of the work carried out by the Wood Working Sub-Section and it may further be stated that after careful checking of cost of production the costs work out to about 50 per cent. less than when the same work is given out on contract.

The Wood Museums and Minor Forest Products Collections were kept up to date and added to during the year, though it is not possible now to make very large additions until the new museums are built as the accommodation available is insufficient.

Bengal.

Mechanical Extraction and Conversion at Sukna, Kurseong Division.—The operations which have been started in the Sukna sal working Circle to determine the possibilities and value of mechanical extraction in small clear felled coupes in the flat foot-hill forests of North Bengal, were continued during the 1921-22 season.

The area cleared was one of only 25 acres and extraction could not commence until January, owing to delay by the railway company in extending the line into the new coupe. As mentioned in last year's report, the D. H. Railway has laid and extends and maintains this forest spur from the Sukna station, free of charge to the Department, in consideration of the freight earned on the transport of sal logs to Siliguri, 7 miles distant, and box planking and fuelwood to tea gardens in the hill sections of the railway.

The improvised skidder was run from January 14th until the end of March and achieved the results given below, which show that even in such small coupes distinct advantages arise from the use of mechanical means of extraction. The difficulties experienced were due to the fact that the machine and tackle are old, are not designed for and are not strong enough for the heavy work (most of the logs are 32' in length and many weigh more than a ton); the machine has only one cable drum and the cable has to be hauled out by a coolie gang to the logs. Shortage of water, insufficiency and lack of skilled labour in the district and irregular supply of log cars, owing to the railway strike, seriously interfered with the work and prevented a fair test being made. The results were :—

No. of logging days from January 14th to March	
29th	60
	c. ft.
Volume of logs hauled in and loaded on cars ..	10426
Volume of logs hauled in but not loaded ..	5914
Average Volume of logs hauled in and loaded per	223.5
diem.	

The value of the plant in use during this half season's work was Rs. 6,032 and the daily labour bill for the engine man and 11

coolies was Rs. 5-13-0, the total cost of extraction being made up as follows :—

	Rs.	A.	P.
1. Felling, dressing and log making ...	0	1	0 per c. ft. log.
2. Labour cost of hauling in and loading ...	0	0	5
3. Depreciation and maintenance (20 per cent. per annum).	0	0	8·3
4. Railway freight to Siliguri station ...	0	2	3
Total cost from Tree Stump to Siliguri station ..	0	4	4·3
5. Additional freight from station to log depôt ..	0	0	2
6. Unloading by hand in Siliguri log depôt ...	0	0	6
Total cost delivered in Siliguri log depôt ...	0	5	0·3

The cost of felling, dressing and carting from Sukna to Siliguri by road is 6 annas per c. ft. of log, so that a saving of from 1.5 to 1 anna per c. ft. results from the employment of mechanical methods. In addition there is the enhanced value of the large logs handled ; the value of a 32' log in Siliguri depôt is Rs. 2-8-0 per c. ft., whereas for logs of a size which can be man handled and carried on bullock carts it averages only Rs. 1-10-0 per c. ft. Furthermore the difficulty in securing a regular and sufficient supply of carts to remove all the sal felled in these coupes, is overcome.

Tree tops, branches and debris from the felled area were prepared for fuelwood by hand ; it was loaded into large bogie cars by coolies and despatched to tea gardens in the hills. The demand for fuelwood is considerable and this branch of the utilisation work resulted in a clear profit to the Department, besides the usual royalty, of Rs. 1-12-3 per 100 c. ft. of stacked wood.

The small American portable saw mill was not run before April 1922 owing to a shortage of labour, but during 23 working days in that month 21,000 sq. ft. of half inch planking and 150 c. ft. of seasoning sticks were sawn from 274 logs of 2,050 c. ft. volume. Difficulties due to insufficient equipment, delay in obtaining spares, lack of skilled labour and irregular supply of water and logs arose but the output in a working day of 7 hours averaged 1,000 sq. ft. and on occasions exceeded 1,500 sq. ft. The daily labour cost of 1 fitter and 14 coolies amounted to Rs. 8-11-0 and the labour cost of sawing the planking was Rs. 9-8-0 per 1,000 sq. ft., compared with Rs. 28 which had to be paid for hand sawing in this district. The trial shewed what additional plant and alterations are necessary to the mill to reduce the crew, decrease the number of delays and assure a daily output of from 1,500 to 2,000 sq. ft. During next season it is hoped, with the additional plant, to run the mill continuously from October to May, with an average output of 1,500—2,000 sq. feet a day for 200 days. The mill will then convert the whole of the softwoods felled in the coupe, it will enable the full royalty rates to be realised and will give a clear profit of from Rs. 1,600 to Rs. 3,600 for the season. Handsawing at Sukna is expensive and there are insufficient sawyers to convert the whole of the softwoods felled into planking

with a market value. The high rate (Rs. 28 per 1,000 sq. ft.) for handsawing and the high wastage would not allow the full royalty rates being realised on what timber could be converted and there would be no clear profit to the Forest Department. The demand for tea box and orange box planking in the district is considerable and a market can readily be found for the output from several mills similar to that at Sukna.

Bihar and Orissa.

The only research work carried out in Hazaribagh Division during the year 1921-22 was the tapping of *salai* (*Boswellia serrata*) for resin. As the work will not be finished until the rains, no statement can as yet be made regarding its prospects. So far the flow of resin has been below expectations (2½ maunds collected to date) but this is due to the fact that the trees which yielded poorly were not eliminated after the first few freshings. One thousand selected trees were tapped and freshed every 4 or 5 days. It was largely with the object of collecting further data of the yield that all the trees were freshed whether their yield was good or bad. When working is commenced on a commercial scale it will of course be necessary to eliminate all trees which yield poorly after the third or fourth freshing.

Tapping of *Stereulia urens* in Angul Division. At present experiments are in progress in order to ascertain—

1. Best method of tapping.
2. Effect of tapping.
3. Cost of extraction and outturn.
4. Most favourable season.

The experiments were started in September 1921 with 7 trees.

The following methods of tapping were tried :—

1. Puncturing of bark in narrow slits.
 - (a) Slits cut parallel to the axis of the tree.
 - (b) Slits cut perpendicular to the axis of the tree.

2. Removal of bark to different depths varying from $\frac{1}{4}$ th of an inch to about 1" or to the cambium layer.

3. French method of tapping pine for resin.

It can be safely said from observation during this period that the first and third methods can be discarded. It should be mentioned that gum has been seen exuding in the form of what may be termed "tears" from slight cracks. Though the colour of the gum thus exuding is pure white, the quantity is insignificant and hence of no use commercially. Horizontal or oblique slits give more gum than vertical slits.

Description of Method No. 2.

The only tool used was that of a carpenter's chisel. Several parallel oblique slits are cut with the chisel. A slit is about $1\frac{1}{4}$ " broad at the top and narrows down to a fraction of an inch at the bottom. The length of a slit depends upon the girth of the tree, that is, the bigger the girth, the longer the slits will be.

It has been observed that this method gives the largest quantity of white gum.

Gum has been collected and sent to an interested firm and to the Forest Economist, Dehra Dun.

It has been graded as follows :—

1. White or nearly so.
2. Brown, and possibly into a third grade of dark gum.

It is interesting to note that gum which may be pure white at the time of collection turns pale yellow if left for a few days. Collections were made at various times, that is, a few days after tapping when there has been no rain during the interval and also when there has been rain. Gum in the latter case was discoloured brown on the tree, while it remained white or nearly so in the former case. The Forest Economist to whom both these samples were forwarded was inclined to think that "the brown discolouration is probably due to tannin from the bark passing in solution into the gum and undergoing oxidation there." The writer is of the same opinion. Samples have been forwarded to the Indian Institute of Science for examination.

It is interesting to note that exudation starts immediately after the slit has been cut into the tree.

No definite opinion can be given yet as regards the effect of tapping on the tree, the cost, and outturn per tree. Experiments are in progress in order to ascertain these points. As soon as these data are complete a report will be prepared.

It may, however, be useful to indicate briefly the lines on which the experiments are going on. Ninety (90) trees have been tapped as explained under method No. 2, girth of each tree tapped been noted. The trees have been divided into three lots. Collection from one lot will be made every fifth day, from the other every eighth day and from the third every tenth day. All the trees are serially numbered. Gum collected from each tree is weighed and entered against the particular tree. Weighing and entering in specially prepared tabular forms is done by the office. Slits on half of the trees of each lot will be freshened after collection while on the other half the slits will be left unrefreshed. This experiment will be carried out throughout the year and it is hoped by then to collect sufficient data to achieve the purpose aimed at.

Burma.

(1) *General working of administration.*—The remarks under this head deal with administration only in so far as economic research and experiments are affected and not with the general administration of the Circle.

During the year under report progress was made with constructional work and proposals were submitted for a new division under the Utilization Circle to be known as the Timber Research Division. Sanction had however not been accorded at the close of the year. These proposals arose out of the visit and subsequent report made by Mr. Pearson, Forest Economist, Dehra Dun, who visited Burma to advise on the subject. His full report has been submitted to the Local Government in connection with the plans and estimates of buildings, etc. at the Forest Depôt, but summarised his recommendations, (which have been accepted by the Forest Department and recommended to Government) are as follows :—

- (1) An extension of the existing saw-mill to make it capable of an output of about 10 tons a day.
- (2) Seasoning experiments in the Tieman dry kiln.
- (3) Extensive natural seasoning experiments in sheds.
- (4) General woodworking workshop.

Mr. Teesdale, the Timber Seasoning Expert, will be in charge of the seasoning experiments and proposals for a suitable staff to assist him in his work have been submitted. Mr. Watson, one of the newly appointed Forest Engineers who has had considerable experience of sawmill practice, arrived on December the 16th 1921, and, since the departure of Mr. Craddock on leave on medical certificate, has been in charge of the sawmill work and will be placed in charge of the Timber Research Division when sanctioned. For the woodworking workshop Mr. A. Cogger was engaged last year and arrived in Burma on July the 2nd, 1922. A nucleus of the ultimate staff required for the Timber Research Division has thus already been got together and as soon as the sanction of the Local Government has been obtained to the formation of the Division, and to the plans and estimates for the buildings and machinery required, steps will be taken to recruit the necessary subordinate staff in each section and to push on with the erection of the buildings and machinery. Much of the latter has already arrived, though some few items still remain to be purchased. This will give effect to Mr. Pearson's recommendations which, as remarked above, have been unanimously accepted by the Forest Department. At this stage it is not considered that any further remarks concerning the general work of administration can usefully be made.

(2) *Experimental activities.* (i) *Wood Technology.*—Nothing has been done in the year under report.

(ii) *Timber Seasoning.*—One shed has already been built and the others recommended by Mr. Pearson will be put in hand as

soon as sanction is received. A good deal of timber of various species had been collected for shipment to Europe but when Mr. Alexander Howard visited Burma in January last he recommended that as some of it had deteriorated considerably it would be advisable to convert these logs at once and this was done, the conversions being carefully graded into those suitable for shipment to Europe and those only suitable for local sale. Both qualities were carefully stacked in the seasoning shed and were kept under the continuous inspection of Mr. Teesdale who took specimens from time to time to test the moisture content. The experiment is still in its infancy and it must be borne in mind that the logs from which the conversions were made had already been seasoned in the open air for some considerable time. The results so far have been quite satisfactory and the planks showed little tendency to split or crack. Whilst none were bad the most promising results were obtained from *thitsi* (*Melanorrhoea usitata*) which gave evidence that it would dry very well under cover without splitting or cracking. Other timbers converted were *thitkado* (*Cedrela Toona*), *thitka* (*Pentace burmanica*), *yemane* (*Gmelina arborea*), *kaunghmu* (*Parashorea stellata*), *padauk* (*Pterocarpus macrocarpus*) and *yindaik* (*Dalbergia cultrata*).

3. *Timber Testing*.—Nothing was done in this direction and on Mr. Pearson's advice the 100,000 lb. testing machine has been transferred to Dehra Dun where it will be utilised primarily for such tests of Burma timbers as may from time to time be asked for by this province. The 50,000 lb. machine has been retained for use by Mr. Teesdale in connection with his seasoning experiments but it is not now intended that extensive testing experiments shall be conducted in Burma as it has been pointed out that this can be better done at Dehra Dun.

4. *Wood Preservation*.—There are no schemes at present under consideration for the preservation of wood by impregnation as a Government enterprise. It is possible that this may be undertaken later when the Timber Research Division has developed further. Messrs. A. V. Joseph & Co. have erected an open tank plant for the creosoting of sleepers but it has not yet been in operation for very long and results are still awaited.

5. *Minor Forest Products*.—There do not appear to be any records in this office of any activities during the year under report in this Circle. The Delta Circle reports that samples of fibre of *thinban* (*Hibiscus tiliaceus*) were sent to Calcutta for testing by a firm interested in rope making but were reported as useless.

6. *Paper Pulp*.—In last year's Annual Report it was noted that concessions had been granted to 5 firms for the manufacture of paper pulp : of these, Messrs. Heilgers, in the Pegu District, have not commenced work, partly owing to the general depression in trade and partly owing to the area finally allotted to them not

proving in all respects satisfactory: Messrs. Jamal Bros' mill which was never very satisfactory was destroyed by fire and up to date work has not been recommended: Messrs. Hockley and Manning were unable to commence work in Tavoy and applied for a further extension of their option which has been granted.

As regards the two concessions in Arracan neither of the concessionaires started work and it is understood that both have been given a time limit in which to commence work or give up the concession. The Conservator, Delta Circle, states that in his opinion neither is likely to undertake operations. The position therefore with regard to paper pulp is that no firm is at the present moment working in the province.

7. *Tans*—It appears improbable that any commercial results will be obtained from the use of the various species of *Cassia*, experiments with which were inaugurated during the war.

8. *Wood-working*.—Nothing has been and nothing can be done until the woodworking shop is completed and is in operation. It is then intended to experiment with any timbers which may appear to possess the desired qualities in the manufacture of tool handles, turned articles, furniture, panelling, flooring blocks, etc. At the outset samples only will be produced in fair quantities and it is intended to distribute these to firms and individuals likely to be interested with a view to their being tested. When a suitable timber is found for any purpose, commercial samples will be manufactured in fair quantity and if the experiment is so far successful that these are approved by the trade, the timber will then be widely advertised and private enterprise invited for its exploitation.

9. *Miscellaneous*.—The Forest Museum at Rangoon was open to the public until about the middle of March, when notice was given that the building in which it was housed would have to be dismantled owing to the operations of the Rangoon Development Trust. The Museum was in consequence closed, the more fragile exhibits being transferred to the office of the Conservator where they are on view and available for study by persons wishing to see any particular article. Being in the office however, the collection is not at the moment available for inspection by the general public. The heavy timber specimens have been temporarily stored and up to the time of writing it has not been found possible to rent a suitable building for the reopening of the Museum. As it is intended to erect a small exhibition room in connection with the wood-working section of the Timber Research Division it is probable that when the building is erected the collection of the Museum exhibits will be placed on exhibition there, pending the erection by the Development Trust of a Provincial Museum which is to contain a forest section and which will ultimately house the Forest Museum collections. The temporary closing of the Museum is much to be regretted as it had attracted a large number of visitors and appeared to be fulfilling a useful purpose.

Central Provinces.

Timber Seasoning.—Sufficient experience has now been gained to show that teak, *haldu* (*Adina cordifolia*), *tiwas* (*Ougeinia dalbergioides*), and *bija* (*Pterocarpus Marsupium* will not season here in the log and consequently all departmental operations are now being so arranged that logs reach railhead as speedily as possible after felling. This saves considerable loss from splitting which is otherwise very serious in this locality where rapid changes in air humidity are frequent.

Timber Testing.—Five teak logs were despatched to Dehra Dun in October 1921 for testing by the Forest Economist's branch.

Minor Forest Products.—7½ seers of gum *karaya* (i.e. the gum of *Sterculia urens*) were collected departmentally and despatched to Messrs. Gillanders Arbuthnot, Calcutta, for report as to whether the gum is suitable for the American palate.

(a) The department has throughout the year supplied ebony (*Diospyros Melanoxylon*) and *karai* (*Saccopetalum tomentosum*) to a billiard firm for the construction of cues.

(b) Specimens of timbers likely to be useful as dipping rods were sent to the Deputy Director of Industries, and to the Excise Commissioner, United Provinces.

Experiments in tapping *bija* trees for gum were started at Turwar, North Mandla Division. What is expected to prove a successful method of tapping which should not damage the trees has been experimented with.

Punjab.

Increased office work owing to attempts to increase inland and export trade, preparation for and erection of the second resin plant at Jallo, and extra work in connection with the transfer of the factory to the co-partnership scheme, have prevented any serious experimental work being done at the Jallo Resin Factory.

As mentioned last year the spruce red wood has been under investigation as regards its qualities and has been proved at Dehra Dun to be slightly stronger than the spruce white wood. In the Bashahr Timber Division spruce red wood sleepers are now being cut. They will be dried in the forest for one year and then floated to the depots; but owing to the fall in the value of spruce timber, it is doubtful if this will pay financially in the near future.

The result of seasoning experiments carried out in the Kangra Forest Division with *ohi* (*Albizzia stipulata*) timber have been reported by the Divisional Forest Officer to the Forest Economist in detail. Seasoning in the log and by girdling trees both seem unsatisfactory; apart from damage by insects scantlings subsequently sawn show a great tendency to warp and split. Green

conversion followed by 3 months seasoning under water and 21 months under cover resulted in the least damage from insects, but green conversion followed by 2 years seasoning piled horizontally and under cover seems to give sufficiently satisfactory results all round.

United Provinces.

UTILISATION.

I.—General work of Administration.

With few exceptions utilisation work in the United Provinces is centralised in the activities of the Utilisation Circle, of which the main object is briefly to act as a sales agency or connecting link between the territorial circles and the consumers of United Provinces forest produce. To further this object a new Timber Supply Division was inaugurated at the commencement of the year, the success of which has been a marked feature of the year and the assistance given by it to territorial divisions has undoubtedly had a material effect on the Forest Revenue of the Province. The factories initiated prior to the year under review have been maintained.

At the Wood Working Institute, Bareilly, experimental work on the uses of new timbers and their commercial possibilities has been continued, side by side with the educational work of training Indian labour in all branches of wood work and the use of wood working machinery.

In spite of general trade depression the Government Turpentine and Rosin Factory, Clutterbuckganj, has continued to prove a sound commercial undertaking. The successful maintenance of the Rosin Industry is of great and increasing importance, not merely to India, but to the Empire as a whole, as has been emphasised by the Imperial Institute Trade Enquiry on Gums, Resins and Essential Oils.

• The Government Sawmill and Turnery, Clutterbuckganj, is now concentrating almost entirely on the manufacture of bobbins, a marked improvement in the quality of goods manufactured has been attained during the year and Bareilly Bobbins now compare very favourably with imported English Bobbins.

II.—Experimental and Commercial Activities.

Timber Seasoning.—After alterations to the seasoning kiln in the Wood Working Institute, operations commenced in August 1921. Experimental work on 32 species was carried out, and commercial work on 8 species, in particular *Dalbergia Sissoo*, *Cedrela Toona*, and *Terminalia tomentosa*. Results have been generally satisfactory.

For special purposes such as cabinet making, panelling, etc., kiln-seasoned timber possesses undoubted advantages over naturally seasoned timber. Commercial enquiries for kiln seasoned planks of *Dalbergia Sissoo* for furniture making have already been received.

Minor Forest Products. (a) *Resin.*—The manufacture of Rosin and Turpentine from the resin of the *Pinus longifolia* of Kumaun has been continued at the Government Turpentine and Rosin Factory, Clutterbuckganj, and in spite of general trade depression results have been satisfactory. New distillation plant has been introduced to effect improvement in manufacture. The question of more rapid transport of resin from forest to factory, to reduce deterioration, is receiving consideration. A successful experiment was made to test the possibility of floating crude resin in receptacles hollowed out from billets of *Bombax malabaricum* and further experiments will be made.

(b) *Khas Khas roots.*—A trial consignment from Gorakhpur was sent to Messrs. Forest Products, Ltd., Cawnpore, for distillation of Vetivera oil. Owing to scarcity of the grass and high cost of collection, however, there is no prospect of success attending its exploitation from this division.

(c) *Earth Colours.*—(Red, yellow and white ochre) were extracted from the Donda Mine in South Banda Range and sent to the Forest Research Institute and other places for analysis and valuation.

(d) *Tufa Lime.*—Deposits were located in South Banda Range and it is estimated that these will yield several lakhs of maunds of a very high quality lime. They are to be worked on a long lease.

(e) *Lignite (coal).*—A sample piece from Saharanpur division was sent for analysis by Director General of Geological Survey of India and was said to be very valuable for briquettes and coke. Further investigations are in progress.

(f) *Lac.*—With a view to introducing the propagation of Lac in Jhansi division, the Divisional Forest Officer was deputed to study methods employed in the Central Provinces and a start has been made by Government in Jhansi Division since the close of the year.

Wood Working. (a) *Turnery.*—Bobbins have been manufactured on a commercial scale in the Government Turnery, Clutterbuckganj. The quality has been improved and markets are increasing, the timber mainly used is *Adina cordifolia* at present, and this will probably be supplemented by *Holoptelea integrifolia* which has also proved very suitable. For solid turnery *Anogeissus latifolia*, *Terminalia tomentosa*, and *Shorea robusta* have been found satisfactory. Experimental turnery work with new timbers is being continued at the Wood Working Institute.

(b) *Cooperage.*—Experiments have been carried out in the Wood Working Institute with 15 species and of these available in

United Provinces, *Shorea robusta* and *Quercus dilatata* were most satisfactory.

These two species appear very suitable for beer casks and are at present being tested by a brewery firm.

(c) Furniture making continues to be one of the main activities of the Wood Working Institute and has proved very remunerative. In addition to the recognised furniture timbers, experimental work has been undertaken with a view to placing *Terminalia tomentosa* on the market for high class panelling and furniture work.

(d) *Miscellaneous Wood Work*.—Experimental work on picture frame mouldings has been carried out and a full range of such in various timbers will shortly be placed on the market ; it is understood that hitherto supplies have been mostly imported from America. Stocks of *Adina cordifolia* and *Terminalia tomentosa* were specially seasoned and cut into blocks for flooring which will shortly be laid as test pieces. Wood wool has been supplied to the fruit trade also standard box shooks for fruit packing. Police batons in *Terminalia tomentosa* were made and supplied to the Police Department. Cotton reels in *Holoptelea integrifolia* and *Adina cordifolia* were made and submitted as samples. Small handles and cheap bed legs have been turned out satisfactorily from small poles of *Dalbergia Sissoo*.

(e) *Match manufacturing*.—A sample log of *Odina Wodier* was sent from Dehra Dun Division to a firm in Cawnpore at their request and was found suitable for matches.

Miscellaneous. (a) Glue tests.—Eleven hundred and fifty glueing tests were carried out in the Wood Working Institute in collaboration with the Forest Research Institute giving most valuable and definite results, Casein glues in particular proved very reliable.

(b) *Railway Sleepers*.—Much valuable work has been done by the Timber Supply Division in improving the organisation for disposal of railway sleepers to the various railways. As a result a considerably larger number of sleepers than usual of *Shorea robusta* have been sawn and disposed of this year. Efforts have also been made to introduce M. G. sleepers of *Terminalia tomentosa*.

(c) *Pit Props*.—A sample load of poles of *Shorea robusta* has been sent to a Colliery Company for testing pit props and the report as to their suitability is awaited.

CHAPTER V.

FOREST ENTOMOLOGY.

Central Institute.

INSECTS OF SAL :—*Borers*.—(a) Enumerations were continued in the forests infested by *Hoplocerambyx spinicornis* to obtain comparison of the annual attack, as affected by climatic conditions and control measures. In the 1921 season the number of trees attacked

is estimated at 6,000, (i.e., 24 per cent. of the attack in the heaviest year) ; the rainfall was 117 inches, (i.e., 34 inches above normal). The rise in the total annual rainfall showed its expected effect by an increased mortality of the attacked trees, but the actual number of deaths in the seven compartments used as sample plots in 1921, was 30 per cent. of the number in 1917, a year with approximately the same rainfall. The reduction is considered to be due to the control measures initiated in 1920-21. Under all conditions of rainfall the distribution of attack is fairly uniform throughout the various girth-classes. A group of compartments was burned over by the divisional officer as a subsidiary control experiment ; the resulting attack was higher in this area than in the neighbourhood.

(b) The Insectary experiments on the correlation of rainfall and periodic emergence of the beetle were repeated, and confirmation obtained of previous results. The survival and successful emergence of the borer in sleepers, beams, rafters, slabs, etc., was demonstrated.

(c) In the Laboratory the life, fecundity, and oviposition of the beetle and the incubation, and early development of the larva were studied under variable conditions of humidity. Dry conditions were found to be unfavourable in all cases and fatal below 60 per cent. relative humidity ; extreme wet conditions are less unfavourable but optimum conditions are those of high humidity, the limits of which are not yet determined.

(d) Further data have been collected on the life histories of other borers in particular of *Xylotrechus smeji* and *Sphaerotrypes siwalikensis*. In connection with the biology of the latter species a revision has been undertaken of the whole genus ; preliminary conclusions were published in Indian Forester, Volume XLVII, pages 514-518, " Bark beetles of the Genus Sphaerotrypes."

INSECTS OF TEAK :—(a) *The Beehole Borer*.—The preliminary note on the ecology and economic status of the beehole borer *Duomitus ceramicus* appeared during the year (Indian Forest Records, Volume VIII, Part III).

On October 17th, 1921, Mr. J. M. D. Mackenzie, I.F.S., was appointed to the post of Divisional Forest Entomologist to investigate the problem of the beehole borer, a programme of operations was drawn up and during October to December a tour was made with the Forest Zoologist in the Northern Shan States, North Toungoo, Insein and West Salween divisions, Burma. This officer reverted from the Research Institute strength to the provincial cadre on 29th January 1922, but continued on special enquiry, *vide* report of the Divisional Forest Entomologist in the Burma section of this Chapter.

(b) *Other Pests*.—A compilation of the available information on teak pests has been started, but completion of the work is postponed until Divisional Forest Entomologists are available.

MISCELLANEOUS PESTS :—The Shot-hole borers of the evergreens.

A tour was made in May and June 1921 in Sibsagar and Lakhimpur divisions, Assam, to study forest insects conditions in mixed evergreen forests. The dominant feature of the borer fauna of felled timber is the numerical superiority of the shothole borers (*Platypodidae* and *Xyleborinae*), which are rich in species of Malayan facies, the majority collected being new to India or undescribed. The species are markedly polyphagous, some apparently confined to natural orders, but most indiscriminate feeders. In the evergreens, trees like *Vatica lanceaefolia* and *Dipterocarpus pilosus*, are attacked in addition to the local series by almost all the species of shothole borers occurring in *Shorea robusta* in Bengal and North-West Assam. Passing into the drier dipterocarp forests with fewer tree species in admixture, e.g., sal or *indaing*, the shothole borer fauna grows sparse and species like *Diapus furtivus* and *Platypus solidus* (which in the moist evergreens are less abundant) become the dominant members of the association. For these reasons in an investigation directed to the control of shothole borers of valuable timbers in evergreen forest, one must consider also the unmarketable or weed species of trees, often the preferred hosts.

The borers of timber under seasoning.—Work was continued on the liability of timber under different methods of seasoning to attack by borers, and on the species of insects responsible for the various forms of damage. In collaboration with the Timber Seasoning Officer a summary of results has been prepared for the press. As far as the reduction of borer-damage is concerned empirical methods of investigation may for certain conditions give practical results, but for many species of timbers the prevention of insect-attack cannot be assured without specific determination of the optimum period for felling or girdling. In refractory cases, where seasoning in the unbarked log is essential, there are indications that by encouraging the attack of minor sap-wood borers immunity from damage by large heartwood borers can be secured.

The borers of living trees.—The general survey made on dead trees of the variety and extent of borer injury has yielded the unexpected information that the living tree is commonly subject to attack by insects of the beehole borer type, which damage the timber without seriously affecting the vitality of the tree. Recognition of this type of damage permits a correct appreciation of the value of empirical methods of seasoning.

Insect pests of Afforestation.—A tour was made in September 1921 in the Afforestation Division, U. P. to determine the pests of young *Acacia arabica*, *Dalbergia Sissoo*, etc. Plantations of this type do not appear to be subject to serious damage except under epidemic conditions, and this can be controlled by general principles.

The Parasites of Scale-insects and wood-borers.—Dr. Waterston's paper describing new species of Chalcidoidea parasites on pests of

chir, sal, tcon, sundri, etc., was issued after the close of the year as Indian Forest Record, Volume IX, Part II.

Insectary.—Some 1,200 specimens for the study of miscellaneous pests have been received in the Insectary during the year. Additions to the Museum are mainly examples of borer-damage to various timbers.

2. DIVISIONAL FOREST ENTOMOLOGIST.

(See under *Burma*).

3. SYSTEMATIC ENTOMOLOGIST.

Dr. M. Cameron, M.D., etc.

The Insect Collection.—The work in this section has resulted in the identification and addition of 672 species of insects not previously represented in the collection. Forty-three of these species are new to science, and are represented either by types or cotypes. The specialists assisting in identification work are Messrs. Andrewes, Arrow, Blair, Corporaal, Marshall, Fleutiaux, D'Orchymont, Kleine, Winn Sampson, for *Coloptera*; Morice, Waterston, Rohwer, Friese for *Hymenoptera*; Meyrick for *Microlepidoptera*; Fraser for *Odonata*; Brunnetti, Senior White, Ricardo for *Diptera* whilst promise of assistance is given by M. Esben-Petersen for *Neuroptera* and Prof. Silvestri for *Isoptera*. To these specialists 2,739 specimens were despatched during the year, of which 1,478 were named and returned. Dr. Cameron in addition to routine work in all groups has given special attention to *Rhynchota*, and to species of economic importance connected with investigations or departmental enquiries. Mr. Beeson has been working on the *Scolytidae*.

The accumulation of identified material has necessitated expansion and rearrangement of the collection on a large scale; for this purpose over 400 store boxes and 13 twenty drawer cabinets were acquired. In all 7,460 species are now accommodated, including 556 novelties out of the 672 recorded during the year, but a very large amount of named duplicates, and an unestimated mass of unnamed material remains to be dealt with, when funds are sanctioned for the purchase of store cabinets. The building up of the insect collection has made unprecedented progress since the establishment of this section, but future acceleration depends on the continued regular supply of store cabinets.

Publication.—The majority of the descriptions of new species have been published by their authors in the entomological literature of England, France and United States, but arrangements are being made for the issue of systematic work by foreign authors in the Records of the Research Institute.

Beeson, C. F. C.

The Beehole Borer of Teak (*Duomitus ceramicus*, Wlk.) Indian Forest Records,

- Beeson, C. F. C. Bark beetles of genus *Sphaerotrypes*,
Indian Forester.
- Beeson, C. F. C. Recent Work in Forest Entomology,
Proc. Fourth Entomological Meeting,
1921, pages 182-183.
- Beeson, C. F. C. Notes on the Imperial Entomological
Conference, London, *Loc. cit.*,
pages 383-386.
- Beeson, C. F. C. The Food Plants of Indian Forest Insects,
Part VI (*Scarabaeidae*) Indian
Forester, June 1921, pages 247-252.
- Mackenzie, J. M. D. Some notes on forest insect pests in
Burma, (*Indian Forester*, Volume
XLVII, pages 309-317).

Burma.

Mr. J. M. D. Mackenzie, Deputy Conservator of Forests, has been on special duty in connection with the investigation of the beehole borer in teak (*Duomitus ceramicus*, Wlk.). From October 17th 1921 to January 28th, 1922 ; he was attached as Divisional Forest Entomologist, Burma, to the Forest Research Institute, Dehra Dun, and from then to the end of the year, he reverted to the provincial cadre, and was placed on special duty, attached to the office of the Chief Conservator of Forests. On March 21st he went to Dehra Dun to work up the technique of the investigation at the Forest Research Institute, where there are specialists, collections, and literature available.

2. In the course of 5 months field work 1798 beeholes were found and mostly dated, in 292 trees ; the highest incidence found was 187, and 106.1 beeholes per tree per 100 years in Pyonochaung Res. N. Toungoo Division, the lowest *nil* in the W. Salween Division (Kyundaung Res.) the Prome plantation and 5 year old plantation in Pile Res., Katha. The average for all trees analysed is 31 beeholes per tree per 100 years.

3. The data so far collected are insufficient to do more than indicate lines of investigations which may yield good results, and much more work will have to be done before any definite conclusion can be reached. The effects of fire-protection and admixture with other species are matters to be specially looked into in the coming year. An unexpectedly low incidence in an Insein plantation with a large admixture of other species, indicates that this may afford some check ; three areas in Pyonochaung Res., N. Toungoo Division, half a mile away from each other, of which two had been until recently, fire protected and the other not, gave much the lowest incidence for the unprotected area, though all three areas shewed approximately parallel rises and falls.

4. The largest trees in any area were often noticed to be comparatively lightly attacked. In some cases they were fire scarred, and their size was fictitious, due to a swollen base; but the question whether the actual vigour of such trees enables them to stop an attack requires looking into.

5. An area of natural forest in Pile Res. Katha, in which trees up to 122 years old were analysed shewed two distinct rises— one in 1860-70 and one (much the greater) in 1890-1900, while the general trend of the curve shews that the degree of infestation in the area has been steadily increasing from 1840. Generally speaking, Okkyi Res., in Bhamo, where younger trees had been formerly analysed, bore this out, but more analyses of natural forest trees are required.

6. Woodpeckers have been found to be a considerable factor in control in young plantations up to 15 or 20 years old, after which their influence declines as the size of the tree becomes such that except near the top the birds cannot reach the bore hole or cannot locate it. This applies to larvae which are nearly full grown: the effect on the younger stages, (i.e., from the egg up to October or November) remains to be looked into. The double hole—one into the sapwood chamber and one 4" to 6" higher up, into the boring is typical of a woodpecker's attack on *Duomitus* after October.

7. An ichneumonid parasite, a compoplegid near *Angitia*, was found to have parasitised a sufficiently large proportion of *Duomitus* larvae in Katha to be well worth further investigation, and this will be taken in hand. Insectaries are to be made, probably in Katha and Tharrawaddy Divisions.

8. A live larva found in February in a tree felled in August, in Pyinmana Division, died on April 1st indicating that from August fellings, larvae are probably unable to emerge as moths; there were indications that November fellings might not bring about this result, as larvae were found almost fully fed in this month.

9. Beeholes were found to be numerous in *Cassia Fistula* (*ngu*) but were made by another species of *Duomitus*, probably *leuconotus*. They were also found in *Callicarpa macrophylla* (*daung satpya*), from which no larvae were obtained. This tree is varbenaceous, and very closely allied to teak; if it proves to be an alternative host, its removal from plantations is indicated, while the possibility of using small plantations of the species as trap areas requires investigation.

10. In the course of analysis, damage by other insects was noted for information and use on future investigations. At least one species of Lamiid (*Nupserha* ? *variabilis*, Gahan) was found to make galls in a creeper, *Thunbergia grandiflora* and to pupate in small borings in teak, *yemane* and *gwe* (*Gmelina arborea* and *Spondias mangifera*): probably at least 2 other species have similar habits.

11. *Haplohammus cervinus* (Lamiidae) was found causing swellings in young plantations in Tharrawaddy, Katha and Mu Divisions a *Sagra* (Chrysomelidae) was taken from an occluded boring in Tharrawaddy and a *Caloclytus* from a short pupating gallery both in teak. Arbelids (? *Arbela tetraonis*) were found in teak, *pyingado*, *yindaik* (*Dalbergia cultrata*) and *unkchinsa* (*Diospyros ehretioides*).

12. *Platypus soldius*, *Xyleborus interjectus*, *Xyleborus submarginatus* and *Xyleborus velatus* (shot-hole borers) were taken from dead portions of live teak.

13. Several teak in natural forest in the Minbu Division died last year, and the only cause to which their death seems to be due was defoliation in October—November, and the strain caused by putting out a second crop of leaves, combined with the shortness of the period during which that crop of foliage can function.

14. The *toon* shoot borer was found wherever *Cedrela Toona* (*thitkada*) had been put into plantations, notably Katha and W. Salween Divisions.

Central Provinces.

Experimental work in connection with lac infection was again carried on. The dates of swarming of larvae have been fairly definitely settled for the Raipur division.

<i>Schleichera trijuga</i> (<i>kusum</i>)	..	{ Middle of July. Latter half of January.
<i>Butea frondosa</i> (<i>palas</i>) etc.	..	First half of July.
<i>Zizyphus Jujuba</i> (<i>ber</i>)	...	First half of November.

Whenever lac work is undertaken it is most important that these dates should be accurately known. In July 1921 about 130 *kusum* trees which had been pruned in August 1920 were inoculated with locally bought lac. The results were not very good. The reason why the results were not good have since become obvious. The hot weather of 1921 was very severe; the brood was poor, numbers of the mother insects having died, the brood was cut too early because the date of swarming was not accurately known. The crop from these trees was only a little more in weight than the brood used to infect them. In January 1922 roughly 2,000 *kusum* trees, pollarded in February 1921, were inoculated with lac. The mistakes made in June-July were again repeated but as the work was heavier it was more extended in time. It was found that inoculation carried out in December was a complete failure, in early January gave poor results but trees infected late in January give every sign of bearing an excellent crop in June—July 1922. Such trees are covered with

dense masses of lac and now appear very promising. The conclusions drawn are :—

- (1) The dates of swarming must be fairly accurately known.
- (2) Brood cut within a fortnight of such dates is likely to give good results. Inoculation can go on for about a week after the larvae have begun to swarm and may still give good results.
- (3) The best results are obtained with brood cut just as the larvae are about to swarm. In small scale work it is therefore best to wait until the brood is actually swarming. In large scale work operations should commence a fortnight earlier.

3. Experiments of a similar nature were carried out on *ber*, (*Zizyphus Jujuba*), *palas*, (*Butea frondosa*) and *ghont* (*Zizyphus xylopyra*) and gave similar results. The success obtained with *ber* was at first very promising and trees inoculated in November "took" very well. The larvae spread all over the young shoots and developed normally. It has been discovered however that heavy mortality occurred in March. The reason appears to be that natural *ber* in this district occurs in dry places. In such localities the commencement of physiological action in the tree after the cold weather period is delayed until May-June. The females, fertilised in February—March and demanding large supplies of food material, do not get it at that time and therefore die. It would seem advisable to reserve *ber* for the cold weather crop and maintain the brood during the hot weather on *palas*.

4. Experiments on pollarding or pruning were continued. The results are so far as follows.

Kusum must be pruned one to two years before inoculation with lac, the period depending on the locality. In some places strong healthy shoots are produced in one year, in others, particularly in dry places, 1½ to 2 years is necessary. *Kusum* trees growing in dense jungle require clearing and pollarding. It is not yet considered definitely proved whether bushy crowned trees growing in the open give better results by pollarding or not.

Ber.—It is considered to be definitely proved that *ber* produces fine strong shoots fit to be inoculated with lac within six months of pollarding.

Ghont.—No definite results yet.

Palas.—No definite results yet but it seems probable that good results will be obtained by pollarding one year before inoculation.

The mortality of bison, deer, monkeys, squirrels and birds in the 1921 hot weather in South Chanda Division was very high. It will be interesting to see if the abnormal casualties amongst birds have any resultant striking after effects on the forest insect pests.

Beyond the annual appearance of the teak defoliator there is nothing further to report.

CHAPTER VI.

FOREST CHEMISTRY.

Central Institute.

The following is a list of the subjects sanctioned for investigation in the Chemical Branch of the Forest Research Institute during the period under report :—

1. *Gum, Resins, Oleo-resins and Essential Oils.*—

(1) General study of essential oils.

(2) General study of gums, resins, oleo-resins, gum oleo-resins and wood oil and natural varnishes.

2. *Miscellaneous Enquiries.*—

(1) General enquiry into oil seeds and their uses.

(2) Investigation into Indian turpentines.

3. *General investigation into the nature and value of dyes obtainable from woods, barks, fruits, flowers and leaves.*

A. *Essential Oils.*—During the past year a large number of essential oils have been examined and the results are briefly summarised below.

(1) *Pinus longifolia.*—The constitution of sesquiterpene *longifolene* is being actively investigated and interesting results have been obtained. Owing to the difficulty necessarily entailed in an investigation of this sort it will probably be some time before any conclusions can be drawn from the experimental data.

Experiments on the synthesis of *d-carene* have been continued.

It may be of interest to mention that the presence of *d-carene* can be used as a means of determining whether a turpentine is of Indian origin, i.e., obtained from the oleo-resin of *P. longifolia*. Advantage was taken of this in an analysis of a sample of turpentine sent from Bareilly which had been stated to emanate from America. It was conclusively proved to be an Indian turpentine.

(2) *Pinus excelsa.*—A sample of the turpentine from the oleo-resin of *P. excelsa* has been thoroughly examined. This turpentine contains *d-d* pinene, *d*-terpineol, a bicyclic sesquiterpene and *n*-undecane. The presence of the last named paraffin hydrocarbon is very interesting. A paper embodying the results of this investigation is in the press.

(3) *Zanthoxylum alatum.*—The seeds of *Z. alatum* yield an oil consisting mainly of phellandrene. It is of no commercial value. The Forest Research Institute is grateful to Colonel C. R. Johnson of Abbottabad for supplying the seeds.

(4) *Zanthoxylum Budrunga*.—The seeds yield an oil consisting almost solely of *l*-sabinene, a terpene not previously found in nature. A sample of the oil is being valued in England.

(5) *Blumea Malcolmii*.—A quantity of the grass of *Blumea Malcolmii* was distilled at Belgaum in November. The oil was found to be of considerable interest and consisted essentially of *d*-carvotanacetone and *l*-tetrahydrocarvone.

(6) *Andropogon Jwarancusa*.—Two samples of this oil have been examined, one from a grass grown in the Hazara District and one from a grass grown in Sind. Although botanically the grasses are identical the two oils are very different in properties. The Hazara grass yields an oil containing over 70 per cent. of a ketone *d*-piperitone (a ketone also present in the oil from *Eucalyptus dives*). The constitution of this ketone was definitely established. The oil from the Sind grass also contains this ketone but only to the extent of 44 per cent. It appears to resemble closely the oil from *C. sennaarensis*, Chiov. from the Soudan.

(7) *Camphor*.—The experimental work in camphor has been completed and a paper embodying the results of the investigation has been prepared for publication.

(8) *Abies Pindrow*, Spach.—A sample of the oil from the leaves of *Abies Pindrow*, Spach was received from Colonel C. R. Johnson of Abbottabad. The oil consists mainly of α - and β -Pinene. A paper giving the results of this investigation was issued after the close of the year.

Fixed oils.—The oils and fats from seeds of the following have been examined:—*Chloroxylon Swietenia*, *Calophyllum Wightianum*, *Shorea robusta*, *Mimusops Elengi*, *Garcinia Cambogia*. A paper embodying the results of this investigation was issued after the close of the year.

Vegetable Dyestuffs.—The experiments on the synthesis of morindone were not successful but some new derivatives of anthraquinone were prepared and the results have been published.

The experiments on rottlerin have been suspended owing to the pressure of other work.

Medical Plant Products.—The experiments on the analysis of various samples of *Artemisia maritima* from Kashmir have been completed and appear to indicate that it would be profitable to use the Kashmir plant as a source of santonin. The results of an analysis made in London by Professor Greenish have confirmed the Dehra figures.

Miscellaneous.—The usual number of routine analyses for Forest Officers have been made and do not call for comment.

At the present time the machinery for the commercial valuation of any products prepared in these laboratories is most deficient. Owing to the kindness of Professor W. H. Perkin, F.R.S., of the

University of Oxford a number of essential oils have been valued but unless the procedure is officially recognised it obviously cannot prove satisfactory. The Imperial Institute has not been made use of as it has always in the past proved useless.

Mr. Gopal Rau visited Belgaum in November and distilled a quantity of the oil from *Blumea Malcolmii*. The Forest Chemist visited Madras in February and attended the meeting of the Science Congress.

A complete record of the analytical work done in the Laboratory has been maintained.

The Branch has received the greatest assistance both from other Research Officers in the Institute and from the Forest Officers of the Department. The Forest Chemist wishes to thank them as without their cordial help progress would be very much hindered ; he wishes and specially to express his thanks to Mr. Robertson, Officer-in-Charge, Minor Forest Products, without whose able assistance much work could not have been undertaken.

The Laboratory equipment has been much improved during the year.

CHAPTER VII.

FOREST PUBLICATIONS.

	Title.	Author.	Date of issue.
	FOREST RECORDS.		
	<i>Issued.</i>		
1	Report on Lac and Shellac . . .	H. A. F. Lindsay and C. M. Harlow.	May 1921.
2	Note on the Regeneration of Sal Forests.	R. S. Hole . . .	July 1921.
3	Note on the Beehole Borer of Teak	C. F. C. Beeson . .	December 1921.
4	Notes on Artificial Regeneration in Bengal.	E. O. Shebbeare, A. K. Glasson, L. E. S. Teague and P. T. Russell.	January 1922.
	<i>In Press.</i>		
5	The Essential Oil from the leaves of <i>Abies Pindrow</i> , Spach.	J. L. Simonsen . .	(Issued in June 1922.)
6	Note on Chalcidoidea	J. Waterston . . .	(Issued in August 1922.)

—	Title.	Author.	Date of issue.
7	Results of Antiseptic Treatment of Sleepers.	R. S. Pearson . . .	(Issued in August 1922.)
8	Notes on Oils and Fats from the Seeds of Indian Forest Trees.	Gopal Rau and J. L. Simonsen. ‡	(Issued in September 1922.)
9	Note on the Constituents of some Indian Essential Oils.	J. L. Simonsen and Gopal Rau.	(Issued in November 1922.)
FOREST BULLETINS. <i>Issued.</i>			
10	Note on Weights of Seeds . . .	S. H. Howard . . .	April 1921.
11	Note on Haldu (<i>Adina cordifolia</i>).	C. E. C. Cox . . .	September 1921.
12	Note on <i>Odiha Wodier</i> . . .	Do. . . .	Do.
13	Note on Semal or Cotton Wood (<i>Bombax malabaricum</i>).	Do. . . .	Do.
14	Note on Rate of Growth of Bengal Sal.	S. H. Howard . . .	Do.
15	Note on the Miscellaneous Forests of the Kumaon Bhabar.	E. A. Smythies . . .	Do.
<i>In Press.</i>			
16	Volume Tables and Form Factors for Sal.	S. H. Howard . . .	(Issued in May 1922.)
17	Note on Kindal (<i>Terminalia paniculata</i>).	R. S. Pearson . . .	(In final print.)
18	Note on Thingan (<i>Hopea odorata</i>).	A. Rodger . . .	(Issued in October 1922.)
19	Note on Gurjun or "Kanyin" . . .	W. A. Robertson . . .	(Issued in November 1922.)
20	Note on Classification of Thinnings.	.....	Do.
21	Note on an Investigation of certain factors concerning the Resin tapping industry in <i>Pinus longifolia</i> .	H. G. Champion.	
OTHER PUBLICATIONS. <i>Issued.</i>			
22	Code for the Collection and Tabulation of Statistical Data.	S. H. Howard . . .	July 1921.
23	Code for the Collection and Tabulation of Statistical Data. Appendices.	Do. . . .	Do.
24	Progress Report of the Forest College, Dehra Dun, for 1920-21.	.....	December 1921

—	Title.	Author.	Date of issue.
	<i>In Press.</i>		
25	Progress Report of Forest Research Work in India, 1920-21.	.....	(Issued in June 1922.)
26	Flora of the Andamans . . .	C. E. Parkinson . . .	.....
27	Mechanical, Physical and Structural Properties of Wood Grown in India, Project No. 1.	L. N. Seaman . . .	(Issued in September 1922.)
28	Note on the methods of preparing volume and money yield tables of teak woods and volume and form factor tables for teak trees.	R. Bourne . . .	(In final print.)

Contributed to Periodicals.

(1) Note on the Essential Oil from the leaves of *Skimmia Laureola*, by J. L. Simonsen. (Journ. Soc. Chem. 1921 XL 126.)

(2) Synthesis of 1 : 6-Dihydroxy-2-Methyl Anthraquinone, by J. L. Simonsen and M. Gopal Rau. (Trans. Chem. Soc. 1921. 119. 1339.)

(3) The Essential Oil from *Andropogon Jwarancusa*, Jones, and the Constitution of Piperitone, by J. L. Simonsen (Trans. Chem. Soc. 1921. 119. 1644.)

(4) Santonin, by J. L. Simonsen. (Journ. Ind. Industries and Labour, 1921. I. Pt. 4.)

Burma.

In addition to the Burma Forest Bulletins mentioned in last years reports the following have been published.

No. 4. Extracts from the Silvicultural Section of Divisional Annual Reports, 1920-21.

No. 5. Note on a short tour in Northern Bengal.

United Provinces.

The " Forest Pocket Book " was published during the year and a reprint of Mr. Benskin's " Afforestation in the United Provinces " is in the press. A certain amount of miscellaneous literature has been supplied to newspapers and periodicals.

APPENDIX I.

Administration Report of the Forest Research Institute and College for the year 1921-22 (1st April 1921 to 31st March 1922).

Administration.—The post of President, Forest Research Institute and College was held by Mr. W. F. Perrée, C.I.E., Chief Conservator of Forests throughout the year.

The names of the officers who held charge of the various branches are given below :—

Branch of Forest Research Institute.	MONTH AND DATE.		Name of Officer in charge of branch.
	From	To	
Silviculture . . .	1st April 1921 .	17th February 1922.	Mr. S. H. Howard, B.A., Deputy Conservator of Forests, United Provinces.
	18th February 1922.	31st March 1922	Mr. H. Trotter, M.C., Deputy Conservator of Forests, Burma.
Forest Botany . .	1st April 1921 .	31st March 1922	Mr. R. S. Hole, C.I.E., F.C.H., F.L.S., F.E.S., Conservator of Forests, India list.
Forest Economy . .	1st April 1921 .	31st March 1922	Mr. R. S. Pearson, C.I.E., F.L.S., Officiating Conservator of Forests, Bombay.
Forest Zoology . .	1st April 1921 .	31st March 1922	Mr. C. F. C. Beeson, M.A., I.F.S., F.E.S., Deputy Conservator of Forests, Punjab.
Forest Chemistry .	1st April 1921 .	31st March 1922	Dr. J. L. Simonsen, D. Sc., F.I.C., F.A.S.B.

APPENDIX II.

Financial.

The expenditure of the past two years is compared below :—

	EXPENDITURE DURING THE YEAR.		Difference + or —.
	1920-21 (9 months, July 1920 to March 1921).	1921-22 (12 months, 1st April 1921 to 31st March 1922).	
	Rs.	Rs.	Rs.
AVI Stores, Tools and Plant ...	26,906	1,11,417	+ 84,511
AVII Building, etc. ...	2,852	6,841	+ 3,989
AIX Miscellaneous ...	31,526	69,069	+ 37,543
BIa Conservators ...	15,641	57,090	+ 41,449
BIb Superior Officers ...	99,244	1,84,863	+ 85,618
BIc Subordinate Forest and Depot Establishment.	3,379	3,364	— 15
BI d Office Establishment ...	34,081	58,672	+ 24,591
BIe Deputation and Special Allowances ...	13,246	22,500	+ 9,254
BI f Compensation for dearness of provisions	995	— 4	— 999
BII Travelling Allowances ...	19,087	31,095	+ 12,008
BIII Contingencies ...	25,088	44,561	+ 19,523
TOTAL ...	2,71,995	5,89,468	+ 3,17,472

The increase under AVI is due to the purchase of machinery for the Economic Branch consequent on its expansion.

The increase under AVII is due to the electric installation in the Wood Workshops of the Economic Branch, additions and repairs to the godowns of the Economic Branch, construction of a motor shed at Gladysville and for making certain alterations to the Botanical Museum building.

The increase under AIX is due to larger expenditure having been incurred on experiments by the Forest Economist and to the purchase of more Chemicals for the Forest Chemist.

The increase under BIa is due to the promotion of Messrs. Hole and Pearson to the class of Conservators.

The increase under BIb is due to the appointment of Experts and Upper Grade Assistants in the various branches of the Institute.

The decrease under *BLc* is nominal and requires no explanation.

The increase under *BId* is due to the figures of 1920-21 representing 9 months against 12 months for 1921-22 and to the appointment of extra establishment.

The increase under *BIe* is due to the payment of duty allowance of Systematic Botanist and Upper Grade Assistants for 12 months instead of for a shorter period in the previous year.

The decrease under *BIf* is due to the abolition of compensation for dearness of provisions.

The increase under *BII* is due to extensive touring of Research Officers owing to the expansion of the Institute.

The increase under *BIII* is due to the purchase of back numbers of certain German works of reference for the Chemical Branch.

W. F. PERRÉE,

President,

Forest Research Institute and College.

APPENDIX III.

Annual Form No. 24.

FOREST DEPARTMENT, INDIA, FOREST RESEARCH INSTITUTE DIVISIONS.

Summary of Revenue of the different Divisions during 1921-22.

BUDGET HEADS.	President.	Silviculturist.	Forest Botanist.	Forest Zoologist.	Forest Economist.	Forest Chemist.	TOTAL.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
REVENUE.							
I.—TIMBER AND OTHER PRODUCE REMOVED FROM THE FOREST BY GOVERNMENT AGENCY—	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.
(a) Timber	...	...	...	...	...	...	...
(b) Firewood and charcoal.	...	...	...	...	...	...	...
(c) Bamboos	...	...	...	...	...	...	...
(d) Sandal-wood.	...	...	...	...	...	...	...
(e) Grass and other minor produce.	...	...	...	...	...	...	...
TOTAL I	...	...	...	...	...	...	...
II.—TIMBER AND OTHER PRODUCE REMOVED FROM THE FOREST BY CONSUMERS OR PURCHASERS—							
(a) Timber	...	...	...	...	...	...	...
(b) Firewood and charcoal.	...	...	...	...	...	...	...
(c) Bamboos	...	...	...	...	...	...	...
(d) Grazing and fodder grass.	...	...	...	...	...	...	...
(e) Other minor produce.	...	...	...	...	...	...	...
(f) Other items	...	...	...	...	...	...	...
(g) Commutation fees.	...	...	...	...	...	...	...
TOTAL II	...	...	...	...	...	...	...
III.—DRIFT AND WASTE WOOD AND CONFISCATED FOREST PRODUCE.							
TOTAL III	...	...	...	...	...	...	...
IV.—REVENUE FROM FORESTS NOT MANAGED BY GOVERNMENT—							
(a) Duty on foreign timber and other forest produce.	...	...	...	...	...	...	...
(b) Revenue from shared and private forests.	...	...	...	...	...	...	...
TOTAL IV	...	...	...	...	...	...	...
V.—MISCELLANEOUS—							
(a) Fines and forfeitures.	...	...	...	...	...	...	...
(b) Refunds	...	...	...	...	212 6 6	4 0 7	216 7 1
(c) Other sources	16,661 15 6	269 0 0	82 10 5	4 8 3	634 0 1	155 9 3	17,797 11 6
TOTAL V	...	...	...	...	...	...	...
GRAND TOTAL REVENUE.	16,661 15 6	269 0 0	82 10 5	4 8 3	846 6 7	159 9 10	18,014 2 7

APPENDIX III—contd.

Annual Form No. 24—contd.

FOREST DEPARTMENT, INDIA, FOREST RESEARCH INSTITUTE DIVISIONS.

Summary of Expenditure of the different Divisions during 1921-22.

BUDGET HEADS.	President.	Sylviculturist.	Forest Botanist.	Forest Zoologist.	Forest Economist.	Forest Chemist.	TOTAL.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.
VI.—LIVE-STOCK, STORES, TOOLS AND PLANT—							
(a) Purchase of cattle.	...	...	...	...	...	...	...
(b) Feed and keep of cattle.	...	...	...	...	...	...	...
(c) Purchase of stores, tools and plant.	2,152 5 0	1,325 1 6	1,214 5 10	16,433 13 3	62,468 1 3	7,823 0 5	1,11,416 11 3
TOTAL A. VI.	2,152 5 0	1,325 1 6	1,214 5 10	16,433 13 3	62,468 1 3	7,823 0 5	1,11,416 11 3
VII.—COMMUNICATIONS AND BUILDINGS—							
(a) Roads and bridges.	...	...	...	...	...	...	...
(b) Buildings.	6,210 9 3	...	...	...	...	...	6,210 9 3
(c) Other works.	391 1 7	...	239 5 9	...	...	...	630 7 4
TOTAL A. VII.	6,601 10 10	...	239 5 9	...	...	...	6,841 0 7
VIII.—ORGANIZATION, IMPROVEMENT AND EXTENSION OF FORESTS—							
(a) Demarcation.	...	...	...	...	...	...	...
(b) Cost of Forest Settlements; compensation for land and rights.	...	...	...	...	...	...	...
(c) Surveys.	...	...	...	...	...	...	...
(d) Working plans.	...	...	...	...	...	...	...
(e) Sowing and planting.	...	...	...	...	...	...	...
(f) Protection from fire.	...	...	...	...	...	...	...
(g) Other Works.	...	...	...	...	...	...	...
TOTAL A. VIII.	...	...	...	...	...	...	...
IX.—MISCELLANEOUS							
(a) Law Charges.	...	...	...	...	...	...	...
(b) Other Charges.	3,774 15 7	4,428 14 11	1,496 15 9	3,356 15 3	36,795 6 1	19,215 12 2	69,068 15 9
TOTAL A. IX.	3,774 15 7	4,428 14 11	1,496 15 9	3,356 15 3	36,795 6 1	19,215 12 2	69,068 15 9
TOTAL A.—CONSERVANCY AND WORKS.	12,528 15 5	5,754 0 5	2,950 11 4	19,790 12 6	1,10,263 7 4	27,038 12 7	1,87,326 11 7
B.—ESTABLISHMENTS.							
I.—SALARIES—							
(a) Conservators.	15,750 0 0	...	22,000 0	...	19,340 5 2	...	57,090 5 2
(b) Superior Officers N. V.	...	14,076 1 4	6,556 8	25,863 14 1	94,247 13 6	15,391 9 2	1,56,226 9 9
Voted.	8,400 0 0	3,240 0 0	6,480 0 0	3,990 0 0	572 9 3	5,954 3 1	26,636 12 4
(c) Subordinate forest and depot establishments.	...	...	...	2,398 0 0	965 12 11	...	3,363 12 11
(d) Office establishments.	12,150 5 3	6,530 0 5	7,334 13 8	9,365 2 1	17,775 15 10	6,615 3 7	53,672 8 10

APPENDIX III—concl'd.

Annual Form No. 24—concl'd.

FOREST DEPARTMENT, INDIA, FOREST RESEARCH INSTITUTE DIVISIONS.

Summary of Expenditure of the different Divisions during 1921-22.

BUDGET HEADS.	President.	Sylviculturist.	Forest Botanist.	Forest Zoologist.	Forest Economist.	Forest Chemist.	TOTAL.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
B.—ESTABLISHMENT—cont'd.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.
SALARIES—cont'd.							
(e) Deputation and special allowances.	1,200 0 0	2,981 1 2	1,501 5 2	1,523 5 4	9,269 9 9	125 10 3	22,490 15 8
(f) Grain compensation allowances.	3 0 0	...	...	...	-7 1 0	...	-4 1 0
TOTAL B. I.	37,563 5 3	29,782 2 11	47,171 6 6	65,830 5 8	1,42,105 1 5	27,087 10 1	3,25,484 13 8
II.—TRAVELLING ALLOWANCES.—							
(a) Conservators.	1,980 8 0	...	801 3 0	...	1,558 0 0	...	3,439 11 0
(b) Superior Officers.	10 8 0	1,579 11 6	386 11 0	2,947 3 0	11,795 9 8	1,381 1 0	19,022 15 2
(c) Subordinate forest and depot establishments.	...	...	...	1,055 6 8	656 10 6	19 2 0	1,631 3 2
(d) Office establishments.	347 7 3	997 3 11	289 4 6	722 0 10	4,135 13 6	469 4 10	7,001 2 10
TOTAL B. II.	1,438 7 3	1,499 2 5	1,477 2 6	4,764 10 6	18,046 1 8	1,869 7 10	31,095 0 2
III.—CONTINGENCIES.							
(a) Stationery.	...	13 8 0	135 15 0	33 4 0	354 11 0	...	637 5 1
(b) Carriage of tents and records.	...	398 7 3	2 0 0	512 8 0	512 0 6	469 9 0	1,894 8 9
(c) Rents, rates and taxes.	1,002 0 1	...	44 0 0	...	2,256 5 2	...	3,302 5 3
(d) Pay of police guards.	...	...	...	...	...	...	...
(e) Official postage.	637 15 7	220 11 3	330 1 9	492 7 6	929 8 3	232 5 9	2,743 2 1
(f) Sundries and telephone charges.	21,330 0 0	591 5 6	1,586 12 3	4,117 8 5	6,492 1 10	1,566 1 1	36,088 13 1
Compensation for dearness of provisions.	...	...	...	...	...	...	...
TOTAL B. III	22,940 0 5	1,224 0 0	2,498 13 0	5,065 11 11	10,544 10 9	2,297 15 10	44,561 3 11
TOTAL B.—ESTABLISHMENT.	61,881 12 11	31,510 5 4	51,147 6 0	55,060 11 11	1,70,895 13 10	31,245 1 9	4,02,141 3 9
GRAND TOTAL OF EXPENDITURE.	74,410 12 1	37,264 5 9	54,008 1 1	75,451 8 5	2,80,069 5 2	58,283 14 4	5,39,467 15 4
SURPLUS OR DEFICIT:	-57,748 12 10	-36,265 5 0	-51,915 6 11	-75,417 0 2	-2,80,112 14 7	-5,121 4 6	-5,71,463 12 9

CALCUTTA;

The 22nd August 1922.

M. N. GUPTA,

Assistant Accounts Officer.

Certified that the totals of this form as printed in Forest College and Forest Research Institute Reports for 1921-22 when added together agree with those entered in the forms for the combined offices as supplied by the Accountant General, Central Revenues, under Article 78 (ii) of the Forest Department Code.

W. F. PERRÉE,

President,

Forest Research Institute and College.

APPENDIX IV.
Annual Form No. 27.

FOREST DEPARTMENT, INDIA, FOREST RESEARCH INSTITUTE.

Outstandings and Liabilities on account of Contractors and Disbursers for the Forest year 1921-22.

Divisions.	DEPARTMENT DEBTOR.			DEPARTMENT CREDITOR.			BALANCE DUE.		REMARKS.
	Opening balance.	Recoveries in Cash and value of supplies and work done during the year.	Total.	Opening balance.	Payments made during year.	Total.	To Department (Outstandings).	By Department (Liabilities).	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	
Sylviculturist	...	14,646 11 3	14,648 11 3	996 7 0	13,794 3 3	14,780 11 0	131 15 9	...	
Forest Botanist	...	4,276 6 6	4,276 6 6	1,408 1 6	3,618 8 2	5,026 9 8	750 3 2	...	
Forest Zoologist	...	11,021 14 2	11,021 14 2	354 4 1	11,200 6 1	11,641 10 2	622 12 0	...	
Forest Economist.	...	25,491 8 2	25,481 8 2	3,433 4 1	24,300 2 6	27,793 6 7	3,111 14 5	...	
Forest Chemist	...	5,111 1 3	5,111 1 3	91 2 8	5,281 14 4	5,376 1 0	264 15 9	...	
TOTAL	...	66,539 9 4	66,539 9 4	6,273 1 1	58,348 2 4	64,621 6 5	4,981 13 1	...	

M. N. GUPTA,
Assistant Accounts Officer.

CALCUTTA ;
The 22nd August 1922.

Certified that the totals of this form as printed in the Forest College and Forest Research Institute Reports for 1921-22 when added together agree with those entered in the Forms for the combined offices as supplied by the Accountant General, Central Revenues, under Article 78 (ii) of the Forest Department Code.

W. F. PERRÉE,
President,
Forest Research Institute and College.

APPENDIX V.

List of Forest Publications issued since the creation of the Forest Research Institute, Dehra Dun.

I.—BULLETINS (OLD SERIES).

	PRICE (exclusive of packing, postage, etc.).
	Rs. A. P.
1.—Note on the Bee-Hole Borer of Teak in Burma, by E. P. Stebbing. (<i>Out of print</i>)	0 4 0
2.—Note on the Quetta Borer (<i>Folesthes sartus</i>), by the same author. (<i>Out of print</i>)	0 8 0
3.—Note on the Chilgoza (<i>Pinus Gerardiana</i>) Bark Boring Beetles of Zhob, Baluchistan, by the same author. (<i>Out of print</i>)	0 8 0
4.— <i>Ficus elastica</i> : its natural growth and artificial propagation, with a description of the method of tapping the tree and of the preparation of its rubber for the market, by E. M. Coventry	0 12 0
5.—Notes on a Visit to some European Schools of Forestry, by Stebbing. (<i>Out of print</i>)	2 0 0
6.—Memorandum on Mechanical Tests of some Indian Timbers, by W. H. Everett	0 2 0
7.—Note on the Chilgoza Forests of Zhob and the Takht-i-Suliman, by E. P. Stebbing. (<i>Out of print</i>)	0 12 0
8.—Note on the Life-History of <i>Hoplocerambyx spinicornis</i> (The Singbhum Sal Borer), by the same author	0 9 0
9.—Note on the Influence of Forests on the Storage and Regulation of the Water-Supply, by S. Eardley-Wilmot	1 0 0
10.—Note on the Duki Fig-Tree Borer of Baluchistan. (<i>Batocera rubus</i>), by E. P. Stebbing. (<i>Out of print</i>)	0 7 0
11.—On Some Assam Sal (<i>Shorea robusta</i>) Insect Pests, by the same author	1 10 0

II.—LEAFLETS.

1.—The Sal Bark-Borer (<i>Sphoerotrypes siwalikensis</i> , Steb.), by E. P. Stebbing. (<i>Out of print</i>)	0 4 0
2.—The Teak Defoliator (<i>Hybloea puera</i> , Cram.), by the same author. (<i>Out of print</i>)	0 2 0
3.—The Teak Leaf Skeletoniser (<i>Pyrausta machoeralis</i> , Wlk.), by the same author. (<i>Out of print</i>)	0 2 0
4.—The Larger Deodar Bark-Borer (<i>Scolytus, major</i> , Steb.), by the same author. (<i>Out of print</i>)	0 4 0
5.—The Blue Pine "Polygraphus" Bark-Borer (<i>Polygraphus, major</i> , Steb.), by the same author. (<i>Out of print</i>)	0 3 0

III.—PAMPHLETS.

1.—Note on Utilization of Khair Forests in Eastern Bengal and Assam, by Puran Singh. (<i>Out of print</i>)	0 4 0
--	-------

APPENDIX V—contd.

III.—PAMPHLETS—contd.

	PRICE (exclusive of packing, postage, etc.).
	Rs. A. P.
2.—The Attack of the Bark-Boring Beetle in the Coniferous Forests in the Simla Catchment Area, by E. P. Stebbing	0 8 0
3.—A Glossary of Forest Technical Terms for use in Indian Forestry, by A. M. F. Caccia. (<i>Revised and issued as Bulletin No. 4, New Series</i>). (<i>Out of print</i>)	0 4 0
4.—Note on Lac and Lac Cultivation, by D. N. Avasia. (<i>Out of print</i>)	0 2 0
5.—Notes on Sal in Bengal by A. L. McIntire. (<i>Out of print</i>)	0 4 0
6.—Note on Forest Reservation in Burma in the Interests of an Endangered Water-Supply, by A. Rodger ..	1 0 0
7.—Note on Andaman Marble Wood or Zebra Wood (<i>Diospyros Kurzii</i> , Hiern.), by R. S. Troup ..	0 4 0
8.—Note on the Collection of Statistical Data relating to the principal Indian Species, by A. M. F. Caccia ..	0 10 0
9.—Tables showing the Progress in Working-Plans in the Provinces outside the Madras and Bombay Presidencies up to 31st December 1908, by the same author	0 10 0
10.—Note on Burmese Leza Wood (<i>Lagerstroemia tomentosa</i> , Presl.), by R. S. Troup	0 2 0
11.—Note on Carallia Wood (<i>Carallia integerrima</i> , DC.), by the same author	0 2 6
12.—Note on Petwun or Trincomali Wood (<i>Berria Ammonilla</i> , Roxb.), by the same author	0 4 0
13.—Note on Burmese In Wood (<i>Dipterocarpus tuberculatus</i> , Roxb.), by the same author	1 0 0
14.—Note on Burma Padauk (<i>Pterocarpus macrocarpus</i> , Kurz.), by the same author	1 0 0
15.—Note on the Preservation of Bamboos from the attacks of the Bamboo Beetle or "Shot-Borer," by E. P. Stebbing	0 7 0
16.—Note on the Best Season for Coppice Fellings of Teak (<i>Tectona grandis</i>), by R. S. Hole	0 4 0

IV.—BULLETINS (NEW SERIES).

1.—Note on Calorimetric Tests of some Indian Woods, by Puran Singh	0 2 0
2.—Memorandum on Teak Plantations in Burma, by F. A. Leete	0 10 0
3.—Note on the Relative Strength of Natural and Plantation-Grown Teak in Burma, by R. S. Pearson ..	0 4 0
4.—Second Edition of the Glossary of Technical Terms for use in Indian Forestry, by A. M. F. Caccia, revised by R. S. Troup	0 6 0
5.—The Blue Pine Tomieus Bark-Borer (<i>Tomieus Ribbentropi</i>), by E. P. Stebbing	0 2 0

APPENDIX V—contd.

IV.—BULLETINS (NEW SERIES)—contd.

	PRICE (exclusive of packing, postage, etc.).		
	Rs.	A.	P.
6.—Memorandum on the Oil-Value of Sandalwood, by Puran Singh	0	2	0
7.—Note on the Chemistry and Trade Forms of Lac, by the same author	0	3	0
8.—Note on some Germination Tests with Sal Seed, (<i>Shorea robusta</i>), by R. S. Troup.....	0	2	0
9.—Note on Resin-Value of <i>Podophyllum Emodi</i> and the best season for collecting it, by Puran Singh	0	1	3
10.—Note on the Bark-Boring Beetle attack in the Coniferous Forests of the Simla Catchment Area, 1907—1911, by R. S. Hole	0	3	0
11.—A Further Note on some Casuarina Insect Pests of Madras, by V. Sivarmaniam Iyer	0	14	0
12.—Note on the Bark-Eating and Root-Boring Beetles of Babul (<i>Acacia arabica</i>), by E. P. Stebbing	0	4	0
13.—Note on <i>Ligno Protector</i> as a possible means of preventing timber from splitting while seasoning, by R. S. Pearson	0	5	0
14.—A Further Note on the Relative Strength of Natural and Plantation-Grown Teak in Burma, by the same author	0	3	0
15.—Note on the Technical Properties of Timber with special reference to <i>Cedrela Toona</i> wood while seasoning, by the same author	0	3	0
16.—Note on Gumhar (<i>Gmelina arborea</i> , Roxb.), by A. Rodger	0	3	0
17.—Note on Bija Sal or Vengai (<i>Pterocarpus Marsupium</i> , Roxb.), by the same author	0	4	0
18.—Note on Sain or Saj (<i>Terminalia tomentosa</i> , W. and A.), by the same author	0	5	0
19.—Note on Benteak or Nana Wood (<i>Lagerstroemia lanceolata</i> , Wall.), by the same author	0	3	0
20.—Note on Sandan (<i>Ougeinia dalbergioides</i> , Benth.), by the same author	0	3	0
21.—Note on Dhaura Bakli (<i>Anogeissus latifolia</i> , Wall.), by the same author	0	4	0
22.—Note on the Causes and Effects of the Drought of 1907 and 1908 on the Sal Forests of the United Provinces, by R. S. Troup	0	5	0
23.—Note on the Preparation of Indian Forest Floras and Descriptive Lists, by R. S. Hole	0	4	0
24.—Note on Turpentine of <i>Pinus Khasya</i> , <i>Pinus Merkusii</i> and <i>Pinus excelsa</i> , by Puran Singh	0	2	0
25.—Development of the Culms of Grasses, by R. S. Hole	0	2	0
26.—Note on the Resin Industry in Kumaun, by E. A. Symthies	1	4	0
27.—Note on Blackwood (<i>Dalbergia latifolia</i> , Roxb.), by E. Benskin	0	4	0
28.—Note on Dhauri (<i>Lagerstroemia parviflora</i> , Roxb.), by the same author	0	4	0
29.—Note on Sundri Timber (<i>Heritiera minor</i> , Lam.), by R. S. Pearson	0	3	0

APPENDIX V—contd.

IV.—BULLETINS (NEW SERIES)—concl'd.

	PRICE (exclusive of packing, postage, etc.).
	Rs. A. P.
30.—The Compilation of Girth Increments from Sample Plot Measurements, by R. S. Troup	0 2 0
31.—Note on Indian Sumach (<i>Rhus Cotinus</i> , Linn.), by Puran Singh	0 2 0
32.—Note on the Burma Myrabolans or "Panga fruits" as a Tanning Material, by Puran Singh	0 1 0
33.—Note on an Enquiry by the Government of India into the Relation between Forests and Atmospheric and Soil Moisture in India, by M. Hill	1 0 0
34.—Note on Red Sanders (<i>Pterocarpus santalinus</i> , Linn. f.), by T. A. Whitehead	0 9 0
35.—Note on Babul (<i>Acacia arabica</i> , Willd.), by J. D. Maitland-Kirwan	0 5 0
36.—Note on Kokan or Lampatia Timber (<i>Duabanga sonneratioides</i> , Ham.), by R. S. Pearson	0 3 0
37.—Note on the Contraction and Warping which takes place in <i>Pinus longifolia</i> timber while seasoning, by the same author	0 11 0
38.—The Construction of Calcareous Opercula by Longicorn Larvæ of the Group <i>Cerambycini</i> (Coleoptera, Cerambycidae), by C. F. C. Beeson	0 3 0
39.—Note on Hollong Timber (<i>Dipterocarpus pilosus</i> , Roxb.), by R. S. Pearson	0 4 0
40.—Note on Pynmia, Ajhar or Jarul Wood (<i>Lagerstroemia Flos-Reginae</i> , Retz.), by the same author	0 6 0
41.—Note on Weights of Seeds, by S. H. Howard	0 3 0
42.—Note on Haidu (<i>Adina cordifolia</i> , Hook, f.), by C. E. C. Cox	0 8 0
43.—Note on <i>Odina Wodier</i> , Roxb., by the same author	0 8 0
44.—Note on Semal or Cotton Wood, by the same author	0 10 0
45.—Note on the Miscellaneous Forests of the Kumaon Bhabar, by E. A. Smythies	1 0 0
46.—Rate of Growth of Bengal Sal (<i>Shorea robusta</i>), I Quality, by S. H. Howard	1 0 0
47.—Volume Tables and Form Factors for Sal (<i>Shorea robusta</i>), by the same author	0 6 0
48.—Note on Kindal or Hengal (<i>Terminalia paniculata</i> , W. and A.), by R. S. Pearson	0 6 0
49.—Note on Thingan (<i>Hopea odorata</i> , Roxb.), by A. Rodger	0 7 0
50.—Note on Gurjun or Kauyin compiled by W. A. Robertson	0 4 0

V.—FOREST RECORDS:

Vol. I, Part I.—A Note on the Lac Insect (<i>Tachardia lacca</i>), its Life History, Propagation and Collection, by E. P. Stebbing. (Out of print)	1 4 0
„ Part II.—A Preliminary Note on the Development of the Sal in Volume and in Money Value, by A. M. F. Caccia. (Out of print)	1 4 0

APPENDIX V—*contd.*V.—FOREST RECORDS—*contd.*

		PRICE (exclusive of packing, postage, etc.) Rs. A. P.
Vol. I, Part III.—1.	<i>Pterocarpus dalbergioides</i> , Roxb. (Andaman Padouk), by B. B. Osmaston	
" "	2. A Further Note on the Chilgoza Bark- Boring Beetles of Zhub, by E. P. Stebbing and Captain E. H. S. James	} 1 4 0
" "	3. A Note on the Present Position and Future Prospects of the Cutch Trade in Burma, by R. S. Troup ..	
" "	4. Note on the Manufacture of Ngai Camphor, by Puran Singh. (<i>Out of print</i>)	
" Part IV.—1.	A Chemical Investigation of the Con- stituents of Burmese Varnish (<i>Melanorrhoea usitata</i> , Sap.), by Puran Singh	
" "	2. The Selection System in Indian Forests as exemplified in Working- Plans based on this system with a short description of some Continental Methods, by A. M. F. Caccia. (<i>Out of print</i>)	} 1 4 0
Vol. II, Part I.—	Note on some Insect Pests of the Himalayan Oaks (<i>Quercus dilatata</i> and <i>Q. incana</i>), by E. P. Stebbing. (<i>Out of print</i>)	} 0 6 0
" Part II.—	Note on the Fissibility of some Indian Woods, by R. S. Troup. (<i>Out of print</i>)	} 1 6 0
" Part III.—1.	Monograph on the Sylviculture of <i>Hardwickia binata</i> (Anjan), by D. O. Witt	} 3 4
" "	2. Notes on Sandal (Germination and Growth of Sandal Seedlings), by M. Rama Rao	
" Part IV.—	Note on Host Plants of the Sandal Tree, by the same author	} 2 0 0
Vol. III, Part I.—	Note on some Statistical and other Information regarding the Teak Forests of Burma, by R. S. Troup ..	} 2 12 0
" Part II.—	Preliminary Note on the Antiseptic Treatment of Timber in India with special reference to Railway Sleepers, by R. S. Pearson	} 0 14 0
" Part III.—	Report on the Investigation of Bamboos as Material for production of Paper- pulp, by W. Raitt	} 0 6 0

APPENDIX V—*contd.*V. FOREST RECORDS—*contd.*

		PRICE (exclusive of packing, postage, etc.). Rs. A. P.
Vol. III, Part IV.—	Note on the Preparation of Tannin Extract with special reference to those prepared from the Bark of Mangrove (<i>Rhizophora mucronata</i>), by Puran Singh	0 7 0
Vol. IV, Part I.—	Note on the Distillation and Composition of Turpentine Oil from the Chir Resin and the Clarification of Indian Rosin, by the same author ..	0 9 9
" Part II.—	Note on some new and other Species of Hymenoptera in the Collections of the Zoological Branch of the Forest Research Institute, Dehra Dun, by P. Cameron	0 4 0
" Part III.—	Note on Useful Exotics in Indian Forests (No. 1 <i>Proscopia juliflora</i> , DC.), by R. S. Hole	0 4 0
" Part IV.—	Note on <i>Albizia Lathamii</i> , by the same author	0 3 0
" Part V.—	Note on the Utilization of Bamboo for the Manufacture of Paper-pulp, by R. S. Pearson. (2nd Edition) ..	2 0 9
Vol. V, Part I.—	Note on Tea-box Industry in Assam, by the same author. (<i>Out of print</i>) ..	0 4 0
" Part II.—	Note on Blue Gum Plantations of the Nilgiris (<i>Eucalyptus Globulus</i>), by R. S. Troup	1 6 0
" Part III.—	Report on the Investigation of Savannah Grasses as Material for Production of Paper-pulp, by W. Raitt. (<i>Out of print</i>)	0 4 0
" Part IV.—	1. Note on Ecology of Sal (<i>Shorea robusta</i>), Part I, Soil-composition, Soil-moisture, Soil-aeration, by R. S. Hole	0 8 0
" " 2.	Note on Ecology of Sal (<i>Shorea robusta</i>), Part II, Seedling Reproduction in Natural Forests and its Improvement, by the same author ..	1 1 0
" " 3.	Note on Ecology of Sal (<i>Shorea robusta</i>), Part III, Soil-aeration and Water-cultures, by the same author..	0 8 0
" Part V.—	Note on <i>Trametes Pini</i> , by the same author	1 0 0
" Part VI.—	Note on a New Species of Forest Grass (<i>Spodiopogon Laceyi</i> , Hole), by the same author	0 8 0

APPENDIX V—*contd.*V.—FOREST RECORDS—*contd.*

		PRICE (exclusive of packing, postage, etc.). Rs. A. P.
Vol. V, Part VII.—Note on the Economic Uses of Rosha Grass (<i>Cymbopogon Martini</i> , Stapf.), by R. S. Pearson and ..	}	1 8 0
” ” Note on the Constants of Indian Geranium Oil (Motia), by Puran Singh. (<i>Out of print</i>)..		
” Part VIII.—1. Note on the Eucalyptus Oil Industry in the Nilgiris	} By Puran Singh.	1 0 0
” ” 2. Note on the Distillation of Geranium Oil in the Nilgiris ..		
” ” 3. Note on the Manufacture of Wintergreen Oil in India. (<i>Out of print</i>) ..		
Vol. VI, Part I.—The Life-History of <i>Diaprus furtivus</i> , Sampson, by C. F. C. Beeson ..		0 10 0
” Part II.—Statistics compiled in the Office of the Sylviculturist, Forest Research Institute, Dehra Dun, during 1915-16 ..		1 6 0
” Part III.—A Note on Thitsi (<i>Melanorrhoea usitata</i> , Wall.), with special reference to the Oleo-resin obtained from it, by E. Benskin and A. Rodger. (<i>Out of print</i>) ..		1 2 0
” Part IV.—A Further Note on the Antiseptic Treatment of Timber, recording results obtained from past experiments, by R. S. Pearson ..		3 0 0
” Part V.—Statistics compiled in the Office of the Sylviculturist, Forest Research Institute, Dehra Dun, during 1916-17 ..		0 10 0
” Part VI.—Note on Preparation of Turpentine, Rosin and Gum, from <i>Boswellia serrata</i> (Roxb.), gum-oleo-resin, by R. S. Pearson and Puran Singh ..		0 13 0
Vol. VII, Part I.—Preliminary Note on the Seasoning of some Indian Timbers by Natural Methods, by R. S. Pearson ..		1 0 0
” Part II.—A Further Note on Thitsi (<i>Melanorrhoea usitata</i> , Wall.), with special reference to the Oleo-resin obtained from it in the Lawksawk and Myelat States, Southern Shan States Forest Division, by F. A. Wright ..		0 4 0
” Part III.—Note on <i>Hopea canarensis</i> , Hole, by R. S. Hole ..		0 3 0
” Part IV.—Note on <i>Ixora Butterwickii</i> , Hole, by the same author ..		0 3 0

APPENDIX V—*contd.*V.—FOREST RECORDS—*concl'd.*

		PRICE
		(exclusive of
		packing,
		postage, etc.).
		Rs. A. P.
Vol. VII, Part	V.—Notes on the Larvæ and Life-Histories of Prionine Beetles, Coleoptera, Cerambycidae, Prionine, by C. F. C. Beeson	0 8 0
"	Part VI.—Note on the Mechanical Strength and Seasoning Properties of <i>Shorea robusta</i> (Sal Timber), by R. S. Pearson	0 8 0
"	Part VII.—The Life-History of the Toon Shoot and Fruit Borer, <i>Hypsipyla robusta</i> , Moore (<i>Lepidoptera</i> ; <i>Pyrilidae</i> ; <i>Phycitinae</i>) with suggestions for its control, by C. F. C. Beeson	2 4 0
"	Part VIII.—Afforestation of Ravine Lands in the Etawah District, U. P., by E. A. Smythies	2 0 0
Vol. VIII, Part	I.—Report on Lac and Shellac, by H. A. F. Lindsay and C. M. Harlow	2 12 0
"	Part II.—The Regeneration of Sal (<i>Shorea robusta</i>) Forests, by R. S. Hole	2 2 0
"	Part III.—Note on the Bee-Hole Borer of Teak, by C. F. C. Beeson	3 0 0
"	Part IV.—Notes on Artificial Regeneration in Bengal, by A. K. Glasson, P. T. Russell, E. O. Shebbeare and L. E. S. Teague	2 0 0
"	Part V.—Note on the Essential Oil from the leaves of <i>Abies Pindrow</i> , Spach, by J. L. Simonsen. (<i>Out of print</i>)	0 2 0
Vol. IX, Part	I.—Results of Antiseptic Treatment of Sleepers. Note on the Indian Sleeper Market, Record of durability tests on Treated Sleepers and conclusions arrived at therefrom, by R. S. Pearson. (<i>Out of print</i>)	2 0 0
"	Part II.—Note on Chalcidoidea (Mainly bred at Dehra Dun from Pests of Sal, Toon, Chir and Sundri), by James Waterston	1 2 0
"	Part III.—Oils and Fats from the Seeds of Indian Forest Trees, Parts I—V, by M. Gopal Rau and J. L. Simonsen. (<i>Out of print</i>)	0 3 0
"	Part IV.—The constituents of some Indian Essential Oils, Parts I—VII, by J. L. Simonsen and M. Gopal Rau	0 6 0

APPENDIX V—*contd.*

VI.—MEMOIRS.

	PRICE (exclusive of packing, postage, etc.).		
	RS.	A.	P.
Note on the Analysis of Cutch and the Preparation of Pure Catechin, Vol. I, Part I, Chemistry Series, by Puran Singh. (<i>Out of print</i>)	1	4	0
Note on the Manufacture of Pure Shellac, Vol. I, Part II, Chemistry Series, by the same author. (<i>Out of print</i>)	0	8	0
On Some Undescribed Scolytidæ of Economic Importance from the Indian Region I, Vol. I, Part I, Zoology Series, by E. P. Stebbing	0	4	0
On Some Undescribed Scolytidæ of Economic Importance from the Indian Region II, Vol. I, Part II, Zoology Series, by the same author. (<i>Out of print</i>)	0	4	0
Indian Woods and their Uses, Vol. I, Part I, Economy Series, by R. S. Troup	2	12	0
Note on the Prospects of the Match Industry in the Indian Empire, Vol. II, Part I, Economy Series, by the same author	1	12	0
Second Edition of the Monograph on "Lac Insect" (<i>Tachardia lacca</i>), Vol. I, Part III, Zoology Series, by E. P. Stebbing	1	0	0
Note on Some Important Insect Pests of the Himalayan Coniferæ (Treating of Deodar), Vol. II, Part I, Zoology Series, by E. P. Stebbing. (<i>Out of print</i>)	0	10	0
Note on the Insect Pests of the Chir Pine (<i>Pinus longifolia</i>), Vol. II, Part II, Zoology Series, by the same author	1	14	0
Memoir on Some Indian Forest Grasses and their Ecology, by R. S. Hole	5	8	0
Note on the Life-History of <i>Chermes Himalayensis</i> , Steb., on the Spruce (<i>Picea Morindra</i>) and Silver Fir (<i>Abies Webbiana</i>), Vol. II, Part III, Zoology Series, by E. P. Stebbing. (<i>Out of print</i>)	1	12	0
Note on the Economic Value of <i>Shorea robusta</i> (Sal), Vol. II, Part II, Economy Series, by R. S. Pearson	1	12	0
On the Structure and Biology of <i>Tachardia lacca</i> , Kerr, with observations on certain insects predaceous or parasitic upon it, Vol. III, Part I, Zoology Series, by A. D. Inms and N. C. Chatterjee	2	2	0
<i>Pinus longifolia</i> , Roxb., Vol. I, Part I, Sylviculture Series, by R. S. Troup	5	0	0

VII.—MANUALS.

Forest Zoology Manual, by E. P. Stebbing. (<i>Out of print</i>)	*10	0	0
Manual of Botany, by R. S. Hole. (<i>Out of print</i>)	3	8	0
Indian Forest Utilization (Second Edition), by R. S. Troup. (<i>Out of print</i>)	2	12	0

* N.B.—Rupees 5 for Officers below Extra Deputy Conservators.

APPENDIX V—*contd.*VII.—MANUALS—*contd.*

	PRICE (exclusive of packing, postage, etc). Rs. A. P.
Explanatory Notes on Forest Law (a new Edition of the Forest Law Manual). (<i>Out of print</i>)	1 2 0
Preparation of Forest Working Plans in India, by W. E. D'Arcy. Revised by A. M. F. Caccia. (Fourth Edition)	0 14 0
Second Edition of Manual of Sylviculture. (<i>Out of print</i>)	1 0 0
Manual of Forest Mensuration, by R. S. Troup. (<i>Out of print</i>)	1 4 0
Surveying and Drawing Manual, by F. A. Brining and D. N. Avasia. (<i>Out of print</i>)	3 12 0

VIII.—OTHER PUBLICATIONS.

*Index to the <i>Indian Forester</i> , Vols. I to XXX, by E. P. Stebbing	1 0 0
*"The Utilization of Bamboo for the Manufacture of Paper Pulp," by R. S. Pearson. <i>Reprinted from</i> "The <i>Indian Forester</i> ," 1920	0 8 0
Practical Determination of the Girth Increment of Trees, by R. S. Troup. (<i>Out of print</i>)	0 4 0
Forest Flora of Chota Nagpur, by H. H. Haines. (<i>Out of print</i>)	9 0 0
Translation of M. Jacquots' "Incendies en Forêt," by C. E. C. Fischer. (<i>Out of print</i>)	0 14 0
Forest Flora of the Siwalik and Jaunsar Forest Divisions, U. P. (Revised Edition), by U. N. Kanjilal. (<i>Out of print</i>)	1 14 0
Commercial Guide to the Economic Forest Products of India, by R. S. Pearson	1 0 0
Catalogue of the Photographic Collection at the Forest Research Institute, Dehra Dun	1 4 0
Forest Research Institute and College Calendar, 1919	1 0 0
Progress Report of Forest Research Work in India for the year 1920-21	2 0 0
Progress Report of the Imperial Forest College, Dehra Dun, for the year 1920-21	1 14 0

*Obtainable from the Manager, Pioneer Press, Allahabad.

APPENDIX V—*concl'd.*VIII.—OTHER PUBLICATIONS—*cont'd.*

	PRICE (exclusive of packing, postage, etc). Rs. A. P.
Note on the Forests of Java and Madoera of the Dutch East Indies, by R. C. Milward	0 13 0
A Note on some European Sylvicultural Systems, with Suggestions for Improvements in Indian Forest Management, by R. S. Troup. (<i>Out of print</i>)	3 4 0
Note entitled "Among the Eucalypts," by R. C. Milward	
The Work of the Forest Department in India, by R. S. Troup	0 4 0
Code for the Collection and Tabulation of Statistical Data, by S. H. Howard	2 0 0
Code for the Collection and Tabulation of Statistical Data (Appendices), by the same author	3 8 0
Mechanical, Physical and Structural Properties of Wood Grown in India, Project No. 1, by L. N. Seaman. ..	

The above may be obtained from the SUPERINTENDENT, Government Printing, India, Calcutta.

Progress Report of Forest Research Work in India

For the Year 1923-24

Including the Administration Report of the
Forest Research Institute, Dehra Dun.



CALCUTTA : GOVERNMENT OF INDIA
CENTRAL PUBLICATION BRANCH
1925

Price Rs. 2-8 or 4s. 6d.

**Government of India Publications are obtainable from
the Government of India Central Publication Branch,
8, Hastings Street, Calcutta, and from the following Agents :—**

EUROPE.

**OFFICE OF THE HIGH COMMISSIONER FOR INDIA,
42, GROSVENOR GARDENS, LONDON, S.W. 1.**

Constable & Co., 10, Orange Street, Leicester Square, London, W.C.	T. Fisher Unwin, Ltd., 1, Adelphi Terrace, London, W.C.
Kegan Paul, Trench, Trübner & Co., 68-74, Carter Lane, E.C., and 39, New Oxford Street, London, W.C.	Wheldon and Wesley, Ltd., 2, 3 & 4, Arthur Street, New Oxford Street, London, W.C. 2
Bernard Quaritch, 11, Grafton Street, New Bond Street, London, W.	East and West Ltd., 3, Victoria Street, London, S.W. 1.
P. S. King & Sons, 2 & 4, Great Smith Street, Westminster London, S.W.	B. H. Blackwell, 50 & 51, Broad Street, Oxford.
Grindlay & Co., 54, Parliament Street, London, S.W.	Deighton Bell & Co., Ltd., Cambridge. Oliver and Boyd, Tweeddale Court, Edin- burgh.
Luzac & Co., 46, Great Russell Street, London, W.C.	Ernest Leroux, 28, Rue Bonaparte, Paris. Martinus Nijhoff, The Hague, Holland.
W. Thacker & Co., 2, Creed Lane, London, E.C.	Otto Harrassowitz, Leipzig. Friedländer und Sohn, Berlin.

INDIA AND CEYLON.

Provincial Book Depôts :

MADRAS :—Office of the Superintendent, Government Press, Mount Road, Madras.
BOMBAY :—Office of the Manager, Government Central Press, Bombay.
SIND :—Library attached to the Office of the Commissioner in Sind, Karachi.
BENGAL :—Office of the Bengal Secretariat Book Depôt, Writers' Buildings, Room No. 1, Ground Floor, Calcutta.
UNITED PROVINCES OF AGRA AND OUDH :—Office of the Superintendent of Government Press, United Provinces of Agra and Oudh, Allahabad.
PUNJAB :—Office of the Government of Punjab, Lahore.
BURMA :—Office of the Superintendent, Government Printing, Burma, Rangoon.
CENTRAL PROVINCES AND BERRAR :—Office of the Central Provinces Secretariat, Nagpur.
ASSAM :—Office of the Superintendent, Assam Secretariat Press.
BIHAR AND ORISSA :—Office of the Superintendent, Government Printing, Bihar and Orissa, P. O. Gulzarbagh, Patna.
COORG :—Office of the Chief Commissioner of Coorg, Bangalore.
NORTH-WEST FRONTIER PROVINCE :—Government Press, Peshawar.

Thacker, Spink & Co., Calcutta and Simla. W. Newman & Co., Ltd., Calcutta. R. Cambay & Co., Calcutta. S. K. Lahiri & Co., Calcutta. The Indian School Supply Depôt, 309, Bow Bazar Street, Calcutta, and 226, Nawab- pur, Dacca. Butterworth & Co. (India), Ltd., Calcutta. Rai M. C. Sarcar Bahadur & Sons, 90-2A, Harrison Road, Calcutta. The Weldon Library, 17, Park Street, Calcutta. Standard Literature Company, Limited Calcutta. Association Press, Calcutta. Chukerverity, Chatterjee & Co., Ltd., 13, College Square, Calcutta. Higginbotham & Co., Madras. V. Kalyanarama Iyer & Co., Madras. P. R. Rama Iyer & Co., Madras. Roehouse and Sons, Madras. Bright & Co., Trivandrum. V. S. Swaminathan, Bookseller, West Tower Street, Madras. Thacker & Co., Ltd., Bombay. D. B. Taraporevala, Sons & Co., Bombay. Sunder Pandurang, Bombay. Ram Chandra Govind & Sons, Kalbadevi, Bombay. N. M. Tripathi & Co., Booksellers, Princess Street, Kalbadevi Road, Bombay. Proprietor, New Kitabhkhana, Poona. The Manager, Oriental Book Supplying Agency, 15, Shukrawar, Poona City. R. S. Gondhalekar's Book Depôt, Publisher and Bookseller, Budhwar Chawk, Poona City. Managing Director, Co-operative Bookstall, Booksellers and Publishers, Poona City. The Standard Bookstall, Karachi, Rawal- pindi, Murree, Lahore, Peshawar and Quetta.	Karsandas Narandas & Sons, Surat. A. H. Wheeler & Co., Allahabad, Calcutta and Bombay. N. B. Mathur, Supdt., Nazir Kanun Hind Press, Allahabad. The North India Christian Tract and Book Society, 18, Clive Road, Allahabad. Ram Dayal Agarwala, 184, Katra, Allahab- bad. Manager, Newal Kishore Press, Lucknow. The Upper India Publishing House, Ltd., 41, Aminabad Park, Lucknow. Munshi Seeta Ram, Managing Proprietor, Indian Army Book Depôt, Juhu, Cawn- pore. Rai Sahib M. Gulab Singh & Sons, Mufid-i- Am Press, Lahore and Allahabad. Rama Krishna & Sons, Booksellers, Anar- kali, Lahore. Puri Brothers, Booksellers and Publishers, Katcheri Road, Lahore. Manager of the Imperial Book Depôt, 63, Chandni Chowk Street, Delhi. Oxford Book and Stationery Company, Delhi. Supdt., American Baptist Mission Press, Rangoon. Proprietor, Rangoon Times Press, Rangoon. The Modern Publishing House, Ltd., 30, Phayre Street, Rangoon. The International Buddhist Book Depôt, Post Box No. 971, Rangoon. Manager, the "Hitavada," Nagpur. S. C. Talukdar, Proprietor, Students & Co., Cooch Behar. Times of Ceylon Co., Ltd. The Manager, Ceylon Observer, Colombo. The Manager, The Indian Book Shop, Benares City. B. C. Basak, Esq., Proprietor, Albert Library, Dacca.
--	--

CONTENTS.

CHAPTER.	PAGE.
I. General	1
II. Silviculture and Working Plans	2
III. Forest Botany	52
IV. Forest Economy	57
V. Forest Entomology	77
VI. Forest Chemistry	82
VII. Forest Publications	84
APPENDICES.	89

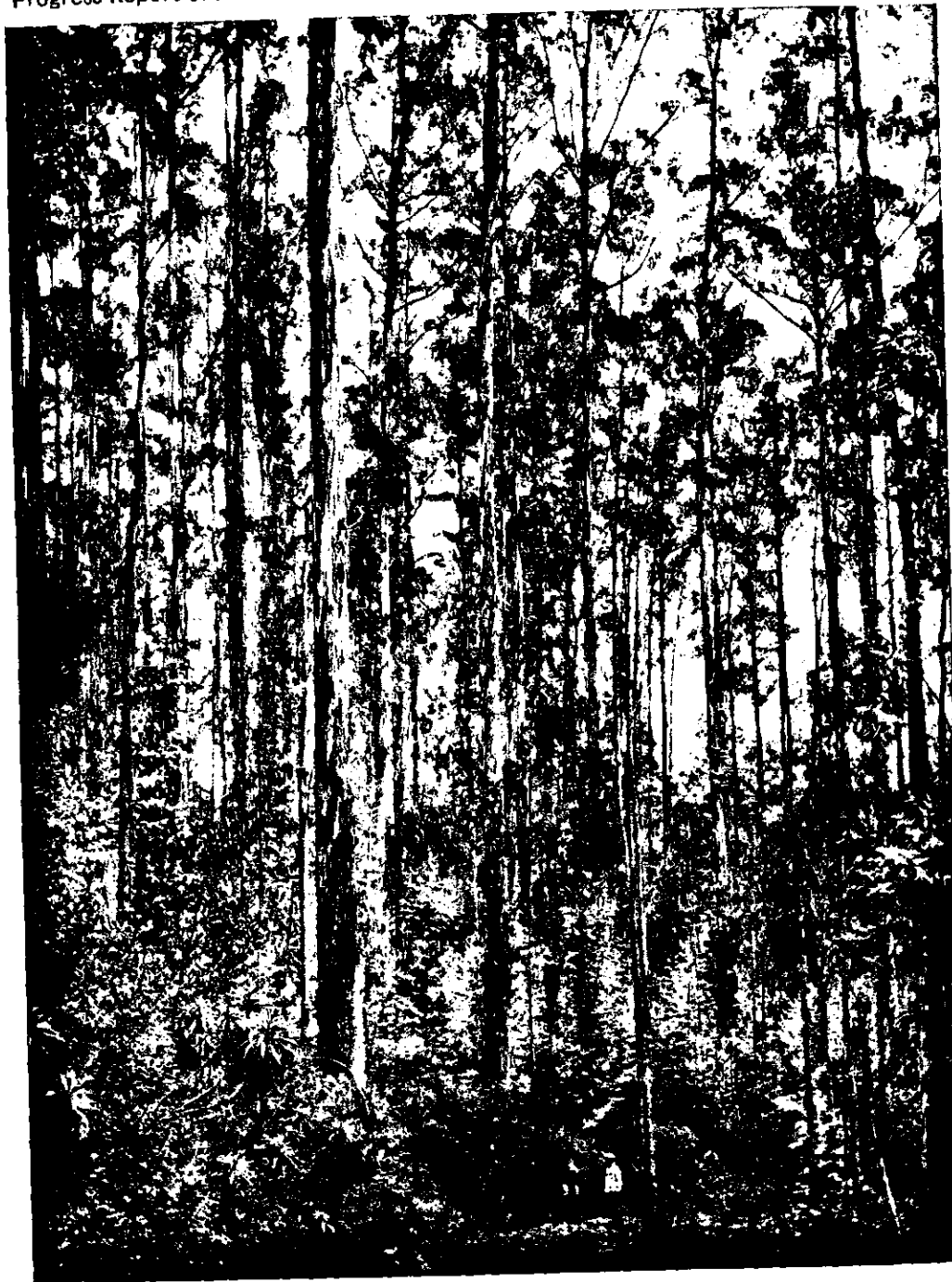


Photo. by R. S. Troup.

Eucalyptus Globulus. Age 49 years. Average girth 6'-9", average height 175 feet.

Progress of Forest Research in India, 1923-24.

CHAPTER I.

GENERAL.

The reports of research work forwarded by the Provinces have, as a rule, been incorporated *verbatim*. In a few instances economy of space and clearness have necessitated some curtailment. The report has already reached a considerable bulk and the time may come when a combined report for the whole of British India will no longer be feasible. Already many of the provinces publish separate detailed reports and a modification in the form of this publication may become necessary. There is obviously a great advantage in having, inside the one cover, an account of the progress of forest research in India as a whole and if the form be changed it is suggested that abstracts of provincial progress be incorporated in some shape, perhaps more condensed than at present, yet capable of fulfilling the important purpose of conveying information regarding the subjects, scope and progress of research in different parts. It is often difficult to trace the progress or results of experimental work and some of the efforts at silvicultural experiments reported during the last few years have not been mentioned again. It is quite as important at this stage of our knowledge of Indian silviculture to record failures as well as successes.

At the Central Institute the branches dealing with Silviculture, Botany, Entomology and Chemistry were maintained as before, in purely skeleton form. An additional officer was sanctioned for the Silvicultural Branch but the post has remained unfilled. This all-important department of our work can no longer cope with enquiries or keep pace with the ledgering and recording of available information. Experience has confirmed the opinion expressed at the meeting of the Silvicultural Association, held in January 1922, that much of the work can be centralised with advantage.

The main feature of the year's work at Dehra lay in the opening of the new Economic workshops and laboratories. This branch has made great progress and is now almost fully equipped in men and apparatus for timber and paper pulp research. Full details will be found in Chapter IV of this report. Mr. Pearson, the Forest Economist, deserves special credit for his achievements.

The financial position may be said to have been somewhat eased by an allotment of Rs. 8,73,000, or Rs. 73,000 more than was recommended by the Incheape Committee, for a period of three

years ending 1925-26. This represents the outlay on education as well as on research. With this sum it is only possible to maintain a moderate standard and output. It is obviously preferable to concentrate on a few lines of research than to endeavour to retain a more comprehensive but ill-equipped and costly establishment. Accordingly every effort has been made to provide for the sections under the highly paid experts, who are on short term agreements, and to supply them with assistants with a view to ensure continuity. The important section dealing with Minor Products has remained closed and as a consequence the Chemical Branch has not been as fully and usefully employed as it should have been.

The Central Institute aims at providing for research and education. This combination, particularly in dealing with forest problems and requirements, requires continuity both of policy and of personnel, correlated with security of finance. The gloom which pervaded at the close of last year was to some extent lifted by the policy of allotting a lump sum for a period of three years. This will prove inadequate for the third year and an early opportunity should be taken of reconsidering the general policy and scope of research work for the next decade. This can only be done by closely associating the department in the deliberations. Each conference at Dehra has awakened keen interest in the work of the Institute but without regular opportunities for renewing that interest there is a gradual slacking off in that degree of contact and co-operation which alone can ensure success.

CHAPTER II.

SILVICULTURE AND WORKING PLANS.

CENTRAL INSTITUTE.

I.—*Experimental Silviculture.*

(i) *General.*

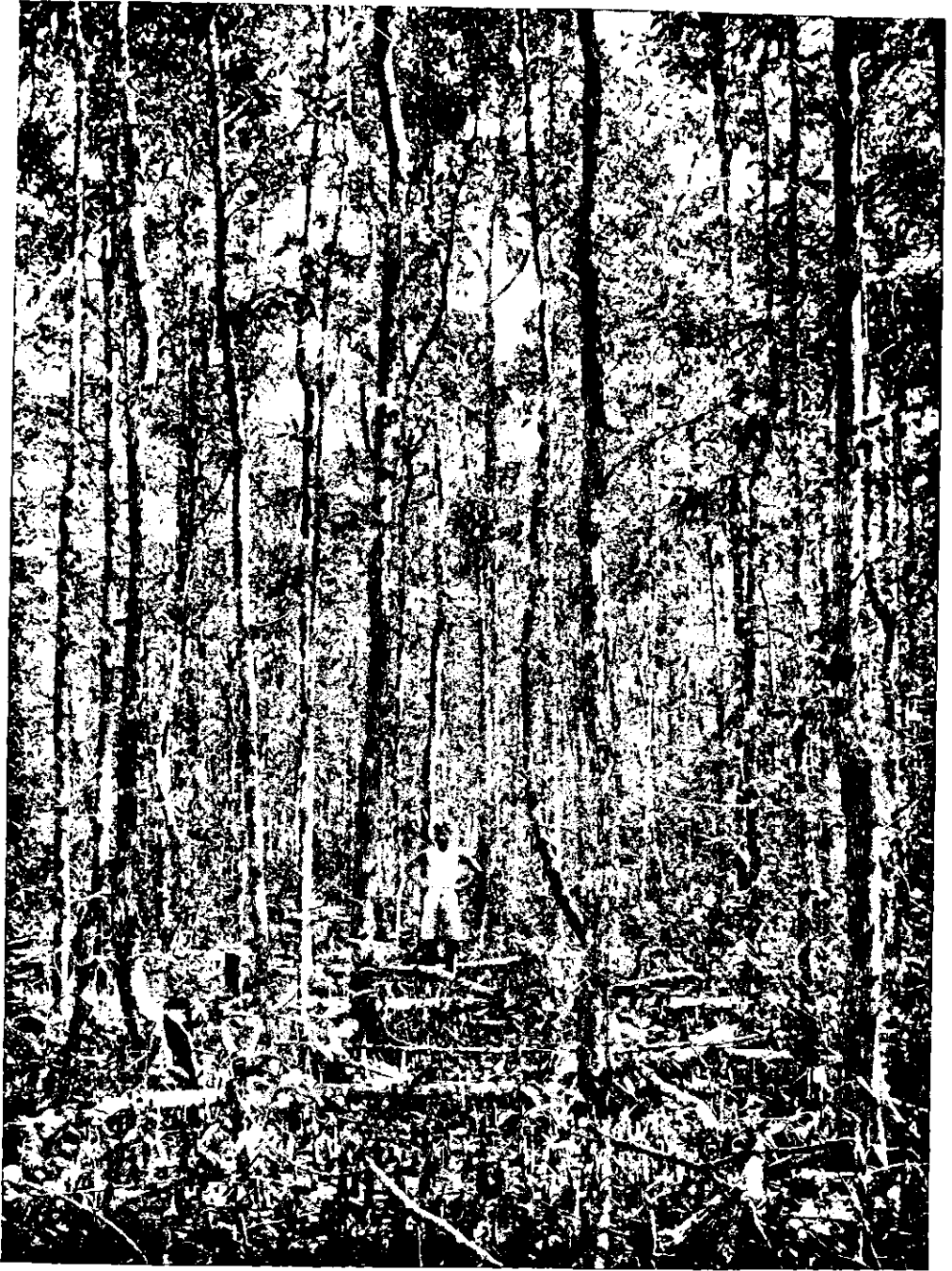
Nil.

(ii) *Natural Reproduction.*

Practically all experiments in natural regeneration are now done by local silviculturists. It was reported last year that the experiment of clear felling *sal* (*Shorea robusta*) in the Thano forest—felled in March 1919—indicated in that locality that the retention of a shelterwood was essential. At present after a further year this still appears to be a fact. For a distance of some 10 yards from the neighbouring forest the young *sal* are excellent 10, 15, 20 ft. high. The centre of the area is still struggling. It is, however, too soon to draw any absolutely final conclusion.

(iii) *Seeds.*

No special work has been done as there was insufficient staff. The following corrections and additions are to be made in the



Photo, by J. R. P. Gent.

Heritiera littoralis—Sundarbans.

“ Weight of Seeds ” Forest Bulletin 41. These have appeared as a result of weighments during the year.

Species.	No. of seeds.	No. of weighments.	REMARKS.
	per oz.		
<i>Adina cordifolia</i>	40	1	Heads.
” ”	3,20,000	3	Clean seed
<i>Acacia arabica</i>	220	4	
<i>Aleurites Fordii</i>	7	2	
<i>Bombax insigne</i>	420	3	
<i>Broussonetia papyrifera</i>	15,000	2	Clean seed. The fruits weigh 140 to the pound.
<i>Buchanania latifolia</i>	30	1	Fruits with pulp.
” ”	110	3	Seeds.
<i>Bucklandia populnea</i>	7,800	6	
<i>Dalbergia latifolia</i>	670	9	Dry fruits.
<i>Ehretia acuminata</i>	2,000	1	
<i>Fagraea fragrans</i>	480	1	Fruits. Museum specimen.
<i>Frenella rhomboidea</i>	6,500	1	Broken fruits.
<i>Ougeinia dalbergioides</i>	800	1	
<i>Pinus mitis</i>	3,900	1	
<i>Pinus pinderosa</i>	650	1	Museum specimen.
<i>Randia dumetorum</i>	1,280	1	Do.
<i>Schima Wallichii</i>	9,960	1	
<i>Shorea robusta</i>	14	1	Winged. They are 230 to the pound.
<i>Sonneratia apetala</i>	1,400	1	
<i>Sterculia villosa</i>	160	2	
<i>Tecoma undulata</i>	3,340	3	
<i>Terminalia belerica</i>	9	1	These are dry with no pulp. The fresh seed with pulp are 30 to the pound.

Adina cordifolia.—A note is required on the figure of 3,20,000. The heads when broken up give a mixture of ripe seeds, aborted and unripe seeds and husks. These are in the proportion of—

Ripe seed	5·8 per cent.
Aborted seeds	13·1 „
Husks	81·1 „

In other words an ounce of heads as collected will give about 16,500 ripe seeds. It is a common custom to collect the heads too late and sow the mixed husks and seeds. The seeds are so minute that very often it is not noticed that the heads have already shed the seed before collection. This explains certainly some of the reports on the non-germination of *Adina* seed.

Broussonetia papyrifera.—The figure given is clean seed. The fruits weigh 9 to the ounce, but when broken up 95 per cent. of the resulting mixture will be husk and only 5 per cent. seed. An ounce of fruits as collected will only give about 800 seeds.

The following *plant per-cent.* were observed during the year:—

Species.	Germination	Plant.	Time to Germinate	REMARKS.
	%	%	weeks	
<i>Buchanania latifolia</i> .	not tested	10	6 to 9	Sown 26th May.
<i>Gmelina arborea</i> .	„	10	3	Sown 27th July. The late sowing was done on purpose. The germination is poor. This species usually gives 40%. The late sowing is probably the cause of this.
<i>Terminalia belerica</i> .	„	57	3	Sown 27th July. Seed untreated.
<i>Gmelina arborea</i> .	„	57	2 to 4	Sown 15th June.

It is much regretted that more work has not been done on seeds, more especially on seed storage which is becoming of interest to several provinces, but such work needs close observation and it was literally impossible to take it up.

(iv) *Nursery Work.*

Nothing special to report.

(v) *Artificial Regeneration.*

The series of transplanting experiments to compare rains with winter transplants, entire with root and shoot cuttings, weeded with non-weeded were continued. As this needs eight variations for each species and careful observations are made regularly to get

reliable figures it represents a good deal of time and labour and results are slow. It will be noted that some of the species are economically of little value. When the experiments were begun those plants which happened to be in the nursery were used. Any new species taken up will be valuable. The following table shows results to date. In reading it, it should be remembered what a non-weeded area is here. It is a cut-back jungle which produces vigorous coppice shoots of the undesired species in the first rains and no cleaning is done. Practically no species can be expected to compete with that. In future cleanings in the cold weather will be done in the so-called un-weeded areas.

Species.	Time and method of transplanting.	PERCENTAGE OF SURVIVALS IN MARCH 1924.				REMARKS.
		W- ded	Ht.	Un- weeded.	Ht.	
<i>Acacia arabica</i>	Rains entire 1922	42	18" to 3'	2	2'	Mortality of weeded, hot weather 1923. Unweeded Jan. and February 1923.
	Rains rooted cuttings 1922.	NÜ	..	NÜ	..	Mortality of weeded, hot weather 1923. The plants never got a hold.
	Winter entire 1922	NÜ	..	NÜ	..	All killed hot weather 1923.
	Winter rooted cuttings 1922.	NÜ	..	NÜ	..	Never struck at all.
<i>Acacia Catechu</i>	Rains rooted cuttings 1922.	2	16"	8	11" to 3'	Weeded mortality June 1923. Unweeded February and March 1923.
<i>Albizia</i> spp	Rains entire 1922	30	4" to 8'	30	3' to 10"	Mortality hot weather 1923.
	Rains rooted cuttings 1922.	68	5" to 8'	50	9" to 4'	
	Winter entire 1922	NÜ	..	NÜ	..	Died first hot weather.
	Winter root and shoot 1922.	NÜ	..	NÜ	..	Do.
<i>Bombax malabaricum</i>	Rains entire 1922	66	1" to 1'	20	1" to 2'	
	Winter entire 1921	54	1" to 1'	20	2" to 2'	
<i>Buchanania latifolia</i>	Rains entire 1922	NÜ	..	NÜ	..	Weeded died first hot weather, unweeded died first January.
	Rains entire 1923	14	2" to 6"	8	2" to 6"	Weeded beds rejected in December 1923 as no hope of survival.
	Rains rooted cuttings 1922.	NÜ	..	NÜ	..	Dead by January 1923.
	Winter entire 1921	NÜ	..	NÜ	..	Never struck properly.

Species.	Time and method of transplanting.	PERCENTAGE OF SURVIVALS IN MARCH 1924.				REMARKS.
		Weeded	Ht.	Un- weeded.	Ht.	
<i>Cinnamomum Camphora</i> (local seed).	Rains entire 1921 .	62	2' to 7'	4	3"-6"	Unweeded killed rains 1922.
	Rains entire 1922 .	26	1'-6" to 2'-6"	NW	..	Heavy mortality hot weather 1923.
	Rains rooted cuttings 1921.	70	4" to 6"	20	9" to 7'	
	Winter rooted 1921	16	4" to 2'	NW	..	Heavy mortality hot weather. Unweeded never struck.
	Winter rooted 1922.	NW	..	NW	..	All dead hot weather 1923.
<i>Cinnamomum Camphora</i> (Florida plants)	Rains entire 1922 .	42	1' to 3'	10	1' to 3'	
<i>Dalbergia latifolia</i>	Rains entire 1922 .	82	5" to 3½'	NW	..	Unweeded were never so good and were gone 1923 hot weather.
	Rains rooted cuttings 1923.	100	4" to 18"	80	5" to 18"	So far faced no hot weather and weeds quite small.
	Winter entire 1923 .	74	..	20	..	Cannot judge yet. Faced nothing.
	Winter rooted cuttings 1923.	100	..	20	..	No sign of life yet.
<i>Eugenia operculata</i>	Winter rooted cuttings 1922.	NW	..	NW	..	Never struck.
<i>Omelina arborea</i>	Rains entire 1923 .	96	4" to 2'	64	4" to 15"	
	Rains rooted cuttings 1922.	92	1' to 6'	50	6" to 5'	Weeded usually 3 leaders from ground.
	Winter entire 1923 .	98	..	30	..	Faced nothing yet.
	Winter rooted cuttings 1923.	98	..	66	..	Do.
<i>Melia indica</i>	Rains rooted cuttings 1922.	NW	..	NW	..	Dead hot weather 1923.
	Winter rooted cuttings 1923.	100	..	NW	..	Impossible to be sure yet. No sign of life.
<i>Frasopia spicigera</i>	Rains rooted cuttings 1922.	NW	..	NW	..	Dead first cold weather.
	Winter rooted cuttings 1922.	NW	..	NW	..	Never struck.
<i>Sapindus detergens</i>	Rains rooted cuttings 1922.	NW	..	NW	..	Never healthy, all dead hot weather 1923.
<i>Terminalia belerica</i>	Rains entire 1922 .	98	3" to 3'	36	5" to 19"	
	Rains rooted cuttings 1922.	58	8" to 17"	44	5" to 3'	
	Winter entire 1923 .	84	..	20	..	Signs of life beginning.
	Winter rooted cuttings 1923.	88	..	50	..	Do.

The following notes seem to be correct for those species which are complete. They should however be observed for at least a further year.

Acacia arabica.—The only way to transplant seems to be entire transplants at the beginning of the rains, kept weeded. Then 40 per cent. success is attained. Line sowings are probably better and will be tried and compared.

Albizzia odoratissima and *A. stipulata*.—Probably root and shoot cuttings are preferable. Growth very fast, and winter cleanings alone are probably sufficient. Unfortunately mixed seed was collected.

Bombax malabaricum.—Rains and Winter entire transplants when weeded succeed. They die back in the hot weather and then spring up again and altogether transplants are slow in getting away. Line sowings probably better.

Buchanania latifolia.—Very difficult to transplant. Weeded sowings are all that is practicable.

Cinnamomum Camphora.—Rains transplants whether entire or rooted cuttings are simple but must be weeded. Will not stand winter transplanting.

Dalbergia latifolia.—Rains entire transplants if weeded give certain success. Nothing can yet be said of the other methods.

Gmelina arborea.—Rains entire and rooted cuttings are easy and certain if weeded and probably would succeed with winter cleanings only. Entire transplanting seems preferable to rooted cuttings. The rate of growth is much the same but the rooted cuttings nearly all send up two or three leaders from the base.

(vi) Reclamation and Afforestation.

The work done was reported last year. The only further matter to report is that in a grass area like Zabarkhet with frost it is more than ever clear that sowings of *Pinus longifolia* solve the difficulty best, if no weeding in the rains is possible. Porcupines and rats do much damage at Zabarkhet. The *chir* (*Pinus longifolia*) really looks splendid. The *sisso* rooted cuttings (*Dalbergia Sissoo*) are still struggling about at the top of the grass fighting with the frost. The *sisso* sowings unweeded are now dead.

(vii) Thinnings and Cleanings.

Nothing to report. No comparative experiments have been started by the Institute yet.

(viii) Mixtures.

Nothing to report.

(ix) Underplanting.

Nothing to report.

(x) Silvicultural Systems.

Nothing to report.

(xi) Miscellaneous.

The collection of drawings of germinating seedlings is being continually added to. It is a pity these are not all published as they are probably the best work of the kind in the world.

II.—WORKING PLANS AND STATISTICS.

(i) Working Plan.

The following working plans have been received during the year:—

- (1) Nilambur Valley Working Plan by R. Bourne. 4 vols.
- (2) Revised Working Plan for the Matharan Plateau Forests Division, Kolaba, Bombay.
- (3) Working Plan for North Toungoo Forest Division, Burma for the period 1920-21 to 1928-29.
- (4) Working Plan for the Saharanpur Forest Division, United Provinces, 1923-33 by E. Benskin.
- (5) Revised Working Plan for Mohnyin Forest Reserve, Katha Forest Division, 1921-30.
- (6) Revised Working Plan for the Mahabaleshwar Forests, Satara Division, Central Circle, Bombay Presidency.
- (7) Revised Working Plan for the Forests of Upper Sind (Sukkur, Shikarpur and Larkana Divisions), Sind Circle, Bombay Presidency.
- (8) Working Plan for the South Kheri Forest Division, Eastern Circle, United Provinces, by K. D. Joshi.
- (9) Working Plan for the Dehra Dun Forest Division, Western Circle, United Provinces, for 1923-24 to 1932-33, by M. P. Bhola.
- (10) Working Plan for the Haran Plantation, Sind Division, 1919-20 to 1934-35, by Malik Jagan Nath.

It is unfortunate that lack of staff prevented a start being made in the demonstration forest at the new site.

(ii) Yield Tables.

The Central Institute worked out results for some 130 plots during the year. The *Sal* yield table for the United Provinces was finally issued during the year. Data are being collected to issue a *sal* yield table generally applicable throughout the *sal* tracts in India but one or two portions still remain incomplected and till the data to fill them are collected the yield table cannot be issued.

Efforts are being made during the coming hot weather to fill the gaps in the data for *Pinus longifolia* and if these are found, as appears likely from recent work in the Punjab, this table will be prepared in the coming year.

The yield table for *Cedrus Deodara* is still unfortunately delayed indefinitely for the sake of certain figures which can only, it appears, be obtained from the Punjab.

(iii) *Volume and Form Factor Tables.*

A general volume table for *Shorea robusta* was compiled and issued during the year.

A general volume table for *Pinus longifolia* was compiled and issued during the year.

These measurements are given on the standard definition of timber and small-wood, and the tables are sub-divided into various height classes. The next undertaking will be to correlate the *Sal* volume table with the locality qualities of the yield table and then, what is more important, to compile tables based on the *local* conception of timber in different localities instead of the standard 8". During the latter part of the year some thousands of trees were measured to provide data for local figures. These will be worked up and published in the coming rains.

Data for other species are being collected.

(iv) *Bark Measurements.*

Bark thickness at breast height and bark percentage in the whole stem are given in the *sal* and *chir* volume tables for these species. Measurements for other species are being collected.

(v) *Miscellaneous.*

The limitation of the application of yield and volume tables must be clearly understood and strongly emphasised. Only the *sal* yield table containing rates of growth and the *sal* volume table, *not* containing rates of growth, have been published from this Institute. The yield table is inapplicable to irregular crops. Most of the existing crops are irregular now, though some of them after 10 years' thinnings may become regular enough to apply yield table figures. The yield table is applicable to *future* crops and its present use is to assist in the calculation of the rotation or conversion period from the present irregular to regular forest, the calculation of reduced areas, etc.

It cannot be used to calculate the volume and yield for P. B. I. unless P. B. I. is already uniform or nearly so when it can be applied direct. If P. B. I. is not uniform and is enumerated and allotted to diameter or girth classes, its standing volume can be taken from the volume table which can be easily and quickly modified to local conditions. This does not give any figure for the rate

of growth of the individual trees in diameter classes. Any attempt to prescribe an increment figure for the single tree of each size on an irregular P. B. I., direct from the main crop of a yield table for regular crops, will lead to very gross inaccuracies and these will err on the side of gross over felling.

If provinces are faced with this problem this Institute can usually give an increment figure for an irregular P. B. I., not too incorrect, so long as it is a species on which some tables have been published from here.

III.—MISCELLANEOUS. (TOURS, PHOTOS, RECORDS, ETC.)

The office of the Silviculturist was held throughout the year by Mr. S. H. Howard.

The staff and the Silviculturist have made tours during the year in the United Provinces, Punjab, Madras and Central Provinces. Two parties of computers went on tour in the United Provinces Divisions to take measurements of single *sal* trees for local volume tables.

The photographic collection now contains some 4,078 prints 4,894 negatives 538 lantern slides, 6 colour positives and 4 cinema films. The collection with the Timber Testing Officer, done by the photographic staff, consists of 850 prints.

In addition to this some 1,200 prints were supplied to various officers and a few lantern slides to the Working Plans Circle, United Provinces.

BENGAL.

I.—EXPERIMENTAL SILVICULTURE.

(i) *General.*

Nil.

(ii) *Natural Regeneration.*

In Kalimpong Division experiments were tried last year to obtain *sal* regeneration on the main ridges in the Tista Valley. This was done by cutting out *Dendrocalamus Hamiltonii* under mature *sal* groups and then burning underneath. Owing to the bad seed year however, this proved to be a failure. The same experiments are being tried this year in the same place over 167 acres.

The Divisional Forest Officer, Kalimpong, notes in his report that he thinks it better from the point of view of coppice regeneration, not to burn in firewood coupes, if the burning cannot be undertaken before March or April; and he also states that he has found natural regeneration of *mandani* and of *Trema orientalis* profuse in the firewood coupes in the Duars.

(iii) *Seed Collection, etc.**Nil.*(iv) *Nursery Works.*

At Rajabhatkhawa small temporary nurseries have been made close to the area to be planted up as well as temporary "Kachha" wells for watering seedlings. It is interesting to note that this has reduced the expenditure on nurseries by 25 per cent. during the past year.

(v) *Artificial Regeneration.*

In Kalimpong Division it has been found that *pipli* (*Bucklandia populnea*) and *chikrassi* (*Chikrassia tabularies*) are doing remarkably well.

(vi) *Reclamation and Afforestation.**Nil.*(vii) *Thinnings and Cleanings.**Nil.*(viii) *Miatures.**Nil.*(ix) *Underplanting.**Nil.*(x) *Silvicultural Systems.**Nil.*

II.—WORKING PLANS AND STATISTICS.

The Working Plan of the Jalpaiguri Division is now being taken in hand. The Kalimpong Working Plan is in Press and will very soon be ready. An extract from the former is attached herewith.

Sal Volume Table.

Girth.	Volume. c. ft.
1'—2'	5
2'—3' 2"	10
3' 2"—4' 2"	23
4' 2"—5' 3"	36
5' 3"—6' 3"	50
6' 3"—7' 4"	87
Over 7' 4"	106

BIHAR AND ORISSA.

I.—EXPERIMENTAL SILVICULTURE.

(i) General.

The general principle followed in carrying out experimental research work has been to lay out plots of a small size in which observations can be carried out in great detail rather than larger sized plots in which only general observations can be made. 39 plots were laid out in the course of the year. One single series of numbers has been adopted for all experimental plots in the whole circle instead of separate series of numbers for each division for the division is not such a stable unit of administration as the circle. Records of experiments are maintained in triplicate, one copy being sent to the divisional forest officer concerned, and one to the Silviculturist, Dehra Dun.

(ii) Natural Regeneration.

Six experimental plots were laid out in the forests of the Banpur Mals in Puri Division with the object of testing whether it will prove possible to re-obtain natural regeneration of *sal* wherever absent or deficient on account of the evergreen invasion induced by past fire protection. In these plots the overwood was thinned out or clear felled in strips or groups. The plots will be burnt over annually for the next few years and the progress of *sal* regeneration recorded. Owing to the great labour scarcity in these forests it is most essential that some method should be found of obtaining regeneration by natural means and it is hoped that one or other of the experiments in progress will prove successful.

In order to test whether fire protection is adversely affecting natural regeneration of *sal* in other forests 4 experimental plots were laid out in the dampest type of *sal* forest found in the Singhbhum, Kolhan, and Angul divisions. Three complementary experimental plots were laid out in drier types of *sal* forest in Singhbhum and Angul divisions to test whether withdrawal of complete fire protection will adversely affect natural regeneration in such types.

Three plots were laid out respectively in pole, middle, aged, and matured *sal* forests in Singhbhum to test the time necessary for obtaining complete established regeneration of *sal*.

Two plots were laid out in Sambalpur division with the object of testing the efficacy of the prescribed system of strip fellings for High *Sal* forest in preventing partially established seedlings from dying back or dying altogether.

Two plots were laid out in Angul division in mixed bamboo forest with the object of seeing whether sufficient natural regeneration of species in the overwood can be obtained within a year or two by felling and burning the bamboos and valueless species. Both plots will be burnt in May 1924.

Five plots were laid out in Sambalpur with the object of ascertaining vitality of stools of different species when coppiced under rotations of 20, 40, 60, 80 and 100 years respectively, as well as ascertaining whether sufficient natural regeneration will be obtained under the simple coppice system under the above rotations to replace aged stools and perpetuate the forest.

One plot was laid out in the Casuarina plantations in Puri division to test whether regular regeneration of Casuarina trees can be secured from coppice or pollard shoots. The trees were coppiced and pollarded at different heights.

One plot was laid out in Puri division to test whether the lives of dying *Strychnos Nux Vomica* trees can be usefully prolonged by coppicing them.

(iii) Seeds, etc.

One experimental plot was laid out in Puri division with the object of testing the effect of pollarding, pruning and coppicing *kuchila* (*Strychnos Nux Vomica*) trees on the production of seed which is a valuable market product.

Experiments in the collection of and on the germination of *sal* seeds were carried out by the divisional forest officer, Puri. The ground under the mother trees was burnt and fallen seeds collected every morning. They were then spread out in a layer either (1) under a thatched roof, the sides being open or (2) over specially prepared beds in the shade of the trees. The seeds under the thatched roof all died. Of those laid out over beds about 60 per cent. germinated. Seeds sown as soon as they were collected from beneath the mother trees gave the best result, nearly 100 per cent. successfully germinating.

(iv) Artificial Regeneration.

Sal sowings in lines on the Bengal method were tried on a small scale in Puri division and gave promise of success. They will be tried on a bigger scale next year. In the Puri teak *toilas* transplanting has given much better results than direct sowing.

Several experiments in artificial regeneration were carried out in Sambalpur division with different species. Owing to improper attention to certain essential points and in some instances to damage by game most of the experiments proved failures. Three plots in which lines sowing of *Gmelina arborea*, *Acacia Catechu*, and *Zizyphus xylopyra* were carried out are of fair promise and permanent records will be maintained for them. A further series of experiments, exercising greater care, will be carried out this year. It is now fairly obvious that under the dry climatic conditions prevalent in Bihar and Orissa the use of nursery transplants is going to prove generally much more successful than direct sowings. Natural conditions are adverse to the successful germination and establishment of seedlings. To prove successful direct sowings have to be made on very thoroughly worked soil and such is

economically practicable in the case of most species only when the soil is an arable one and sowings can be made in ploughed lines.

Four plots were laid out to ascertain the best planting distance for *Casuarina* trees, the distances adopted being respectively 4' x 4', 6' x 6', 8' x 8' and 10' x 10'. The plots will be subsequently subdivided and the sub-plots subjected to different degrees of thinning and pruning.

(v) *Reclamation and Afforestation.*

The remaining area of 80 acres belonging to the Forest Department on the seashore near Puri town was planted up with *Casuarina* trees at a cost of Rs. 8 per acre. Of the total area of land 2,308 acres, here in the possession of the Department about 2,000 acres have been planted up with *Casuarina* trees. Part of the remaining area has been planted up with *Calophyllum Inophyllum* and part has been left unafforested owing to its unsuitability for planting.

(vi) *Silvicultural Systems.*

Four experimental plots have been laid out in Sambalpur and Angul divisions with the object of ascertaining whether the methods of working *Dendrocalamus strictus* forests prescribed or proposed will lead to any diminution of production of new culms.

II.—WORKING PLANS AND STATISTICS.

The revision of the Working Plan for the old Singhbhum division, (since constituted into two new divisions, Kolhan and Saranda) was completed during the year and a commencement made in the revision of the Working Plan for Puri division. A preliminary Working Plan report was submitted for Angul division.

(i) *Yield Tables.*

Five permanent sample plots were laid out in poor quality *sal* forest in the Kolhan, Singhbhum and Sambalpur divisions. The value of the data obtained has been somewhat reduced owing to the great difficulty in securing ring countings in such poor and slowly grown crops. Three *Anogeissus latifolia* sample plots were laid out in Singhbhum division and one teak sample plot in Puri division. In addition sites for further sample plots were selected. Shortage of staff has prevented more progress being made in laying out plots.

(ii) *Volume and Form Factor Tables.*

Owing to shortage of staff proposed work under this head could not be started.

(iii) *Miscellaneous.*

The Research Officer toured in all forest divisions with the exception of Porahat and the Santal Parganas.

BOMBAY.

As in previous years research work on silvicultural problems was limited to experiments initiated by Divisional Forest Officers in their respective divisions. For want of a Provincial Silviculturist, no co-ordination of this work can be carried out, nor can continuity be maintained.

BURMA.

I.—EXPERIMENTAL SILVICULTURE.

(i) *General.*

Experimental Plots.—Owing to the changes in personnel, few experimental plots were laid out during the year, but just after the close a serious attempt was made with a series of plots dealing with the regeneration of *ingyin* (*Pentacme suavis*). Of experiments during the year, four plots with different methods of sowing and planting *ingyin* were all complete failures although the natural regeneration, owing to the excellent seed year (1923) was prolific.

There is probably a normal or optimum of available moisture for each species, and therefore a distinct tendency for each to pass to drier soils as the rainfall increases. Dryness may be physical or physiological. As examples of the general tendency, catch grows on clay near the dry zone and on coarse sand near Toungoo (80 inches), teak thrives on stiff soils in Prome (45 inches) but prefers a sandy loam in Tharrawaddy and Toungoo (80 inches); both teak and catch disappear from natural forest where the rainfall is much over 90 inches.

This does not imply that teak cannot grow where rainfall is heavier, first class growth has been recorded from Arakan (125-250 inches), but it does mean that the larger trees of evergreen and moist forest can usually outgrow teak if the rainfall exceeds 90 inches and the latter can only survive if protected.

A preliminary study of the Pegu Yoma suggests that the major structure is a gently folded anticlyne with an axis just west of the main crest. There are minor folds on both sides of it. The highest layer is a coarse sand, usually ferruginous or lateritic, which crops out on both sides and probably underlies the Irrawaddy and Sittang valleys. The next strata, chiefly fine grained sandstone with some clay layers, giving rise to a light loam, from the dip slope stretching eastwards from the main crest over much of Toungoo and Pyinmana. Heavy clays below the sandstone, and themselves containing narrow belts of sand, crop out in Prome, Zigon and Tharrawaddy. The outcrops are largely north and south.

It is proposed that a forest officer with special qualifications should carry out a geological and soil survey for a whole division. The laboratory work, which will be restricted mainly to a mechanical analysis and to a determination of the pH factor, will at first be done by the Agricultural Department but it is hoped that this work also will be taken over later by a forest officer with special qualifications.

The immediate object of the survey is to discover some standard system by which areas coming under concentrated regeneration can be classified before planting starts. Lack of method has led to many areas being stocked with the wrong species; for example areas capable of producing first class *pyinkado* (*Xylia dolabriformis*), or *taukkyan* (*Terminalia tomentosa*) but only third class teak have been sown up with teak.

In conjunction with the survey, each soil sample will be accompanied by an accurate description of the growth in the vicinity, including tree species with their heights and diameters, bamboo species with heights and diameters and the species of shrubs, herbs, grasses, etc., forming the undergrowth. From a series of such analyses and descriptions it is hoped that the factors influencing the site quality for each important species may be determined and that an indicator list may be compiled whereby the assessment of site qualities will be fixed and standardised.

Growth of Teak.—The general effect of these soil conditions on the growth of teak is that first class plantations are normal over a large part of Toungoo, less common under the reduced rainfall of Pinyinmana, and almost absent in Zigon and Tharrawaddy. It is also characteristic that the best growth west of the Yoma is in northern Zigon, with a stiff soil but light rainfall.

Figures of average height in a number of old and new plantations were collected during the year. There are fairly large groups, about half a class above Nilambur first quality and also, unfortunately, whole plantations a full class below third quality. So far as can be ascertained at present, *taungya* plantation teak grows much more slowly at first, but reaches its proper position on the Nilambur tables about the end of the fourth year. *Yemane* (*Gmelina arborea*) under favourable conditions, probably a light silt, grows about a class above teak and should normally be rather better than first quality for that species.

(iii) Natural Regeneration.

Experimental plots in dry and moist *Dipterocarp* forest were selected, and older ones maintained under observation. Resulting regeneration is due to a variety of causes which cannot be entirely isolated, but the general conclusion seems to be that burning is essential to prepare the ground and, in the case of dry forest of *Dipterocarps*, desirable to help the establishment of seedlings. Once seedlings are established, fireprotection stimulates growth. Even under cover of matted climbers fire-protected in (*Dipterocarpus*

tuberculatus) grows far more rapidly than that exposed to even light fires, and seedlings of *kanyin* (*Dipterocarpus turbinatus*) are killed at once by fire, not being out of danger until 15 or 20 feet high. Indications with *ingyin* (*Pentacme suavis*) are similar to those with *in* but *ingyin* is extremely intolerant of shade and will need much more careful tending.

The *ingyin* seed crop was especially good in 1923 and the resultant natural regeneration has been prolific. It is thought that this has been largely due to the extremely favourable season. The rains started early and the fallen seed had no time to deteriorate before germinating. And as it seems extremely probable that the greatest cause of mortality among *ingyin* seedlings is bad solid aeration, due to excessive soil moisture, they must have been favoured by the irregular rainfall and sunny intervals of 1923.

Experiments with *taungya* plantations in dry deciduous forest (Shwebo Division) have not proved successful, and owing to the absence of *ya* cutters this method of regeneration can never be used generally. Natural regeneration is rare and an experiment was started to induce it. All the bamboo and undergrowth were felled on a selected area and the whole burnt in April 1924. All trees were left standing but the crop is open and there is no need to open the canopy.

Little progress has been made with the study of the natural regeneration of the evergreen forests except those containing *kanyin*. The regeneration of this species appears to be simply a matter of fireprotection as it can push its way up through anything. Artificial regeneration of evergreen forest by the *taungya* method has shown little promise, the results have generally been poor and the *ya* cutters dissatisfied as the heavy timber entails hard work and poor paddy crops. Regeneration must be mainly natural and experiments are urgently required more especially as the focus of hardwood exploitation is being moved to the evergreen forest of South Tenasserim.

Experiments are being made both in Henzada-Maubin and in Zigon with the coppicing of *in* (*Dipterocarpus tuberculatus*). In Henzada, simple coppice is required and experiments are mainly directed towards finding the best method and time. Results to date indicate that stumps 9" high give better results than stumps cut flush with the ground, and also that only a small percentage of trees over two feet in breast height girth will coppice at all. In Zigon, in poor type *in* forest on flat ground with abundant regeneration, coppice with standards is being tried.

(iv) Seeds.

The office continued to arrange for seed supply both to divisional officers in the province and to forest officers and public bodies outside it. The *pyinkado* (*Nydia dolabriformis*) seed crop was poor and only a small part of the demand for the 1924-25 *taungyas* could be met.

Some orders, particularly for teak seed, were received too late for the seed to be collected. It is essential that all orders for seed should be registered some months in advance and before the particular seed required is due to ripen.

Experience in Myitkyina and Mansi during the year confirms the belief that teak seed, treated by burning or burying, is not as reliable in Upper Burma as fresh seed, although it germinates more quickly. Fresh seed from mature trees sown in April has germinated well in Lower Burma. In North Arakan the method of direct sowing with treated seed as practised in Chittagong is being tried. This system is worth a trial in Upper Burma.

(v) Nursery Work.

Extensive nursery experiments with *in* (*Dipterocarpus tuberculatus*), and *ingyin* (*Pentacme suavis*), etc., were started just after the close of the year. Seedlings are plentiful and various methods of sowing and transplanting will be tried.

Eucalypts, especially *E. rostrata*, have been grown successfully in Maymyo reserve, being planted out from split bamboo tubes in which they were placed almost as soon as germination had taken place. The bamboo tubes can be used again and again. Seedlings planted out in the cold weather are said to grow best.

Sagawa (*Michelia Champaca*) was successfully raised and planted out in Katha.

Pyinkado (*Xylia dolabriformis*) can be transplanted when quite young, and again after five or six months' growth, but not in the interval. Experience to date suggests that the older seedlings do not recover from transplanting, though they may survive for months or even years.

Similarly success with transplanting large seedlings of *ingyin* (*Pentacme suavis*) is still rather problematical. *Yinma* (*Chikrasia* sp.) germinated well in nurseries and transplanted well, but the growth was slow.

Thale (*Palaquium polyanthum*) sown in North Arakan germinated very late and by the end of the rains seedlings were only 8"-10" high.

(vi) Artificial Regeneration.

"Stump" planting of year old teak has proved a great success in Katha and, where carefully supervised, in Lower Burma. It is necessary in Katha because germination and early growth are exceptionally slow.

In Lower Burma the Manbla method of transplanting seeds as they germinate, from nurseries started in the *yus* in April, is equai-

ly successful and less expensive. Under the very heavy rainfall of Arakan it was not a success, but this may have been partly due to careless transplanting.

An experiment with *kyi* (*Barringtonia acutangula*) in swamp forest in North Arakan has proved only that the development of this species is so slow that the cost of formation and tending is likely to be prohibitive.

The transplanting of *Eucalypts* in split bamboo during the cold weather has proved successful at Maymyo. *E. rostrata* has grown best. It coppices well in Australia (Milward) but not in the Nilgiris (Troup). Even if it does not coppice well at Maymyo it is probably the most suitable species for serious forestry. Clear felling coupes in natural forest produce only 1,251 stacked cubic feet and a net revenue of Rs. 20 per acre. *Eucalypts* in the Nilgiris have given an outturn of 21,818 stacked cubic feet per acre, nearly 20 times the present yield at Maymyo. It is not unreasonable to assume that *E. rostrata* at Maymyo will produce five times the yield of the natural crop or 6,255 stacked cubic feet and a net revenue of Rs. 100 per acre. It should be noted that the "natural" forest in this case is largely secondary growth resulting from shifting cultivation.

Early sowing with *pyinkado* (*Xylia dolabriformis*) has generally given the best results but a reserve of seed to replace casualties is essential. Broadcast sowing of *pyinkado* in *taungya* has been most successful but the cost is prohibitive, Rs. 12.5 an acre for seed alone. Failures with *pyinkado* have nearly always been due to lack of seed, and divisional forest officers should collect, every seed year, three times the amount required for a year. The percentage of germination falls from about 80 to 40 in the second year, but seed years are general, and a bad seed year in one division usually means a bad seed year for the whole province.

The most successful species in the older guava *taungya* of Insein Division are *thabye-byu* and *thabye-kyetkye* (*Eugenia* spp). Both unfortunately have a rather branching habit. It is thought that *pyinkado* (*Xylia dolabriformis*) and cutch (*Acacia Catechu*) promise even better. This is a special case of a shallow sand over almost impervious lateritic clay. The original trees were short, branchy and climber ridden.

(vii) Reclamation and Afforestation.

The only work of afforestation is that carried out on the Kachin Hills in Bhamo with *maibu* (*Alnus nepalensis*) and *layaung* (*Betula alnoides*). Broadcast sowing following burning continues to give successful results and although the seedlings are mostly killed back by frost in the following cold weather, they appear to be able to

spring up again. English alder is being tried in frost hollows (1924) as an experiment.

(viii) *Thinnings and Cleanings.*

All experience to date favours thinnings in teak plantations as heavy as those adopted in Nilambur. In 1916 an acre of 1901 teak was thinned out to 70 trees per acre. In 1924 the average tree was 86 feet high and 3 feet in girth or well over Nilambur I Class (Mohnit in Pyinmana). This may have been partly due to an excellent undergrowth of *kyathavng* (*Bambusa polymorpha*) but suggests at least that Nilambur methods are by no means too drastic. The only reported case of damage due to heavy thinning was in a sample area of 1917 teak thinned in 1922-23 (Mawhun, Katha), where a number of trees were bent over by a gale.

By the congested state of old plantations we are encouraging weak stems, ultimate check to height growth, over-clean soil and erosion. Heavy thinnings would stimulate girth increment, obviate any premature check to height growth, encourage the development of undergrowth, and prevent erosion of the soil. It is hoped that a special effort will be made in 1924-25 to tend any plantations which have been left unthinned for more than five years.

It is probable that a thinning table giving the number of trees per acre should be based more on height growth than on age. When the average height of a wood passes 30 feet it should be opened out to an average spacing of $8\frac{1}{2} \times 8\frac{1}{2}$ feet. This is certainly correct for teak and *yemane* (*Gmelina arborea*) and probably for most other species. Even more drastic thinnings may be necessary for cutch.

(ix) *Mixture.*

Included under this head are not only the intimate mixtures made with the idea of reducing cost of completing the canopy but also those mixtures by groups or patches formed to utilise to the greatest possible extent the varying site qualities.

The ideal subsidiary species for an intolerant species such as teak is one with great weed-suppressing qualities but with a growth slightly slower than teak. In the past *binga* (*Stephegyne diversifolia*), and *hnaic* (*Adina cordifolia*) have been most commonly employed, the seed being either sown broadcast or dropped from seed bearers left standing for the purpose. *Pyinma-ywetthe* (*Lagerstrœmia Flos-Reginæ*) and *pyinma-ywetgyi* (*I. macrocarpa*) have also been largely employed and have given excellent results. The latter can also be used with *pyinkado* (*Xylia dolabriformis*), but *pyinma-ywetthe* grows rather faster than *pyinkado* in early youth. A mixture which seems likely to give good results is that of a fast growing light-demander such as *yemane* (*Gmelina arborea*), *myauknago* (*Duabanga sonneratioides*) or *dwan* (*Eriolaena Candollei*) with *pyinkado*. These light-demanders or "nurses" keep

down the weeds but their shade is not sufficient to interfere with the *pyinkado*. It is probable that the best subsequent treatment of these nurses will be to cut their side branches and if necessary their tops to free the *pyinkado* and leave the rest of their crowns to keep down weeds.

The various species of *Lagerstroemia* grouped as *pyinma* cannot only be trusted to remain below the teak but are sufficiently tolerant of shade to survive as a permanent understorey. Suitable natural undergrowth in teak plantations are *thetyingyi* (*Croton oblongifolius*) and, above all, *kyathaung* (*Bambusa polymorpha*).

The choice of principal species best suited to the soil is apt to conflict with the requirements of exploitation. It was originally intended that each species should be exploited separately on its own rotation. This led to concentration of species and consequently to planting on unsuitable soil. It was then discovered that soil variations occur within very narrow limits and that rigid adherence to soil as a guide to species would lead to a most intricate mixture. Theoretically the smallest group would be the size of a mature tree, or about 30 x 30 feet; actually such intensive work is, under present conditions, neither possible nor desirable, and the practical limit of area may be taken as an acre. If there are no important differences of soil conditions, it is desirable that the species unit be conterminous with that cultivated by a single family (3-4 acres). The rotation in any case is likely to be fixed for all species on the basis of that for teak.

It is interesting to note that a *taungya* made in Henzada in 1905 contained a mixture of teak and *pyinkado*, partly by alternate lines and partly alternately in the same lines. The inevitable has happened and the crop now consists of patches of pure teak and pure *pyinkado* with the latter predominating.

Another point in connection with mixture is the regeneration of forests from which only floatable timbers can be economically exploited at present. Of such areas those likely to remain inaccessible should be planted with teak on the most suitable soils only without attempting to restock areas less favourable to its growth. Areas likely to become accessible should be left unplanted for the present. Regeneration would waste standing timber which may later be saleable; and, should concentrated exploitation and regeneration be started, irregular teak plantations are likely to be more bother than they are worth.

As regards other species, most of those tried to date have proved slow growing and therefore expensive. *Yemane* (*Gmelina arborea*) is very fast growing, but for that very reason introduces complications. It demands a light alluvial soil, usually mere patches along a stream, and will be mature before teak is half-grown. It is therefore difficult on the one hand to provide a separate series and on the other to reconcile it with the working of other species. *Yemane* suffers very severely from insects, cattle and game, and is likely to be

confined to areas for local supply on a short rotation. Swamps have been planted so as to complete regeneration over whole compartments but the expenditure (on such species as *ma-u Anthocephalus Cadamba* and *pyinma Lagerstoemia Flos-Reginæ*) seems hardly justifiable. If the area is large it will probably be more useful as a grazing ground for extraction animals, and if it is small there may be considerable interference between the trees of the swamps and those of the higher ground possibly to the prejudice of the latter. This does not apply to the plains reserves of Lower Burma which are nearly all swamp. In such cases both land and small timber are so valuable that very intensive methods and a short rotation are justifiable.

(x) *Silviculture Systems.*

Burning.—Stubble burning in the first year probably encourages the growth of teak, but has in some cases destroyed species such as *pyinkado (Xylia dolabriformis)* which belong to a moister type of forest. Early burning in young teak plantations in lieu of fire-protection seems to have no effect on height growth but probably encourages grass and thus causes casualties. Cutting and burning as an alternative to weeding both retard growth and cause additional casualties. Early burning at a later stage, when the teak are 25-30 feet high, seems to be an advantage, or at any rate an insurance against damage.

(xi) *Miscellaneous.*

Spacing.—There appears to be no justification for altering the 6' x 6' spacing for teak, and all divisional forest officers state that 9' x 9' spacing for *yemane (Gmelina arborea)* has given rise to bushy, forker plants, whereas those spaced 6' x 6' are straight and well formed. Spacing whether 15' x 15', 12' x 12', 9' x 9' or 6' x 6' appears to have little effect on the height growth of teak and the only factors affecting spacing are the certainty, rapidity and cost of establishment. The disadvantages of wide spacing are the necessity for full stocking and the recent discovery that isolated plants have a tendency to fork. The comparative costs of establishment 6' x 6' and 9' x 9' in Zigon Division show that there is little to choose between the two methods and that 6' x 6', if anything, gives a better crop for a smaller cost.

Small experiments with spacing 9' x 3' and 6' x 3' are being undertaken in Pyinmana.

Trees which grow slowly during the first few years, particularly *pyinkado (Xylia dolabriformis)*, might benefit by closer spacing provided the initial cost is not increased, but it is probable that this can be avoided by the judicious use of subsidiary species, whether broadcast or not, as weed-killers or nurses.

II.—WORKING PLANS AND STATISTICS.

(i) Yield Tables (Sample plots).

Further progress was made during the year in laying out sample plots. The plots formed previously and during the year are as follows:—

Species.	Object of plot.	NUMBER OF PLOTS.		
		Previ- ous.	This year.	TOTAL.
Teak (<i>Tectona grandis</i>)	Volume increment per acre	56	49	105
	Volume increment per acre under different thinning.	..	32	32
<i>Kanyin</i> (<i>Dipterocarpus turbinatus</i>).	Volume increment per acre	2	..	2
<i>Ingyin</i> (<i>Pentacme suavis</i>).	Diameter increment of individual trees	1	..	1
<i>Yemane</i> (<i>Gmelina arborea</i>)	Volume increment per acre	2	..	2
<i>In</i> (<i>Dipterocarpus tuberculatus</i>).	Volume increment per acre	9	..	9
	Diameter increment of individual trees	8	..	8
<i>Taukkyan</i> (<i>Terminalia tomentosa</i>).	Volume increment per acre	..	2	2
	TOTAL	78	83	161

The 32 sample plots to demonstrate the effects of different thinnings in teak were from 4—6 years old. The 49 sample plots for the volume increment per acre of teak were in plantations formed between 1856 and 1900. Fifteen of them helped to fill the gap between the years 1870 and 1887.

There should now be sufficient teak sample plots to draw up a rough yield table but a few more will be required at the extremes of quality, both above Nilambur I, and below Nilambur III. Just after the close of the year areas were selected for sample plots in *ingyin* (*Pentacme suavis*) and *thitsi* (*Melanorrhoea usitata*) and it is hoped that more progress can now be made with species other than teak such as *kanyin* (*Dipterocarpus turbinatus*), *pyinkado* (*Xylia dolabrijformis*), *tauikkyan* (*Terminalia tomentosa*), *pyinna* (*Lagerstræmia Flos-Reginæ*), etc. More information is required about the comparative rates of growth of the various oaks and allied species and it is also necessary to have some *in* (*Dipterocarpus tuberculatus*) sample plots in undulating or hilly country. *In* plots formed to date have mainly been chosen on coarse sand deposited by the Irrawaddy.

Two sample plot parties were in camp throughout the open season and it is hoped that funds will permit of a third being formed.

This third party is required to assist especially with the formation of experimental plots and it is considered that a trained party should be attached for a short time during the open season to each working plans party. The working plans officer, who explores in detail large tracts of forest, has unrivalled opportunities for selecting sample plots, but neither the time nor the staff to enumerate and measure the growing stock on them.

(ii) *Volume Tables.*

Rough volume tables for the following species and divisions were published during the year as Burma Forest Bulletin No. 10:—

Teak (*Tectona grandis*); Prome and Pyinmana divisions.

Pyinkado (*Xylia dolabriformis*); Zigon, Tharrawaddy and Ataran divisions.

In (*Dipterocarpus tuberculatus*); Zigon, Katha and Ataran divisions.

Taukkyan (*Terminalia tomentosa*); Zigon division.

Volume tables for all the more important species in Shwebo division are under compilation and an attempt is being made to compile a volume table based on 3" girth classes and 20' height classes.

(iii) *Miscellaneous.*

Progress was continued with the collection of photographs illustrating silvicultural operations and cognate subjects. A number of the photographs were sent to England for use in the British Empire Exhibition and some 84 lantern slides have been prepared for lecture purposes.

Work on arranging the library has been delayed for want of suitable accommodation, but it is hoped that a large room will soon be available, and that officers on recess will make use of the books and files. The proposed combination of the offices of the Conservator of Forests, Working Plans Circle and the Silviculturist will release a clerk who will act as librarian and record clerk.

Ledger filing has proceeded steadily but is not quite up to date on account of the large numbers of old files turned over from the office of the Chief Conservator of Forests and the brief tenure of office of the Silviculturist.

COORG.

I.—EXPERIMENTAL SILVICULTURE.

(i) *General.*

Much of the work during the year is purely of local importance and much more is as yet incomplete and inconclusive. Such work is not reported on.

(ii) Natural Regeneration.

An experiment in poor unhealthy sandal (*Santalum album*) to test the results of coppicing and pollarding shows that coppicing gives better height and girth growth.

The results of opening the canopy over *Hopea parviflora* in varying degrees has shown (i) that *Hopea* puts on more rapid growth when exposed to light, (ii) that overexposure results in their death in the hot weather, (iii) that extensive exposure results in greater natural regeneration but a subsequent greater mortality.

(iii) Seeds.

Sandal seeds (*Santalum album*) were coated in three ways with a preparation containing strychnine to try and avoid the damage done by ants and squirrels. The germination was 77 per cent. in the untreated check experiments and after transplanting both treated and untreated were immediately nipped off just above ground level by squirrels and rats. The method appears to be a failure.

(iv) Nursery Work.

Nil.

(v) Artificial Regeneration.

Experiments since 1914 have shown that the following species can be quite successfully raised in the abandoned *kumris* of the deciduous ghat forests but that some shade will be required until species are well established: (1) *Dysoxylum glandulosum*, (2) *Bombax malabaricum*, (3) *Hardwickia pinnata*, (4) *Dipterocarpus indicus*, (5) *Hopea parviflora*, (6) *Artocarpus hirsuta*, (7) *Vateria indica*, (8) *Calophyllum cuneifolium*, (9) *Dichopsis elliptica*.

(vi) Reclamation and Afforestation.

Nil.

(vii) Thinnings and Cleanings.

Nil.

(viii) Mixtures.

Nil.

(ix) Underplanting.

Since 1915-16 attempts have been made to cover the ground of the dry eastern forests of North Coorg (and especially of sandal

plantations) with (1) *Michelia Champaca*, (2) *Ardisia humilis*, (3) *Carissa spinarum*, (4) *Eugenia Jambolana*, (5) *Schleichera trijuga*, (6) *Randia dumetorum*, and (7) *Pongamia glabra*.

Only *Carissa spinarum* and *Pongamia glabra* were successfully raised.

(x) *Silvicultural Systems.*

From experiments in the evergreen forests of the Western Ghats it appears that survivals of seedlings, saplings and poles (up to 1½ feet) per acre a year after felling decrease with intensity and manner of felling. The nearest approach to clear felling seems to be to leave 15—20 trees on either the upper or lower storey, on which experiment 1,082 of the said seedlings, saplings and poles per acre were counted the following year.

(xi) *Miscellaneous.*

Nil.

II.—WORKING PLANS AND STATISTICS.

Nil.

CENTRAL PROVINCES.

I.—EXPERIMENTAL SILVICULTURE.

(i) *General.*

A few plots were laid out during the year mainly to determine the correct density of thinning in teak and the securing of regeneration of *sal*.

A number of plots already laid out are still maintained but so far it is too early to publish definite conclusions.

(ii) *Natural Reproduction (including coppice, rootsuckers, etc.)*

In the majority of divisions coppice reproduction is relied on and is remarkably vigorous. The chief need is for thinning in clumps to produce straight single stems freed from contemporary competition. Seedling reproduction of teak in most areas follows as a natural sequence to opening out the canopy but is too often destroyed by excessive rains grazing. With more vigorous exclusion of grazing of cattle and especially of buffaloes natural reproduction of our main timber species would present little difficulty—seedlings observed in blanks and under gaps in the canopy in the rains are usually destroyed year after year by trampling and hardening of the soil. It is most marked in areas where a thorny scrub undergrowth prevents the access of cattle to certain patches. Teak and other seedling manage to survive.

A different problem is presented by *sal* in *e.g.*, the Banjar Range where rigid exclusion of grazing, fireprotection and to a limited extent opening out the canopy have so far failed to produce established regeneration. It is thought that the acidity of the soil due to the accumulation of humus brought on by years of fireprotection is the cause of *sal* seedlings failing to survive and experimental areas in which burning combined with ploughing up the soil have been initiated. Other *sal* regeneration experimental areas have been started in North Mandla and South Raipur.

In the Raigarh plateau of Balaghat the failure of *sal* to reclothe the large and extending blanks is largely due to frost. At Supkhar apparently promising regeneration is yearly cut back and never reaches the pole stage. A possible solution is the introduction of *chir* pine (*Pinus longifolia*) as a nurse in these blanks and the present *chir* plantation is being watched from this point of view.

In South Raipur where there is no danger from frost and where the soil is not too acid, *sal* regenerates freely and renders the new uniform system working plan feasible.

(iii) Artificial Regeneration.

An experimental *taungya* plot was laid out in Seoni Division but results so far have not been received.

Planting of *maida* (*Litsaea sebifera*) was carried out at Pachmarhi in a small area of 1/10 acre to discover its practicability at the request of the Municipality. It was found that by planting one year old coppice shoots cut from stools of the previous year there were no failures.

Probably the most successful planting operation of past years was that of *chir* pine at Supkhar in Balaghat. The Silviculturist in a note to Government this year showed the folly of stopping the reafforesting of blanks in frost liable *sal* areas by means of *chir* and obtained permission for planting to be continued on a small scale.

The following figures show that the *chir* pine here compares favourably with figures from other provinces:—

Age in years.	Average girth in inches.	Maximum girth in inches.	Average height in feet.	Maximum height in feet.	Stems per acre.
5 . . .	..	..	2.5	5.0	6,000
10 . . .	5.8	14.5	11.0	18.4	3,600
15 . . .	10.0	24.5	23.4	33.4	1,880
20 . . .	12.5	30.0	35.6	47.0	1,510

Volume per acre figures for smallwood from sample plots laid out are:—

Age 13	1,917 cubic feet.
Age 17	2,075 „ „

(iv) *Thinnings and Cleanings.*

Though not the result of definite research the following observations may be of interest. These operations are being carried out as extensively as funds permit in all divisions and constitute the main silvicultural activity of the province at present. The operation bears on—

- (1) the felling or girdling of fast growing soft wood species such as *Odina Wodier*, etc.
- (2) the thinning of coppice clumps and stands of congested poles—to favour valuable species.
- (3) the removal of one individual in the case of double stems throughout.

The general appearance of the Central Provinces teak and mixed type of forest after a thinning of this kind is surprisingly good and it is now recognised that until woods are so treated it is impossible to decide which areas are fit to continue under coppice systems.

The degree to which the canopy should be opened out at different ages is still not fully understood; the thinning so far carried out have however proved none too heavy.

Teak coppice requires thinning at 5 years—where there are 3 or more shoots per stool the two farthest apart if promising may be left at the first thinning. Climber cutting should precede the work and a fire follow it provided that there is no mass of grass liable to convert a ground fire into a serious blaze.

It was found that much labour and time was saved by substituting lopping for felling in the case of large old standards of species such as *Bassia latifolia*, *Terminalia tomentosa*, etc., and by clearing all thorny species and clumps of rootsuckers of e.g. *Diospyros Melanoxyton*, *Aegle Marmelos* without marking.

In the combined operation referred to the marking immediately precedes the felling. Inferior species interfering with valuable species are cut; where they are spreading and very large, they are lopped or girdled or both. Clumps of coppice shoots are reduced to 1 or 2 in all cases, and climbers are cut. The felling is watched carefully to ensure that the minimum damage to the crop of the future is caused. In forests containing very different age classes, each patch is treated on its merit, whichever trees are considered most profitable to leave are left to the exclusion of the remainder. In even aged pole forest the thinning is more simple. In the former case we still have sufficient trees which must obviously be removed to justify the ignoring of what age class should be finally left. The treatment required is still too

elementary to be concerned with more advanced problems of distribution of age classes.

The following conclusions have been arrived at:—

- (1) Thinnings are practicable in the Central Provinces.
- (2) Without thinnings we cannot decide on the quality of a given locality or allot it to either coppice or high forest systems.

(3) Typical teak associates such as *Anogeissus latifolia*, *Terminalia tomentosa*, etc., must be carefully watched and left where required to assist in drawing up the teak.

(4) It is essential to concentrate on thinning operations and even curtail the extension of other main fellings till the former are brought up to date.

A fire in Saugor Division following a clear felling and in Damoh following a thinning in forest full of thorny undergrowth proved very beneficial. *Bija* (*Pterocarpus Marsupiuni*) reproduction was a feature of the former.

II.—WORKING PLANS AND STATISTICS.

Working Plan work is at present at a standstill in this province in spite of the fact that many new plans are required immediately and that almost all the others require revision to provide for proper thinnings and cleanings in regrowth.

The South Raipur Working Plan was completed in April. The new system of Compartment Histories, and Control Forms embodied in it which render fuller check possible, is to be adopted in all future Working Plans.

(i) Sample Plots.

The following gives the results of the season's work in laying out permanent Sample Plots:—

Species.	Division.	No. of Plots.
<i>Teak.</i> Vol. increment per acre . . .	South Chanda	3
	South Raipur	1
	Saugor	2
	Melghat	11
<i>Sal.</i> Vol. increment per acre . . .	South Raipur	29
<i>Bhirra.</i> <i>Bhirra</i> (<i>Chloroxylon Swietenia</i>) . . .	Hoshangabad	1
<i>Chir.</i> <i>Chir Pine</i> (<i>Pinus longifolia</i>) . . .	Balaghat	3
		50

There are now 26 permanent teak sample plots and 46 permanent *sal* plots in the province—all in even aged woods of all qualities. Whereas in the *sal* it was possible to find even aged crops upto even 80 or 90 years of age, teak could not be found in even aged fully stocked woods of more than 54 years and older crops are badly wanted. •

The number of temporary and experimental plots in the province is 57.

The institution of an annual Range Officer's return certifying to the upkeep of painted numbers, boundary ditches, etc., has been found useful in preventing plots from falling into disrepair.

(ii) *Volume Tables.*

Over 3,000 *sal* and 4,000 teak trees of qualities, I, II, III and IV and all ages were measured for total height, girth over bark at $4\frac{1}{2}$ ' length of useful log or pole and girth over bark at $\frac{1}{2}$ total height. One per cent. of these trees were measured as ordinary type or sample trees in detail. A *Sal* and Teak Volume Table, it is hoped, will hence be able to be published separately before the end of the present rains.

(iii) *Miscellaneous.*

In the Melghat from measurements of thinned and unthinned trees the following figures for quality II teak in the province 70' to 90' height of mature trees) were obtained:—

Age.	Thinned or dominant. Girth in inches. A	Unthinned but vigorous. Girth in inches. B	Unthinned and partially suppressed. Girth in inches. C
5	7.5	5.0	2.2
10	15.8	9.1	4.8
15	23.7	14.0	7.0
20	32.3	19.0	9.0
25	41.0	23.5	12.0
30	49.2	28.0	14.4

That a given tree may vary between the condition of B and C was found to be quite possible. In one instance where a sudden freeing of the crown had occurred the annual ring distance jumped from $\frac{1}{15}$ inch to $\frac{1}{8}$ inch.

UNITED PROVINCES.

I.—EXPERIMENTAL SILVICULTURE.

(i) *General.*

Investigations followed along the lines mentioned in last year's report; the chief items of research and the progress made in the investigations may be briefly mentioned under the following heads.

(i) *The study of the natural regeneration of sal.*—This subject continues to receive attention and is of the utmost importance as the system of management now being adopted depends on our being able to regenerate at will in a reasonable time any compartment of *sal* forest. So far we can only be certain of doing this where considerable quantities of advance growth are already existing. In the case of regeneration *de novo* from seed the experimental plots in Haldwani still give hopes of ultimate success.

(ii) *The study of natural and artificial regeneration of the more important timber species.*

These investigations continue in most divisions.

(iii) *The application of taungya cultivation on a large scale.* This is being carried out with much success in the Gorakhpur Division by Mr. Wood, and experimentally in other divisions.

(iv) *Yield tables for sal.*—These tables have been prepared by Messrs. Howard and Smythies and published by the Forest Research Institute.

(v) *Volume tables for sal.*—A number of figures have been collected for the Forest Research Institute.

(ii) *Natural Regeneration.*

(a) *Sal.*—Investigations may be divided into conditions favourable for germination and conditions necessary for continued growth. In the former case extensive operations have been carried out in many divisions to mitigate adverse conditions of undergrowth by early burning and to provide a suitable germinating bed by this means. The following are the results obtained.

Burning should be done early in April; it should be carried out in the evening or at night when the wind has dropped and should be done against the wind. When there is much grass on the area two burnings may be done, the first to burn the grass as soon as it will burn and the second to burn the leaves in March. When carried out in this way no damage is done to the flower on the trees. Carelessness and inattention to these details, burning with the wind to save time, late burning of areas with much grass results in scorching and destroying the flower. The results of burning for several years in succession have been most satisfactory. In Gonda division *Clerodendron* 10 to 12 feet high has been reduced to 2—3 feet high, thinned out and much weakened. The same results have been obtained with *rohini* (*Mallotus philippi-*

nensis). The lower branches are killed and the whole growth of this weed weakened. In Bahraich similar results were obtained but *Flemingia* was not affected. To do any good the fire must be continued from year to year. The effect of burning on the *sal* seedlings already on the ground is also marked. The shoots thrown out by these seedlings are much healthier in appearance and of greater height than before burning. Excellent regeneration has been obtained as the result of such burning before a seed year.

The second problem is to get these seedlings to grow instead of dying back and eventually perishing as is their normal fate under a close canopy. The Lakhmanmandi experiments in the Haldwani division have shown that—

- (a) A close canopy is fatal.
- (b) Burning restricts the normal mortality under a close canopy.
- (c) A good shelterwood felling eliminates dying back.

The seedlings in the shelterwood plots are growing from the top but they have not yet grown away from the grass as was expected, and until this has happened and the whole area is filled with thoroughly established young *sal* a solution cannot be claimed.

The latest technique in the management of *sal* in these provinces makes every possible use of coppice regeneration whether the silvicultural system is theoretically "High Forest" or "Coppice." Thus in the Dehra Dun Division very large areas have been successfully regenerated by coppice under a shelterwood, which fulfils the double function of seedling up blanks and protecting the young coppice from frost. The Ramnagar Division has also adopted this method under suitable conditions with excellent results, and the same considerations influence the details of the management of several working circles in Pilibhit and South Kheri. Nothing has happened to cast doubt on the conclusions put forward in last year's report. It seems that the regeneration by seed of any compartment of *sal* forest must be a long process. Much has been learnt in the last five years, several causes of mortality have been eliminated, but it must be several more years before this investigation can be brought to a satisfactory conclusion.

(b) *Miscellaneous Species*.—As regards the natural regeneration of *Terminalia tomentosa*, *Anogeissus latifolia* and *Holoptelea integrifolia* which is under investigation on a large scale in Ramnagar and Gonda divisions no progress has been made. It was observed in Dehra Dun that profuse natural regeneration of *Terminalia tomentosa* was obtained in compartments which had been burnt departmentally in 1922-23.

The successful fire protection of the North Kheri forests is given as a cause for the disappearance of the regeneration of this species.

The regeneration of *Anogeissus pendula* was investigated in the Jhansi division and observations went to show that this species

could be regenerated by seed under a shelterwood in the usual way. Seedlings germinating under a close canopy all perished.

(iii) *Nursery Work.*

With the increasing attention being paid to artificial regeneration several new nurseries were laid out, mostly for the supply of root and shoot cuttings of *sissu* or teak. In many divisions germination of teak was not obtained till the second year. In Gorakhpur by sowing the nursery beds in April covering with grass which was watered once a week and then removing the grass at the break of the rains excellent germination was obtained. In *haldu* and *bakli* sowings, boulders placed on the mounds prevent the seed being washed away.

(iv) *Artificial Regeneration.*

The most interesting feature of the year has been the work in Gorakhpur about which Mr. Wood writes:—

Coupe 2, Tikonia.—The 1919 sowings continued to grow well and no mortality was experienced. One of the strips was measured in December, that is when the seedlings were $4\frac{1}{2}$ years old. The height of the dominant crop was average 12 feet 9 inches, giving an average annual height growth of 34 inches. The old trees here are rather below 3rd quality and Hole's ideal seedling development for trees $5\frac{1}{2}$ years old is 32.2 inch per annum. (Indian Forest Records, Volume VIII, Part II, page 4.)

The teak continued to grow well. The teak root and shoot cuttings which were put in at the break of the 1922 rains grew well and developed rapidly. This was very marked in the case of those which were planted earliest at the break of the rains. The best of these, being 2' 6" high at the break of the rains and one year old, actually grew to a height of 12' during the rains. On these results teak root and shoot cuttings were put out in May with a heavy watering at planting. Shoots resulted in about 10 days, no further watering was done and they went right away when the rains broke. These shoots 1 year old are now upto 5' 6" high, and are very much better than any obtained by planting when the rains break.

The 20 acres of recently sown *sal* was badly hit in the hot weather, which was very severe. They went ahead well in April and May, being then rising 1 year old, but the soils heavy and bad, and in June we had for a week a rapid alternation of wet east and dry west winds. The former blew daily till midday and the latter on from then till evening. The rapid alternation was too much for the seedlings, very many of which died, whilst the survivors all looked as if they had been badly frost bitten. Over most of the area, however, a sufficient crop remains. *Coupe I., Bhari Babban.*—The area of 1 year old sowings destroyed by pig was successfully re-sown and has done well. Pig damage has been slight.

Coupe 1, West Lehra.—The 12 acres of *sal* sowings are now $1\frac{3}{4}$ years old. The best plant at $1\frac{1}{2}$ years old was 4' 6" high. This is better soil and results have been most promising. The winds of June here made the whole area look frost bitten but no seedlings were killed, weeding was carried out at no cost as the surrounding population were ready to weed in return for being allowed to take away the grass weeded out. The grass between the lines was sold for Rs. 35 or Rs. 3 per acre, so that we have begun to get returns the year after sowing. The line of *asna* went right ahead and plants are in some cases upto 6' in height.

Taungya Plantations.—The West Lehra *Taungya* entered on its second year during the year under report. The position at the end of March 1923 was that some 140 acres had been cleared, comprising the whole of the coppice failures in coupes 1 and 2. This had carried one *Kharif* and one *Rabi* crop and by the end of March 1923 the *Rabi* was reaped and the land clear and clean. In April our lines were dug 18' apart and the method adopted was to dig trenches 1 foot wide and 1 foot deep, the earth being taken out and piled on one side. The depth of the trenches was measured and when passed the bottom of the trench was hit over with pick-axes when available, otherwise with *phaovias*. The earth was then left to bake in the sun and at the end of May the trenches were filled in and everything was got in readiness for the sowing. All preparations were made for the latter to conform with the following principles:—

- (1) Only seed actually taken from the trees was to be used and of this the biggest seed to be preferred.
- (2) No seed to be exposed naked to the sun, and seed to be sown at once on picking, the collectors and sowers being so balanced that the latter should never have very much seed in hand.
- (3) The work to go forward instantly the rains broke, and all seed to be sown during rain fall or within 24 hours of rain.
- (4) The seed to be sown on its side, the seed covered with earth sufficient to cover the seed but leaving the wings exposed.

Once the *sal* was sown the spaces between the lines were dug and sown with crops broadcast. When the crops were about 10 days old the lines received the first weeding, no *kurpis* were allowed, the rice, weeds, etc., being pulled out by hand. The subsequent weedings were done by *kurpis*. Germination of the *sal* was complete over the whole area, and there were no gaps in the lines. Development was good up till October. A large proportion of the area had, however, been sown with *arhar* (*Cajanus indicus*) and when this grew up in October it arrested the development of the *sal*. In the cold weather the whole area was attacked by pig. These animals proved impossible to deal with in the *arhar*, but the area in the open was protected perfectly well. Everything we could

think of was tried. Parties of Gurkhas were sent out from the recruiting depot but in the *arhar* it was impossible to get at the pig, and practically the whole of the sowings—some $\frac{3}{4}$ of the area, in the *arhar* was destroyed and will have to be redone this year. The sowings of *arhar* will, in future, not be permitted on the *taungya* after the *sal* has been sown. We have, therefore, this year failed to regenerate the failure in the coppice with *taungya* but our failure was solely due to the fatal mistake of growing *arhar*, a mistake which will not be repeated. In the open, in spite of the conditions for sowing having been most unfavourable, we have, however, demonstrated the usefulness of the method. Here the lines are completely stocked with vigorous *sal*, and it must be said that this April, in spite of a very unusually strong *Loo*, the seedlings have shot up with such vigour, that unless something very unusual happens, they are certain to survive their first hot weather after which experience shows there is little more to fear.

Much work has been done in other divisions both with and without *taungya*, some of it in the way of experiment and more of it as a routine measure under the prescriptions of working plans. In the North Kheri division *jaman* (*Eugenia Jambolana*) has been found to be the best species for the afforestation of the high alluvium *phantas*. Teak was very promising but was destroyed by the remarkable floods of September-October. On the low alluvium (W. C. IV) nearly 200 acres of open grass land were taken in hand for artificial regeneration of *khair* (*Acacia Catechu*), *simal*, *sissu* and *bhillaur* (*Trewia nudiflora*), and a few mounds were sown with teak. This was done in accordance with paragraph 157 of the new working plan. Mounds about 1 foot in height were made on these areas. There are four plantations, one in each range. The one at Sathiana in Dudwa Range was made on much higher ground than the others. Germination was good in all plantations, but the seedlings were practically all killed by the floods in September-October except at Sathiana where the results are very good; *khair*, *simal*, *sissu* and teak are all doing well there.

The planting of *jaman* root and shoot cuttings was carried out with much success in the South Kheri division.

The propagation of bamboos was continued with somewhat varying results; some success was obtained by planting rhizomes both in Dehra Dun and Lansdowne. The former division reports the best results from planting nursery raised seedlings.

(v) *Reclamation and Afforestation.*

The Afforestation Division continued work on a large scale and over 2,000 acres are dealt with annually. Increasing attention is being paid to *khair*. The work has now been reduced to a matter of routine standardised. In other divisions, especially North Kheri, Gorakhpur and Gonda the conversion of grass and

waste land into plantations is being carried out. Extensive experimental work is also being done in Saharanpur. The afforestation of the *chandars* of Pilibhit and South Kheri is being taken up seriously and the planting of *sissu* root and shoot cuttings as a frost protection to the existing *sal* will be made on an extensive scale.

(vi) *Underplanting.*

The undersowing of *sissu* with *sal* in Haldwani has not given any definite results as yet. In South Kheri a similar experiment was destroyed by floods.

(vii) *Silvicultural Systems.*

The silvicultural system described on page 55 of last year's report where 20—40 seed trees are selected to the acre and everything else clear felled and coppiced has continued to give excellent results wherever conditions are favourable to the application of this system. Thus in Dehra Dun, Ramnagar, Pilibhit and South Kheri a large area of *sal* has been perfectly regenerated in this way. A definite system of coppice with standards where the standards act as a frost protection wood has been evolved for the Nawadia and Gola working circles of Pilibhit and South Kheri. Under this system starting with coppice with standards the standards are removed during a period of 10 years after which the coppice grows on into high forest.

(viii) *Miscellaneous Experiments.*

The burning of *sal* coppice coupes after the completion of the work and before 15th April has been found to be beneficial in all divisions which have tried it. The resulting coppice comes from the ground level, suppressed advance growth seems to be rejuvenated and sends out new vigorous shoots and the ground is cleaned of rubbish. Experiments on the elimination of *rohini* (*Mallotus philippinensis*) were continued in most divisions with varying results. Girdling and painting the girdle with sodium arsenite seems to be the best method; although the roots are not killed the resulting shoots are weak and can be easily dealt with in subsequent years.

An experiment has been initiated in Dehra Dun with the object of propagating quick growing fodder trees in the grazing working circle.

Four experimental bamboo (*Dendrocalamus strictus*) plots were laid out in the Lansdowne division with the object of ascertaining (under the existing system of fellings)—

- (1) The best rotations.
- (2) The optimum density of the overwood.

II.—WORKING PLANS AND STATISTICS.

The working plan position in the United Provinces is quite satisfactory, all arrears have been worked off since the creation of the Working Plans Circle, and the revision of plans now progresses in an orderly manner. During the year the following plans were under preparation, Chakrata Leased Forest, Ramnagar, Banda, Jhansi, Gorakhpur, Afforestation, East Almora. As regards statistics the yield table for *sal* by Messrs. Howard and Smythies was published during the year. The following sample plot work was done:—

Deodar.—One new plot was laid out.

Chir.—6 new permanent plots were laid out, 4 old and 7 temporary plots were measured.

Oak.—4 new plots were laid out.

Sal.—2 new plots in quality II and 3 plots in quality III were laid out, 2 old plots were remeasured.

Sain.—2 new plots were laid out.

Sissu.—9 old plots were remeasured and 2 new plots laid out.

Sandan.—1 new plot was laid out.

A party was detailed to measure volumes and heights of individual trees for compilation of the local volume table which is being prepared in co-operation with Forest Research Institute. The measurements were sent to Dehra Dun for compilation.

PUNJAB.

I.—EXPERIMENTAL SILVICULTURE.

(i) *General*.

Nil.

(ii) *Natural Regeneration*.

The experiments made of the best methods of regenerating spruce and fir were continued in Kulu and Lower Bashahr and the results have been disappointing. In the 100' strip in Kulu all the seedlings were found dead in April 1924 possibly due to late snow in March. In other plots the reproduction is very scanty and so far no information as to the best method of regenerating these forests has been obtained.

The experiments in the best rotation for cutting bamboos were continued in Hoshiarpur Division. An exception must be made to last year's statement that biennial cutting gives the best results. For lance staves for military purposes greater maturity is required and it will be necessary to carry on the experiment for some years to determine at what age the bamboos are most

suitable for this purpose. There is a lack of elasticity in bamboos 2 years old.

In the course of regeneration operations in the *Populus euphratica* forests of the south-west Punjab (which partake of the nature of clear felling and regeneration by root-suckers) it was found that while regeneration was entirely satisfactory in areas which contained numerous stumps of felled trees, it was more difficult to obtain in areas less well stocked with stumps, often indicating stiff or saline soils. In the latter areas considerable improvement in the stock of root-suckers was obtained by ploughing or hoeing up the soil with an ordinary country plough or with hoes.

Frequent failure of cultural operations to supplement the natural regeneration of *chil* (*Pinus longifolia*) on hot dry soils, especially those subject to heavy trampling by cattle in the past, drew attention to the importance of a fuller study of methods. Little could be done during the year owing to lack of seed, but so far as experimental work has gone, the advantage of shade during the hot dry months of April-June seem to be clearly established. It seems probable that failure is largely due to the loss of moisture by such soils and steps are being taken to try the effect of catch-drains cut at intervals of some 20' in areas in which patch sowing and dibbling is to be done, and also of more intensive trenching along contours and sowing the seed on the berm of the lower side of the trench. As 1924 will be a fairly good seed year it is hoped that conclusive results will be available shortly.

(iii) Seeds.

An experiment was made in Seraj Division in speeding up the germination of ash seed by soaking in hot water and sulphuric acid for periods from 24 to 72 hours, the sulphuric acid of strength 10 per cent., 25 per cent. and 50 per cent. The result showed no difference from untreated seed.

(iv) Nursery Work.

To compare the effects of frost-lifting on soil mixed with ashes and plain soil, some patches in the Seraj Division were prepared 2' in diameter and 9" depth. To half of these wood ash was added and the remainder were left untouched. *Kail* was sown in patches just before the rains, and the germination was fairly successful.

During the hard frost of November it was very evident that frost-lifting was bad in those patches treated with ashes, while in those untreated it was negligible. After the snow had melted in March, the seedlings lifted in November were still alive, but quickly died after exposure to the sun. The locality was cool and damp and the soil had a considerable admixture of clay.

From this experiment it would appear that the danger of frost-lifting is increased in the case of light, well worked soil such as is obtained when ashes are added; thus if *kail* and spruce are to be sown in the rains in a locality where severe frost is expected in

November, it would appear expedient to dibble in; the burning of debris in such localities is probably inimical to reproduction.

Attempts to grow eucalyptus in the Irrigated Plantations of the Punjab have not yet been attended with any marked success. It seems probable that much of the failure has been due in the past to the use of "pot-bound" plants purchased from outside sources: in future care will be taken to grow the plants required in the plantations from seed. Reports show that *Eucalyptus rudis*, *E. paniculata*, *E. tereticornis* and *E. saligna* sown in boxes in September, the seedlings later being transplanted into nursery beds from 6—8 weeks, did quite well when planted in the forests. The seedlings were raised under the shade of a 4-year old clump of *Melia Azedarach*.

(v) *Artificial Regeneration.*

Attempts were made to commence deodar reproduction on the *taungya* method in Lower Bashahr, but the results were not very successful. At Kiuli the villagers were induced to take up over 100 acres of forest burnt in 1921, and grow catch crops, in return for clearing the areas of burnt timber and sowing deodar. Some areas were also sown departmentally with crops on the same lines. The following is the summary of what has been learnt from this *taungya* experiment:—

1. Zamindars cannot be induced to take up forest land temporarily unless there is a land famine. If their own land is as much as they can manage, they will not take up land, however good, for the sake of two or three catch crops.
2. The Forest Department should not attempt temporary cultivation.
3. Zamindars will only take up small and scattered areas; these are difficult to control and protect until fully established.

The phenomenal success attending the use of *shisham* (*Dalbergia Sissoo*) "root and shoot" cuttings in the comparatively small scale work of previous years, led to further experiments. In Daphar Plantation experiments have shown that provided there is some rain before irrigation starts in April, the best season to put out the cuttings is February. The Divisional Forest Officer, Northern Plantation Division, writes as follows in connection with the experiments in Daphar:—

"In Daphar some 10 acres were planted in February 1923 on high ground where sowings had previously failed; we have got 100 per cent. success and all plants have grown 4 feet in the year. Many are 8 or 9 feet in height in 12 months."

"Cuttings have proved invaluable for filling up blanks and bad ground. Compartment 20 of Daphar is worse than any other ground yet attempted in this type of work for

it has a drop of 20 feet in 600' and the soil is rotten with *kallar* salts, overlying a *kankar* pan. Even here we have got 60 per cent. success with cuttings, though of course the growth is bound to be much slower than on better ground."

Experiments to provide a protection against drought and birds for deodar seed sown in burnt areas where no shelterwood exists.

Seed of the following were sown (in Seraj Division) in patches along with the deodar seed:—

1. Barley.
2. Clover.
3. *Kathu* (a vegetable cultivated by the hillmen).

There was no drought, so this part of the experiment failed but the protection afforded by these subsidiary crops which came up with the deodar was very marked. Damage by birds in the patches in which there was no green stuff other than deodar scantlings was very serious, and re-sowing had to be done over many areas. But where the subsidiary crops had come up with the deodar there was little or no damage by birds, as the seedlings were not conspicuous.

To devise the best methods of getting artificial regeneration of *ban* oak (*Quercus incana*) the following experiments of sowing were tried in Dharmsala Range of Kangra Division over an area of half acre and are detailed below:—

(a) *Plot No. 1.* Area $\frac{1}{4}$ acre.

	Rs.	A.	P.
Hoed up in January 1923	6	12	0
Hoed up in February 1923	3	0	0
1 maund of seed sown broadcast on 17th February 1923 and earth balls broken	3	0	0
	12		0
	12		0

Percentage of success 80 per cent.

(b) *Plot No. 2.* Area $\frac{1}{8}$ acre.

Hoed up once and earth balls broken, after broadcast sowing on 20th February 1923.

	Rs.	A.	P.
Cost of hoeing	5	0	0
Cost of 20 seers seed sown	1	4	0
	6		0
	6		0

Success 90 per cent.

(c) Plot No. 3. Area $\frac{1}{8}$ acre.

	Rs.	A.	P.
Hoed up once and earth balls not broken at a total cost	4	0	0
Sown broadcast with 20 seers of seed on 22nd February 1923	1	4	0
	<hr/>		
	5	4	0
	<hr/>		

Success 95 per cent.

From the above results it is probable that the broadcast sowing of *ban* seed after hoeing up the soil and without breaking the earth balls is more economic and gives better results. The condition of seedlings in this case is more healthy than the rest.

In order to make comparison of the above sowing with the ordinary method of sowing in pits and dibbling, similar plots have been made and *ban* seed sown in February last. The seeds have not yet germinated and so the results cannot be summarised and will be mentioned in next year's report.

(vi) Reclamation and Afforestation.

Deep ploughing in the more level ground has resulted in the eliminating of a poor useless grass named "*lan*" and its replacement by the more valuable grass *dhaman*, which in untreated areas is only found on the deeper richer soils. Where the "*dhaman*" grass already exists shallow ploughing is sufficient to improve the quantity of grass. At the same time the chief credit for the improvement of the fodder supply is undoubtedly due to the holding up of moisture by the trenches and ridges which are a usual feature of reclamation work in the Punjab as in the United Provinces, since the better grasses will only grow when the moisture content of the soils is raised. Attempts to introduce lucerne in the Pabbi have failed, as though it germinates it will not stand the heat and drought of early summer in these arid hills.

Of trees used in afforesting the more broken ground and in giving a light cover for the fodder areas located in easier ground the *walaiti jand* (*Prosopis juliflora*) has been most successful, the seedlings growing vigorously even on the hard red clay slopes where little else can exist. *Shisham* (*Dalbergia Sissoo*) appears to be likely to succeed in the lower ground along nullahs, etc., where sufficient moisture is retained: the same is the case with *Melia Azedarach*, which grows particularly well on the bandhs. *Kikar* (*Acacia arabica*) has proved a disappointment; it will not stand frost, (which occurred for the first time in the Pabbi since work was started) and was killed back to the ground on a large scale: it also seems to suffer severely from the attacks of white ants.

(vii) Thinnings and Cleanings.

Research work is urgently required to find out to what age or size pure *kail* forests can be left without thinnings, without reducing the quantity and quality of the final yield. There are vast areas of pure young *kail* woods in the Lower Bashahr Division which should according to European ideas, be thinned at once. But the work is expensive and the produce from thinnings at present unsaleable.

II.—WORKING PLANS AND STATISTICS.

An experiment to ascertain the rate of girth increment of tapped and untapped *chil* was started in Kangra and Hoshiarpur Forest Divisions.

In Hamirpur Range of Hoshiarpur Division, 3 sample plots were laid out during the year in Humal, Platu and Kharal Forests, to ascertain the volume and number of trees per acre in fully stocked *chil* forests.

NORTH-WEST FRONTIER PROVINCE.

I.—EXPERIMENTAL SILVICULTURE.

(i) General.

Experiments during the year were rather restricted owing to re-organization.

(ii) Natural Regeneration. (Including coppice, root-suckers, etc.)

(a) Silver Fir (*Abies Pindrow*).—Regeneration of this species appears to establish itself in small groups on cool slopes, well sheltered from the sun, and immune from grazing. There was an unusually good seed year in 1922 and in April and May 1923. The ground was thickly carpeted with seedlings, but these practically had all died by the end of June, especially under conditions of light shelterwood. More seedlings survived under heavy shelterwood than in any other areas.

(b) Olive (*Olea cuspidata*).—Regeneration of this species was kept under observation, in order to ascertain whether their subsequent development, when freed from brushwood, was greater than when growing under brushwood; owing however to the slow growth of this species, no results can yet be ascertained, except that seedlings so freed from brushwood, suffered more severely from browsing.

(iii) Seeds.

Nil.

*(iv) Nursery Work.**Nil.**(v) Artificial Regeneration.*

(i) Silver Fir.—In Reserved Forest Tajwal Compt. 2 of the Dungagali Range, 11 acres were sown under different circumstances as follows:—

- (a)* Weeds and undergrowth were cut over $\frac{1}{3}$ rd of the area and patches hoed up were sown.
- (b)* Weeds and undergrowth cut and burnt over $\frac{1}{3}$ rd of the area and the ashes thoroughly mixed with the earth in the hoed up patches. These were then sown.
- (c)* Seed sown in hoed up patches: no weed, etc., cut. In May 1923 all areas had germinated freely and a dense crop of seedlings survived up to June: then prior to the rains large numbers died. *(b)* showed by far the best results, and at the beginning of October a fairly large number had survived. *(a)* and *(c)* were practically complete failures.

(ii) Olive.—Germination was good, especially where the brush-wood had been burnt, but porcupines destroyed practically all the seedlings in the experimental area.

(iii) Blue Pine.—Experimental sowings were made in areas which had been clear felled, and the slash collected and burnt. Seed germinated well in April and May, but heavy mortality occurred in June: by the end of October not more than 6 per cent. of the seedlings had survived.

(iv) Deodar.—Direct sowings were made in lines, but success has been poor. In Kamalban Compts. "E" and "F," the felling refuse was collected and burnt, and seed sown in the ashes, which had been mixed with the soil; here germination was good and the seedlings are doing well.

(vi) Reclamation and Afforestation.

A mixture of blue pine and maple seed was sown in hoed up patches over a blank area of 60 acres: these blanks were covered with a dense growth of weeds. Very few seedlings have survived.

*(vii) Thinnings and Cleanings.**Nil.**(viii) Mixtures.**Nil.**(ix) Underplanting.**Nil.*

(x) *Silvicultural Systems.**Nil.*(xi) *Miscellaneous.*

Experiment of inoculating blue pine with ribes, fungus.—Four blue pine poles near Kamalban Rest House were inoculated with the spores of *cronatium ribucolum*, by washing the infected leaves on to the exposed surface of the blue pine poles: no result has been observed as yet.

II.—WORKING PLANS AND STATISTICS.

(i) *Working Plans.*

- (a) A Revised Working Plan of the Galli Forests, by Mr. E. A. Greswell, Deputy Conservator of Forests, was published during the year.
- (b) Revision of the Working Plan of the Khanpur Range Forests was commenced in the last quarter of the year.
- (c) A Revised Working Plan of the *Chil* areas of the Siran Division was revised by Mr. E. A. Greswell, Deputy Conservator of Forests, during the year, but is not yet published.
- (d) A Working Scheme for Giddarpur Guzara was prepared by Khan Mohammed Khan, Extra Assistant Conservator of Forests, this also has not yet been published.

(ii) *Volume and Form Factor Tables.*

Volume Tables for Blue Pine and Fir were compiled for the Galli Forests, and published in the Revised Working Plan.

A volume table was prepared for *chil* (*Pinus longifolia*) showing the volume of single trees by classes, as follows:—

Class.	Diameter over bark at breast height.	Volume of item down to 10" diameter at the thin end including bark by quarter girth method.
I	30" & over	223 c. ft.
II	24"-29"	152 "
III	18"-23"	80 "
IV	12"-17"	28 "
V	Below 12"	6 "

These data are based on the measurement of 5,852 trees.
Bark measurements, etc.—Data collected for the Siran W. P.

Inches of radius.	Corresponding diameter at stump height under bark.	Diameter at stump height over bark.	Thickness of bark
	Inches.	Inches.	Inches.
1	2	3	1
2	4	5	1
3	6	7	1
4	8	9	1
5	10	12	2
6	12	14	2
7	14	16	2
8	16	18	2
9	18	20	2
10	20	22	2
11	22	25	3
12	24	27	3
13	26	29	3
14	28	31	3
15	30	33	3
16	32	35	3
17	34	37	3
18	36	39	3

(iii) *Miscellaneous.**Nil.*

MADRAS.

I.—EXPERIMENTAL SILVICULTURE.

(i) *General.*

Experiments already in existence dealing with different methods of regeneration were continued and a number of new plots were instituted in the Nilambur plantations to ascertain the best method of raising an underwood under teak.

A number of sample plots laid out by Mr. Bourne in 1918 in connection with his working plan for the Nilambur Teak Plantations were taken over by this office.

Experiments everywhere were seriously handicapped by the abnormally heavy rains during June-July and August and by the failure of the North-East Monsoon.

(ii) *Natural Regeneration.*

A number of observation plots are being maintained to note (a) the behaviour (progress or decline) of seedlings of certain species resulting from natural regeneration and left entirely to themselves, (b) the effect of exploitation on the seedling growth previously in existence, (c) the progress of natural regeneration on an evergreen area clear felled.

Most of the plots have not reached the stage when any definite conclusions can be drawn but it seems to be established that regeneration of some sort can be counted on after exploitation in an evergreen forest, but the problem remains to induce regeneration of those species which will be most saleable.

(iii) *Seeds.*

In the nurseries at Dhoni and Nilambur many methods of treating the seed of *Terminalia paniculata* were attempted during March—April with very indifferent success. In the Nilambur nursery practically no germination was obtained at all. In the Dhoni nursery in one bed 6' x 3', 140 seedlings were obtained by covering the bed with a whole bag of seed and watering copiously, a method too expensive to be practicable.

It is not a question of whether the fruits contain seed, but whether the seed is good. A recent examination of a large number of seeds at Nilambur failed to produce a single good one. In 1922-23 the quality of seeds from the same trees was much better.

The experiments will be repeated annually to see whether the quality of the seed varies in any fixed rotation.

Very little success has been obtained with seeds of *Bischofia javanica*. Some germination has been obtained in the nursery, but direct sowing in the forest has invariably proved a failure. In the Assam Research Report for 1922-23 100 per cent. germination is claimed and enquiries are being made as to the methods adopted.

The following germination results have been obtained, further to those published in the Report for 1922-23. Species which have given more than 50 per cent. germination:—

Species.	Age of seed.	Germination. Per cent.	How treated.
<i>Hardwickia pinnata</i>	1 year .	56	Immersed for 36 hours in boiling water.
<i>Mangifera indica</i>	3 weeks .	59	Untreated.
<i>Terminalia tomentosa</i>	4 days .	62	Crushed before sowing.
<i>Xylia xylocarpa</i>	15 weeks .	50	Untreated.
Other germination results.			
<i>Gmelina arborea</i>	51 days .	20	Untreated.
<i>Dichopsis elliptica</i>	2 „ .	20	„
<i>Bombax malabaricum</i>	14 „ .	6	„
<i>Vateria indica</i>	7 „ .	98	„

Factors affecting germination.—

Terminalia tomentosa, untreated seeds 4 days old gave 12 per cent. germination in one case and 26 per cent. in another. Seed from the same source and sown four days after collection but slightly crushed before sowing, gave 62 per cent.

(iv) Nursery Work.

Nil.

(v) Artificial Regeneration.

In the 1921 plantation in the Nilambur Range mango seeds were dibbled over an acre in pits at an interval of 6' × 6' between the teak seedlings, this plot became water-logged during the South-West monsoon and practically all the seedlings died out.

In the Chenath Nair R. F. (Palghat No. 27), the experiment to discover with what success certain evergreen species can be established by sowing or planting in the open, which was recorded in detail last year, has borne out the conclusion tentatively drawn.

The results up to March 31st 1924 are appended and the conclusions recapitulated.

Species.	No. of pits sown.	Percentage of success.	Average height.	Number transplanted.	Percentage of success.	Average height.
			Ft. In.			Ft. In.
<i>Hardwickia pinnata</i> . . .	40	2.50	1 0	40	10	1 0
<i>Calophyllum tomentosum</i> . . .	50	Nil	..	38	Nil	..
<i>Vateria indica</i>	40	100	2 0	40	35	1 7
<i>Bischofia javanica</i>	40	Nil	..	40	72.50	3 4
<i>Hopea parviflora</i>	50	10	0 6	50	46	2 10
<i>Artocarpus hirsuta</i>	50	100	2 11	50	22	2 8

(a) Sowings of *Artocarpus hirsuta* and *Vateria indica* gave 100 per cent. success, and were more successful than transplanting.

(b) Transplants of *Bischofia javanica* and *Hopea parviflora* were very fairly successful and have shown good growth. A better stocking should be obtained by putting 2 or more seedlings into each pit instead of one.

(c) *Hardwickia pinnata* and *Calophyllum* have failed as also has *Mesua ferrea*, which was put in to replace *Calophyllum* in June 1923.

The experiment (No. 29 Palghat) to compare the results of sowing and transplanting evergreen species on prepared and unprepared soil under the shade of evergreen forest (noted in detail in the Report for 1922-23) is being continued.

Height growth during the year has been negligible, but casualties have been very few and the various species appear healthy and well-established. More light has been admitted by removing the lower storey and development will be noted.

An experiment (No. 30 Palghat) to compare sowing and planting of deciduous species in the open (see Report for 1922-23) will now be closed and the area handed back to the district.

The success obtained in the first year has been maintained and further casualties are unlikely. A tabular statement is appended.

Species.	Date of sowing or transplanting.	Number of patches.	Number of survivals on 6th May 1924.	Average height.
				Ft. In
<i>Xylia dolabriformis</i> seeds . . .	26th May 1922	200	172	1 0
" " transplants	26th May 1922	200	24	0 9
<i>Gmelina arborea</i> seeds . . .	28th May 1922	200	13	2 6
" " transplants 8 months old . . .	27th May 1922	200	45	3 6
<i>Terminalia tomentosa</i> seeds . . .	27th May 1922	200	183	3 4
" " transplants	23rd June 1922	200	130	3 4
<i>Lagerstroemia</i> seeds	30th May 1922	200	116	3 0
<i>Bombax malabaricum</i> seeds . . .	7th June 1922	200	13	0 7
" " transplants 2 months old	4th July 1922	100	51	2 2

N.B.—The statement in the Report for 1922-23 that seeds of *Gmelina arborea* and *Bombax malabaricum* were not available was incorrect; in each case seeds were sown in 200 pits but in April 1923 there were no survivals. During the growing season a few seedlings of both species threw up new shoots.

Both sowing and transplanting of *Terminalia tomentosa* was successful. So in regeneration of this species by sowing, blanks could be filled up with surplus seedlings from pits which contain two or more. Sowing of *Xylia* was much more successful than transplanting. Seedlings, though small, are sturdy.

For lack of seedlings, transplanting of *Lagerstroemia* was not attempted.

Transplanting.—As reported last year an experiment (No. 28 Palghat) was made in the Sappal valley—Chenath Nair, R. F. with stumped seedlings of certain evergreen species. 60 seedlings each of the following species were taken, 20 being 5' high, 20 - 3½' and 20 - 2' high.

- (1) *Mangifera indica*.
- (2) *Mesua ferrea*.
- (3) *Calophyllum tomentosum*.
- (4) *Hardwickia pinnata*.

Nos. 1 and 2 gave very indifferent results and were tried again this year with no better success. No. 3 failed entirely and was replaced this year by *Bischofia javanica*. This species and No. 4

(*H. pinnata*) have done quite well and may be expected to maintain the standard reached.

(vi) *Reclamation and Afforestation.*

Nil.

(vii) *Thinnings and Cleanings.*

Nil.

(viii) *Mixtures.*

Nil.

(ix) *Underplanting.*

A number of plots were laid out in the teak plantation of Nilambur (1910, 1912, 1916, 1917, 1919, 1920 and 1921) to ascertain at what age an underwood of *Hopea parviflora* or *Artocarpus hirsuta* can most satisfactorily be introduced under teak. The method adopted was dibbling 6 seeds in pits 6' x 6' apart, sowing in trenches 1' wide and 6' apart. The weather was unfavourable from the start and the excessive rainfall during the South-West Monsoon which flooded many areas and uprooted the small seedlings in others by its sheer weight and persistence, was followed by a failure of the North-East Monsoon and a consequent drought lasting practically from December 1923 to May 1924. Upto January 1924 there was a very fair number of seedlings in most of the plots, but not one plot succeeded in retaining more than 5 per cent. of its seedlings to the end of the hot weather.

The failure, except where seed was bad, must be attributed to climatic conditions and the experiments will be repeated. Some important lessons have, however, been learnt from the failure in the year under review which should afford a better chance of success in future.

It has always been realised that the seed of both *Hopea* and *aini* (*Artocarpus hirsuta*) retains its vitality for a short time only and that its freshness is therefore all important: but it was again driven home to us that the freshness of seed cannot be relied upon unless it is locally gathered, or unless it is obtained from some other locality under the direct supervision of a subordinate from the requisitioning district. The indent for these seeds has to be met at a time when all districts are busy, e.g., at the beginning of the rainy season and it is not to be expected that District Forest Officers can give the necessary attention to indents from other divisions when they are in all probability hard put to it to ensure fresh seed for their own needs.

A great deal of damage was done to small seedlings by drip, and the older the teak plantation the greater the force of drip: much of this could have been prevented by mulching the seedlings as soon as they appeared instead of mulching only after the rains as a protection against drought.

Weeding was in many instances too thorough: instead of clearing only the pits and furrows themselves of weeds, the whole area was kept clean throughout, with the result that no material was available for mulching after November. Moreover the retention of weeds where they do not interfere with seedlings will assist to prevent damage from wash and to retard the disappearance of moisture from the soil when the hot weather comes.

The problem of obtaining fresh seed is a vital one and in the case of *Hopea* which cannot be relied upon to seed freely more than once in three years, a satisfactory compromise may perhaps be effected by raising extensive nurseries when seed is available and by resorting to transplanting instead of sowing. The District Forest Officers, Palghat and South Mangalore, will both employ *Hopea* transplants in their regeneration programme for 1924-25 and the results will provide important information.

(x) *Silvicultural Systems.*

Nil.

(xi) *Miscellaneous.*

(a) It may be remarked that during the growing season of 1922-23, 100 *benteak* seedlings (*Lagerstroemia lanceolata*) established themselves on the area, in Plot 27, Palghat (See A. R.) and have prospered better than any of the evergreens. A number have been attacked by the borer "*Phassus malabaricus*" and have been cut back, while some others were removed as they were interfering with the species included in the experiment. The remainder average about 4' in height and one has exceeded 7'. It is very possible that this species regenerated itself so freely as a result of burning carried out in preparing the area, as the Madras Silviculturist has noticed their presence on a fire-line in the locality though they are not readily to be found in the adjoining forest.

(b) *Weeding.*—In the Nalkore R. F. (South Mangalore Division) two contiguous half-acre plots Nos. 13 and 14 of South Mangalore were laid out in September 1920 in a mixed forest containing *Hopea* seed bearers to note the effect of weeding on natural regeneration of *Hopea*. One plot has been kept weeded and the other unweeded.

An enumeration in March 1924 showed that there were 1,908 seedlings in the unweeded plot and 4,646 seedlings in the weeded plot.

Two similar contiguous plots Nos. 11 and 12 of S. Mangalore in which *Hopea* seed was also sown broadcast in June 1921 were enumerated in March 1924.

There were 6,656 seedlings in the unweeded plot and 3,485 in the weeded plot.

As the overhead shade is heavy, the weed growth is not sufficiently strong to kill out the young *Hopea* seedlings. In all the four plots seedlings vary from 6" or less to 6' in height.

The above enumerations show (1) that there is no object in keeping an area weeded after broadcast sowing of *Hopea* under shade and when natural regeneration is relied upon, sufficient seedlings to the acre should be obtained without resorting to weeding.

(2) that the presence or absence of weeds does not appreciably affect the height growth of *Hopea* when the seedlings are under heavy overhead shade.

II.—WORKING PLANS AND STATISTICS.

(i) Working Plans.

Nil.

(ii) Yield Tables.

Sample plots dealing with the volume increment of teak in the Nilambur Plantations are maintained by this office.

Two sample plots were laid out at the end of the year in the pure natural crop of *Xylia xylocarpa* in Nilambur Division—one thinned and the other unthinned. The Research Ranger, Nilambur, has been instructed to select and measure up typical trees of the more important species in the felling areas of the Nilambur Division.

The periodical girth increment of a number of *Hopea parviflora* trees is being recorded.

District Forest Officers have been requested to supply this office with details of all statistical experiments conducted in their divisions. No sample plots fell due for remeasurement during the year.

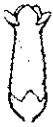
The Research Ranger, Nilambur, selected a number of typical trees of the more valuable deciduous species in the area felled during the year by the district staff, and measured them up in accordance with the system in force at Dehra Dun. More trees will be selected during the next felling season. The object in view is to provide a nucleus for yield tables and, by ascertaining the actual volume of trees of certain diameter classes, to provide a check for yield tables compiled in a rougher manner.

CHAPTER III.

BOTANY.

CENTRAL INSTITUTE.

As occurred last year the Forest Botanist was employed for 6 months of the year on work in no way connected with botany. The field study of the *Dipterocarps* was therefore again postponed.



B



C



D



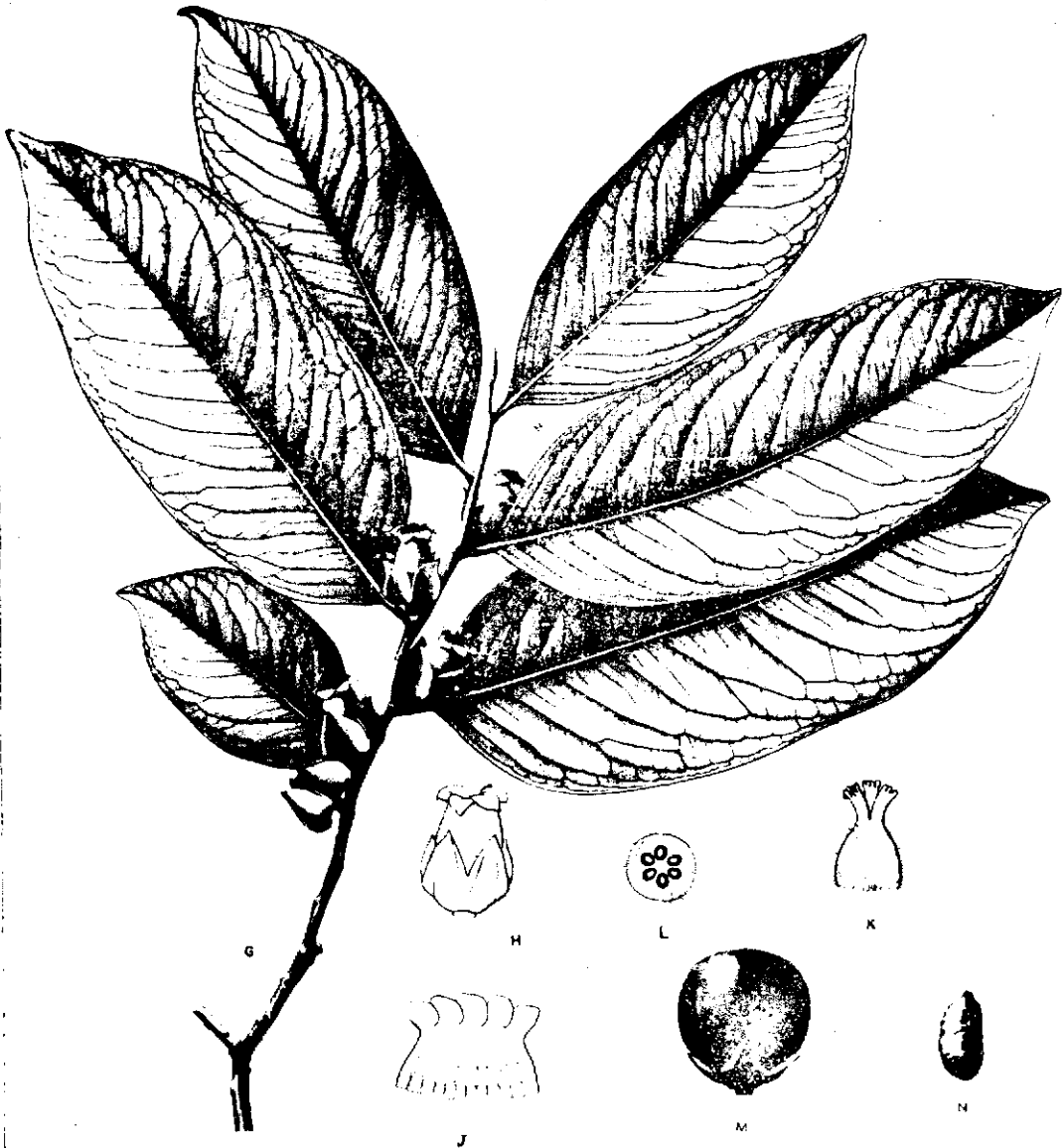
E



F

GANGA SINGH, *del.*

DIOSPYROS HOLEANA, GUPTA & KANJILAL - SP. NOV. ♂



GANGA SINGH, *del.*

DIOSPYROS HOLEANA. GUPTA & KANJILAL SP. NOV. ?

Twisted fibre in chil (Pinus longifolia) and the formation of Chilka.—These questions have been on the Botanist's programme for years without any work having been done on them. As the grant under travelling allowance did not allow of any distant tour a short one to Kumaon was arranged in order to see if the Forest Botanist could co-operate in any way with the local officers investigating the above subjects. As regards twist in *Chil* the Forest Botanist had arranged to discuss the question with Mr. Champion who had been investigating it for some years but owing to unforeseen causes the meeting never took place and the Forest Botanist was no longer employed on botanical work on the date fixed for the discussion. Meanwhile Mr. Champion's work on Twisted Fibre is being published.

Chilka has, for the time being at any rate, ceased to be of interest as owing to a fall in the price of wood tar it can no longer be worked profitably. The time chosen for visiting the *Chilka* areas was very unfavourable as firstly collection and distillation had ceased and secondly, owing to all the pine forests having been badly burnt in 1921, the best *Chilka* producing trees and stumps had been destroyed. Examination of material collected in previous years seems to indicate that *Chilka* is often the result of the breaking of a large branch and leaving a comparatively short broken end which remains living and becomes heavily impregnated with resin. As far as could be judged by the charred stumps it seems that stumps of trees felled in thinning or on the edge of fire-lines tend to become impregnated with resin whereas stumps of trees felled in regeneration fellings or in the middle of fire-lines rapidly die and produce little or no *Chilka*. If this is correct it indicates that *Chilka* is produced as the result of a severe injury which does not kill the portion of the tree injured. To produce *Chilka* artificially therefore seems of very doubtful economic value since it would probably always be better to collect the resin for distillation in the usual way than to allow it to soak into the wood and there produce *Chilka*. It also seems probable that all the *Chilka* likely to be required can be obtained from the bottom log of any tree that has been tapped for resin. Such logs are at present not used for timber and usually contain a good deal of *Chilka*.

Herbarium.—The incorporation of unnamed material is now practically finished and there is very little of this class of work remaining. The unnamed Queensland specimens referred to last year were disposed of by exchange with the Botanic Gardens, Sydney, for named Australian specimens.

Exchanges with foreign herbaria have been continued and valuable contributions have been received from the Arnold's Arboretum, The United States "National Herbarium", Philippine Islands, Geneva, Singapore, Ceylon, New Zealand and Sydney. Exchanges with other botanical institutions in India have been discontinued as nothing has been received in return.

5,672 sheets were added to the herbarium during the year of which 2,218 came from the old Saharanpur herbarium. These

specimens had been lying unidentified for many years but they have all now been named and incorporated in the herbarium.

Of the Indian plants the main contributions were received from Messrs. R. N. Parker, C. E. Parkinson, B. L. Gupta and R. S. Hole.

Two hundred and six specimens were identified for Forest Officers and others. This number only represents such plants as were especially sent for identification but does not include a large amount of work done for visiting officers nor casual work done for other branches in the Institute.

One hundred and ninety-two consignments of seeds weighing nearly 1,494 lbs. were despatched to various correspondents in fulfilment of indents during the year.

One hundred and twenty-eight volumes excluding duplicates and periodicals were added to the library during the year.

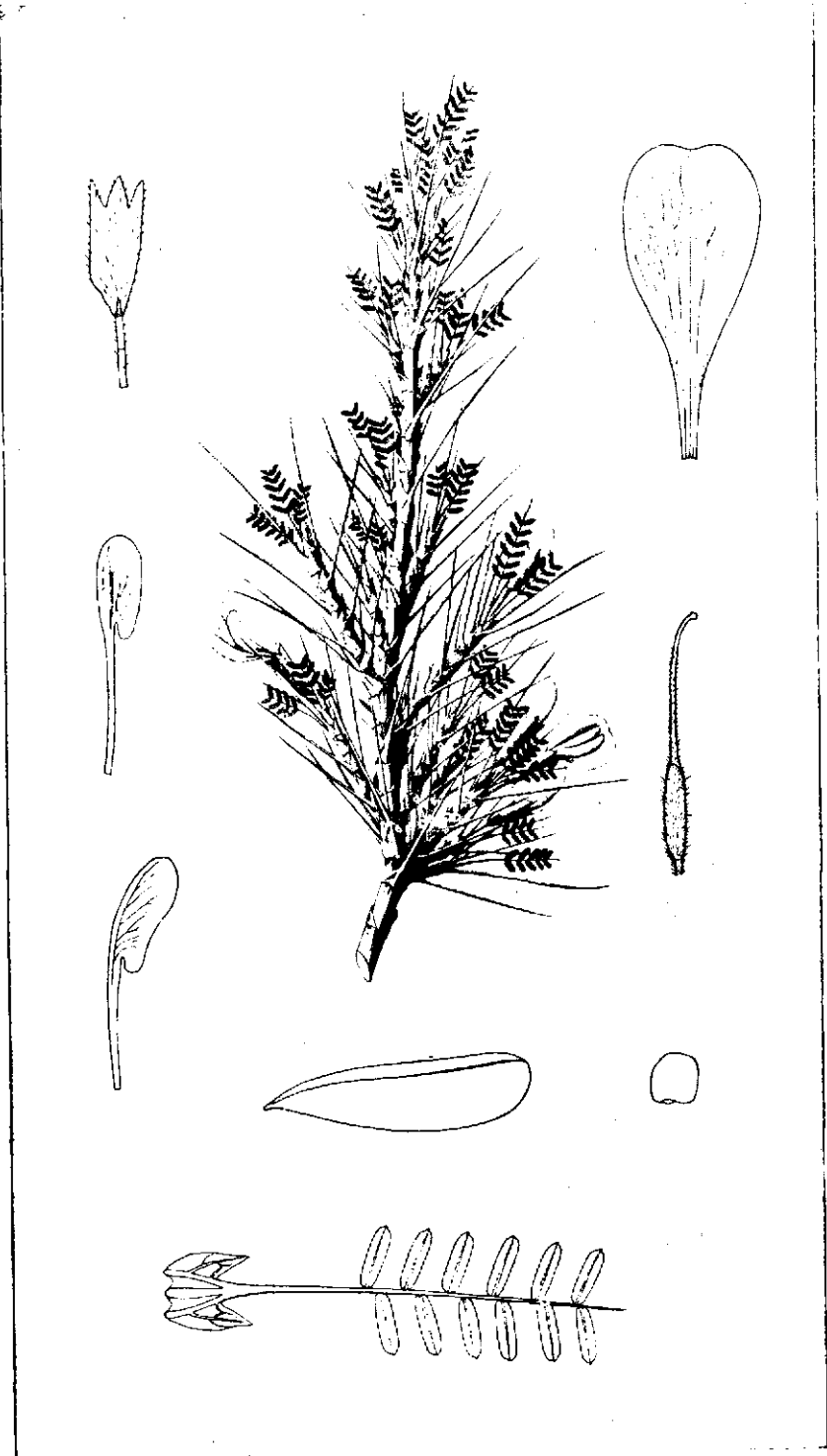
Systematic work.—Apart from the current work of identification which occupies most of the time of the staff, the checking of names in the genus *Artemisia* and a portion of the neighbouring genus *Tanacetum* has been done. Some interest in these plants had been aroused owing to enquiries for *Santonin* and it was found that much of our material of *Artemisia* was wrongly named and confused with several species of *Tanacetum*.

When touring in Kumaon it was found that several species of *Oenothera* had been naturalized as they have elsewhere in the North-West Himalaya. Except in the case of *O. rosea*, Sims., which is the commonest and most widely distributed species, it was found that in the Dehra Dun herbarium, where names had been given to these plants they were usually incorrect. As no recent literature is available in Dehra the sheets in the herbarium were sent to Kew where Mr. Dunn kindly named and returned them. The following species are established in the North-West Himalaya: *O. rosea*, Sims., *O. tetraptera*, Cav., *O. Drummondii*, Hook., *O. stricta*, Ledeb. and *O. polymorpha*, Levl.

In connection with Mr. Osmaston's Flora of Kumaon the existence of undescribed species of *Tetrastigma* was noticed. Here too the Dehra Dun material was much confused and in the absence of authentic specimens it was not considered advisable to undertake the description of new species in this genus. Our material was accordingly sent to Mons. Gagnepain in Paris, who kindly revised and checked the names and described two new species in the genus. It is possible that further work in the field will show that there is still another species that will have to be recognized.

The upper Kali valley visited on the Kumaon tour is botanically an interesting area. It was twice visited by Duthie some 40 years ago. Further material of some of Mr. Duthie's discoveries was collected and a new species in each of the genera *Berberis*, *Leptodermis* and *Spiraea* found.

The latter cannot be described as the flowers are still unknown, it is however in an accessible part of Kumaon so that flowering specimens can probably be obtained from the local forest staff.



Astragalus aegacanthoides, Parker.

Pathology.—The root disease of *Dalbergia Sissoo* referred to last year has been studied. Inoculations with *Fomes lucidus* and *Polyporus gilvus* have been made separately but up to date there is nothing to report. A third fungus which is a species of *Fusarium* and which has been frequently found associated with *P. gilvus* has been lately isolated and inoculations tried—which of these various fungi is the true cause of the disease is not yet clear.

In view of the discovery of *Cronartium ribicola* on *Ribes rubrum* in Hazara District it has become necessary to ascertain whether it has any connection with the Indian form of *Peridermium* on the 5 needle pine. Consequently inoculations on *Pinus excelsa* have been made both at Hazara and Mussorie. During the Kumaon tour the blue pine area at the head of the Kali valley was visited. Four species of *Ribes* were found but no signs of *Cronartium* on any of them nor of *Peridermium* on the pine.

Peridermium complanatum on *Pinus longifolia* has been recently discovered in Dehra Dun. A uredo form of fungus believed to be a *Coleosporium* found on *Campanula canescens* has been used to try and inoculate the pines in the belief that this might be the alternate form with the *Campanula* as host.

A root disease of *Pterocarpus Marsupium* is being studied and a fungus believed to be responsible for the death of many saplings in Kaunli garden has now been isolated. Inoculations on healthy saplings will be made as soon as the fungus is in a fit condition.

The abnormally quick absorption of preservatives by certain spruce timbers led to an enquiry as to whether the excessive permeation was due to a weakness of the tissues. It is due to weakness and the cause of the weakness appears to be a fungus. Specimens received from Captain J. H. Warr, Timber Preservation Officer, have been found to contain an unidentified fungus which is being cultivated, when ready samples of healthy timber will be inoculated under varying degrees of moisture. This investigation is being carried out in collaboration with the Timber Preservation Officer.

No progress has been made in the *sal* root disease for want of fresh material for cultural purposes. The fungus does not occur in Dehra Dun.

The investigation of the Spike disease on *Santalum album* with reference to the location and progressive accumulation of starch is nearly completed. A note on the results of this investigation is being prepared.

A number of new specimens have been added to the mycological herbarium. A further large collection of Indian Forest Fungi has been made and sent to Dr. J. Weir, Washington, for naming and exchange.

The investigation on *Trametes pini* on *deodar* (*Cedrus Deodara*) in Kashmir is complete and will be published in the near future.

UNITED PROVINCES.

Specimens of *Salvia lanata*, an important minor product were collected in Kumaon and identified at the Forest Research Institute.

It has now been verified after identification of specimens by the Forest Botanist that *Artemisia maritima* is found in the Garhwal hills.

The *kut* (*Sanssurea lappa*) which was sown last year in North Garhwal is still growing fairly well.

BIHAR AND ORISSA.

Pathology.—The *sal* root fungus *Polyporus shoreæ* is at present responsible for the death of many *sal* trees annually in Puri division. It is considered that the disease has probably spread on account of the dense undergrowth of evergreen species which has been induced by past fire protection, and it will now be watched whether the abandonment of fire protection will lead to any decrease in the virulence of the disease.

BURMA.

(i) *Ecology.*

Progress in the study of soils has been stimulated by a series of publications by Dr. Dudley Stamp, Professor of Geology at Rangoon University. His pamphlets on tertiary deposits and the ecology of part of the dry zone are both helpful and suggestive, and a more elaborate volume on forest crops as modified by rainfall and soil is under preparation. The Silviculturist is much indebted to him for assistance and advice on several occasions.

ASSAM.

No information available.

BENGAL.

No information available.

PUNJAB.

No information available.

CENTRAL PROVINCES.

No information available.

BOMBAY.

No information available.

MADRAS.

No information available.

ANDAMANS.

No information available.

COORG.

No information available.

CHAPTER IV.

FOREST ECONOMY.

CENTRAL INSTITUTE.

I.—General Work of Administration.

The year 1923-24 has seen the virtual completion of the new workshops and laboratories in their new home, the machinery and instruments for which were purchased largely in 1920 and were received in India during that and the following year. In order not to waste the time of certain sectional officers, namely those of Timber Testing and Wood Working, some of the experimental machines were erected as a temporary measure at the old Institute at Chandbagh, and this plant has during the year under report all been re-erected in the new buildings at Kaulagarh. The Economic Branch now comprises sections of Seasoning, Timber Testing, Wood Preservation, Paper Pulp and Wood Working, the latter sub-divided into wood workshops, veneer, and sawmills and it is therefore very well equipped and nearly completely staffed. The only section not yet functioning is that of Minor Forest Products.

The Forest Economist, Mr. Pearson was in charge throughout the year. His work has been taken up mainly with organising the sections at the New Site, in general administration, and arranging for the supplies of raw material to enable the Sectional Officers to get to work. He also visited the North Western Railway Creosoting Plant at Dhilwan; visited Delhi in connection with wood work for the New Capital and in connection with products to be sent to the Empire Exhibition; Bareilly in connection with a new venture in wood working and also inspected some experimental treated sleepers on the Hardwar—Lhaksar section of the Oudh and Rohilkhand Railway. The Assistant Forest Economist, Mr. H. Trotter was engaged in organising the work in the new laboratories and workshops, having to arrange for the purchase and disposal of all accessories, as well as the supervision of all labour in connection with the Wood and Iron Workshops. He also has had a large amount of routine work to carry out, thus releasing the Forest Economist and allowing him to attend to more important administrative duties.

The greatest difficulties in starting the work of research has been in connection with the superior staff. Specialists in the various branches of Forest Utilisation are few and far between, and have to be recruited from far afield. They can only be obtained on short term agreements and as, at the most critical stage of our development, some of the most important officers' agreements terminated endless difficulties were encountered which resulted in delays and very serious loss in continuity of purpose and therefore in work. The loss of Mr. C. V. Sweet, a most eminent Timber Seasoning Specialist, is much to be regretted, the more so in that his inability to enter into a new agreement was due solely to the sickness of a member of his family. The services of Mr. Fitzgerald were, however, obtained at the end of the year to replace Mr. Sweet. Dr. H. P. Brown who was lent to this Institute for 22 months by the Syracuse State School of Forestry and who carried out invaluable work on the anatomy of Indian Timbers, also left on the termination of his agreement. Fortunately it has been possible to retain his services for a portion of each year in America, that is during his vacation period. Mr. L. N. Seaman, Officer-in-Charge, Timber Testing, has been re-engaged and a Forest Officer of Imperial status, Mr. Ranganathan has been appointed as his assistant, while Mr. Mohammed Husnain has been appointed Upper Grade Assistant, thus materially strengthening the cadre of this important section. Mr. W. Raitt has been in charge of the Section of Paper Pulp throughout the year, and Mr. M. P. Bhargava, an officer trained in England in paper technology, appointed as his assistant. Mr. Nagle has been in charge of the post of Superintendent, Wood Workshops with Mr. Hesse as his assistant.

Mr. Pilgrim, Officer in Charge, Tans, relinquished his duties in June 1923, after being connected with this Institute for 8 years. He has completed invaluable work during this period, by carrying out surveys of tan materials, in Central India, Northern Bengal and the Sunderbans, Northern Burma and Mergui.

The definite allotment of a stated sum for working expenses and staff for a period of three years as laid down in 1922, has assisted more towards continuity of work than any other factor. Admittedly the grant is insufficient, resulting in the necessity of keeping the sections of Minor Forest Products and ultimately that of Tans in abeyance, as also necessitating very considerably curtailment in experimental work. On the other hand by knowing what funds were available in advance it has been possible to adhere to a definite policy, which is the basis of all sound research work. Had the staff difficulties been settled as satisfactorily it would have been possible to record even greater progress.

Important enquiries and resulting research work are dependent on the confidence of the public in the specialist or institution to whom the enquiry is addressed. The class of enquiry now received has changed since the appointment of specialists in each section of Forest Utilisation, and is now of far greater importance. The obvious corollary to this is the efficiency of the equipment of the

laboratories at the disposal of each specialist. The laboratories and workshops of the Economic Branch are now the most up to date in the British Empire and probably the most comprehensive in the world, while the general staff is admittedly of a very high class, the result being that the Forest, Ordnance and Railway Departments freely consult the Sectional Officers with respect to the problems which arise in connection with the use of timber, while a very large number of enquiries emanate also from the Commercial World. The justification for this branch of the Institute has, therefore, been achieved, but it can only be maintained by employing the highest class of specialists. Any drop in efficiency will be reflected at once by the loss of confidence of the public, with a corresponding loss to the country.

The Trade Supplement to the "Indian Forester," for which the Assistant Forest Economist is responsible, has continued to prove a success and has increased in circulation. It is hoped to enlarge this monthly publication and to make it of still greater value, but until the administrative staff is strengthened this cannot be undertaken.

With the expansion of the branch very considerable interest has been taken, not only by officials but by commercial men and also the Army, in matters connected with Forest Research. As a proof of this assertion a very large number of people have favoured us with visits. Amongst others may be mentioned two parties of the Imperial Legislative Council, His Excellency the Governor of the United Provinces, Sir William Marris, the Finance Member, Sir Basil Blackett, the Chief Commissioner of Railways, Mr. C. D. M. Hindley, the Forest Member for Bombay, Mr. Mehta, the Secretary for Education, Health and Lands, Mr. Butler, the Agent of the Oudh and Rohilkhand Railway, Mr. Coates, the Chief Engineer, Railway Board, Mr. Allum, the Chief Conservators of Forests, Bombay and United Provinces, Messrs. Copleston and Billson; the General Commanding, Eastern Command; the Superintendent, Gun Carriage Factory, Jubbulpore, Major Tute, and many other distinguished visitors.

A step towards the furtherance of propaganda work in Forest Utilisation was taken in the early part of the year, when Mr. Sweet, the Officer in Charge of Seasoning, delivered a most interesting lecture on the proper seasoning of Timbers in India, to a large gathering of commercial men in Calcutta. Mr. Seaman, Officer in Charge of Timber Testing, also gave a similar lecture on Timber Testing and its importance in engineering and commercial industries, to an interested gathering in Bombay. Both lectures were extremely well reported on and from the Bombay side several enquiries resulting from the lecture were received and every endeavour was made to give useful information to the enquirers.

Publications issued during the year are dealt with in the Section reports. There is one however which requires special mention as it pertains to four sections together. This is a publication known as "Project IV of the Economic Branch." The work deals

with an enquiry on sleeper wood in all its aspects; and lays down the procedure according to which this intensive investigation is to be carried out. Part I lays down the lines according to which all species of timber will be tested for mechanical strength, including spike pulling tests. Part II deals with the investigation from the Seasoning view point, and lays down the lines according to which air seasoning experiments will be carried out. Part III pertains to treating sleepers with antiseptic solutions, followed by durability tests, and Part IV outlines the preparation of a key for the identification of sleeper woods. The draft of this Project was submitted to all Chief Engineers of Railways for criticism and the final draft was sent to the press in February 1924. A special and somewhat lengthy mention has been made of this work, as it is an investigation which may have far reaching effects, while it clearly illustrates the co-ordination of work in no less than four sections of the Economic Branch.

II.—Experimental and Commercial Activities.

1. Section of Wood Technology.

Dr. H. P. Brown was in charge of this Section up till October 1923, when his agreement terminated. During the 20 months that he has been at the Institute he has laid a sound foundation to the work on the technology of Indian timbers. He has prepared photomicrograph sections of approximately 180 of our most important timbers and written an invaluable Elementary Manual on the anatomical structure of Indian Timbers for instructional purposes. A key to 60 of the more common Indian timbers has also been drawn up. Both of the above manuscripts are now in the Press. Fortunately Dr. Brown's services are not altogether lost to India, as the Government of India have arranged that, during the 4 months' vacation enjoyed by him at the University of Syracuse, United States of America, he will continue his work on Indian Timbers and prepare a Manual dealing with approximately 450 species. This Manual is not only to deal with the anatomy of the timbers but will contain also information relating to the durability, seasoning qualities, treatment, and uses of the woods, which subjects will be dealt with by Mr. Pearson, the Forest Economist. A fair start on this work has been made already by both officers. On the other hand, due to the mass of information available, all of which has to be sorted out and allotted to its proper place, it is anticipated that it will take from 3 to 4 years to complete this work of reference.

2. Section of Timber Seasoning.

As mentioned in the administrative portion of this Report the Seasoning Section suffered a very severe loss in the return of Mr. C. V. Sweet to America and there was a considerable hiatus period in the hot weather and rains of 1923 when the Section had no Officer in charge.

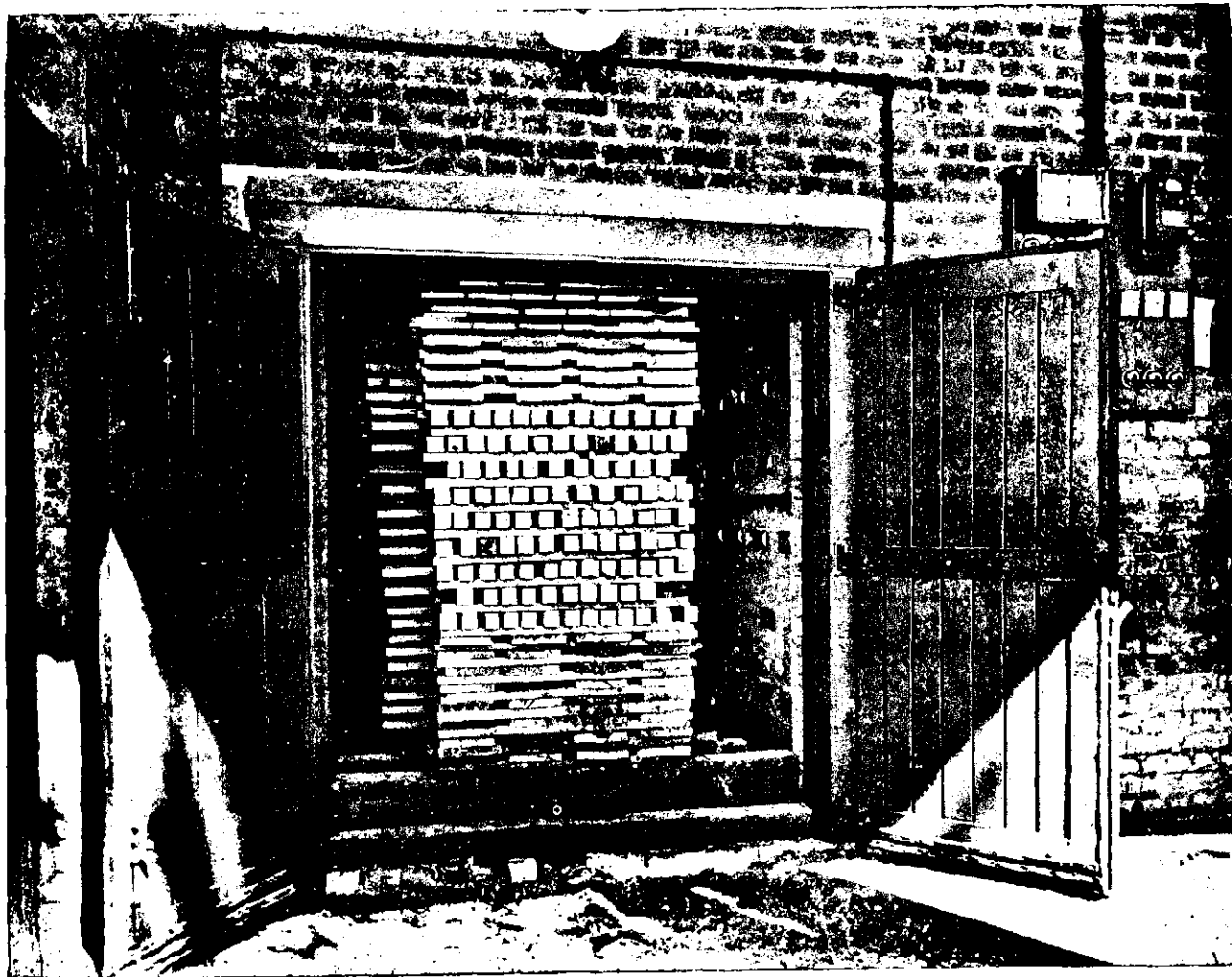


Photo by I. N. Sharma, March 1924.

Sturtevant-Kiln, showing 16 varieties of Timber Testing specimens and *Cullenia excelsa* stacked ready for drying.

Mr. S. Fitzgerald, the present Seasoning Officer, arrived in Dehra in February 1924 and lost no time in getting down to serious work. The Sturtevant Kilns were loaded up and running within a few days of his arrival and the Tieman Kilns were in use very shortly after.

The first charge of timber put through the Sturtevant kilns was a consignment of *Cullenia excelsa* from Madras. Two kilns were loaded as a start, one with $\frac{1}{2}$ " to $\frac{5}{8}$ " planks and the other with 1" boards.

A course of temperature and humidity was set by Guide Chart and followed with success, the resulting seasoned timber being turned out with 6 per cent. moisture and without any appreciable degradation, due to kiln seasoning. As this timber is found in large quantities over extensive areas in Madras and as this Province has to date been unable to find a proper use for it owing to its liability to fungus attack after conversion; it is satisfactory to know that kiln seasoning will reduce their difficulties in this respect very considerably. This experiment with *Cullenia excelsa* timber was continued a step further in order to try and find a profitable use for the timber. Gamble gives two opinions on *Cullenia excelsa*. He describes it as (1) useful as a box timber and (2) worthless. Kiln Seasoning has shown that if no time is wasted between the saw and the kiln, that the timber is by no means "worthless" but has the appearance of a useful box wood. To put this to the test tea boxes of this wood are now being made up and will be subjected to various tests and a report will be issued during the coming year.

Other artificial seasoning experiments include the successful drying of *Terminalia bialata*, a common Andaman timber while a large number of specimens are always under preparation for the Timber Testing Section. In addition, 200 sleepers were partly dried for the Wood Preservation Section. As the kilns were active for one month only at the end of the year a very comprehensive report cannot be expected. Experiments now in hand include the drying of *Tectona grandis* from Burma, *Dichopsis elliptica* from Madras and *Anogeissus latifolia* and *Terminalia tomentosa* from the United Provinces. The artificial drying of *Dalbergia Sissoo* gun wheel felloes for the Jubbulpore Gun Factory, reported on in last year's report was most encouraging. The experiment showed that these felloes, containing 30 per cent. to 40 per cent. moisture can be kiln seasoned down to 6 per cent. moisture in 70 days, and a very intensive examination by the Seasoning Officer showed that the degrade or loss of useful timber during the seasoning process was only 2.6 per cent. The Jubbulpore Officer who checked the degrade independently, after the timber was returned to the Gun Factory, arrived at a figure of about 1 per cent. to 5 per cent. and he has officially reported that there was no appreciable loss of timber due to kiln seasoning. This most satisfactory finding is now resulting in the Gun Carriage Factory at Jubbulpore embarking on a kiln outfit and the Forest Research Institute has been asked to assist in its design and initial operation.

In addition to the above the Seasoning Officer visited the Indian Bobbin and Allied Woodcrafts Company at Bareilly to give expert advice on the installation of drying kilns in their Bobbin Mills. He has also worked out a kiln project for the State Workshops of Hyderabad State and for Messrs. Spedding and Company of Lahore.

With regard to air seasoning there are two sets of experiments in progress. These were started by Mr. Sweet before his departure. The first is laid at Messrs. Martin and Co.'s Timber Yard at Calcutta and the second is at the Gun Carriage Factory at Jubbulpore. In both experiments, fresh sawn timber of various species is stacked in open but protected godowns and specimens are weighed periodically to record the loss of moisture as time proceeds. Periodically a Forest Research Institute Officer visits the experiments and takes careful moisture determination from other specimens and ultimately when the timber is sufficiently seasoned, the whole lot will be re-examined and graded. The object of these experiments is to ascertain the exact rate of drying under an ideal conditions for air seasoning as procurable in the climates of Jubbulpore and Calcutta respectively. The degrade or loss of timber during this air seasoning in both wet and dry climates can then be compared with the degrade of kiln seasoning and the respective merit of each method can be estimated for the various species under trial. The experiments are not yet complete but will probably take another 6 to 10 months before anything definite can be said.

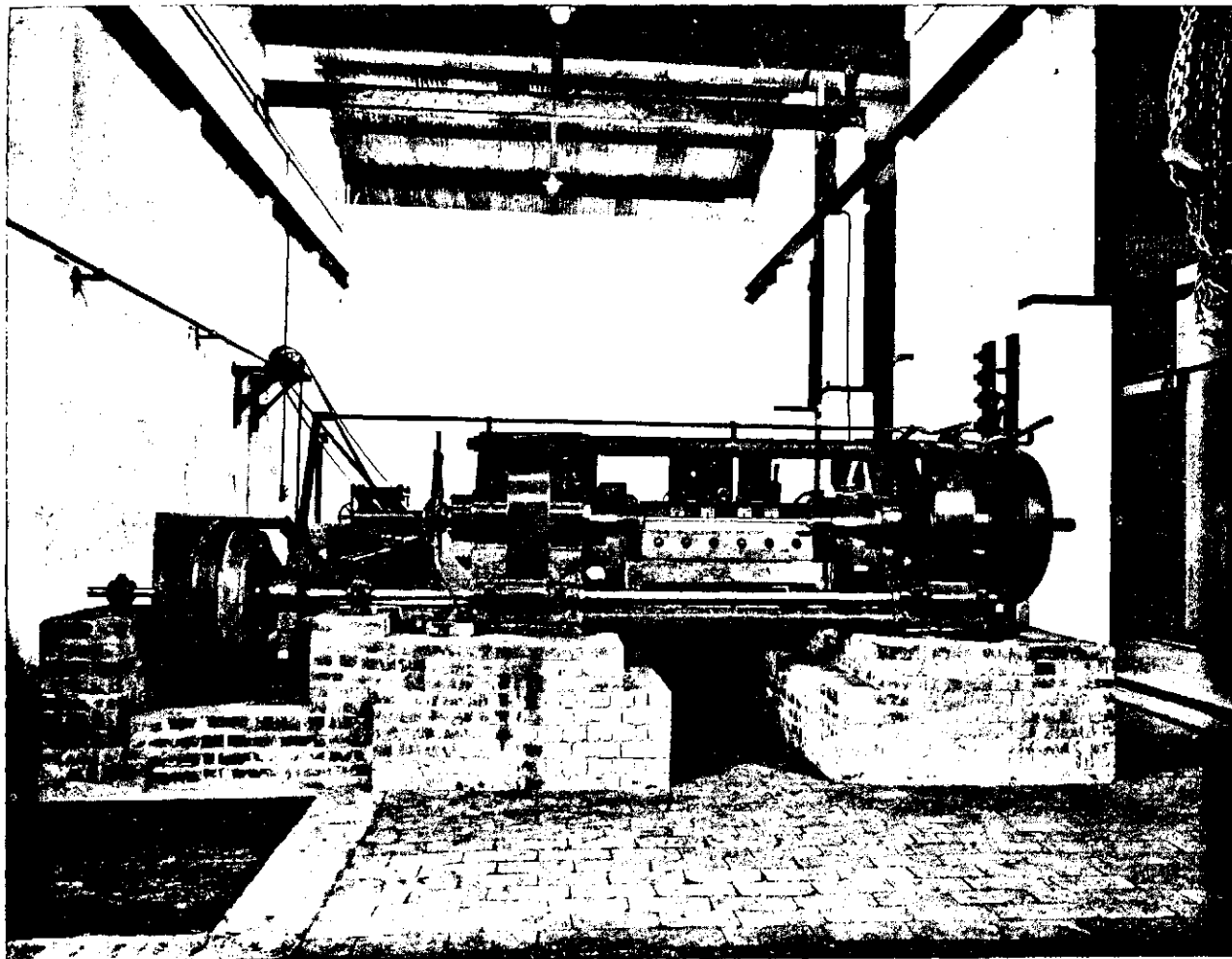
3. Section of Timber Testing.

Mr. L. N. Seaman held charge of this Section throughout the year. He was assisted by Mr. S. Kamesam during the first few months but this officer was posted later on promotion to the Wood Preservation Section and it was not till March 1924, that an Imperial Assistant and an Upper Grade Assistant were appointed to the Timber Testing Section.

During the year under review work was chiefly confined to the programme laid down under Projects Nos. 0, 1, 2, 3 and 4.

Project No. 1 comprises standard tests of small clear specimens (i) in the green (ii) air dry and (iii) kiln dry condition, and may be regarded as the real foundation of all timber testing work. From the results obtained under this Project a very fair judgment can be formed of the qualities and likely uses of a timber even before the special tests under other Projects are started. The results also afford a reliable basis of comparison between species and render unnecessary a great deal of testing by eliminating at the start species that would not be worth investigating for special uses, having failed under Project 1.

Project No. 2 comprises tests of structural timbers on full sizes up to 18 ft. in length, and indicates directly the suitability of



Rotary Veneer Cutter.

timbers for construction and building purposes and gives the allowable stress for use in calculating dimensions for structural numbers.

Project No. 3 is an investigation of suitability of timbers for use as vehicle parts, in particular for gun carriage poles. This enquiry was taken up at the suggestion of the Superintendent, Gun Carriage Factory, Jubbulpore, but up to the present little work has been done under this Project as machines were busy on other work.

Project No. 4 is a composite project, participated in by all the sections of the Economic Branch, and is a study of the railway sleeper problem in India as explained previously in this report.

Lastly, all minor investigations required to answer special enquiries involving a relatively small number of tests are grouped together under Project No. 0.

Since the opening of the Timber Testing Section 26 consignments of timber have been tested under Project No. 0 of which 14 were handled during the current year. The work related principally to the testing of woods for Oil Well Sucker Rods, Tool Handles and Picker Arms for Bobbin Factories.

Under Project No. 1, 18 consignments have been completed, 11 of them in the current year, and 7 are still in progress of investigation. Complete results are now available on timber from 15 localities, comprising *Tectona grandis*, *Terminalia tomentosa*, *Dipterocarpus alatus*, *Dipterocarpus tuberculatus*, *Dipterocarpus turbinatus*, *Cedrus Deodara* and *Anogeissus latifolia*.

There are three species now being tested under Project No. 2, and one under Project No. 3.

Seven species have been tested under Project No. 4, and fresh consignments are coming in every week.

During the year this section has made 11,452 mechanical tests, 10,430 physical determinations and analysed and computed the results of these tests. This in itself is no small achievement considering that this section was transferred from its old workshops to the new laboratories at Kaulagarh in the middle of the year.

During the year a large amount of technical correspondence has been handled, including strength reports on working stresses, grading suggestions and general advice relating to enquiries regarding the uses of various timbers from private firms, the Public Works Department, the Military Works Department and Railways. As the results of tests carried out by this section a trial is now being made in Burma with *Heritiera minor* and *Terminalia tomentosa* for sucker rods in oil wells, and the Military Supply Department are including *Parrotia jacquemontiana* in their next purchase of axe helve woods; this timber having proved itself an excellent wood for tool and hammer handles.

During the year the Officer in Charge made one tour to the Ferozepore district to examine Railway Sleepers in connection with Project No. 4, and one to Jubbulpore to consult with the staff of

the Gun Carriage Factory, concerning details of Project No. 3. He also went to Poona, Bangalore and Guindy with a view to standardizing testing practice in India. Gratifying reports have been received in connection with all these undertakings and it is felt that some really useful work is being done by this section. The scheme for co-operation in all testing centres is progressing satisfactorily, and though Sibpur College, Alipore Test House, and Benares University are still to be consulted in this connection it is probable that all Testing Laboratories in India will fall in readily with a scheme for useful co-operation thereby standardizing all Testing Work in the country.

Publications emanating from this Section during the year include a second edition of the Scheme of Operations for Project 1 and an Interim Report on Project 0 and 1.

4. Section of Paper Pulp.

Mr. W. Raitt held charge of this Section throughout the year and Mr. M. P. Bhargava joined as his assistant on the 1st August 1923.

During the greater part of the year the staff was engaged in erecting the experimental Pulp and Paper making plant. This was completed in March and has now begun to operate. Owing to this the Officer-in-charge was unable to carry out his usual tour programme but in February he paid a visit to the Papanasam Reserved Forests in Tinnevely at the request of the Chief Conservator of Forests, Madras. The Chief Forest Engineer, Madras, is engaged in working out a development scheme for these forests of which it is hoped that pulp making may form an important part. This case is still pending but an interim report on the possibilities of the scheme and detailing the data required to be collected has been furnished to the Chief Conservator of Forests, Madras. The Officer in Charge also visited Nilambur and several of the higher ranges in Coorg and Wynaad to note the progress of seeding and regeneration of the bamboo *Bambusa arundinacea*.

Publications during the year were necessarily limited by the curtailment of the tour programme. A report on the Cuttack Bamboo Pulp project has been issued as Bulletin No. 5 of the Department of Industries, Bihar and Orissa. This will shortly be followed by a supplement detailing the results obtained in the experimental factory on the bamboo concerned, *Dendrocalamus strictus*. In addition to this a working programme for the Section (Project No. 5) is in the press and will be published shortly.

Twenty-five requests for advice and information on Paper Pulp Schemes were received during the year and in every case expert information was given as to the soundness of the undertaking.

Laboratory investigations were carried out as usual and reports furnished to the parties interested.

The following is a list of some of the enquiries dealt with by this Section and is sufficient to show the importance of having an expert in these matters who can give sound and experienced advice:—

No.	Species.	On behalf of.	Completed or pending.	REMARKS.
1	Bamboo— <i>D. strictus</i> .	Durbar of Sirmoor State	Completed	By permission of President. Forest Research Institute.
2	<i>Bhabar</i> grass . . .	Do.	Do.	
3	<i>Stipa Sibirica</i> , grass .	Conservator of Forests, Kashmir.	Do.	
4	Bamboo	Department of Agriculture, Federated Malay States.	Do.	
5	Bamboo pulp . . .	Do.	Do.	
6	Lemon grass after distillation.	Do.	Do.	
7	Lemon grass after distillation pulp.	Do.	Do.	
8	<i>Keruing</i> wood, a <i>Dipterocarpus</i> .	Do.	Do.	
9	A famine fodder grass	Chief Conservator of Forests, Bombay.	Do.	
10	Lemon grass after distillation.	Conservator of Forests, Central Provinces.	Do.	
11	Cotton Stalks . . .	Director of Industries, Central Provinces.	Pending	In connection with Papanasam Development Scheme.
12	Do. . . .	Director of Agriculture, Punjab.	Do.	
13	<i>Sal</i> bark after tannin extraction.	British India Corporation, Cawnpore.	Completed	
14	<i>Eta</i> bamboo, <i>Ochlandra travancorica</i> .	Chief Conservator of Forests, Madras.	Pending	
15	Bamboo, <i>D. strictus</i> .	Director of Industries, Bihar and Orissa.	Pending	
16	Water hyacinth . .	Director of Industries, Bengal.	Do.	
17	Limestone	Durbar of Sirmoor State.	Completed	
18	Limestone for Papanasam.	Chief Conservator of Forests, Madras.	Pending	

5. Section of Wood Preservation.

The Wood Preservation plant started functioning in April 1923 in connection with experiments for the Punjab sleeper treating Syndicate. Owing to the untimely failure of this Syndicate, however, only a small amount of work was completed but impregnation values were obtained for *Picea Morinda* (spruce), *Abies Pindrow* (silver fir), *Pinus longifolia* (chir) and *Pinus excelsa* (kail). Captain J. H. Warr, the present Officer-in-Charge of this section carried out these experiments on behalf of the Syndicate but had to return to England at the end of a month owing to the failure of the Syndicate. His services were re-engaged, however, as Officer-in-Charge, early in the cold weather and from that time onwards excellent progress has been made.

As mentioned earlier in this report, a programme regarding the utilization of hitherto little known sleeper woods was drawn up as Project IV and under this scheme preliminary experiments on the antiseptic treatment of the following species were completed:—

Dipterocarpus tuberculatus (in) *Dipterocarpus turbinatus* (gurjan) *Terminabiti Manii*, *Planchonia burmanica*, *Shorea obtusa* (thitya), *Terminalia paniculata* (kindal), *Lagerstroemia lanceolata* (nana) *Eugenia Gardneri* and *Dillenia* spp.

In addition to these preliminary experiments the whole programme of work to be carried out under Project IV was completed for *Terminalia tomentosa* and 171 sleepers of this species, treated by the different methods indicated in the Project, were despatched to the Bombay, Baroda and Central India Railway and 45 sleepers of the same species to the Oudh and Rohilkhand Railway, to be laid down in the line for durability tests.

In addition to this work 200 metre gauge sleepers of each of the following species:—

Shorea assamica, *Dipterocarpus pilosus*, *Lagerstroemia Flos-Reginae*, *Bischofia javanica*, *Dillenia indica*, *Cynometra polyandra* and *Terminalia myriocarpa* were received from Assam under Project IV but owing to their high moisture content treatment could not be undertaken till the end of the year when work was started on *Dipterocarpus pilosus* and *Shorea assamica*.

Interim reports on all the above experiments were issued to interested parties and a complete note on the treatment of *Terminalia tomentosa* is in the press.

Some Karri sleepers were received during the year from West Australia for powellising experiments under pressure but here again owing to their wet condition work could not be started until the sleepers had dried out to about 25 per cent. of moisture.

The Officer-in-Charge and his Assistant, Mr. S. Kamesam paid several visits to the N. W. Railway plant at Dhilwan and valuable advice regarding certain changes recommended in the plant was

adopted by the Engineer-in-charge with excellent results. Some interesting experiments were completed in connection with the use of Wood Tar creosote as an antiseptic for sleeper treatment and some *Terminalia tomentosa* sleepers were treated with this creosote and sent to the B., B. & C. I. Railway for durability tests. Minor experiments include the treatment of *Pinus longifolia* and *Pinus excelsa* paving blocks and the treatment of *Bambusa polymorpha* and the sapwood of *Shorea obtusa* for fence posts.

Regular inspections of the experimental sleepers laid in the various Railway systems were carried out during the year and the results recorded in Forest Bulletin No. 53 have been brought up to date.

From the above report it will be seen that some excellent foundation work has been done by this Section and if all goes well some very valuable information will have been obtained at a very early date.

6. Section of Tans.

As foreshadowed in last year's report this section was closed in May 1923, but not before Mr. Pilgrim, who had held the post of Tan Expert with distinction for 8 years, had prepared and submitted for publication no less than seven most valuable reports on the many tan materials of Burma mentioned in Chapter VII.

On Mr. Pilgrim's retirement it is necessary to record an appreciation of his work and of the accuracy with which he worked and of his untiring zeal in carrying out his many tan surveys often in very unhealthy localities, such as the Mangrove Forests of South Burma.

7. Section of Wood Workshop.

The work carried out in these shops during the year has been chiefly of a constructional character, but every effort has been put forward to keep the Timber Testing and other sections well supplied with specimens and other requirements.

The workshops were finally transferred to the New Site in September 1923 and this section was fully occupied for several months in getting its own workshop and those of other sections ready for research work. Orders for furniture and fittings numbered 330 during the year and some of these took several weeks to complete. The Saw-mill was fitted with log roll, flooring, husk carriage, stringers, fixtures for Pendulum Saw, weather board, etc. Fitments were made for the kilns and laboratory. The Paper Pulp Hall was fitted with a partition laboratory, benches, lockers, almirahs, stair-cases sandtraps, floors, etc., and all the workshops and laboratories were painted to a finish. The Timber Testing Section was floored and all belting covered in and made absolutely safe and fool proof. Almirahs, racks, tables, ladders, benches, stools, boxes, indexing cabinets and other furniture were made and supplied to the various sections. Foundations were excavated and machines laid down in

the Wood Workshops. The fitments for the Veneer Shop were received late in the year and this sub-section was actually in running order before the end of March.

The first piece of work allotted to the Veneer Plant is the preparation of five and seven ply wood panels for the Legislative Assembly Halls at New Delhi. The wood selected for this work is *Dalbergia Sissoo*, *Dalbergia latifolia*, *Tectona grandis*, *Terminalia tomentosa*, *Terminalia bialata*, *Albizzia Lebbeck* and *Petrocarpus dalbergioides*.

Most of these have never been plyed before and it will be interesting to see their respective values as figured panels cut on the rotary. A preliminary run of *Terminalia tomentosa* resulted in an extremely handsome panel and it is hoped that the others will prove equally satisfactory.

Other work done in this section includes the collection and preparation of about 80 specimen planks and about 5,000 hand specimens for the Empire Exhibition. These were despatched to England in good time and should make a fine display. In this connection the thanks of the Forest Economist are due to those Forest Officers who co-operated so ungrudgingly in the collection and selection of the excellent specimen planks received at Dehra Dun for forwarding to England.

In a report of this nature, the supply of specimens to the Timber Testing Section Laboratory can be dealt with in a few words but in practice this is by far the heaviest charge which the Wood Workshop has to deal with and in the year under review a steady average of no less than 1,000 specimens a month were prepared for the Testing Machines. As every specimen is cut to size, shaped and carefully measured, this performance reflects considerable credit on Mr. W. Nagle, the Wood Workshops Superintendent.

8. Mechanical.

Sub-section.

This sub-section worked at high pressure throughout the year erecting machines and maintaining the boilers and electrical plant in good order.

The work carried out by the Mechanical and Electrical workshops is far too detailed to enumerate in a report of this nature but the policy of including an iron workshop among the buildings of the New Economic Branch has been fully justified. The staff employed includes one Indian Mechanical Engineer with an Electrical Engineer Assistant and the necessary fitters, blacksmiths and switch board men.

All repairs are done *in situ* and the workshop can undertake the making of bolts, washers, pipe threads and fittings and can replace broken or damaged parts.

The erection of the complicated machinery and pipe fittings in the Paper Pulp Hall and Seasoning kilns was completed during the year and the Babcock and Wilcox high pressure Boiler was

carried out without a hitch and is now working daily at full pressure.

The Electrical Assistant was responsible for the installation of 18 motors ranging from $\frac{1}{2}$ to 75 B. H. P. in addition to the new generating set for converting alternating current into direct current for use with all the motors in the Timber Testing workshop and it is satisfactory to record that all electric motors have been maintained in good running order throughout the year.

The shortage of electrical power obtained from the Mussoorie supply has been felt on several occasions owing to the main line to the New Site being of insufficient calibre to carry the full charge but this matter has been taken up with the electrical authorities and it is hoped that sufficient power will be forthcoming at an early date.

BENGAL.

Utilization.

Minor Forest Products.—The only point of interest is that increasing difficulty is being experienced by certain Tea Estates in the Darjeeling District in obtaining supplies of cane from reserve forests for making tea baskets.

There is plenty of cane in the forests; but that in the accessible parts near the gardens is getting worked out and they now have to go longer distances to obtain supplies which materially increases the cost per basket.

At least one Tea Garden Manager has imported cuttings of various species of Willow from England and planted them on his own waste land, and hopes that in time he will be able to supply all his own requirements in the tea basket line.

Tans.—A supply of each of the following was collected in the Darjeeling Division and sent to the Superintendent, Calcutta Research Tannery, for experiment and the tannage of exhibit leathers for the British Empire Exhibition:—

- (i) Acorn cups of *sungru katus* (*Quercus pachyphylla*).
- (ii) Bark of *patlay katus* (*Quercus fenestrata*).
- (iii) Bark of *dalno katus* (*Castanopsis indica*).

His report was as follows:—

- (i) On analysis the sample was found to contain

Tannin	13.79 per cent.
Soluble non-tannins	14.29 per cent.
Insolubles	71.92 per cent.

Tannage.—Two bends of buffalo hide were tanned with a blend of the acorn cups and myrabolans. The leather obtained was tight, solid and of light colour. The yield of leather was 55.25 per cent. on the lime weight of the pelt.

Conclusion.—A good tanstuff, which could be used for the same purpose as Turkish Valonia in heavy leather tannage.

(ii) On analysis the sample was found to contain

Tannin	3.69 per cent.
Soluble non-tannins	1.76 per cent.
Insolubles	94.53 per cent.

Tannage.—One bend of buffalo hide was tanned with the collected bark. The leather obtained was solid, tight and of good tensile strength; but of dark colour. The yield of leather was 58.4 per cent. on the lime weight.

Conclusion.—A weak tanstuff more suitable for making extract than for direct use in tanning.

(iii) On analysis the sample was found to contain

Tannin	11.74 per cent.
Soluble non-tannins	4.15 per cent.
Insolubles	84.13 per cent.

Tannage.—One piece of cow-hide was tanned with the stuff. The leather was full, of tight grain, soft in feel; but got discoloured.

Wood Working.—(a) The whole of the new sawmill plant for the operations in the Mahaldaram Forests at Tung (Kurseong Division) has been installed and is now ready to start work as soon as the yarding engine, ordered from America, arrives and begins hauling in the logs from the coupes.

(b) The mechanical extraction and conversion work at Sukna was carried out on precisely the same lines as last year. A new yarding engine is also on order for Sukna and it was hoped that it would have arrived in time to have cleared this year's coupes; but after waiting in vain for some time it was found necessary to patch up the old engine and make it do. Unfortunately only half the coupe could be cleared before the engine gave out altogether.

Miscellaneous.—Application has been made to the Department for a lease of a block in Sanchal Range (Darjeeling Division) to start the manufacture of matches. The matter is at present under consideration.

BIHAR AND ORISSA.

I.—General Work of Administration.

A preliminary utilization programme indicating possible lines of development of forest resources was drawn up during the year by the Provincial Research Officer. It was decided that so far as major produce is concerned it was first necessary to find out what our resources actually were before making any attempt to develop markets. A detailed enumeration survey of all species was commenced in Puri division in conjunction with the preparation of the

new working plan and similar enumeration surveys will gradually be carried out in other divisions.

In addition to developing and extending lac cultivation on existing trees in suitably concentrated areas of host trees the Local Government have sanctioned the establishment of plantations of lac bearing species to act as brood lac farms to the extent of 900 acres in Palamau district, and 300 acres in each of the districts of Singhbhum and the Santal Parganas. Sites for the plantations in Palamau District were selected by the Research Officer and sites in the other two districts will be selected this year. In addition two islands in the Mahanadi river in Sambalpur division, which already contain numerous *ghont* (*Zizyphus xylopyra*) and *kusum* (*Schleichera trijuga*) trees are being planted up with more lac bearing species so that eventually the islands will contain purely such species.

The Kundri brood lac farm in Palamau division yielded a good surplus of Rs. 10,600 but the results would have been still better had it not been for the fact that at the time of swarming in July heavy rain fell for about 10 days thereby causing a heavy insect mortality and necessitating the purchase of a large quantity of brood lac to keep the farm going. Hitherto the Baisakhi crop has constituted the main market crop in Kundri but it is proposed now to try and increase the Katki crop at the expense of the Baisakhi crop as it is in Katki that the main demand for brood lac occurs.

Experimental infection of small areas of *ghont* and *khair* forest in Palamau proved a failure, the lac on *ghont* being destroyed by hail and that on *khair* (*Acacia Catechu*) dying about the end of March. The cause of death in the case of lac on *khair* may be due to the fact that the *khair* growing round villages on which lac is locally cultivated are leafless for a shorter period than the *khair* growing on poor forest soils and that therefore in the case of latter trees the female insect does not get sufficient nutrition. If this explanation is correct we may find that lac cultivation on forest trees will in the case of several species such as *ghont* and *khair* have to follow different lines for its cultivation on the more vigorous trees found round villages. An attempt will be made this year to get a Katki crop of *khair* and *ghont* in forest areas.

Gum.—The tapping experiments in the Angul division described in previous years' reports were continued during the year. Results obtained may be summarised as follows:—

- (1) The purest gum is yielded in the dry weather months November to May but the quantity then yielded is insignificant and insufficient to justify exploitation on a commercial scale.
- (2) Gum is copiously exuded in the rainy season and although owing to discolouration it is of inferior quality to the gum yielded in the dry season it is only the gum yielded in the rains which can be collected on a commercial scale.

- (3) The best method of tapping is by horizontal slits 3" to 4" in length cut down to the cambium and situated not in direct vertical lines.
- (4) The slits must be freshened when the gum is collected and 7 days is the most suitable interval at which to carry out freshening and tapping.
- (5) Crooked trees yield more gum than straight trees, and trees on a southern aspect more than those on other aspects.
- (6) There is little or no difference in the field from slits situated above and below a height of 5 feet from the ground respectively.

Kuchila (*Strychnos Nux Vomica*).—Departmental collection of *kuchila* fruits was carried out on a small scale in part of Puri division. It was found that the average yield of dry seed was about 2 seers per tree. In a moderately good seed year about 35 per cent. of the trees seed. The cost of collecting 530 maunds of seed averaged Rs. 2-5 per maund and at the present market rate of Rs. 4 per bag of 1½ maunds there is not much margin for profit. Experiments referred to (in Chapter II) were started to test the effect of pollarding and pruning *kuchila* trees on the production of seed.

Tans.—In consequence of the rising market demand for miscellaneous tanstuffs it was decided to try departmental collection of one or two tanstuffs on a small experimental scale. A firm agreed to advance the money for the purpose on condition the produce was supplied at a cost price which should not exceed certain agreed upon maximum limits. A start was made by collecting leaves of *Anogeissus latifolia* in the Chaibasa division but collection was soon stopped as it was found that the cost worked out to about Rs. 4 per maund against a maximum estimate of Rs. 1-8 per maund. The high cost of collection was entirely due to collection being carried out in the hot weather when new leaves are scarce and the results cannot be considered as a fair indication of what costs on a commercial scale would amount to.

UNITED PROVINCES.

Utilization.

I.—General Work of Administration.

What Mr. Canning forecasted in last year's report has now come to pass. There is very little to report for there is no research agency left in the Circle.

The Sawmill and Turnery and the Turpentine Distillery were handed over to a Syndicate on the 1st September 1923. The Timber Supply Division ceased to exist on the 31st March 1924 and the Government Central Wood Working Institute has been handed over to the Industries Department, mainly because the latter is a transferred subject.

PUNJAB.

Utilization.

The propagation of lac in Mukerian Range was continued satisfactorily. 2,700 trees were infected and sold for Rs. 850 to a contractor who has also undertaken to propagate lac on all the trees of *Zizyphus Jujuba* and *Butea frondosa* growing in the lac area. The success achieved in the propagation of lac in Mukerian Range of Hoshiarpur Division was so encouraging that a start was also made in the Una Range, and 381 trees over an area of 98 acres were actually infected at a cost of Rs. 25-4. *Sal* trees in the Una Range are also being treated as an experiment for lac propagation.

Tapping of *kamal (Odina Wodier)* trees in Nurpur Range of Kangra Forest Division was undertaken on a small scale in spring 1923 and results obtained are noted below :—

Tapping started in the second week of April and closed by 30th June. 217 trees=655 blazes were operated and yielded 37 seers of gum or 2.63 chhataks per tree or 5 seers 10 chhataks per 100 blazes. Due to high storms the flow in May was much hampered. Dimensions of the blazes were 1" oblique, 4" wide and 1" deep.

Cost of tapping and collection was Rs. 6-10 and the sale amounted to Rs. 19 giving a net profit of Rs. 12-6. It is proposed to extend the work on a large scale in the Lower hills of Kangra and put a greater output of gum for sale in the market in future.

CENTRAL PROVINCES.

General Work of Administration.

Departmental felling, so desirable in the Central Provinces to counteract the dilatory habits of contractors and the lack of real improvement of the growing stock resulting from incomplete working in all classes of forest has now happily made a definite start.

The Sironcha Forests of South Chanda are now being felled departmentally throughout and arrangements are being made to open out more Felling Series in the Low Mixed Forests which often belie their name in containing excellent material hitherto untouched.

Experimental and Commercial Activities.

Efforts were made to secure a better standard of logging work and better management of the draught animals.

Minor Forest Products—Lac.

South Raipur Division.—The following comments with regard to *kusam (Schleichera trijuga)* Lac are given by the present Divisional Forest Officer :—

The last 3 years' experience of *kusam* lac propagation has shown that pruning of the host is essential. Only complete pruning has

been carried out and the merits or demerits of various degrees of pruning cannot be discussed yet. The objects of pruning are (a) to provide a large number of succulent young shoots for the newly hatched larvæ, (b) to make the tree accessible to climbers for infection and collection work.

A number of large *kusam* trees have been noticed to dry up and die after pruning.

As regards the season of pruning, there so far appears to be little difference in the shoots resulting from pruning carried out in August—September or in January—February.

As regards the collection of brood—this should be done when the larvæ are just ready to emerge. The date of emergence, however, may vary from 7 to 15 days in the same locality and without preliminary microscopic examination it is impossible to fix the date of collection for a given locality. It is hence advisable to wait till the larvæ are actually emerging before commencing operations in a given locality. Infection with brood which was not ripe has proved a failure in most cases.

In the rains of 1924 the following swarming dates were reported:—

(1) *Kusam* (*Schleichera trijuga*)

Risgaon Range	. . .	27th June 1924.
Sitanadi	„ . . .	4th July 1924.
Birguri	„ . . .	4th July 1924.
Dhamtari	„ . . .	15th July 1924.
Singpur	„ . . .	15th July 1924.

(2) *Palas* (*Butea frondosa*)

Birguri Range	. . .	4th July 1924.
Dhamtari	„ . . .	8th July 1924.
Singpur	„ . . .	5th July 1924.

Bundle infection has been used in this division so far with good results. The single stick method although considered in many ways decidedly better has not been introduced on account of its impracticability and cost. Lac work in the Division has been steadily expanding. From nil in the rains of 1921, the lac revenue in 1924 has grown to Rs. 38,589 and there is still room for further expansion. There has been a set-back to the present crop (July 1924) due to (a) the fact that some of the brood used in January 1924 was cut unripe and did not swarm and (b) much *kusam* and *palas* lac died last May from the effects of excessive heat.

Whereas in July 1923, 1,821 *kusam*, 323 *ber*, and 680 *palas* were infected, in January 1924 only 1,068 *kusam* and 1,060 *palas* were treated. The present crop (July 1924) is on the whole poor in quantity and quality. However propagation work for the cold weather crop has been well done and the crop of January 1925 should be good.

Propagation and even pruning have become a feature of private enterprise in villages in the Division but the general growth of the industry is attended by various evils in the way of theft of Government and private lac and such offences are extremely difficult to prove.

Damoh Division ghont Lac (Zizyphus xylopyra).—No experiments have been carried out to determine the actual extent to which infection affects the condition of a tree but the Divisional Forest Officer has observed that the leaf flush is delayed in trees heavily infected in November. This question is important as *ghont* is more liable to be killed by infection than, e.g., *palas* (*Butea frondosa*). It appears that infection carried out in November should be lighter per tree than that carried out in July in view of the precarious conditions and dry localities in which the host has to live. In support of a policy of infecting, e.g., only 10 per cent. of a tree in November it may be said that trees so treated have been observed to carry a higher percentage of surviving larvæ than heavily infected adjacent trees. The infection should be carefully regulated according to the season—the danger of heavy infections in November is very great.

BURMA.

The proposed timber research division was again not sanctioned this year but arrangements were made to organise the Wood-Working Section into a self-contained unit and towards the end of the year a definite programme of future research work was drawn up.

The results of timber tests made by Dehra Dun have already proved useful in supplying a reliable statement of strength of the timbers tested to which it has been possible to refer enquirers.

Divisional Officers have given every assistance in getting the materials for the experiments.

Seasoning.—With the departure of Mr. Teesdale progress in this section received a severe set back. After his departure the kilns were mostly employed on seasoning mixed lots of timber for the Exhibition but this work has naturally provided very little useful information. Towards the end of the year Mr. Pemberton, Forest Engineer, was placed in charge of the kilns and since then it has been possible to do whole species runs of sucker rod planks and timber for use in the Workshops. These runs have revealed certain defects in the working of the kilns and a good deal of time has been spent in remedying them. Studies of cost were started but in view of defects in operating and the tentative nature of the work the cost of the runs carried out to date has been unduly high but given full loads of single species there is no reason why the rates should not approach a commercial basis. The year's results go to confirm the writer's opinion that these spray kilns, although admirable as a piece of research apparatus cannot be recommended as a commercial proposition in a climate of high temperature and humidities.

The whole species runs have included *Dalbergia Oliveri*, *Heritiera minor* and *Gluta taroyana*.

Wood Preservation.—Late in the year arrangements were begun to supply Dehra Dun with material in conjunction with the general scheme for testing various hardwood sleepers. At present it seems unlikely that there will be any great local demand for creosoted sleepers in Burma in view of the existing supplies of resistant timbers and it is to be feared that high freights to India and the low prices obtainable will throttle any development of an export trade in sleepers.

Paper Pulp and Tans.—With the completion of the pulp and paper making plant in Dehra Dun it is hoped that semi-commercial investigations into Burma's raw paper products may be completed.

Minor Products.—A small number of enquiries have been dealt with and a rough survey made of the occurrence of *Traktogenos Kurzii* and *Hydnocarpus castanea* in connection with complaints received that local supplies of *chaulmoogra* seed could not be obtained. Roots of *Derris elliptica* (*tuba* root) have been supplied to various quarters. Work in Minor Products has been seriously hindered by a lack of trained staff for collecting and the absence of reference material in connection with botanical identification.

Mr. Cogger with a small staff of Chinese carpenters was occupied making specimen furniture from various timbers with very successful results, so much so that there have been more requests for supplies of furniture than could be dealt with.

Amongst other lines of enquiry sucker rods for oil wells, dash boards for motor cars, drawing boards, T squares, instrument boxes have been successfully made and an investigation is in hand for the making of motor car hood sticks.

BOMBAY.

Experimental and Commercial Activities.

Paper Pulp.—A sample of grass kept in storage to meet the demand for fodder in famine years was sent to the Research Institute for testing its suitability for paper pulp. It is reported to be not suitable for paper making. The quality and yield of pulp is satisfactory but it is extremely dirty owing to undigested matter from the flower and seed sheaths which are highly lignified. Treatment which would destroy this is too severe for the stem and leaf.

Wood Utilisation.—An experiment was arranged in Calcutta about the middle of November last to test picking sticks in Jute mills. The species tested are *Lagerstroemia microcarpa*, *Anogeissus latifolia*, *Hardwickia binata*, *Grewia tiliæfolia* and *Stephegyne parvifolia*. The last broke very soon and it is obviously not suitable. The other samples lasted well, though wearing out faster than hickory. Further tests are in progress. Picking sticks of

the same timbers were also under test in a cotton mill at Hubli. In this test as well *kalam* (*Stephegyne parvifolia*) soon proved its unsuitability and the other specimens were still in service at the end of seven months' continual work.

A scheme of enquiry was drawn up by the Forest Economist, Dehra Dun, to test *Diospyros*, *Ougeinia* and *Grewia* against hickory picking sticks. Samples of all the four species were supplied to the Forest Economist. Provisional experiments with the first two timbers as also with *Anogeissus latifolia* indicate their suitability. Further tests are in progress.

ASSAM.

No information available.

ANDAMANS.

No information available.

COORG.

No information available.

MADRAS.

No information available.

CHAPTER V.

FOREST ENTOMOLOGY.

CENTRAL INSTITUTE.

Insects of Sal.—(a) The large heart-wood borer. In last year's Report an estimate was given of the annual abundance of the large heart-wood borer of *sal* in Thano forest from 1916-1922. It was concluded that the epidemic, which had been raging for seven years, had been brought completely under control. This conclusion is borne out by the incidence recorded in the enumerations of 1923; only 2,625 trees were found to be infested, against 4,411 in the year before.

An attempt to estimate the value of the damage caused by the borer led to the somewhat pessimistic conclusion that the costs of application of remedial measures, and the value of the financial loss prevented by them cannot be calculated under present conditions of forest management. The subject has been approached again during the year under review with successful results. Since 1916 *Hoplocerambyx spinicornis* has been responsible for a depreciation in the value of *sal* timber varying between 2 annas 7 pies and 4 annas 10 pies per cubic foot. In the years 1916-1919, during which the epidemic raged uncontrolled over 7 square miles of *sal*

forest, a million cubic feet of timber were damaged, resulting in a loss of two and a half lakhs of rupees. In the period 1920-23, during which remedies were applied, the loss has been reduced to a total of half a lakh and to Rs. 7,000 in the year 1923. It is estimated that the loss prevented lies between one and three lakhs. The control measures were not carried out at departmental expense, on the contrary there was a profit of over Rs. 12,000 on the timber sales. Even assuming that the epidemic would have died out naturally, if no control measures had been used, the profit on the operations is Rs. 1,09,234.

This is the first occasion on which the large scale control of a forest insect in India has been shown to be a profitable operation.

It is estimated that the annual loss in the *sal* forests of India due to *Hoplocerambyx* amounts to Rs. 2,50,000. By the use of more frequent dry-wood fellings it should be possible to prevent this loss; in the United Provinces, for example, an increased net revenue of at least Rs. 1,12,500 (or nearly two annas per acre per annum) might be expected.

(b) Work has been continued in the Insectary on the other borers of the sapwood and heartwood of *sal*.

(c) Injury to young *sal* crops in Ganjam, Madras, was examined; termites and scale insects were found to be associated with bark-cracks and incipient rot in the sapwood.

(d) Reports of extensive defoliation of *sal* were received from Assam, but advantage could not be taken to study this outbreak during the present year.

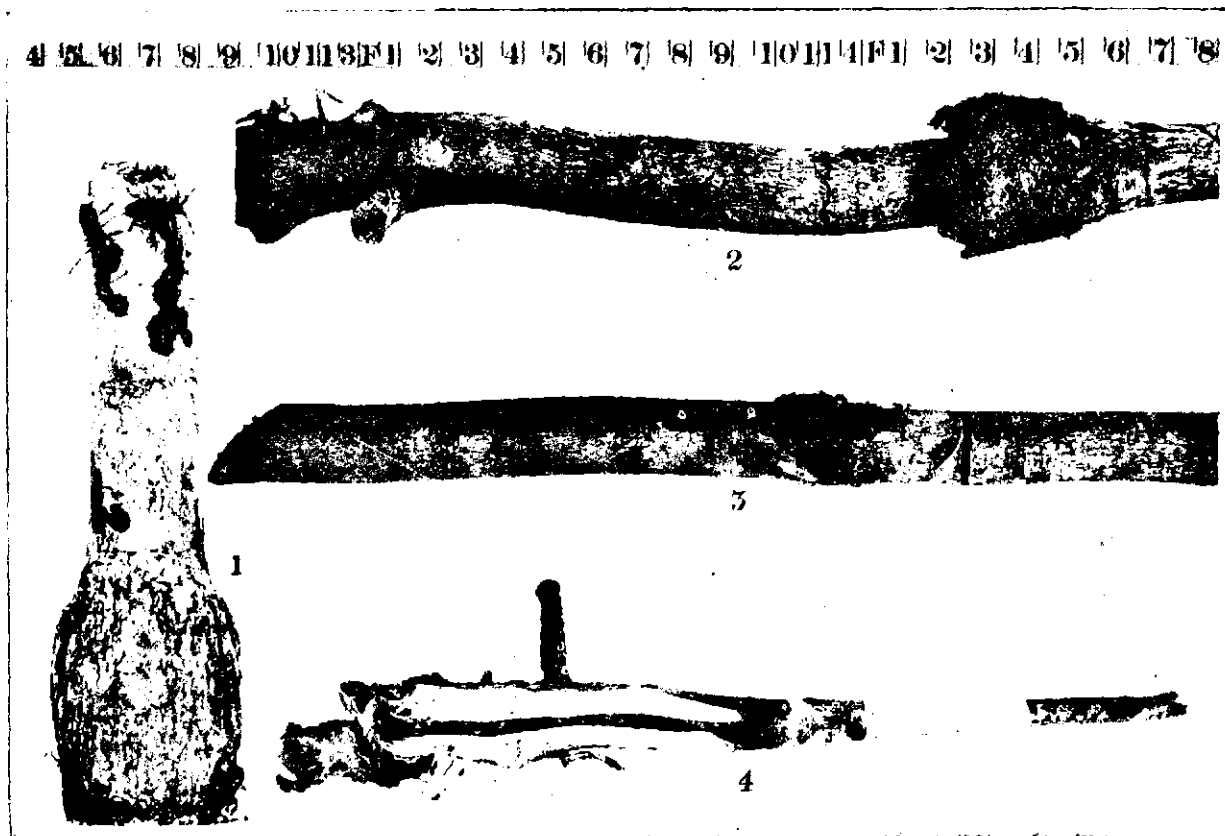
Insects of Teak.—Defoliators.—As a result of a visit by the Forest Entomologist to the teak plantations of Nilambur, an Upper Grade Assistant has been deputed for one year to study the problem of teak defoliation. Permanent sample plots involving 147 acres, in which there are 11 statistical plots have been established. Defoliation will be graded and mapped and the loss of increment determined. An insectary will be maintained to study the life-cycles and food-plants of the defoliators, and control measures will be tested.

The possibility of starting work on the same lines in the teak plantations of the Chittagong Hill Tracts has been considered and increment plots have been chosen; preliminary work on the biology of the defoliators will be commenced next year.

The Teak Sapling borer.—*Haplohammus cervinus* is found to be an important pest of young plantations of teak and *Gmelina arborea*. Preliminary experiments have been started in the Chittagong Hill Tracts.

The Beehole borer.—*Duomitus (Xyleutes) ceramicus* has been discovered attacking teak in the Chittagong Hills.

Insects of Conifers.—Deodar defoliator.—For the last two years an epidemic outbreak of a species of *Geometridae* has affected the deodar forests of the outer Himalayas in the Simla Hill States and Jaunsar. Preliminary studies have been made on the life-history



TWO IMPORTANT TEAK PESTS.

Fig. 1. Teak sapling with canker produced by larva of *Haplohammus cervinus*; beetles feeding on bark.
 Figs. 2, 3, 4. Teak saplings bored by *Phassus malabaricus*; the exit hole is covered by a conspicuous mat of wood and bark fragments; the larval gallery extends from the roots for several feet in the pith.

of the pest and control measures have been devised to be tested in the season of 1924.

Dying off of Spruce.—The causes of the mortality of older stands of spruce in Jaunsar are apparently many; the importance of the insect factor has been investigated in a short visit and a plan of operations devised.

Bark-beetles.—A revision of the genus *Polygraphus* bark-beetles of pines, spruce, fir, deodar, etc., has been completed with the discovery of several new species.

Miscellaneous Pests.—Borers of timbers.—The collection of records of the host trees and swarm periods of Indian timber borers has formed the major feature of Insectary work. Advantage was taken of tours in Malabar, the foot hills of the Nilgiris, the Naga Hills, the Chittagong Hills, and the District of Kumaon and west Nepal to collect material from forests hitherto unworked entomologically. On the Malabar Coast attention was paid to marine borers in the creeks used as timber depôts.

The Biology of the Benthidae.—This very little known family has been written up for publication; not because of the completeness of the discoveries but because a specialist has been found to do the systematic work.

Dry wood borers.—Work on *Stromatium*, *Dinoderus*, *Lyctus*, *Sinoxylon*, etc., continues. As the life-cycle of *Stromatium* for example has now extended for four years, it is evident that the investigation will be prolonged. In view of the numerous enquiries outside the forest department more time will be devoted to this problem.

General Economic Entomology.—The rearing of defoliators, seed-borers, root-pests, etc., is undertaken as part of the routine of the Insectary and a very large number of records of feeding-habits and distribution is obtained. It is impossible to refer to any of these in a condensed Annual Report so that it will be realised there is a considerable lack of proportion between this record and those of entomological work in the Provinces.

General Insectary Work.—Enquiries from the department were accompanied by 129 consignments of specimens for examination. Enquiries and material were also received from the following States:—

Jubbal, Kashmir, Nepal, Patiala and Tehri.

A total of 24,078 insects has been bred out and records kept.

Museum.—The collection illustrating damage to wood by insects has been augmented by 20 different specimens.

Library.—147 books in addition to periodicals were added to the Zoological library during the year.

Tours.—By the Forest Entomologist to Dehra Dun Division, United Provinces in April; to Chakrata Division, United Provinces, at the end of June 1923; to Nilambur, Coimbatore, Nilgiris, Madras and Calcutta in January-February 1924. By Assistants to

Chakrata in June, to Kumaon and West Nepal in June-August, to Naga Hills and Chittagong Hill in March.

Systematic Entomology.

The Insect Collection.—During the year 497 species not previously represented in the collection were added; of these 45 species are new to Science and are represented in most cases by co-types in this collection, the types being deposited in the British Museum. Approximately 20,000 specimens were mounted and labelled and of these 3,603 were sent to specialists in various parts of the world for determination. The following entomologists have given their services on behalf of the Institute:—

Dr. Uvarov for Orthoptera; Drs. Arrow, Blair, Marshall, Jordan, Karny, Horn, Gebhardt, Cameron and Kleine; Messrs. Andrews, Champion and Maulik; Mons. Lesne, Herrn. Eggers and Heikertinger and Colonel Winn-Sampson for Coleoptera; Miss Ricardo for Diptera; Messrs. Waterston, Rohwer, Cushman and Crawley for Hymenoptera; M. Esben-Petersen for Neuroptera; Dr. Meyrick and Messrs. Prout and Fletcher for Lepidoptera; Major Fraser for Odonata and Mr. Green for Coccidae.

The following families have been revised and expanded:—Hemerobiidae, Tenebrionidae, Anthribidae and Lamiidae.

Special attention has been given to the systematic study of larvæ of the Longicornia with a view to immediate identification in order to replace the long and expensive method of rearing the adult under artificial conditions. The study will be extended to the immature forms of other families of economic importance. Babu S. N. Chatterjee, Lower Grade Assistant, has compiled a catalogue of Indian Nitidulidae which will be published shortly. A large number of species have been identified from material sent in by Forest Officers and in addition 89 specimens for the Indian Museum, Calcutta. The collection has been improved by exchanges with the Agricultural Research Institute, Pusa, as well as with several specialists in Europe and elsewhere.

Arrangements for increase in accommodation for the collections have consisted in the acquirement of 21 drawer-cabinets and the renewal of about 300 store-boxes.

BENGAL.

The observations on the borers of *Cryptomeria*, *Utis* and other species in *taungya* plantations of Darjeeling ceased on the transfer of Mr. Gardener. The Divisional Forest Officer notes that the empirical control measures are doing some good.

Observations were made by Mr. Sarkar on *Hymenotychis sordida*, Zell, a borer of the fruits of *Heritiera Fomes* in the Sundarbans.

BIHAR AND ORISSA.

Damage to *Casuarina*, teak and *Strychnos Nux Vomica* by defoliators was recorded in Puri Division.

CENTRAL PROVINCES.

The *sal* forests of Bilaspur, Mandla, and Balaghat were attacked by defoliators and *Hoplocerambyx spinicornis*.

BOMBAY.

Observations were made on *Phassus malabaricus* a borer of teak saplings, also found to attack *Macaranga Roxburghii*, *Trema orientalis*, and *Grewia tiliifolia*. The intensity of attack is believed to be due to too drastic cleanings leaving practically pure teak for the first two or three years.

MADRAS.

Insect attack.—In the course of a tour in South Kanara a cluster of dead saplings of *Hopea parviflora* was noticed in the forests of Jalsur East, where extensive fellings have been carried out to liberate the seedling growth of *Hopea*. Investigation shows that the stems of these dead trees were riddled with the larvae of some beetle. Sections containing larvae were sent to Dehra Dun and a reply was received to the effect that the beetle was a species of *Sphaerotrypes* (near *Globulus*) which generally was to be found in felled timber after exploitation but that an overflow had probably spread to the young *Hopea*. The surmise was correct as heavy fellings had recently taken place. Similar overflow attack must be carefully watched for and checked by the prompt removal of affected trees.

A number of natural seedlings of *Lagerstroemia lanceolata* varying in height from 3'—6' on a small clear felled area in the Sappal valley (evergreen forest) were noted to have been badly damaged by the borer "*Phassus malabaricus*" which also attacks young seedlings and saplings of teak, *Gmelina arborea* and various miscellaneous soft woods.

ASSAM.

No information available.

COORG.

No information available.

ANDAMANS.

No information available.

BURMA.

No information available.

CHAPTER VI.

FOREST CHEMISTRY.

CENTRAL INSTITUTE.

The sanctioned programme of work in the Chemical Branch of the Forest Research Institute was as follows:—

1. *Gums, Resins, Oleo-resins and Essential Oils.*

(1) General study of essential oils.

(2) General study of gums, resins, oleo-resins, gum oleo-resins and wood oil and natural varnishes.

2. *Miscellaneous enquiries.*

(1) General enquiry into oil seeds and their uses.

(2) Investigation into Indian Turpentine.

3. *General investigations into the nature and value of dyes obtainable from woods, barks, fruits, flowers and leaves.*

Essential Oils.—As in the past two years the main energies of the laboratory have been devoted to investigations dealing with essential oils. Much of the completed work has been published and is summarised below.

Pinus longifolia.—Work on the constitution of the sesquiterpene, longifolene, has been continued during the year. Sufficient results have now been obtained to justify a tentative constitution being allotted to this substance and this is discussed in detail in a paper published in the Journal of the Chemical Society.

So far no economic use has been found for this waste product of the turpentine industry.

The study of the "abietic acid" derived from the rosin of *P. longifolia* has been continued during the year. From the results so far obtained it would appear to be a new acid since it differs in certain respects from the acid obtained from the American colophony. By the kindness of Dr. W. Schorger of the Burgess Laboratories a quantity of American colophony has been received thus rendering possible a direct comparison of the two acids.

Progress in this investigation is likely to be slow owing to the difficulties involved in working with this class of substance.

Pinus Merkusii.—The turpentine from the oleo-resin of *P. Merkusii* was distilled at Jallo and the oil examined. The study of the Indian turpentine derived from all the species of *Pinus* occurring in India has now been completed and the results have been published in the Forest Records.

Cupressus torulosa.—An examination of the oil from the leaves of the Himalayan Cypress has shown it to consist mainly of α -sabinene, α -pinene, terpinene, dipentene and possibly Y-terpineol. The last named substance has not previously been found in nature.

Andropogon grass oil from Etawah.—At the request of Mr. McDonald the oil occurring in a species of *Andropogon* found at Etawah in considerable quantity has been examined. This grass which would appear to be closely related to *A. Jwarancusa*, Jones, has not yet been definitely identified botanically and is possibly a new species. Unfortunately the oil is unlikely to prove to be of economic value but its study has raised several points of considerable scientific interest which it is hoped to investigate further.

Zanthoxylum ovalifolium.—In continuation of previous work on the oils from the seeds of the various species of *Zanthoxylum* found in India the oil from the seeds of *Z. ovalifolium* has been examined. It is interesting in containing a large percentage of safrol but as the value of this substance (which is obtained from camphor oil) is low, approximately Rs. 2 per lb. it would hardly prove remunerative to distill the seeds.

Juniperus communis.—Oil of juniper from the leaves of *Juniperus communis* grown in the Himalaya has been examined. It differs markedly from the normal juniper oil of commerce resembling more closely the oil from the twigs of *J. sabina*.

Oxidation of Indian turpentine.—The experiments on the rate of oxidation of Indian turpentine in the presence of anticalalysts have been continued during the year and are approaching completion. There appears to be little doubt that the oxidation can be almost completely inhabited and it will probably prove desirable to repeat the experiments on a full commercial scale.

Fixed Oils.—A few analytical determinations of the oil content of seeds have been made during the year but no new oils have been examined.

Lathyrism.—The bulk of the work on lathyrism has, during the year, been carried out at Pusa and Kasauli. Feeding experiments are now being carried out on monkeys and are yielding results of considerable interest. It is however likely to be some time before decisive results are obtained.

The absence of an Officer-in-Charge of the Minor Forest Products has been very severely felt and practically no new problems have been suggested during the year under review. In addition very great difficulty has been experienced in the collection of material for investigation. It is hoped that the appointment of a full-time officer will not be further delayed.

ASSAM.

No information available.

BENGAL.

No information available.

MADRAS.

No information available.

BIHAR AND ORISSA.

No information available.

CENTRAL PROVINCES.

No information available.

BOMBAY.

No information available.

COORG.

No information available.

ANDAMANS.

No information available.

BURMA.

No information available.

PUNJAB.

No information available.

UNITED PROVINCES.

No information available.

CHAPTER VII.

FOREST PUBLICATIONS.

Serial No.	Title.	Author.	Date of Issue.
	MANUALS. <i>In Press.</i>		
1	Elementary Manual on Indian Wood Technology.	H. P. Brown.	....

Serial No.	Title.	Author.	Date of issue.
FOREST RECORDS.			
<i>Issued.</i>			
2	The Constituents of some Indian Essential Oils.—The Essential Oil from the gum-oleo-resin of <i>Boswellia serrata</i> , Roxb.	J. L. Simonsen	April 1923.
3	Note on the Possibilities of Camphor Cultivation from <i>Cinnamomum Camphora</i> in Northern India.	S. H. Howard, W. A. Robertson and J. L. Simonsen.	July 1923.
4	The Constituents of some Indian Essential Oils, Parts IX and X.	J. L. Simonsen	Do.
5	Note on the Work of Extraction of Broad Gauge Sleepers from Nepal.	J. V. Collier	November 1923.
6	The Constituents of some Indian Essential Oils, Part XI.—The Essential Oils from the Leaves of <i>Cupressus torulosa</i> , Don.	J. L. Simonsen	September 1923.
7	Oils and Fats from the Seeds of Indian Forests Plants, Part VI.—The Oil from the Seeds of <i>Aleurites montana</i> , Wils., and Part VII.—The Oil from the Seeds of <i>Salvia plebeia</i> , R. Br.	Part VI, by R. N. Parker, M. Gopal Rau, W. A. Robertson and J. L. Simonsen, and Part VII, by M. Gopal Rau and J. L. Simonsen.	March 1924.
8	A <i>Sal</i> (<i>Shorea robusta</i>) Yield Table for the United Provinces.	E. A. Smythies and S. H. Howard.	December 1923.
9	The Constituents of some Indian Essential Oils, Part XII.—The Essential Oil from the oleo-resin of <i>Pinus Merkusii</i> .	J. L. Simonsen	Do.
10	Interim Report on the Work under Projects No. 1 and No 0.	L. N. Seaman	March 1924.
<i>In Press.</i>			
11	General Volume Tables for <i>Sal</i> (<i>Shorea robusta</i>).	S. H. Howard	(Issued in April 1924.)
12	Analysis of the Tanning Properties of certain Burma <i>Lagerstroemias</i> .	E. Pasupati . . . (Reported by J. A. Pilgrim).	(Issued in September 1924.)
13	The Constituents of some Indian Essential Oils, Part XIII.—The Essential Oils from a new species of <i>Andropogon</i> occurring in the Etawah District.	J. L. Simonsen	Do.

Serial No.	Title.	Author.	Date of Issue.
FOREST RECORDS— <i>contd.</i>			
<i>In Press—contd.</i>			
14	Tannin Investigation of some Burmese <i>Dipterocarps</i> .	J. A. Pilgrim .	(Issued in June 1924.)
15	The Mangroves of South Tenasscrim.	Do.	(Issued in September 1924.)
16	Burma Oak and Chestnut Tans .	Do.	(Issued in December 1924.)
17	The Constituents of some Indian Essential Oils, Parts XIV and XV.	J. L. Simonsen .	....
18	Contribution towards a Knowledge of Twisted Fibre in Trees.	H. G. Champion .	....
19	Note on Regeneration with the assistance of <i>Taungya</i> in Burma.	H. R. Blanford .	....
20	On Some Indian <i>Brenthidæ</i> , Parts I, II and III.	Part I, by R. Kleine, Part II, by C. F. C. Beeson. Part III, by J. C. M. Gardner.	....
FOREST BULLETINS.			
<i>Issued.</i>			
21	Summary of Results of Treated and Untreated Experimental Sleepers laid in the various Railway Systems of India.	R. S. Pearson .	October 1923.
22	Dry Slides and Flumes (Wet Slides).—Being Extracts from a Note on American Logging Practice.	C. G. Rogers .	December 1923.
23	Animal Haulage, Caterpillar Tractors and Portable Sawmills.—Being Extracts from a Note on American Logging Practice.	Do.	Do.
<i>In Press.</i>			
24	Report on Tan Values of Indian Myrobalans and Burma <i>Terminalias</i> .	J. A. Pilgrim .	(Issued in June 1924.)
25	Tan Investigation of the Burma Hill Pine, <i>Pinus Khasya</i> , bark and <i>Ppinkado</i> , <i>Xylia dolabriformis</i> .	Do.	Do.
26	General Volume Tables for <i>Chir</i> (<i>Pinus longifolia</i>).	S. H. Howard .	(Issued in August 1924.)

Serial No.	Title.	Author.	Date of Issue.
OTHER PUBLICATIONS.			
<i>Issued.</i>			
27	A Forest Flora of the Andaman Islands.	C. E. Parkinson	July 1923.
28	Mechanical, Physical & Structural Properties of Wood Grown in India, Project No. 1 (<i>Reprinted</i>).	L. N. Seaman	June 1923.
29	Progress Report of the Imperial Forest College, Dehra Dun, for the year 1922-23.	....	December 1923.
30	Progress Report of Forest Research Work in India, for the year 1922-23.	....	March 1924.
<i>In Press.</i>			
31	Project No. IV.—Scheme of Investigations on Sleepor Woods.	R. S. Pearson, L. N. Seaman, C. V. Sweet, J. H. Warr and H. P. Brown.	....
32	Project No. V.—Testing of Raw Material for Paper-Pulp.	W. Raitt	....
33	Progress Report of the Imperial Forest College, Dehra Dun, for the year 1923-24.	....	(Issued in December 1924.)

Contributed to Periodicals.—

1. Natural Regeneration of Eucalyptus, by R. N. Parker (Indian Forester, 1923, Vol. XLIX, pp. 251-252).

2. Calculation of the Yield of a Forest by Formulæ, by S. H. Howard (Indian Forester, 1923, Vol. XLIX, p. 257).

3. Growth in Trees, by H. Trotter (Indian Forester, 1923, Vol. XLIX, pp. 293-301).

4. Oecology of Indian Savannah Plants, by Sher Singh (Indian Forester, 1923, Vol. XLIX, pp. 356-368).

5. A General Modification of Von Mantel's Formula, by C. E. Simmons (Indian Forester, 1923, Vol. XLIX, pp. 393-395).

6. Note on the Afforestation of grassy blanks in Sal Forest, by S. H. Howard (Indian Forester, 1923, Vol. XLIX, pp. 484-489).

7. *Polyporus Gilrus* (Schw.) Fr. and Pat., a suspected root parasite of *shisham* (*Dalbergia Sissoo*), by A. Hafiz Khan (Indian Forester, 1923, Vol. XLIX, pp. 503-506).

8. Frost as a cause of unsoundness in Sal, by A. E. Osmaston (Indian Forester, 1923, Vol. XLIX, pp. 539-543).

9. Height Growth of Seedlings, by S. H. Howard (Indian Forester, 1924, Vol. L, pp. 11-15).

10. The evolution of a sal seedling, by E. A. Smythies (Indian Forester, 1924, Vol. L, pp. 57-67).

11. A new species of *Astragalus* from Kumaon, by R. N. Parker (Indian Forester, 1923, Vol. XLIX, pp. 78-79).

12. The Constituents of Indian Turpentine from *Pinus longifolia*, Roxb., Part III, by J. L. Simonsen (Trans. Chem. Soc. 1923).

13. 5-Methyl-1:2:8-Trimethoxyanthraquinone and 7-Methyl-1:2:8-Trimethoxyanthraquinone, by J. L. Simonsen (Trans. Chem. Soc.) (*In Press.*)

14. Santonin from *Artemisia maritima*, Linn. (*A. Brevifolia*, Wall), by J. L. Simonsen (Pharm. Jl. 1923).

15. Previously Undescribed Scolytidæ and Platypodidæ from the Indian Area, by F. Winn Sampson, (Annals and Magazine of Natural History, 1923, XI, 63, pp. 285-289).

16. On new Curculionidæ from India, by S. K. Marshall (Annals and Magazine of Natural History, 1923, XIII, 75, pp. 282-296).

17. Les Trechinæ (Carabidæ) de la Region Orientale, by A. Jeannel (Annals and Magazine of Natural History, 1923, XII, pp. 393-435).

United Provinces.

1. Working Plans for Saharanpur, South Kheri and Dehra Dun Divisions.

2. Practical Forest Management, by C. G. Trevor and E. A. Smythies.

Burma.

The following Burma Forest Bulletins were issued during the year:—

No. 9.—Thinnings in Teak Plantations, by H. R. Blanford, O.B.E.

No. 10.—Rough Volume Tables for Teak (*Tectona grandis*), *Pyinkado* (*Xylia dolabriformis*), *In* (*Dipterocarpus tuberculatus*) and *Taukkyan* (*Terminalia tomentosa*).

APPENDIX I.

Administration Report of the Forest Research Institute and College for the year 1923-24 (1st April 1923 to 31st March 1924).

Administration.—The post of President, Forest Research Institute and College was held by Mr. W. F. Perrée, C.I.E., Chief Conservator of Forests, except for the period from 28th April to 23rd November 1923 when he was on leave and Mr. W. Mayes, Conservator of Forests, officiated as President, in his place.

The names of the officers who held charge of the various branches are given below :—

Branch of Forest Research Institute.	MONTH AND DATE.		Name of officer in charge of branch.
	From	To	
Silviculture . . .	1st April 1923.	31st March 1924.	Mr. S. H. Howard, B.A., Deputy Conservator of Forests, United Provinces.
Forest Botany . . .	1st April 1923.	31st March 1924.	Mr. R. N. Parker, F.C.H., Deputy Conservator of Forests, Punjab.
Forest Economy . . .	1st April 1923.	31st March 1924.	Mr. R. S. Pearson, C.I.E., F.L.S., Conservator of Forests, Bombay.
Forest Entomology . . .	1st April 1923.	31st March 1924.	Dr. C. F. C. Beeson, D.Sc., M.A., F.E.S., Deputy Conservator of Forests, Punjab.
Forest Chemistry . . .	1st April 1923.	31st March 1924.	Dr. J. L. Simonsen, D. Sc., F.I.C., F.A.S.B., Forest Chemist, F.R.I., and C.

APPENDIX II.

FINANCIAL.

The expenditure of the past two years is compared below.

	EXPENDITURE DURING THE YEAR.		Difference (+) or (-).
	1922-23 (12 months, 1st April 1922 to 31st March 1923.)	1923-24 (12 months, 1st April 1923 to 31st March 1924.)	
	Rs.	Rs.	Rs.
AVI Stores, Tools and Plants	58,673	67,943	+ 9,270
AVII Building, etc.	9,484	3,291	- 6,193
AIX Miscellaneous	75,367	1,27,588	+ 52,221
B1a Conservators	54,737	65,469	+ 10,732
B1b Superior Officers Non-Voted	2,03,210	1,55,248	- 47,962
B1b Superior Officers Voted	37,805	41,307	+ 3,502
B1c Subordinate Forest and Depot Establishment.	5,994	7,083	+ 1,089
B1d Office Establishment	67,353	69,913	+ 2,560
B1e Deputation and Special Allowances.	..	..	..
B1f Compensation for dearness of provisions.	..	..	..
B1g House rent and other allowances.	595	553	- 42
BII Travelling Allowances	17,234	32,300	+ 15,066
BIII Contingencies	32,381	43,750	+ 10,869
TOTAL	5,63,333	6,14,445	+ 51,112

The increase under AVI is due to the expenditure on the completion of the erection of machines and internal fittings for the laboratories of the Economic Branch as also to the purchase of Arithmometers for statistical work in the Silvicultural Branch and Cabinets for the Entomological Branch.

The decrease under AVII is due to less expenditure having been incurred on repairs to buildings during the year.

The increase under AIX is due to larger purchases of chemicals and to more expenditure having been incurred on an experimental work in the Economic Branch.

The increase under BIA is due to the pay of Mr. R. S. Pearson having been charged for the full year instead of part only in the previous year, when he was away on leave.

The decrease under BII Non-Voted is due to the termination of the appointment of the Tan Expert and the late appointment of Mr. Fitzgerald in succession to Mr. Sweet.

The increase under BII Voted is due to the appointment of Imperial Assistants in the Economic Branch.

The increase under BIC is due to annual increments of Lower Grade Assistants.

The increase under BID is due to annual increments and to the appointment of extra temporary establishment for the Silvicultural and Economic Branches.

The decrease under BIIg is insignificant and requires no explanation.

The increase under BII is due to payment of travelling allowances for the journeys to the New Site and to more extensive touring of Research Officers.

The increase under BIII is due to preparation of illustrations for Dr. Brown and Mr. Pearson's work on Indian Timbers.

W. F. PERRÉE

*President,
Forest Research Institute and College.*

APPENDIX III.

Annual Form No. 24.

FOREST DEPARTMENT, INDIA, FOREST RESEARCH INSTITUTE DIVISION.

Summary of Revenue of the different Divisions during 1923-24.

BUDGET HEADS.	President.	Sylviculturist.	Forest Botanist.	Forest Entomologist.	Forest Economist.	Forest Chemist.	TOTAL.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
REVENUE.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.
I.—TIMBER AND OTHER PRODUCE REMOVED FROM THE FORESTS BY GOVERNMENT AGENCY—							
(a) Timber	..	..	..	..	..	..	..
(b) Firewood and charcoal.	..	..	..	..	..	..	..
(c) Bamboos	..	..	..	..	..	..	..
(d) Sandal-wood	..	..	..	..	..	..	..
(e) Grass and other minor produce.	..	..	..	..	..	..	..
TOTAL I	..	..	..	..	..	..	..
II.—TIMBER AND OTHER PRODUCE REMOVED FROM THE FORESTS BY CONSUMERS OR PURCHASERS—							
(a) Timber	..	..	..	..	..	..	..
(b) Firewood and charcoal.	..	..	..	..	..	..	..
(c) Bamboos	..	..	..	..	..	..	..
(d) Grazing and fodder grass.	..	..	..	..	..	..	..
(e) Other minor produce.	..	..	..	..	..	..	..
(f) Other items.	..	..	..	..	..	..	..
(g) Commutation fees.	..	..	..	..	..	..	..
TOTAL II	..	..	..	..	..	..	..
III.—DRIFT AND WAIF WOOD AND CONFISCATED FOREST PRODUCE.							
TOTAL III	..	..	..	..	..	..	..
IV.—REVENUE FROM FORESTS NOT MANAGED BY GOVERNMENT—							
(a) Duty on foreign timber and other forest produce.	..	..	..	..	..	..	..
(b) Revenue from shared and private forests.	..	..	..	..	..	..	..
TOTAL IV	..	..	..	..	..	..	..
V.—MISCELLANEOUS—							
(a) Fines and forfeitures.	..	..	..	..	..	..	..
(b) Refunds	..	..	..	..	87 8 0	..	87 8 0
(c) Other sources	3,045 2 8	..	..	15 1 4	1,323 8 6	25 12 0	4,409 8 6
TOTAL V	3,045 2 8	..	..	15 1 4	1,411 0 6	25 12 0	4,497 0 6
GRAND TOTAL REVENUE.	3,045 2 8	..	..	15 1 4	1,411 0 6	25 12 0	4,497 0 6

APPENDIX III—*contd.*Annual Form No. 24—*contd.*FOREST DEPARTMENT, INDIA, FOREST RESEARCH INSTITUTE DIVISION.
Summary of Expenditure of the different Divisions during 1923-24.

BUDGET HEADS.	President.	Sylviculturist.	Forest Botanist.	Forest Entomologist.	Forest Economist.	Forest Chemist.	TOTAL.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.
EXPENDITURE.							
<i>A.—Conservancy and Works.</i>							
I.—TIMBER AND OTHER PRODUCE REMOVED FROM THE FORESTS BY GOVERNMENT AGENCY—							
(a) Timber
(b) Fitewood and charcoal.
(c) Bamboos
(d) Sandal-wood
(e) Grass and other minor produce.
TOTAL A. I.
II.—TIMBER AND OTHER PRODUCE REMOVED FROM THE FOREST BY CONSUMERS OR PURCHASERS—							
TOTAL A. II.
III.—DRIFT AND WAIF WOOD AND CONFISCATED FOREST PRODUCE—							
TOTAL A. III.
IV.—REVENUE FROM FORESTS NOT MANAGED BY GOVERNMENT—							
(a) Duty on foreign timber and other forest produce.
(b) Revenue from shared and private forests.
TOTAL A. IV.
—RENT OF LEASED FORESTS AND PAYMENTS TO SHARE-HOLDERS IN FORESTS MANAGED BY GOVERNMENT—							
TOTAL A. V.

APPENDIX III—contd.

Annual Form No. 24—contd.

FOREST DEPARTMENT, INDIA, FOREST RESEARCH INSTITUTE DIVISION.

Summary of Expenditure of the different Divisions during 1923-24.

BUDGET HEAD.	President.	Sylviculturist.	Forest Botanist.	Forest Entomologist.	Forest Economist.	Forest Chemist.	TOTAL.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.
VI.—LIVE-STOCK, STORES, TOOLS AND PLANT—							
(a) Purchase of cattle.	..	..	..	..	..	..	..
(b) Feed and keep of cattle.	..	..	..	..	..	..	..
(c) Purchase of stores, tools and plant.	225 12 0	4,444 6 0	330 4 0	8,484 1 6	53,630 6 3	828 1 6	67,942 15 3
TOTAL A. VI.	225 12 0	4,444 6 0	330 4 0	8,484 1 6	53,630 6 3	828 1 6	67,942 15 3
VII.—COMMUNICATIONS AND BUILDINGS—							
(a) Roads and bridges.	..	..	..	..	..	..	..
(b) Buildings	2,395 13 0	..	..	..	..	..	2,395 13 0
(c) Other works	600 3 0	..	294 15 0	..	..	..	895 2 0
TOTAL A. VII.	2,996 0 0	..	294 15 0	..	..	..	3,290 15 0
VIII.—ORGANIZATION, IMPROVEMENT AND EXTENSION OF FORESTS—							
(a) Demarcation	..	..	..	..	..	..	..
(b) Cost of Forest Settlements; compensation for land and rights.	..	..	..	..	..	..	..
(c) Surveys	..	..	..	..	..	..	..
(d) Working plans	..	..	..	..	..	..	..
(e) Sowing and planting.	..	..	..	..	..	..	..
(f) Protection from fire.	..	..	..	..	..	..	..
(g) Other works.	..	..	..	..	..	..	..
TOTAL A. VIII.	..	..	..	..	..	..	..
IX.—MISCELLANEOUS—							
(a) Law charges	..	..	..	..	..	..	..
(b) Other charges	1,675 14 6	6,696 9 2	1,169 5 9	1,980 3 9	1,09,958 11 2	6,126 14 6	1,27,587 10 10
TOTAL A. IX.	1,675 14 6	6,696 9 2	1,169 5 9	1,980 3 9	1,09,958 11 2	6,126 14 6	1,27,587 10 10
TOTAL A.—CONSERVANCY AND WORKS.	4,897 10 6	11,140 15 2	1,794 8 9	10,444 5 3	1,63,589 1 5	6,955 0 0	1,98,821 9 1
B.—ESTABLISHMENTS.							
1.—SALARIES—							
(a) Conservators	16,768 6 0	..	21,783 12 10	..	26,916 11 0	..	65,468 13 10
(b) Superior officers—							
Non-voted	..	15,753 5 0	..	25,350 0 0	97,496 7 3	16,648 5 4	1,55,248 1 7
Voted	..	4,591 11 0	9,240 0 0	8,597 7 0	11,377 11 0	7,500 0 0	41,306 13 0
(c) Subordinate forest and depot establishments.	..	..	..	4,761 13 0	2,320 11 0	..	7,082 8 0

APPENDIX III—concl'd.

Annual Form No. 24—concl'd.

FOREST DEPARTMENT, INDIA, FOREST RESEARCH INSTITUTE DIVISION.

Summary of Expenditure of the different Divisions during 1923-24.

BUDGET HEADS.	President.	Sylviculturist.	Forest Botanist.	Forest Entomologist.	Forest Economist.	Forest Chemist.	TOTAL.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.
I.—SALARIES—concl'd							
(d) Office establishments.	10,644 7 0	8,969 14 0	7,609 5 0	10,961 4 0	25,589 3 3	6,129 5 9	69,913 7 0
(e) Deputation and special allowances.	..	..	..	..	..	..	..
(f) Exchange compensation allowance.	..	..	..	..	..	..	..
(g) House rent and other allowances.	..	..	..	..	553 1 0	..	553 1 6
TOTAL B. I.	27,412 13 0	29,314 14 0	38,633 1 10	49,670 8 0	1,64,253 12 6	30,287 11 1	3,39,572 12 5
II.—TRAVELLING ALLOWANCES—							
(a) Conservators	1,271 3 0	..	146 13 0	..	988 6 2	..	2,406 6 2
(b) Superior officers.	..	2,766 2 0	510 9 0	3,765 2 0	15,484 1 11	799 12 9	23,225 11 8
(c) Subordinate forest and depot establishments.	..	..	..	811 7 0	859 0 0	..	1,670 7 0
(d) Office establishments.	..	984 6 0	127 3 8	662 7 0	2,972 12 9	150 7 3	4,897 4 8
TOTAL B. II.	1,271 3 0	3,750 8 0	784 9 8	5,239 0 0	20,304 4 10	950 4 0	32,299 13 8
III.—CONTINGENCES—							
(a) Stationery	..	20 5 0	104 3 0	11 0 0	47 7 0	..	182 15 0
(b) Carriage of tents and records.	..	418 8 3	244 7 0	438 7 9	52 0 0	..	1,153 7 9
(c) Rents, rates and taxes.	680 2 2	..	48 0 0	3 12 0	1,194 8 0	..	1,926 6 2
(d) Menial establishment.	1,469 3 0	..	157 12 0	83 11 0	16 0 0	..	1,726 10 0
(f) Official postage.	600 0 0	150 1 0	549 1 6	490 1 6	855 7 6	200 6 0	2,845 1 6
(g) Sundries	20,439 9 1	685 5 0	1,950 0 8	8,124 15 6	2,536 1 0	1,586 6 10	35,322 6 1
(h) Uniforms	..	36 3 3	29 6 3	..	42 13 6	..	111 7 0
(i) Telephone charges.	470 0 0	..	..	..	..	11 15 6	481 15 6
TOTAL B. III.	23,658 14 3	1,310 6 6	3,082 14 5	9,151 15 9	4,747 5 0	1,798 12 4	43,750 4 3
TOTAL B.—ESTABLISHMENTS.	52,342 14 3	34,375 12 6	42,500 9 11	64,061 7 9	1,89,305 6 4	33,036 11 5	4,15,622 14 2
GRAND TOTAL OF EXPENDITURE.	57,240 8 9	45,516 11 8	44,295 2 8	74,505 13 0	2,52,894 7 9	39,991 11 5	6,14,444 7 3
SURPLUS OR DEFICIT.	-54,195 6 1	-45,516 11 8	-44,295 2 8	-74,490 11 8	-3,51,483 7 3	-39,965 15 5	-6,09,947 6 9

CALCUTTA;

The 15th September 1924.

M. N. GUPTA,

Assistant Accounts Officer.

Certified that the totals of this form as printed in the Forest College and Forest Research Institute Reports for 1923-24 when added together agree with those entered in the Forms for the combined offices as supplied by the Accountant General, Central Revenues, under Article 78 (ii) of the Forest Department Code.

W. F. PERRÉE,

President,

Forest Research Institute and College.

APPENDIX IV.

Annual Form No. 27.

FOREST DEPARTMENT, INDIA, FOREST RESEARCH INSTITUTE.

Outstandings and Liabilities on account of Contractors and Disbursers for the Financial year 1923-24.

Division.	DEPARTMENT DEBTOR.		DEPARTMENT CREDITOR.			BALANCE DUE.
	Recoveries in cash and value of supplies and work done during the year.	Total.	Opening balance.	Payments made during year.	Total.	To Department (Outstandings).
(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.
Sylviculturist	18,197 14 8	18,197 14 8	399 3 6	17,878 12 0	18,277 15 6	80 0 10
Forest Botanist	3,196 6 6	3,196 6 6	207 15 2	3,306 11 0	3,514 10 2	318 3 8
Forest Entomologist	4,864 7 11	4,864 7 11	499 14 11	4,781 0 8	5,280 15 7	416 7 8
Forest Economist	28,684 12 11	28,684 12 11	2,496 10 8	26,429 3 4	28,925 14 0	241 1 1
Forest Chemist	2,737 15 11	2,737 15 11	410 6 0	2,327 9 11	2,737 15 11	..
TOTAL	57,681 9 11	57,681 9 11	4,014 2 3	54,723 4 11	58,737 7 2	1,055 13 3

CALCUTTA;

The 15th September 1924.

M. N. GUPTA,

Assistant Accounts Officer.

Certified that the totals of this form as printed in the Forest College and Forest Research Institute Reports for 1923-24 when added together agree with those entered in the Forms for the combined offices as supplied by the Accountant General, Central Revenues, under Article 78 (ii) of the Forest Department Code.

W. F. PERRÉE,

President,

Forest Research Institute and College.

APPENDIX V.

List of Forest Publications issued since the creation of the Forest Research Institute, Dehra Dun.

	PRICE (exclusive of packing, postage, etc.). Rs. A. P.
I.—BULLETINS (OLD SERIES).	
1.—Note on the Bee-Hole Borer of Teak in Burma, by E. P. Stebbing. (<i>Out of print</i>)	0 4 0
2.—Note on the Quetta Borer (<i>Aolesthes sartus</i>), by the same author (<i>Out of print</i>)	0 8 0
3.—Note on the Chilgoza (<i>Pinus Gerardiana</i>) Bark Boring Beetles of Zhob, Baluchistan, by the same author. (<i>Out of print</i>)	0 8 0
4.— <i>Ficus elastica</i> : its natural growth and artificial propagation, with a description of the method of tapping the tree and of the preparation of its rubber for the market, by E. M. Coventry	0 12 0
5.—Notes on a Visit to some European Schools of Forestry, by E. P. Stebbing. (<i>Out of print</i>)	2 0 0
6.—Memorandum on Mechanical Tests of some Indian Timbers, by W. H. Everett	0 2 0
7.—Note on the Chilgoza Forests of Zhob and the Takht-i-Suliman, by E. P. Stebbing. (<i>Out of print</i>)	0 12 0
8.—Note on the Life-History of <i>Hoplocerambyx spinicornis</i> (The Singbhum Sal Borer), by the same author	0 9 0
9.—Note on the Influence of Forests on the Storage and Regulation of the Water-Supply, by S. Eardley-Wilmot. (<i>Out of print</i>)	1 0 0
10.—Note on the Duki Fig-Tree Borer of Baluchistan (<i>Batocera rubus</i>), by E. P. Stebbing. (<i>Out of print</i>)	0 7 0
11.—On Some Assam Sal (<i>Shorea robusta</i>) Insect Pests, by the same author	1 10 0
II.—LEAFLETS.	
1.—The Sal Bark-Borer (<i>Sphaerotrypes sicalikensis</i> , Steb.), by E. P. Stebbing. (<i>Out of print</i>)	0 4 0
2.—The Teak Defoliator (<i>Hyblæa puera</i> , Cram.), by the same author. (<i>Out of print</i>)	0 2 0
3.—The Teak Leaf Skeletoniser (<i>Pyrausta machæralis</i> Wlk.), by the same author. (<i>Out of print</i>)	0 2 0
4.—The Larger Deodar Bark-Borer (<i>Scolytus major</i> , Steb.), by the same author. (<i>Out of print</i>)	0 4 0
5.—The Blue Pine "Polygraphus" Bark-Borer (<i>Polygraphus major</i> , Steb.), by the same author. (<i>Out of print</i>)	0 3 0
III.—PAMPHLETS.	
1.—Note on Utilisation of Khair Forests in Eastern Bengal and Assam, by Puran Singh. (<i>Out of print</i>)	0 4 0
2.—The Attack of the Bark-Boring Beetle in the Coniferous Forests in the Simla Catchment Area, by E. P. Stebbing. (<i>Out of print</i>)	0 8 0

PRICE
(exclusive of
packing,
postage, etc.).
Rs. A. P.

III.—PAMPHLETS—contd.

3.—A Glossary of Forest Technical Terms for Use in Indian Forestry, by A. M. F. Caccia. (Revised and issued as Bulletin No. 4, New Series.) (Out of print)	0	4	0
4.—Note on Lac and Lac Cultivation, by D. N. Avasia. (Out of print)	0	2	0
5.—Notes on Sal in Bengal, by A. L. McIntire. (Out of print)	0	4	0
6.—Note on Forest Reservation in Burma in the Interests of an Endangered Water-Supply, by A. Rodger	1	0	0
7.—Note on Andaman Marble Wood or Zebra Wood (<i>Diospyros Kurzii</i> , Hiern.), by R. S. Troup	0	4	0
8.—Note on the Collection of Statistical Data relating to the principal Indian Species, by A. M. F. Caccia	0	10	0
9.—Tables showing the Progress in Working-Plans in the Provinces outside the Madras and Bombay Presidencies up to 31st December 1908, by the same author	0	10	0
10.—Note on Burmese Leza Wood (<i>Lagerstromia tomentosa</i> , Presl.), by R. S. Troup	0	2	0
11.—Note on Carallia Wood (<i>Carallia integerima</i> , DC.), by the same author	0	2	6
12.—Note on Petwun or Trincomali Wood (<i>Berria Ammonilla</i> , Roxb.), by the same author	0	4	0
13.—Note on Burmese In Wood (<i>Dipterocarpus tuberculatus</i> , Roxb.), by the same author	1	0	0
14.—Note on Burma Padouk (<i>Pterocarpus macrocarpus</i> , Kurz.), by the same author	1	0	0
15.—Note on the Preservation of Bamboos from the Attacks of the Bamboo Beetle or "Shot-Borer," by E. P. Stebbing	0	7	0
16.—Note on the Best Season for Coppice Fellings of Teak (<i>Tectona grandis</i>), by R. S. Hole	0	4	0

IV.—BULLETINS (NEW SERIES).

1.—Note on Calorimetric Tests of some Indian Woods, by Puran Singh	0	2	0
2.—Memorandum on Teak Plantations in Burma, by F. A. Leete.	0	10	0
3.—Note on the Relative Strength of Natural and Plantation-Grown Teak in Burma, by R. S. Pearson	0	4	0
4.—Second Edition of the Glossary of Technical Terms for Use in Indian Forestry, by A. M. F. Caccia, revised by R. S. Troup.	0	6	0
5.—The Blue Pine Tomiucus Bark-Borer (<i>Tomiucus Ribbentropi</i>), by E. P. Stebbing	0	2	0
6.—Memorandum on the Oil-Value of Sandalwood, by Puran Singh.	0	2	0
7.—Note on the Chemistry and Trade Forms of Lac, by the same author	0	3	0
8.—Note on some Germination Tests with Sal Seed (<i>Shorea robusta</i>), by R. S. Troup	0	2	0
9.—Note on Resin-Value of <i>Podophyllum Emodi</i> and the best season for collecting it, by Puran Singh	0	1	3

PRICE
(exclusive of
packing,
postage, etc.).
Rs. A. P.

IV.—BULLETINS (NEW SERIES)—*contd.*

10.—Note on the Bark-Boring Beetle Attack in the Coniferous Forests of the Simla Catchment Area, 1907-1911, by R. S. Hole	0 3 0
11.—A Further Note on some Casuarina Insect Pests of Madras, by V. Subramania Iyer	0 14 0
12.—Note on the Bark-Eating and Root-Boring Beetles of Babul (<i>Acacia arabica</i>), by E. P. Stebbing	0 4 0
13.—Note on <i>Ligno Protector</i> as a possible means of preventing timber from splitting while seasoning, by R. S. Pearson	0 5 0
14.—A Further Note on the Relative Strength of Natural and Plantation-Grown Teak in Burma, by the same author	0 3 0
15.—Note on the Technical Properties of Timber with special reference to <i>Cedrela Toona</i> wood while seasoning, by the same author	0 3 0
†16.—Note on Gumhar (<i>Gmelina arborea</i> , Roxb.), by A. Rodger	0 3 0
17.—Note on Bija Sal or Vengai (<i>Pterocarpus Marsupium</i> , Roxb.), by the same author	0 4 0
18.—Note on Sain or Saj (<i>Terminalia tomentosa</i> , W. and A.), by the same author	0 5 0
19.—Note on Benteak or Nana Wood (<i>Lagerstræmia lanceolata</i> , Wall.), by the same author	0 3 0
20.—Note on Sandan (<i>Ougeinia dalbergioides</i> , Benth.), by the same author	0 3 0
21.—Note on Dhaura Bakli (<i>Anogeissus latifolia</i> , Wall.), by the same author	0 4 0
22.—Note on the Causes and Effects of the Drought of 1907 and 1908 on the Sal Forests of the United Provinces, by R. S. Troup	0 5 6
23.—Note on the Preparation of Indian Forest Floras and Descriptive Lists, by R. S. Hole	0 4 0
24.—Note on Turpentine of <i>Pinus Khasya</i> , <i>Pinus Merkusii</i> and <i>Pinus excelsa</i> , by Puran Singh	0 2 6
25.—Development of the Culms of Grasses, by R. S. Hole	0 2 0
26.—Note on the Resin Industry in Kumaun, by E. A. Smythies	1 4 0
27.—Note on Blackwood (<i>Dalbergia latifolia</i> , Roxb.), by E. Benskin	6 4 0
28.—Note on Dhauri (<i>Lagerstræmia parviflora</i> , Roxb.), by the same author	0 4 0
29.—Note on Sundri Timber (<i>Heritiera minor</i> , Lam.), by R. S. Pearson	0 3 0
30.—The Compilation of Girth Increments from Sample Plot Measurements, by R. S. Troup	0 2 0
31.—Note on Indian Sumach (<i>Rhus Cotinus</i> , Linn.), by Puran Singh	0 2 0
32.—Note on the Burma Myrobalans or "Panga fruits" as a Tanning Material, by Puran Singh	0 1 0
33.—Note on an Enquiry by the Government of India into the Relation between Forests and Atmospheric and Soil Moisture in India, by M. Hill	1 0 0
34.—Note on Red Sanders (<i>Pterocarpus santalinus</i> , Linn. f.), by T. A. Whitehead	0 9 0

PRICE
(exclusive of
packing,
postage, etc.).
RS. A. P.

IV.—BULLETINS (NEW SERIES)—contd.

35.—Note on Babul (<i>Acacia arabica</i> , Willd.), by J. D. Maitland-Kirwan	0 5 0
†36.—Note on Kokan or Lampatia Timber (<i>Duabanga sonneratioides</i> , Ham.), by R. S. Pearson	0 3 0
37.—Note on the Contraction and Warping which takes place in <i>Pinus longifolia</i> timber while seasoning, by the same author	0 11 0
38.—The Construction of Calcareous Opercula by Longicorn Larvæ of the Group <i>Cerambycini</i> (Coleoptera, Cerambycidae), by C. F. C. Beeson	0 3 0
39.—Note on Hollong Timber (<i>Dipterocarpus pilosus</i> , Roxb.), by R. S. Pearson	0 4 0
40.—Note on Pyinma, Ajhar or Jarul Wood (<i>Lagerstræmia Flos-Reginæ</i> , Retz.), by the same author	0 6 0
41.—Note on Weights of Seeds, by S. H. Howard	0 3 0
42.—Note on Haldu (<i>Adina cordifolia</i> , Hook, F.), by C. E. C. Cox	0 8 0
43.—Note on <i>Odina Wodier</i> , Roxb., by the same author	0 8 0
44.—Note on Semal or Cotton Wood, by the same author	0 10 0
45.—Note on the Miscellaneous Forests of the Kumaon Bhabar, by E. A. Smythies	1 0 0
46.—Rate of Growth of Bengal Sal (<i>Shorea robusta</i>), 1 Quality, by S. H. Howard	1 0 0
47.—Volume Tables and Form Factors for Sal (<i>Shorea robusta</i>), by the same author	0 6 0
48.—Note on Kindal (<i>Terminalia paniculata</i>), by R. S. Pearson	0 6 0
†49.—Note on Thingan (<i>Hopea odorata</i> , Roxb.), by A. Rodger	0 7 0
50.—Note on Gurjun or Kanyin compiled by W. A. Robertson	0 4 0
51.—An Investigation of Certain Factors concerning the Resin Tapping Industry in <i>Pinus longifolia</i> , by H. G. Champion	0 8 0
52.—Classification of Thinnings	0 6 0
53.—Summary of results of Treated and Untreated Experimental Sleepers laid in the various Railway Systems of India, by R. S. Pearson	0 6 0
†54.—Dry Slides and Flumes (Wet Slides), by C. G. Rogers	3 12 0
†55.—Animal Haulage, Caterpillar Tractors and Portable Sawmills, by the same author	7 0 0
†56.—A Report on the Tan Values of Indian Myrobalans and Burma <i>Terminalias</i> , by J. A. Pilgrim	0 6 0
†57.—Tan Investigation of the Burma Hill Pine <i>Pinus Khasya</i> bark and <i>Pyinkado</i> , <i>Xylia dolabriformis</i> , by the same author	0 3 0
†58.—General Volume Tables for Chir (<i>Pinus longifolia</i>), by S. H. Howard	0 8 0

V.—FOREST RECORDS.

Vol. I, Part I.—A Note on the Lac Insect (<i>Tachardia lacca</i>), its Life History, Propagation and Collection, by E. P. Stebbing. (Out of print)	1 4 0
--	-------

PRICE
(exclusive of
packing,
postage, etc.).
Rs. A. P.

V.—FOREST RECORDS—*contd.*

Vol. I, Part	II.—A Preliminary Note on the Development of the Sal in Volume and in Money Value, by A. M. F. Caccia. (<i>Out of print</i>) . . .	1 4 0
„ Part	III.—1. <i>Pterocarpus dalbergioides</i> , Roxb. (Andaman Padouk), by B. B. Osmaston . . .	} 1 4 0
„ „	2. A Further Note on the Chilgoza Bark-Boring Beetles of Zhob, by E. P. Stebbing and Captain E. H. S. James . . .	
„ „	3. A Note on the Present Position and Future Prospects of the Cutch Trade in Burma, by R. S. Troup . . .	
„ „	4. Note on the Manufacture of Ngai Camphor, by Puran Singh (<i>Out of print</i>) . . .	
„ Part	IV.—1. A Chemical Investigation of the Constituents of Burmese Varnish (<i>Melanorrhæa usitata</i> , Sap.), by Puran Singh . . .	} 1 4 0
„ „	2. The Selection System in Indian Forests as exemplified in Working-Plans based on this system with a short description of some Continental Methods, by A.M.F. Caccia. (<i>Out of print</i>) . . .	
Vol. II, Part	I.—Note on some Insect Pests of the Himalayan Oaks (<i>Quercus dilatata</i> and <i>Q. incana</i>), by E. P. Stebbing. (<i>Out of print</i>) . . .	0 6 0
„ Part	II.—Note on the Fissibility of some Indian Woods, by R. S. Troup. (<i>Out of print</i>) . . .	1 6 0
„ Part	III.—1. Monograph on the Sylviculture of <i>Hardwickia binata</i> (Anjan), by D. O. Witt . . .	} 3 4 0
„ „	2. Notes on Sandal (Germination and Growth of Sandal Seedlings), by M. Rama Rao.	
„ Part	IV.—Note on Host Plants of the Sandal Tree, by the same author . . .	2 0 0
Vol. III, Part	I.—Note on some Statistical and other Information regarding the Teak Forests of Burma, by R. S. Troup . . .	2 12 0
„ Part	II.—Preliminary Note on the Antiseptic Treatment of Timber in India with special reference to Railway Sleepers, by R. S. Pearson.	0 14 0
„ Part	III.—Report on the Investigation of Bamboos as Material for production of Paper-pulp, by W. Raitt. (<i>Out of print</i>) . . .	0 6 0
„ Part	IV.—Note on the Preparation of Tannin Extract with special reference to those prepared from the Bark of Mangrove (<i>Rhizophora mucronata</i>), by Puran Singh . . .	0 7 0
Vol. IV, Part	I.—Note on the Distillation and Composition of Turpentine Oil from the Chir Resin and the Clarification of Indian Rosin, by the same author. (<i>Out of print</i>) . . .	0 9 0

PRICE
(exclusive of
packing,
postage, etc.).
Rs. A. P.

V.—FOREST RECORDS—*contd.*

Vol. IV, Part	II.—Note on some new and other Species of Hymenoptera in the Collections of the Zoological Branch of the Forest Research Institute, Dehra Dun, by P. Cameron . . .	0 4 0	
„ Part	III.—Note on Useful Exotics in Indian Forests (No. 1 <i>Prosopis juliflora</i> , DC.), by R. S. Hole.	0 4 0	
„ Part	IV.—Note on <i>Albizzia Lathamii</i> , by the same author.	0 3 0	
„ Part	V.—Note on the Utilisation of Bamboo for the Manufacture of Paper-pulp, by R. S. Pearson. (<i>2nd Edition</i>) . . .	2 0 0	
Vol. V, Part	I.—Note on Tea-box Industry in Assam, by the same author. (<i>Out of print</i>) . . .	0 4 0	
„ Part	II.—Note on Blue Gum Plantations of the Nilgiris (<i>Eucalyptus Globulus</i>), by R. S. Troup.	1 6 0	
„ Part	III.—Report on the Investigation of Savannah Grasses as Material for Production of Paper-pulp, by W. Raitt. (<i>Out of print</i>).	0 4 0	
„ Part	IV.—1. Note on Oecology of Sal (<i>Shorea robusta</i>), Part I, Soil-composition, Soil-moisture, Soil-aeration, by R. S. Hole . . .	0 8 0	
„ „	2. Note on Oecology of Sal (<i>Shorea robusta</i>), Part II, Seedling Reproduction in Natural Forests and its Improvement, by the same author . . .	1 1 0	
„ „	3. Note on Oecology of Sal (<i>Shorea robusta</i>), Part III, Soil-aeration and Water-cultures, by the same author . . .	0 8 0	
„ Part	V.—Note on <i>Trameles Pini</i> , by the same author . . .	1 0 0	
„ Part	VI.—Note on a New Species of Forest Grass (<i>Sporodiopogon Lacei</i> , Hole), by the same author. (<i>Out of print</i>) . . .	0 8 0	
„ Part	VII.—Note on the Economic Uses of Rosha Grass } <i>Cymbopogon Martini</i> , Stapf.), by R. S. } Pearson, and }	1 8 0	
„ „	Note on the Constants of Indian Geranium } Oil (<i>Motia</i>), by Puran Singh. (<i>Out of } print</i>) }	1 8 0	
„ Part VIII.—1.	Note on the Eucalyptus Oil } Industry in the Nilgiris } „ „ 2. Note on the Distillation of } Geranium Oil in the Nil- } giris. } „ „ 3. Note on the Manufacture of } Wintergreen Oil in India } (<i>Out of print</i>).	1 0 0	By Puran Singh
Vol. VI, Part	I.—The Life-History of <i>Diapus furtivus</i> , Sampson, by C F. C. Beeson	0 10 0	

PRICE
(exclusive of
packing,
postage, etc.).
Rs. A. P.

V.—FOREST RECORDS—contd.

Vol. VI, Part	II.—Statistics compiled in the Office of the Sylviculturist, Forest Research Institute, Dehra Dun, during 1915-16	1 6 0
"	Part III.—A Note on Thitsi (<i>Melanorrhæa usitata</i> , Wall.) with special reference to the Oleo-resin obtained from it, by E. Benskin and A. Rodger. (<i>Out of print</i>)	1 2 0
"	Part IV.—A Further Note on the Antiseptic Treatment of Timber, recording results obtained from past experiments, by R. S. Pearson	3 0 0
"	Part V.—Statistics compiled in the Office of the Sylviculturist, Forest Research Institute, Dehra Dun, during 1916-17	0 10 0
"	Part VI.—Note on the Preparation of Turpentine, Rosin and Gum, from <i>Boswellia serrata</i> (Roxb.) gum-oleo-resin, by R. S. Pearson and Puran Singh	0 13 0
Vol. VII, Part	I.—Preliminary Note on the Seasoning of some Indian Timbers by Natural Methods, by R. S. Pearson (<i>Out of print</i>)	1 0 0
"	Part II.—A Further Note on Thitsi (<i>Melanorrhæa usitata</i> , Wall.), with special reference to the oleo-resin obtained from it in the Lawksawk and Myelat States, Southern Shan States Forest Division, by F. A. Wright.	0 4 0
"	Part III.—Note on <i>Hopea canarensis</i> , Hole, by R. S. Hole	0 3 0
"	Part IV.—Note on <i>Ixora Butterwickii</i> , Hole, by the same author	0 3 0
"	• Part V.—Notes on the Larvæ and Life-Histories of Prionine Beetles, Coleoptera, Cerambycidae, Prionine, by C. F. C. Beeson	0 8 0
"	Part VI.—Note on the Mechanical Strength and Seasoning Properties of <i>Shorea robusta</i> (Sal Timber), by R. S. Pearson	0 8 0
"	Part VII.—The Life-History of the Toon Shoot and Fruit Borer, <i>Hypsipyla robusta</i> , Moore (<i>Lepidoptera</i> ; <i>Pyralidae</i> ; <i>Phycitinae</i>) with suggestions for its control, by C. F. C. Beeson	2 4 0
"	Part VIII.—Afforestation of Ravine Lands in the Etawah District, U. P., by E. A. Smythies (<i>Out of print</i>)	2 0 0
Vol. VIII, Part	I.—Report on Lac and Shellac, by H. A. F. Lindsay & C. M. Harlow	2 12 0
"	Part II.—The Regeneration of Sal (<i>Shorea robusta</i>) Forests, by R. S. Hole	2 2 0
"	Part III.—Note on the Bee-Hole Borer of Teak, by C. F. C. Beeson	3 0 0

PRICE
(exclusive of
packing,
postage, etc.).
Rs. A. P.

V.—FOREST RECORDS—*contd.*

Vol. VIII, Part	IV.—Notes on Artificial Regeneration in Bengal, by A. K. Glasson, P. T. Russell, E. O. Shebbeare and L. E. S. Teague	2 0 0
, Part	V.—Note on the Essential Oil from the leaves of <i>Abies Pindrow</i> , Spach., by J. L. Simonsen	0 2 0
Vol. IX, Part	I.—Results of Antiseptic Treatment of Sleepers, by R. S. Pearson	2 0 0
, Part	II.—On Chalcidoidea (Mainly bred at Dehra Dun, U. P., from pests of <i>Sal</i> , <i>Toon</i> , <i>Chir</i> and <i>Sundri</i>), by James Waterston	1 2 0
, Part	III.—Oils and Fats from the Seeds of Indian Forest Trees, Parts I—V, by M. Gopal Rau and J. L. Simonsen	0 3 0
, Part	IV.—The Constituents of some Indian Essential Oils, Parts I—VII, by J. L. Simonsen and M. Gopal Rau	0 6 0
† „ Part	V.—Further Experiments in the Air-Seasoning of Indian Timbers and General Recommendations as to Seasoning Methods, by C. V. Sweet with a chapter on “Damage to Timber by Insects,” by C. F. C. Beeson	2 8 0
† „ Part	VI.—The Constituents of some Indian Essential Oils, Part VIII.—The Essential Oil from the gum-oleo-resin of <i>Boswellia serrata</i> (Roxb.), by J. L. Simonsen	0 3 0
† „ Part	VII.—Note on the Possibilities of Camphor Cultivation from <i>Cinnamomum Camphora</i> in Northern India, by S. H. Howard, W. A. Robertson and J. L. Simonsen	1 4 0
† „ Part	VIII.—The Constituents of some Indian Essential Oils, Parts IX and X, by J. L. Simonsen	0 4 6
† „ Part	IX.—Note on the Work of Extraction of Broad Gauge Sleepers from Nepal, by J. V. Collier	1 11 0
† Vol. X, Part	I.—The Constituents of some Indian Essential Oils, Part XI.—The Essential Oil from the leaves of <i>Cupressus torulosa</i> , Don., by J. L. Simonsen	0 3 0
† „ Part	II.—Oils and Fats from the Seeds of Indian Forest Plants, Part VI.—The Oil from the Seeds of <i>Aleurites montana</i> , Wils., by R. N. Parker, M. Gopal Rau, W. A. Robertson and J. L. Simonsen; and Part VII.—The Oil from the Seeds of <i>Salvia plebeia</i> , R. Br., by M. Gopal Rau and J. L. Simonsen	0 9 0

PRICE
(exclusive of
packing,
postage, etc.).
Rs. A. P.

V.—FOREST RECORDS—*concl'd.*

†	Vol. X, Part III.—A Sal Yield Table for the United Provinces, by E. A. Smythies and S. H. Howard	1 5 0
†	„ Part IV.—The Constituents of some Indian Essential Oils, Part XII.—The Essential Oil from the Oleo-resin of <i>Pinus Merkusii</i> , by J. L. Simonsen	0 2 0
†	„ Part V.—Analysis of the Tanning Properties of certain Burma <i>Lagerstramias</i> , by E. Pasupati. Reported by J. A. Pilgrim	0 5 0
†	„ Part VI.—General Volume Tables for <i>Sal</i> (<i>Shorea robusta</i>) by S. H. Howard	1 7 0
†	„ Part VII.—Interim Report on the Work under Projects No. 1 and No. 0, by L. N. Seaman	0 9 0
†	„ Part III.—The Constituents of some Indian Essential Oils—The Essential Oil from a New Species of <i>Andropogon</i> occurring in the Etawah District, by J. L. Simonsen	0 3 0
†	„ Part IX.—Tannin Investigation of some Burmese <i>Dipterocarps</i> , by J. A. Pilgrim	0 7 0
†	„ Part X.—The Mangroves of South Tenasserim, by the same author	0 15 0
-†	„ Part XI.—Report on Burma Oak and Chestnut Tans, by the same author	1 1 0

VI.—MEMOIRS.

	Note on the Analysis of Cutch and the Preparation of Pure Catechu, Vol. I, Part I, Chemistry Series, by Puran Singh. (<i>Out of print</i>).	1 4 0
	Note on the Manufacture of Pure Shellac, Vol. I, Part II, Chemistry Series, by the same author. (<i>Out of print</i>)	0 8 0
	On Some Undescribed Scolytidae of Economic Importance from the Indian Region I, Vol. I, Part I, Zoology Series, by E. P. Stebbing	0 4 0
	On Some Undescribed Scolytidae of Economic Importance from the Indian Region II, Vol. I, Part II, Zoology Series, by the same author. (<i>Out of print</i>)	0 4 0
†	Indian Woods and their Uses, Vol. I, Part I, Economy Series, by R. S. Troup	2 12 0
	Note on the Prospects of the Match Industry in the Indian Empire, Vol. II, Part I, Economy Series, by the same author	1 12 0
	Second Edition of the Monograph on "Lac Insect" (<i>Tachardia lacca</i>), Vol. I, Part III, Zoology Series, by E. P. Stebbing	1 0 0
	Note on Some Important Insect Pests of the Himalayan Coniferae (Treating of Deodar), Vol. II, Part I, Zoology Series, by E. P. Stebbing. (<i>Out of print</i>)	0 10 0
	Note on the Insect Pests of the Chir Pine (<i>Pinus longifolia</i>), Vol. II, Part II, Zoology Series, by the same author. (<i>Out of print</i>)	1 14 0

PRICE
(exclusive of
packing,
postage, etc.).
Rs. A. P.

VI.—MEMOIRS—contd.

Memoir on Some Indian Forest Grasses and their Oecology, Vol. I, Part I, Botany Series, by R. S. Hole	5	8	0
Note on the Life-History of <i>Chermes Himalayensis</i> , Steb., on the Spruce (<i>Picea Morinda</i>) and Silver Fir (<i>Abies Webbiana</i>), Vol. II, Part III, Zoology Series, by E. P. Stebbing. (<i>Out of print</i>)	1	12	0
Note on the Economic Value of <i>Shorea robusta</i> (Sal), Vol. II, Part II, Economy Series, by R. S. Pearson	1	12	0
On the Structure and Biology of <i>Tachardia lacca</i> , Kerr, with observations on certain insects predaceous or parasitic upon it, Vol. III, Part I, Zoology Series, by A. D. Imms and N. C. Chatterjee	2	2	0
<i>Pinus longifolia</i> , Roxb., Vol. I, Part I, Sylviculture Series, by R. S. Troup	5	0	0

VII.—MANUALS.

†Forest Zoology Manual, by E. P. Stebbing	*10	0	0
Manual of Botany, by R. S. Hole. (<i>Out of print</i>)	3	8	0
Indian Forest Utilisation (Second Edition), by R. S. Troup. (<i>Out of print</i>)	2	12	0
Explanatory Notes on Forest Law (a new Edition of the Forest Law Manual). (<i>Out of print</i>)	1	2	0
†Preparation of Forest Working Plans in India, by W. E. D'Arcy. Revised by A. M. F. Caccia. (Fourth Edition)	0	14	0
†Second Edition of Manual of Sylviculture	1	0	0
†Manual of Forest Mensuration, by R. S. Troup. (<i>Out of print</i>)	1	4	0
†Surveying and Drawing Manual, by F. A. Brining and D. N. Avasia	3	12	0
Schlich's Manual of Forestry, Vol. I, by W. Schlich	7	8	0

VIII.—OTHER PUBLICATIONS.

‡Index to the <i>Indian Forester</i> , Vols. I to XXX, by E. P. Stebbing	1	0	0
‡ The Utilisation of Bamboo for the Manufacture of Paper-pulp, by R. S. Pearson. <i>Reprinted from</i> "The Indian Forester," 1920	0	8	0
†Practical Determination of the Girth Increment of Trees, by R. S. Troup	0	4	0
Forest Flora of Chhota Nagpur, by H. H. Haines. (<i>Out of print</i>)	9	0	0
Translation of M. Jacquots' "Incendies en Forêt," by C. E. C. Fischer. (<i>Out of print</i>)	0	14	0
Forest Flora of the Siwalik and Jaunsar Forest Divisions, U. P. (Revised Edition), by U. N. Kanjilal. (<i>Out of print</i>)	1	14	0
†Commercial Guide to the Economic Forest Products of India, by R. S. Pearson	1	0	0
Catalogue of the Photographic Collection at the Forest Research Institute, Dehra Dun	1	4	0
†Forest Research Institute and College Calendar, 1922	2	12	0
Progress Report of Forest Research Work in India for the year 1922-23	2	12	0
Progress Report of the Imperial Forest College, Dehra Dun, for the year 1922-23	1	8	0

PRICE
(exclusive of
packing,
postage, etc.).
Rs. A. P.

VIII.—OTHER PUBLICATIONS—*contd.*

Note on the Forests of Java and Madoera of the Dutch East Indies, by R. C. Milward	0 13 0
A Note on some European Sylvicultural Systems, with Suggestions for Improvements in Indian Forest Management, by R. S. Troup. (<i>Out of print</i>)	3 4 0
Note entitled "Among the Eucalypts", by R. C. Milward. (<i>Out of print</i>)	3 4 0
The Work of the Forest Department in India, by R. S. Troup	0 4 0
Code for the Collection and Tabulation of Statistical Data, by S. H. Howard. (<i>Out of print</i>)	2 0 0
Code for the Collection and Tabulation of Statistical Data (Appendices) by the same author. (<i>Out of print</i>)	3 8 0
†Mechanical, Physical and Structural Properties of Wood grown in India, Project No. 1, by L. N. Seaman (<i>Reprinted</i>)	2 0 0
The methods of preparing Volume and Money Yield Tables for Teak woods and Volume and Form Factor Tables for Teak trees, from data collected in the Nilambur Teak Plantations of the South Malabar Division, South India, by R. Bourne	9 0 0
†A Forest Flora of the Andaman Islands, by C. E. Parkinson	12 8 0

The above may be obtained from the Manager, Government of India, Central Publication Branch, Calcutta.

* N. B.—Rupees 5 for Officers below Extra Deputy Conservators.

† Obtainable from the above officer as well as from the Librarian, Central Library, Forest Research Institute and College, Dehra Dun.

‡ Obtainable from the Manager, Pioneer Press, Allahabad.