

FOREST RESEARCH 1928-29 IN INDIA



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planted 1928. Height about 55 ft. Karwar, Bombay.

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This Report is printed on paper made in the Paper Pulp Section of the Forest Research Institute, Dehra Dun, from the male bamboo (*Dendrocalamus strictus*).

Progress of Forest Research in India, 1st April 1928 to 31st March 1929.

CHAPTER I.

GENERAL.

THE CENTRAL FOREST RESEARCH INSTITUTE.

1. The whole of the Research staff of the Forest Research Institute with the exception of the members of the Chemical Branch is now in the new buildings.

Construction of quarters has continued and the following have now been completed :—

Quarters for Branch Officers	4
" " Sectional Officers	7
" " Upper Grade Assistants	5
" " Head clerks and Upper subordinates at Rs. 10,000	9
" " Clerks and subordinates at Rs. 6,000	56
" " Lower Grade clerks and subordinates at Rs. 3,500	40
" " Menials at Rs. 600	104

Roads, electric lighting and water have been supplied for the whole area.

2. A new electric plant was erected by the Mussoorie Hydro Electric Company on a plot of land leased to them for the purpose. This will supplement the present insufficient supply obtained from water power in the hills.

3. A market and school have been built and are occupied.

A hospital has been built but is not yet fitted up.

It is proposed to erect a house for the President, also a rest-house for visitors and a post office.

4. The Railway Training College and subsidiary buildings erected on 130 acres of land handed over from the forest estate, are now nearing completion.

5. The following statement shows the expenditure up to the end of March 1929 on the new Institute :—

No.	Head.	Expenditure up to 31st March 1928.	Expenditure during 1928-29.	Total.
1	2	3	4	5
1	Main Building	27,97,426	1,48,678	29,46,104
2	Residential Buildings	10,05,022	3,88,538	13,93,560
3	Chemical Section	23,510	..	23,510
4	Economic Branch	7,51,265	21,478	7,72,743
5	Miscellaneous Buildings . . .	1,00,746	2,297	1,03,043
6	Roads and Bridges	1,78,761	21,348	2,00,109
7	Maintenance of buildings during construction.	6,714	1,942	8,656
8	Grass walls, surface drainage, sewers, water supply, preliminary expenses, Electricity, Temporary quarters, Machinery, light railway, etc.	19,27,514	1,25,640	20,53,154
9	Land	12,88,120	—1,798	12,86,322
	TOTAL	80,79,078	7,08,123	87,87,201

6. During February and March 1929, a Committee appointed by the Government of India visited the Institute. Their report appeared in May 1929 and the following extracts are taken from it :—

“ THE CONSTITUTION OF THE COMMITTEE.

“ 1. *Personnel and terms of reference.*—The following press communique was issued by the Government of India on the 5th February 1929 :—

“ In order to define the lines of future activity and advance of the Forest Research Institute which is now nearing completion, the Government of India have decided to appoint a small committee consisting of Sir Chunilal Mehta, K.C.S.I., M.A., LL.B., J.P., who will be Chairman, and of Professor F. A.

Lindemann, F.R.S., Professor of Experimental Philosophy, Oxford, and Mr. F. H. Wroughton, Manager, Bombay-Burma Trading Corporation, Limited, Rangoon, who will be members.”

“ 2. The terms of reference to the Committee are as follows :—

“ To enquire into—

“ (a) the organisation, working and control of the Forest Research Institute at Dehra Dun, with special reference to the scientific and economic value of the work already done, and the desirability, or otherwise, of periodical scrutiny in the future ;

“ (b) the need for ensuring co-ordination, with a view to the achievement of scientific accuracy and to the better interchange of knowledge, between the enquiries in progress at the Institute and similar investigations abroad, especially in America and Europe, and for ensuring suitable publicity of such results as are capable of utilization for industrial purposes ;

“ (c) the system of recruiting members of the staff, especially technical experts and

“ (d) the system of training Indians for scientific research : and to make recommendations.”

“ 3. The Committee will start work at Dehra Dun from about the middle of February.”

“ *Acknowledgments.*—In accordance with the above the Committee met at Dehra Dun ; and they wish to thank the Inspector General of Forests and President of the Forest Research Institute and all the officers who supplied whatever information was required and who gave every assistance to the Committee. The report itself was written in Delhi.”

“ CONTROL OF THE INSTITUTE.

EXTERNAL.

* * * * *

“ *The Constitution of an Advisory Board.*—It may happen in the future that the greater independence of Provincial Forest Departments will involve some reduction in the degree of contact between the Central Institute and the Provinces. In such circumstances the creation of an Advisory Board, meeting at least once a year and representing provincial interests, would certainly be desirable. It may happen, too, that the President of the Institute will feel the need for outside advice before establishing new sections or inaugurating schemes of research which involve large sums of money. There is also the possibility that Government, before sanctioning new and elaborate proposals originating in the Institute itself, might be anxious to obtain some independent

opinion on their value. In view of these possibilities we suggest that consideration might be given to the expediency of establishing in the future an Advisory Board which would both assist the President in determining the general policy of the Institute and aid Government in discharging its responsibilities for the effective supervision of work there.

"The Board would be empowered to enquire into the financial and administrative activities of the Institute; it would approve annual programmes of work; it would recommend the budget estimates and it would advise on and criticise the general policy of the Institute especially in connection with the adoption of new research projects. We suggest that the Board might be composed of the following members :—

"The Secretary of the Department of Education, Health and Lands,

"The Inspector General of Forests or the President of the Forest Research Institute,

"Two Conservators from Governors' Provinces,

"A representative of the Railway Board,

"A scientist nominated by the Government of India,

"A member of the Indian Associated Chamber of Commerce, and

"A member of the European Associated Chamber of Commerce.

"Ministers of Forests in provinces where forests are transferred might also be invited to join the Board.

"We do not desire to define too closely either the composition or constitution of the Board but, generally speaking, our idea is that representatives should be selected from various provinces in rotation and that, with a view to continuity of policy, seats should be vacated at intervals of either two or three years. A Board so constituted could give helpful advice from an independent viewpoint on both departments of the Institute's activities—the one which deals with forestry proper and the one which deals with the utilisation of timber and other forest products. We are convinced, however, that the Board can only be of real use if its membership is small, if it represents adequately the interests of forestry proper as well as of science and industry, and if it meets at least once a year. If these conditions are not fulfilled the Board might be a cumbrance rather than a help to the President of the Institute and its *raison d'être* would disappear.

INTERNAL.

"Control by the President of the Forest Research Institute.

"The need for harmonious relations between the Institute and the controlling Government department is obvious. If they understand each other's problems, mutual sympathy and tolerance will be the result. But the relation in which they stand to each other involves certain difficulties. The similarity between research work and artistic work is

not always realised. In the nature of things it is almost as difficult for a public department to carry on research as it would be for it to produce literature. Both forms of creative effort are impatient of regulation or control. In both the main desideratum is the utmost possible liberty for the artist; and this every public department of its very nature abhors. We are strongly of the opinion that the best way for a government to assist research is to get a good man and trust him to carry on the work with the minimum amount of interference or control.

"We understand that the President of the Institute is entitled within limits, provided he does not overstep his budget or incur any commitments for future years, to sanction expenditure for staff or apparatus. We are of the opinion that this system should be extended as far as constitutionally possible and that the necessity for reference to the department, with the inevitable delays which this involves, should be reduced to an absolute minimum. We understand that the advice of the President is always taken before staff is to be engaged and we are of the opinion that this arrangement should continue. One cannot expect the Head of an Institute to inspire, or accept responsibilities for research work if he does not believe in the men who are working for him."

7. Other important recommendations made by the Committee are :—

- (1) The appointment of a Director of Research who must be a **first** class scientist. He will be subordinate to the President, Forest Research Institute and College.
- (2) The appointment of a Personal Assistant to the Inspector General of Forests and President, Forest Research Institute and College.
- (3) Centralisation of Branch offices.
- (4) Improvement of methods of recruitment of the sectional officers and subordinates.
- (5) The necessity for training officers abroad and for keeping in touch with other similar Institutions by means of visits. Stress was also laid on maintaining intimate touch with forest officers in provinces, with the Railways, etc.

8. Progress in the various branches of Forest Research has been good and the new buildings give ample accommodation for all the staff.

(a) Silviculture.

A conference of experts from all over India and Burma was held in March 1929.

Much progress has been made in the regeneration of evergreen, *Shorea* and teak forests.

(b) *Botany.*

The Systematic Botany of the forest tracts of India has made much progress under Mr. R. N. Parker. Dr. K. D. Bagchi published a most valuable account of the Peridermium fungus on *Pinus longifolia*.

(c) *Forest Economy.*

Mr. H. Trotter has directed this large branch very ably during the year, assisted by Mr. W. Raitt and Mr. S. Fitzgerald who have now retired, Mr. L. N. Seaman, Dr. S. N. Kapur, Mr. F. D. Ardagh, Mr. B. H. Osmaston, Mr. W. Nagle and junior officers.

(d) *Forest Entomology.*

Dr. C. F. C. Beeson has continued in charge of this branch and his work is yearly becoming of more value to the forests of India.

(e) *Chemistry.*

Dr. S. Krishna joined the Forest Research Institute and started work in a most efficient manner.

9. All Research officers gave valuable instruction during the year to the students of the Forest College.

10. Mr. A. Rodger, Inspector General of Forests, was President, and Mr. C. G. Trevor, Conservator of Forests, Vice President, throughout the year.

A statement showing the names of officers in charge of the various branches and sections during the year will be found in Appendix I.

11. In Chapter VII will be found a list of publications of the Forest Research Institute during the year. Publications of provinces will be found in the local reports.

The Provinces.

Full details of the work done in all branches of Forest Research will be found in the following pages. Burma, as the owner of nearly half the forests in British India, properly leads the way and Madras, the United Provinces and Bengal have also done a great deal of useful work. In all the remaining provinces a start has been made.

CHAPTER II.

SILVICULTURE AND WORKING PLANS.

CENTRAL INSTITUTE.

I.—EXPERIMENTAL SILVICULTURE.

(i) *General.*

The Kaunli experimental garden has been handed over to Saharanpur Division as a nursery, arrangements having been made for the preservation of the more interesting plantations.

The new nurseries have been got into condition and are proving satisfactory though the soil is somewhat heavy for many species, a defect which is being remedied. Permanent arrangements for shading and irrigating the beds have been made, and generally the new nurseries are much better than the old ones. The 20-acre experimental garden in which the nurseries are situated, is very suitable for the purpose, and is gradually being taken up by experiments. It lacks at present an area with anything that can be called a forest soil, or where plants can be put out under the normal forest conditions with root and light competition with pre-existing weed species: to meet this need, 3 compartments were sown with miscellaneous species of which 2 are already well established.

A paper was contributed to the Silvicultural Conference on methods of Experimental Research which met with approval, a resolution being passed that a general account more or less on the lines of this paper should be compiled and published for general use.

Phenological observations were continued for *Dalbergia Sissoo*, *Dalbergia latifolia*, *Gmelina arborea*, *Shorea robusta*, and *Pinus longifolia* and commenced on *Cedrela Toona*, *Albizia procera*, and *Mangifera indica*.

These observations require to be continued for several years before compilation and analysis, and co-operation with other observers is required to give them their full value. This it is hoped to arrange with Provincial Silviculturists.

Seasonal height growth observations were continued on *Acacia Catechu*, *Adina cordifolia*, *Dalbergia latifolia*, *Dalbergia Sissoo*, *Gmelina arborea*, *Shorea robusta*, *Terminalia belerica*, *Terminalia tomentosa* and *Tectona grandis* and commenced on *Broussonetia papyrifera*, *Eugenia Jambolana*, and *Bombax malabaricum* making 12 species in all.

(ii) *Natural regeneration.*

Methods of research were reviewed in the paper for the Silvicultural Conference. Four trees of *Anogeissus latifolia* have been selected at

Mohand, Saharanpur Division, United Provinces, for a study of the annual seed production and fertility. The results were as follows :—

Tree No.	Total seed produced.		Number of Tests.	Average germinative capacity (per cent.).	Total number of fertile seeds produced.
	Oz.	No. thousands.			
1 .	130	370	4	·093	343
2 .	104	359	4	·042	149
3 .	99	256	4	·102	262
4 .	13	50	4	·178	89
TOTAL .	346	1,035		·081	843

The average germinative capacity of seeds is thus only 8 in 10,000 seeds.

The collection of data for the variation in seed crop with individual trees of *Shorea robusta*, *Pinus longifolia*, and *Terminalia tomentosa* is being continued.

(iii) *Seeds.*

Routine work has been continued. During the year 53 weighments were made, adding 30 new species to the list for which we have figures. Germination tests are carried out as a routine measure for all the seeds that are received.

A study of the effect of the size of seed on subsequent development was made with *Shorea robusta*, *Pinus longifolia* and *Terminalia tomentosa*. The tests with the first two species give definite proof that the bigger the seed the better the plant per cent. and average heights of the seedlings.

The effect of age and dominance of the parent tree on seed and seedlings has been studied with *Pinus longifolia* and *Shorea robusta*. The results are still not conclusive and will be repeated as opportunity arises.

Inheritance of growth form was taken up for investigation last year, plantations of different seed from widely different localities being raised on adjoining plots. We now have such comparative plots for—

Shorea robusta (4) Dehra Dun (Bhabar), Lansdowne (Hills), United Provinces, Bihar and Orissa and Central Provinces.

Pinus longifolia (6) Dehra Dun, Chakrata, Lansdowne, Kangra, Rawalpindi and Hazara.

Tectona grandis (4) Burma, Nilambur, Dehra Dun, Coorg and Central Provinces and seeds received from Jhansi and Bombay this year.

Gmelina arborea (6) Burma, Dehra Dun, Coorg, Central Provinces, Buxa and Chittagong, Bengal.



Photo. by Har Swarup, December 1928.

Pinus longifolia sown June 1925. Demonstration Area, New Forest.

Terminalia tomentosa (4) Dehra Dun, Coorg, large and small seeded varieties from Burma.

Butea frondosa (2) United Provinces and Burma.

Adina cordifolia (2) United Provinces and Burma.

Acacia Catechu (2) United Provinces and Burma.

In the case of the first four species, it should be easy to lay out standard sample plots later on, when in 10 years or so the trees are big enough. For the rest, approximately $\frac{1}{4}$ acre plots have been made. For *Pinus longifolia*, 100 plants of each origin, selected as comparable, are being kept under detailed observation as regards phenological data and general development, and this procedure will be extended to the other species as opportunity arises.

A study has been commenced of the possible inheritance of individual characters with seed from six local trees of *Pinus longifolia* of varying habit, and varying degree of spiral grain. To minimise casualties, the seeds were pre-germinated and the seedlings raised in earthen pots and put out in the cold weather.

The investigations on bamboo congestion have received a set back from severe damage by rats.

Seedling studies on the basis of those reproduced in Troup's "Silviculture of Indian Trees" have been continued. The artist has added the following species to the list of those dealt with:—

Completed.

Acacia ferruginea.
Alnus nitida.
Amoora Rohituka.
Anogeissus acuminata.
Avicennia officinalis.
Balanocarpus utilis.
Buxus sempervirens.
Bursera serrata.

Incomplete.

Dipterocarpus pilosus.
Dipterocarpus tuberculatus.
Lagerstroemia floribunda.
Millettia pendula.
Mimusops hexandra.
Picea Smithiana.
Picea spinulosa.
Schima Wallichii.
Shorea Talura.

These bring the total completed (out of the Forest Economist's list of the 100 most important timber trees) to 47 and to 53 out of the second 100. Five species not included in these lists have also been dealt with.

Seed Storage.

Supplies of seeds of *Albizia Lebbeck*, *Albizia procera*, *Butea frondosa*, *Bauhinia variegata*, *Acacia Catechu*, *Cassia Fistula*, *Dalbergia Sissoo*, *Holarrhena antidysenterica*, *Tectona grandis*, *Sapium sebiferum*, *Terminalia belerica*, *Zizyphus Jujuba*, *Lagerstroemia Flos-Reginae*, *Terminalia*

tomentosa, *Pinus longifolia* have been laid down for seed storage and their initial germinative capacity determined. The methods used are :—

- (1) stored in air tight tins in office room,
- (2) stored in gunny bags hung under thatched shelter,
- (3) buried in charcoal 2 feet under ground.

The series will be expanded as opportunity arises and the seed tested annually.

Seed Treatment.

The effect of exposure of seeds to sun, rain and wind from the time of collection to the break of the monsoon rains, were studied with *Acacia Catechu*, *Dalbergia Sissoo* and *Terminalia tomentosa*. The differences obtained were insignificant except that the exposure reduces the vitality of the *Terminalia* seed. Four duplications were made to avoid chance inequalities of soil.

Species.	Treat-ment.	Commence-ment of germination.	Plant per cent.	Average height.		REMARKS.
				Survivals.	Total No. of seed sown.	
<i>Terminalia tomentosa</i> .	a	10 days .	12.8	11.0	1.4	} A decidedly better result for sheltered seed.
	b	17 „ .	25.5	13.6	3.5	
<i>Dalbergia Sissoo</i> .	a	10 „ .	52.5	5.4	2.7	} Slightly better result with exposed seed.
	b	10 „ .	45.5	5.3	2.4	
<i>Acacia Catechu</i> .	a	13 „ .	53.0	16.6	8.5	} Plant per cent. better for exposed seed and average height better for sheltered seed.
	b	13 „ .	48.2	18.0	8.7	

NOTE.—a=Seed exposed to sun, rain and wind.
b=Seed stored in bags under shelter.

(iv) *Nursery Work.*

Stock for Demonstration Area was raised in the nurseries and occupied most of the space, i.e., *Teak*, *Rosewood* and *Gmelina*. The following species were also raised :—

<i>Adina cordifolia</i> .	}	for comparison of stock raised from United Provinces and Burma seed.
<i>Bombax malabaricum</i> .		
<i>Cinnamomum Cecidodaphne</i> .		
<i>Swietenia macrophylla</i> .	}	for routine experiments.
<i>Holoptelea integrifolia</i> .		
<i>Alstonia scholaris</i> .		
<i>Boswellia serrata</i> .		
<i>Sterculia villosa</i> .		
„ <i>pallens</i> .		

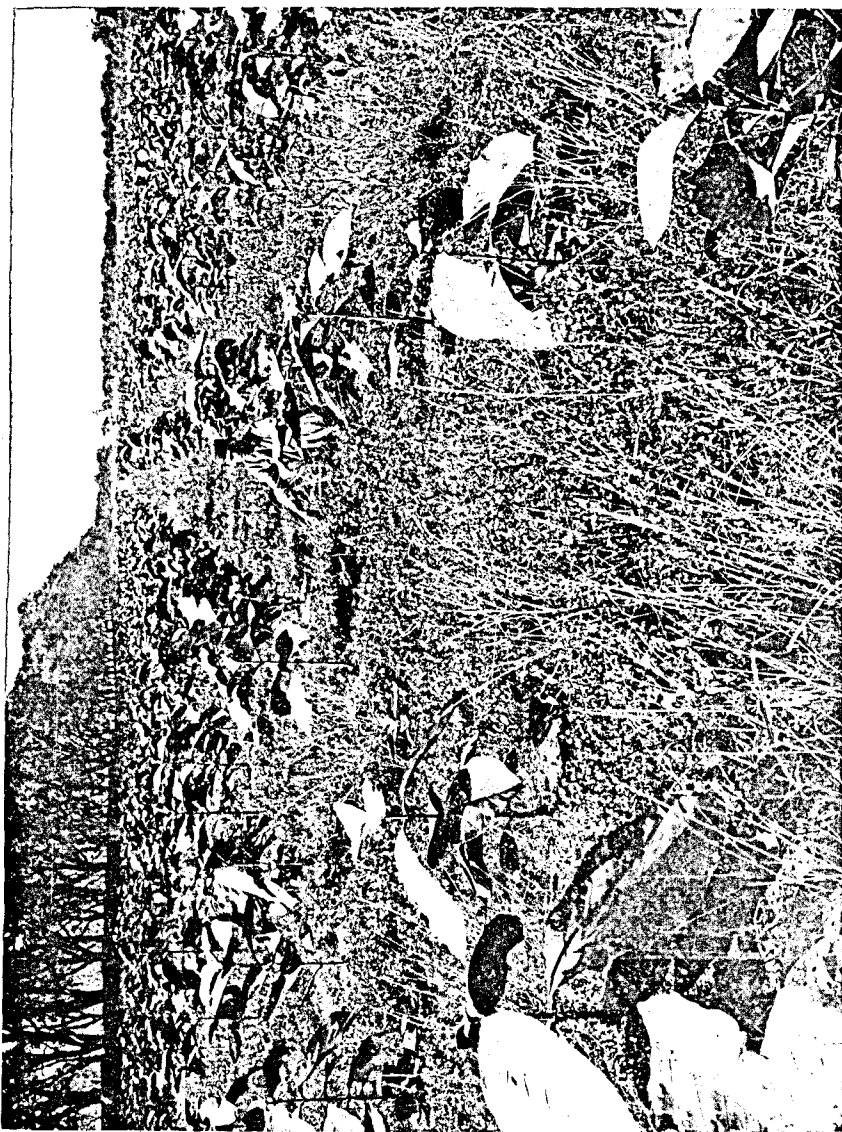


Photo. by Har Swarup, December 1924.

Tectona grandis. Stump planted March 1928, sown in nursery in May 1927.
Irrigated during March to June 1928. Compt. 34, Demonstration Area, New Forest.

Phyllanthus Emblica.
Anogeissus latifolia.
Terminalia myriocarpa.
Alnus nitida.
Acer oblongum.

} for routine experiments.

Alnus nepalensis still proves very difficult to raise here though *Alnus nitida* does well enough, particularly after pricking out in the nursery bed. The plants left in the original bed died off completely, while the pricked-out plants grew beyond expectations.

The *Terminalia myriocarpa* beds were badly attacked by termites, and the application of various insecticides seemed to result in more casualties than ever from poisoning, as well as from the insects. *Boswellia* is not so easily raised as might be expected, and we have not succeeded in getting a well stocked seed bed.

Last year's experiment on the effect of manuring was repeated; three parallel sets were used, one for *Dalbergia latifolia* and two for *Tectona grandis*. The following manures were used:—

	Average height.		
	Teak.	Rosewood.	
(1) (a) Farmyard manure, 5 tons to the acre, 3 beds .	14.8	11.8"	15.3"
(b) " " 10 " " 3 beds .	..	14.0	14.4
(2) (a) Sodium nitrate, .7 cwt. " 2 beds .	..	11.6	14.5
(b) " " 1.5 " " 2 beds .	..	11.9	14.3
(c) " " 1.3 " " 1 bed .	14.9	..	..
(d) " " 2.6 " " 1 bed .	16.0	..	..
(3) (a) Ammonium sulphate .7 " " 2 beds .	..	14.1	16.1
(b) " " 1.5 " " 2 beds .	..	11.2	12.3
(c) " " 1.3 " " 1 bed .	17.6	..	..
(d) " " 2.6 " " 1 bed .	18.1	..	..
4) Control	12.9	13.0	15.7

Tectona grandis was pre-germinated and pricked out spaced 9"×9", and the *Dalbergia* was sown in lines 9" apart and thinned to equal spacing. The chemical manure was applied in dilute solution when the seedlings were established and repeated twice (thrice in one case). Farmyard manure was applied before sowings and was well mixed in the top 6" of the soil.

It will be noticed that no benefit is traceable with rosewood, whilst the heavier treatments have produced some degree of response with the

teak. The nurseries were made on rich rice land already containing adequate minerals. It is accordingly proposed to experiment further only with farmyard manure and leaf mould, and to watch for signs of deterioration in unmanured beds continually cropped.

Spacing experiments.

An experiment was started in 1927 to determine the optimum spacing in the beds when raising teak stock for stumps. Spacings of 6"×9", 9"×9", 9"×12" and 12"×12" were tried, each with 4 repetitions.

The experiment was repeated with pre-germinated teak seed (Nilambur) in three repetitions, but a bigger scale investigation still seems desirable.

The figures for average height of seedlings at the end of the 2nd season shew a definitely small increase for each increase in the spacing, but this is less significant than the per cent. of plants obtained suitable for use as stumps for plantation work, which is 85 per cent. for 12"×12" and 75 per cent. for 9"×9". If economy in stock is more important, 12"×12" is indicated, but if economy in space and consequently in weeding, is more important, 9"×9" will be preferable. The 1928 experiment as far as it has gone, confirms this conclusion.

Spacing.	1927 EXPERIMENT.					1928 EXPERIMENT.									
	Average height.					Percentage of suppressed and use-less plants.					Average height.				
	1	2	3	4	Avg.	1	2	3	4	Avg.	1	2	3	Avg.	
6"×9"	15.6	16.0	26.9	19.8	19.6	38	37	28	29	33	7.8	11.5	11.5	9.7	
9"×9"	20.5	17.1	30.1	29.0	24.2	17	30	21	33	25	9.3	10.3	10.9	10.2	
9"×12"	20.7	25.8	24.7	35.8	26.8	12	20	22	25	20	12.5	10.5	10.2	11.1	
12"×12"	31.5	16.0	23.9	37.1	27.1	11	16	16	16	15	13.5	10.0	14.5	12.8	

Nursery shades as a protection against frost.

Four types of nursery shades were used:—

- (1) Thatch to give 100 per cent. shade except lateral light and sun.
- (2) Batten shade 66 per cent. shade except lateral light and sun.
- (3) Bamboo chicks 50 per cent. shade except lateral light and sun.
- (4) Batten shade 30 per cent. shade except lateral light and sun.
- (5) Control—no shade.

They were tried over teak. Resultant frost damage shows, though not quite conclusively, that 50 per cent. shade gives all that is necessary to save the plants, the percentage of frost-bitten plants being respectively (1) 14, (2) 9, (3) 8, (4) 10, (5) 90, (control).

(v) Artificial regeneration.

This year again, severe frost played havoc with plantings and sowings. Teak, our best indicator, was mostly cut back, few plants under 6' in height escaping. It was, however, not so serious for the sal as in February 1927. The phenomenally early cessation of the monsoon was fatal for late work and injurious to all.

No new line sowings were tried.

Rains entire transplanting was tried for—

<i>Acer oblongum</i>	.	.	.	85 per cent. success in December.
<i>Terminalia myriocarpa</i>	.	.	83	" " " "
<i>Anthocephalus Cadamba</i>	.	.	89	" " " "
<i>Sterculia villosa</i>	.	.	45	" " " "
" <i>pallens</i>	.	.	48	" " " "
<i>Anogeissus latifolia</i>	.	.	20	" " " "
<i>Alstonia scholaris</i>	.	.	52	" " " "
Last year's transplants	.	.	<i>Gardenia latifolia</i>	76 per cent. success.

Winter transplanting—

Gardenia latifolia was planted out every week after winter rain in December 1927 to March 1928, but the species proved too delicate for the test. This was repeated this year with *Adina cordifolia* but the result does not look at all promising.

Weeding and soil working in winter.

The experiment was tried with sowings of sal, one and two seasons old, and with teak and *Gmelina* stumps one season old. Frost totally upset all the measurements with teak and *Gmelina* and the results for sal showed a slight advantage with weedings as represented by increased height increment.

	Two seasons old.	One season old.	
Weeded lines . . .	3.1"	.6"	Increment up to June alone considered.
Unweeded lines . . .	2.6"	.4"	

Experiment 34.—Effect of number of plants per patch.

This was tried this year with sowings of sal, sissoo and *Gmelina*. The patches have been thinned to—

- 1 to 4 plants for *Gmelina*.
- 2 to 5 " " Sissoo.
- 3 to 6 " " Sal.

The growth has not been fast enough to introduce appreciable root and light competition, and to show any results yet.

Rains stump planting were tried for three species with the results shown :—

<i>Odina Wodier</i> . . .	(100 plants)	96 per cent.	in December.
<i>Boswellia serrata</i> . . .	(50 „)	28 „ „	„
<i>Cleistanthus collinus</i> . . .	(100 „)	80 „ „	„

Owing to the short monsoon, development was poor.

Winter stump planting.

Results for 1927-28 work were as follows in December, 1928 :—

<i>Pongamia glabra</i> .—32 per cent. surviving—height 1-9", average 4.6".
<i>Odina Wodier</i> .—94 per cent. surviving—height 3-17", average 7.3".
<i>Cleistanthus collinus</i> .—48 per cent. surviving—height 3-16", average 7.3".
<i>Trewia nudiflora</i> .—54 per cent. surviving—height 8-23", average 13.2".

In December 1928, stumps of *Adina cordifolia*, *Acrocarpus fraxinifolius*, *Pterocarpus Marsupium*, *Gardenia latifolia* were put out.

March Stump planting.

A comparative study with stump planting in March has been started with *Acacia Catechu* and *Tectona grandis* both with and without irrigation during summer months, in view of success reported from provinces.

Stump planting ; general investigations.

The extended series of experiments on general lines begun in 1927 have been continued and some bigger scale repetitions were carried out in the Demonstration Area with teak, *Gmelina* and rosewood.

—Experiment 25.—Effect of diameter of stump.

The optimum diameter was found to vary as expected with species, falling within the range tried for 6 species but indicating bigger cuttings in *Bombax*, *Spondias*, *Eugenia* and possibly *Shorea*.

One acre plots with teak (424 plants), *Gmelina arborea* (766) and *Dalbergia latifolia* (1395).

For teak, the result indicates that 0.7" diameter gives the best average height and percentage of success, though the result is uniformly good from 0.6" to 0.9" and tends to fall off rapidly beyond these limits.

For *Gmelina*, possibly 1.0" limits the size of a useful stump but this needs check.

For rosewood 0.5" to 0.6" diameter gives the best result, and 0.8" diameter appears the limiting size of a useful stump.

These experiments are being continued and will be repeated, but the shoots have been seriously affected by frost, which is likely to upset some of the conclusions drawn.

Experiment 26.—Effect of Root length.

Last year's 3 species were supplemented this year with *Albizzia odoratissima* (210) and *Dalbergia latifolia* (200).

Albizzia odoratissima gives results uniformly proportional to the root length, while with *Dalbergia latifolia* the growth was not good enough to show any difference. These experiments are still in progress.

It appears that with a species which strikes readily, little is gained by the longer root, but with a difficult species like *Shorea* it may often be worth while, and in unfavourable (dry) areas or years a greater length is also required.

Experiment 27.—Effect of Stem length.

This investigation was repeated with *Albizzia odoratissima* (108), *Albizzia procera* (42) and *Gmelina arborea* (150). The results up-to-date are that percentage of survivals is best for 1½" stems and about 12 per cent. inferior for 6" stems. Total height is a little better for the 6", but not added height. There is no appreciable difference in percentage of multiple shoots. These results confirm last year's conclusions. The experiment is being continued.

Experiment 28.—Depth of planting.

Many of the deeply planted *Eugenia Jambolana* stumps produced shoots in the second year. The investigation was repeated with *Pongamia glabra* (200) and *Gmelina arborea* (200). The results show no difference in *Pongamia* while *Gmelina* shows survival per cent. and best average height for the standard set and definitely poorer results if the root stock is left exposed.

Experiment 29.—Effect of injury of the stump.

Although at the end of the first year's growth no difference was discernible between the intact and injured sets of *Sapindus emarginatus*, there is now a difference discernible without actual measurement. The average height of the best shoot is 22 per cent. behind for the injured stumps ; for which also 10 per cent. are recorded vigorous as compared with 37 per cent. with the uninjured ones.

In 1928 this was repeated with *Albizzia procera* (200) and *Dalbergia latifolia* (200). The results show that with *Albizzia procera* the average height is rather less (10 per cent.) for injured stumps of bigger diameters only, whilst the smaller stumps show no difference ; injured *Dalbergia latifolia* show the same total survivals as the control, but 4 per cent. less normal plants and their average height is 17 per cent. less than the control.

Experiment 24.—Effect of date of transplanting.

In 1927 sets of 25 stumps of *Kydia* were put on July 22nd, August 7th, 21st, and September 6th and 22nd, and at the end of the first season the percentage of survivals were 96, 56, 88, 96 and 100, and average height 9.2, 6.6, 4.9, 2.6 and 2.0 inches respectively. After one more year, the survivals are the same in all lots but the last in which they are fewer. Height is definitely related to the date of planting. This experiment was repeated in 1928 with *Dalbergia latifolia*—25 stumps planted on 6th and 21st July, 4th and 20th August, and 4th September. Results show that delay of 2 weeks in planting has resulted in a loss of 25 per cent. of the height though the survival per cent. is not affected. A month's delay causes a loss of 40 per cent. of the height growth and halves the percentage of good plants. Six weeks' delay results in only 8 per cent. healthy plants, and only 32 per cent. of the possible height. Two months' delay involves total failure.

Experiment 32.—Effect of season of soil preparation.

Results after two seasons do not indicate any decided advantage for any one season as against another.

Repetition in 1928 with sowings of *Shorea robusta*, transplants of *Adina cordifolia* and stumps of *Gmelina arborea* again shew nothing conclusive, but development was very poor in all cases.

Experiment 33.—Effect of depth of soil working.

After two seasons' growth, no apparent correlation is traceable with various species and forms of planting. In the new experiments, 9" and 15" gave the same growth from teak stumps, whereas with *Trewia* stumps there was definite correlation in favour of the deeper pits.

Experiment 30.—Effect of delayed planting.

Using stumps of *Dalbergia latifolia* and storing them moist for 3, 6, 9 and 14 days, the development recorded shows that delay up to a fortnight in putting out stumps need only result in a loss of an extra 6 per cent. of the stumps, and 2" in average height, in comparison with the control which showed 92 per cent. survivals and a height of 11.0".

Experiment 45.—Effect of abnormal shape of stumps.

This experiment was tried in 1927 with *Chickrassia* and *Terminalia* and there is no difference in development or survival per cent. compared with the control.

Branch cuttings.

A thorough investigation of the possibility of raising plants from branch cuttings seems worth while for species being raised in plantations, particularly the soft wooded ones less unlikely to succeed this way. A scheme has been prepared and is being followed with *Dalbergia Sissoo*, *Gmelina arborea*, *Broussonetia papyrifera*, *Odina Wodier*, *Garuga pinnata*,

Kydia calycina and *Trewia nudiflora*. Planting has been done both after the winter rains and just before the new vegetative activity in March or April, and will also be done early in July.

Experiment 54.—Miscellaneous Investigations.

Effect on seasonal and total height growth of cutting back in the cold weather after frost injury is commenced with 420 plants of *Tectona grandis*.

Experiment 53.—

How does cutting back all shoots except 1 from a stump with several affect the growth of the shoot retained? Commenced with 48 plants of *Bischofia*.

Experiment 47.—

Changes of soil consequent on afforestation is continued. Five areas have been selected, one each under sal, *chir*, *Gmelina*, teak, and rosewood. A complete analysis of soil at five seasons of the year down to a depth of 3' is being made in conjunction with the Biochemist.

Experiment 48.—

Ecological quadrats—one in each area is being maintained and changes in the undergrowth consequent on afforestation are being studied.

Experiment 49.—Root development of stump cuttings.

This was studied for *Albizia odoratissima*, teak, *Gmelina* and rosewood.

Complete drawings have been made to show the development of stumps at various times after planting and it will be repeated with other species as the material is available.

The possibility of rot spreading from the stump is being carefully watched.

Experiment 51.—Stump planting of teak in summer without irrigation.

A set of stumps are being planted every week from first week of March and will be continued till the break of monsoon rains.

A detailed study of *Pinus longifolia* was made in the Demonstration Area, and a note is being prepared which may be published separately later on. A similar study of *Shorea robusta* is still incomplete, and nothing need be added beyond what was reported last year.

(vi) *Reclamation and Afforestation.*

On the whole, fair progress has been made in the afforestation of the Demonstration Area, New Forest. The area has been accurately resurveyed with the result that the area of the *Chir working circle* has been increased by 15 acres. Of the total area of 198 acres to be stocked, operations have covered 142 acres of which the details are given below.

Removal of hedges, *bunds* and houses have been completed.

1. In the *Sal* working circle, the 1924 and 1925 areas are growing satisfactorily; 1926 sowings, which were seriously affected by the 1927 frost, have recovered over most of the area. The failures in parts were resown in 1928 and have again suffered in the 1929 frost. It is now feared that a part of these areas will have to be completely redone. Of the 1927 sowings, the Bihar and Orissa and Central Provinces areas are progressing satisfactorily.

In 1928, two compartments were sown with seed obtained from hill areas of Lansdowne Division, United Provinces, and one compartment with local seed.

The remaining three compartments are being kept for seed from Haldwani and North Kheri Divisions in the United Provinces, and Hoshiarpur Division, Punjab. Out of 20 acres, 17 acres have been completed. 2.5 acres are still to be done, and 0.5 acre is the area of all the blanks due to frost.

Best and average heights are—

	Area.	Height.	
		Acres.	Best. Average.
1924	2.4	13'	6'
1925	5.6	6'	3'
1926	3.6	2'	1'
1927	2.4	2'	1'
1928	3.0	8"	4"

The 1925 work was done in lines 12' apart, and interplanting was done this year over 0.5 acre with *chir* transplants, and two other compartments have *Tephrosia* and *Albizia odoratissima* interplanted.

2. The *Chir* working circle is most promising. The stocked area totals 78.3 acres; 33.5 acres still remain to be done. It is rather unfortunate that the area will again not be completed in the coming season for want of seed.

The best and average height are as follows:—

	Areas stocked.	Height.	
		Acres.	Best. Average.
1925	31.7	100"	36"
1926	24.7	40"	18"
1927	1.1	16"	10"
1928	20.8	6"	3"

3. Quite good progress has been made in the *Rosewood* working circle. Here again the frost in February 1929 has cut back most of the plants. Of the 24.6 acres, 15 acres carry enough plants to stock the area.

So far only compartment 1 seems safe from frost, and is now fully stocked, though the height is very irregular.

The irrigated plantations over 4 acres made during the year gave excellent results. The plants averaged about 3' by October 1928 and the area was fully stocked. Frost has cut back about 70 per cent. of the seedlings, but new shoots are now growing fast, and it is hoped that these will grow above the frost level during the coming season.

The whole area will be completely afforested in 1929, plenty of nursery stock being in hand.

4. *Teak* working circle.—The plantations looked quite well at the end of the 1928 growing season, but almost all were so badly frost-bitten that they have had to be cut back: new shoots were quickly developed and the casualties are few. Six acres were planted with irrigation in March 1928, and put on much better growth than July work.

Only 6 acres remain to be done and it is hoped to complete them in the coming year.

Gmelina arborea has been planted over 13 acres. It is growing satisfactorily and the oldest areas now average 6' in height and are growing fairly well and flowering freely. A little work is required to complete the stock in some of the 1928 compartments and this will be seen too in July 1929. Frost damage occurred, but not severely.

(vii) *Thinnings and Cleanings.*

As noted under the Statistical Section, attention has been given to the matter of putting thinning research on a better footing. Proposals were tested in Chakrata Division, United Provinces, in deodar and blue pine sample plots, and the results summarised in a paper read before the Silvicultural Conference which endorsed the recommendations made. Existing sample plots of major species will now be reviewed in light of this decision.

(viii) *Mixture and (ix) Underplanting.*

By far the most important instance in practice is that of teak plantations. The matter was discussed at length in a most interesting debate at the Silvicultural Conference, and the Central Silviculturist has been asked to collect, summarise and publish all available information.

II.—WORKING PLANS AND STATISTICS.

(i) *Working Plans.*

All working plans as received are cut up for record on the specific and general ledger files, but this work has fallen seriously in arrears owing to shortage of superior staff.

(ii) Yield Tables.

Yield tables for *Pinus excelsa* have been completed and put through the Press, though not actually issued till after the end of the year. These tables are based on 93 plot measurements on 77 plots and so are definitely provisional only, but they should meet immediate requirements. The quality classes were differentiated on a rather different basis from that hitherto used, in that convenient and easily remembered crop height limits at a fixed age (90 years) were adopted for each quality. Stand tables were appended for the first time, shewing the distribution of diameter classes to be expected in a crop of given diameter.

A sample plot party toured in Jaunsar, United Provinces, in April-June 1928 to inspect existing deodar and blue pine plots with a view to classification as regards density and thinnings. In all, 33 additional plots (22 deodar and 11 blue pine) were laid out with special attention to an attempt to get comparable plots for measuring increment with different intensities of thinning. Incidentally a study was made of the associated vegetation with a view to the recognition of types.

156 new sample plot files were received for calculation as also 114 re-measurements. The distribution by provinces is as follows:

Province.	New plots.	Old plots re-measured.
Assam	7	..
Bengal	14	8
Bihar and Orissa	17	12
Burma	23	61
Central Provinces	1	19
Madras	54	..
United Provinces	5	14
TOTAL .	121	114
Forest Research Institute .	35*	..
GRAND TOTAL .	156	114

* Includes 2 temporary plots.

The list of plots for major species may be summarised to show the stage reached.

Species.	* PERMANENT SAMPLE PLOTS.								TEMPORARY SAMPLE PLOTS.										
	Assam.	Bengal.	Bihar and Orissa.	Burma.	Central Provinces.	Madras.	N. W. F. Province.	Punjab.	United Provinces.	Total.	Bengal.	Bihar and Orissa.	Burma.	Central Provinces.	Madras.	N. W. F. Province.	Punjab.	United Provinces.	Total.
<i>Shorea robusta</i>	30	88	..	42	10	..	..	127	297	..	..	1	12	..	..	32	45	342	
<i>Cedrus Deodara</i>	..	..	..	..	..	..	33	41	74	..	..	..	..	..	36	24	60	134	
<i>Pinus longifolia</i>	..	..	..	3	3	29	56	91	..	..	..	..	..	12	56	68	159		
<i>Pinus excelsa</i>	..	..	..	..	9	18	14	41	..	..	..	..	5	38	3	46	87		
<i>Tectona grandis</i>	4	13	191	38	60	..	3	309	..	..	8	..	1	9	318				
<i>Dalbergia Sissoo</i>	..	..	..	..	..	45	28	73	..	..	..	..	7	7	80				
Other species	7	68	15	48	2	13	7	85	245	19	11	22	11	3	7	73	318		
TOTAL	7	102	116	239	85	83	12	132	354	1,130	19	11	31	23	5	89	130	308	1,438

* Excluding those abandoned as sample plots.

The numbers of permanent sample plots at the end of the last three years have been 875, 986 and 1,130. The numbers of plots for which calculations have been made in the last three years are 184, 86 and 232.

(iii) Volume Tables.

During the year, General Volume Tables both on the standard and on the local commercial basis for *Pinus excelsa* (Punjab, North West Frontier Province, United Provinces) and *Acacia Catechu* (United Provinces) have been sent to the Press; and those for *Heritiera* in the Sundarbans, and *Shorea robusta* (commercial volumes only) in Bengal, completed last year, were actually published.

Two field parties collected volume data for blue pine and deodar in Chakrata Division, United Provinces, in May-June 1928, one party also collecting form quotient data for further study.

Three parties were sent to Haldwani Division, in December-January to complete the field data for the *Acacia Catechu* tables and to collect volume data for miscellaneous species in the coupes of the year.

The following number of trees have been measured up :—

Species.	STANDARD VOLUME.*			COMMERCIAL VOLUME.			REMARKS.
	In 1928-29.	Pre-vi-ous.	Total.	In 1928-29.	Pre-vi-ous.	Total.	
<i>Pinus excelsa</i> . .	141	2,040	2,182	148	1,966	2,114	1928-29 figures were collected in the United Provinces.
<i>Cedrus Deodara</i> . .	285	472	757	285	467	752	
<i>Acacia Catechu</i> . .	..	25	25	303	1,716	2,019	
<i>Dalbergia Sissoo</i> . .	2	258	260	40	608	648	All data were collected in the United Provinces.
<i>Lagerstroemia parviflora</i> . .	2	223	225	16	346	362	
<i>Bombax malabaricum</i> . .	106	32	138	537	57	594	
<i>Odina Wodier</i> . .	5	32	37	13	55	68	

* Excludes sample trees of sample plots.

It is hoped to complete the data and produce tables for *Bombax malabaricum* and *Dalbergia Sissoo* in the coming season.

(iv) *Bark measurements, heartwood, etc.*

Bark measurements are included in the tables published.

The *Acacia Catechu* tables include full data for heartwood as this is of chief importance in this species.

(v) *Miscellaneous.*

Form Quotients.—As noted above, field data were collected for a study of form quotients, 302 deodar and 110 blue pine being measured. It has not yet been possible to work up the figures.

Buttress allowance.—Special attention has been given to the difficulties involved in measuring buttressed trees, notably *Bombax*. The figures are under compilation.

Girth Diameter ratio was worked out for *Bombax malabaricum* (242 trees) and checked for sal.

Diameter tape.—A comparative test was made with calliper measurements, on 200 sal trees which were measured twice with each instrument by each of two men. The figures did not shew any very definite advantage for one or the other instrument.

It has been a busy year for the statistical section. Several investigations into special problems, mainly in connection with the Silvicultural Conference held at Dehra Dun at the end of the year were undertaken. Among them are the following :—

1. Comparison of Diameter tape and Callipers.
2. Comparison of various methods of calculating crop height.
3. Stem and stump analysis procedure.
4. Determination of age of trees without annual rings.

5. Determination of yield of irregular crop.

6. Methods of thinning research.

The statistical code has been revised with a view to publication of a new one. Copies of all sample plots files for the Punjab have been prepared and sent to the Divisional Forest Officers concerned.

III.—MISCELLANEOUS.

(i) *Photographic Section.*

A change of photographer has been made during the year which has again been a busy one. The output of work during the last three years has been :—

Year.	Negatives.	Prints.	Lantern Slides.
1926-27	969	2,175	61
1927-28	1,219	2,436	14
1928-29	1,922	3,048	54

It may again be mentioned that most of the prints are enlargements.

Of the negatives, 145 were made by the Silviculturist on tours, and 1,356 refer to the Timber Testing Section.

Of the prints, 737 were additions to the Silvicultural Collections which now total 3,475 photographs, and 240 were for despatch.

A collection of photographs representing forest types in India was sent to the United States Forest Service in answer to a request received, and a fine set illustrating North America types was received subsequently from them.

(ii) *Records.*

The task of changing over the filing system to the one now standardised, has been completed during the year. An additional typist has been employed throughout the year, and this has made it possible for the recording room to keep abreast of the work passed on to them. On the other hand, there is a very large number of publications awaiting ledgering, owing to the lack of an assistant competent to deal with it: the Silviculturist has found it impossible to keep up with this work as it comes in.

The new filing system as regards the General Ledger files is a vast improvement on the old, but there is urgent need of scrutinising the files for checking, weeding, cross referencing and completing them before they become too bulky. There are at present 278 subject heads for which files have been opened and 1,050 species files. The Silvicultural

Conference accepted our filing system for Provincial Silviculturists' offices.

(iii) *Museum.*

One of the large models of silvicultural system—a *chir* pine forest being worked under the shelterwood compartment system—is nearly complete, and the case for the second (which will probably be an irrigated plantation like Changa Manga) has been constructed.

An exhibit of different types of fencing was collected in connection with the Silvicultural Conference. It has been erected out of doors in the first place, but it is intended to transfer it to the museum.

(iv) *Staff.*

There has been no change of superior staff during the year under report. Lala Ishwar Das Mahendra was in charge of the Statistical Section and has been largely instrumental in widening the scope of current investigations. Pt. Bhawani Dat Pant continued to give his time to experimental work and enabled the Silviculturist to devote more of his time to general direction and special work. As noted above, the need is now for an Assistant Silviculturist able to deal with foreign literature and to undertake any kind of investigational work which may be required.

The staff as a whole continued to work well.

The Silviculturist toured in Jaunsar, United Provinces, in April-June (8 weeks), and Bombay in January-February (6 weeks). The Statistical Assistant toured in Jaunsar (2 weeks) and Haldwani Division, United Provinces (2 weeks). The Experimental Assistant's touring was limited to the neighbourhood of Dehra Dun.

(v) *Silvicultural Conference.*

The chief event of the year was the 3rd Silvicultural Conference held in Dehra Dun on March 16th-20th. Twenty-four delegates attended from all provinces of India and Burma, Kashmir also being represented. The agenda included 22 items, several of them sub-divided, and almost the whole field of silvicultural work was covered. Important decisions were reached regarding research methods and many other matters. The Silvicultural Branch contributed 15 major papers and several shorter notes.

ASSAM.

I.—EXPERIMENTAL SILVICULTURE.

(i) *General.*

Good progress was made in the Silviculture Branch during the year.

The Silviculturist attended the Silvicultural Conference at Dehra Dun in March 1929.

Experimental Plots.

In addition to the maintenance of the seven experimental plantation plots of not more than 5 acres in each case mentioned in last-year's report, the following were started during the year :—

Holongapar Reserve.— $\frac{1}{4}$ acre after being hoed was sown with *hollong* (*Dipterocarpus pilosus*) seeds under a shelter crop of *boga medeloa* (*Tephrosia candida*) and light overhead cover of pole growth of inferior species.

Rangapahar Reserve.—Five acres of inferior forest were clear felled and burnt in preparation, later sowing of *boga medeloa* in lines and for planting up *bonsom* (*Phoebe Hainesianana*) seedlings 6'×6'. 10,000 *bonsom* seedlings were raised in an adjoining nursery.

Jeypur Reserve.—Over 8·8 acres of typical *hollong* and *nahor* (*Mesua ferrea*) forest (demarcated and surveyed) which was previously exploited for overmature stems, climbers and undergrowth were cut and existing natural regeneration was freed. Two Indicator Plots each measuring 5'×21'—9" were selected and demarcated in this area and all plants counted and measured.

Jeypur Reserve.—Another area of 4·1 acres in proximity to the above in *makai* (*Shorea assamica*) *hollong* and *nahor* forest was selected and similar operations to the foregoing were carried out.

In some cases resowing or replanting of blanks in the Experimental Plots of the previous year had to be done, and some years must elapse before results from these can be summarized. Hitherto where only partial success has been attained, the cause has been late sowing or faulty transplanting.

In addition to the seven Sample Plots for recording diameter increments in trees laid out in the previous year, four more were started and measurements were recorded by the Silviculturist during the year. These were :—

Sadiya Division.—Sadiya Fuel Reserve. One Plot of $\frac{3}{4}$ acre of 1922 *Hollock Plantation*.

Sylhet Division.—Bhanugach Reserve. Two Plots each $\frac{1}{2}$ acre of 1924 *Gomari* (*Gmelina arborea*) *Plantation*.

Cachar Division.—Inner Line Reserve. One Plot $\frac{1}{2}$ acre of 1922 *Teak Plantation*.

In accordance with the resolution passed at the Dehra Dun Conference in March 1929, copies of descriptions and measurements of all Sample Plots and Experimental Plots in the standardized forms are being sent to the Central Silviculturist at Dehra Dun who will later ask for summaries of any of the Plots he may wish to know about.

An analysis was made by the Silviculturist during the year of old Sample Plot registers previously maintained in the Lakhimpur and Sibsagar Divisions and the results made over to the Working Plans Officer.

(ii) *Natural Regeneration.*

Sal (Shorea robusta).

Hill Focus, Khasia Hills I, in Kamrup Division promises well as the result of being burnt, and thatch has already begun to replace the *sau* grass (*Pollinia ciliata*) and evergreens, creepers are numerous but these will disappear, as elsewhere, as the result of continued burning.

The Plains Foci and Strip Fellings are successful wherever the principal undergrowth is thatch, and such as are situated in Periodic Block I. will be extended.

The Foci containing coffee instead of thatch are less successful owing to the difficulty of burning properly.

The Observation Plot at Kulsi is divided into two portions. One area has been clear-felled after the ground was fully stocked with sal seedlings and this is burnt yearly; the other portion has been thinned so as to leave a number of blanks, and is protected from fire but weeded twice annually. In the burnt area the fires have induced the typical condition of vigorous sal shoots, 2' and more high, standing in heavy thatch, but in the protected area the sal has died out wherever the overhead canopy remained intact, and is distinctly stagnant in the open patches, the more promising plants having only attained a height of 1' to 16" in 3 years. Creepers are non-existent in the burnt portion but very plentiful in the weeded area. The experiment is proceeding as expected except that thatch is invading the weeded part of the Plot: it was not thought that thatch could establish itself in competition with the usual damp-type evergreen and miscellaneous undergrowth in the absence of fire.

In the Nowgong Division an area of 5 acres of plains sal forest is being treated as an experimental area with a view to finding out the best method of obtaining natural regeneration of sal in this locality. Four to five standards per acre have been left as seed bearers the remainder of the trees having been felled and the undergrowth which was made up of evergreen shrubs and *sau* is being burnt annually. Thatch grass is already beginning to spread over the area and a number of sal seedlings have made their appearance. It will be necessary to continue to experiment.

(iii) *Seeds.*

This has been an exceptionally bad seed year (1929) for sal in Assam. Other important species seeded well.

Germination of Chaulmugra (Taraktogenos Kurzii).

The experimental *Chaulmugra* Plantation started in Lakhimpur has been continued successfully. The plants are reported to be thriving well under overhead cover and it has been noticed that some of the seeds have germinated after being a year in the ground. The Divisional Forest Officer considers that satisfactory results with this species cannot be obtained if the aril of the seed dries before it is sown. This might account for previous unsatisfactory results, when the seed has been despatched to distant places. Further experiments which should prove of value are in progress.

(iv) *Nursery work.*

Work in the experimental nurseries in the Holongapar and Jokai Reserves which were commenced in the latter part of 1926-27, was continued during the year and a further series of sowing of seeds of important species was made in order to ascertain the best time of year to make sowings of the different species found in our forests.

(v) *Artificial Regeneration.*

All areas under artificial regeneration in the following Reserves were inspected by the Silviculturist during the year:—

	{ Sadiya Fuel Reserve.
	Pobha "
	Jokai "
	Upper Dehing Reserve, East Block.
	" " " West Block.
	Holongapar Reserve.
Eastern Circle .	{ Sola "
	Doyang "
	Rangapahar "
	Kurkrikata "
	Kholahat "
	Dhansiri "
	Kulsi "
	Kochugaon "
Western Circle .	{ Bhanugach "
	Inner Line "

The following areas were sown or planted up during the year:—

Pobha Reserve.—76 acres *hollock* (*Terminalia myriocarpa*) sown with *poma* (*Cedrela Toona*) in March 1928. 10 acres *bola* (*Morus laevigata*) in rains 1928, result mostly fairly well stocked with *hollock* 5' high. A large blank due chiefly to failure of *poma* in very light soil was resown with *hollock* towards the close of the year. The *bola* germinated well, but was attacked by deer. The *hollock* again suffered from severe frost bite.

Sadiya Fuel Reserve.—3 acres sown with *hollock* and *jati poma*, (*Cedrela Toona*) and 2 acres sown with *bola* average height of plants 3'.

Jokai Reserve.—13 acres sown broadcast with *hollock*, *poma*, *ajhar* (*Lagerstræmia Flos-Reginæ*) in belts 8 ft. wide 10 ft. apart in March 1928 in a previously clear-felled area resulted in abundant germination and excellent growth of these species during the year. The average height of plants being—*Gomari* (*Gmelina arborea*) 7½ ft., *Poma* (*Cedrela* sp.) 7 ft., *Hollock* (*Terminalia myriocarpa*) 9 ft., *Bola* (*Morus laevigata*) 5 ft., *Sam* (*Artocarpus Chaplasha*) 20 inches. *Ajhar* (*Lagerstræmia Flos-Reginæ*) 4½ ft.

Holongapar Reserve.—The programme of planting up 50 acres in lines cleared 12 ft. wide and 33 ft. apart in the coppiced area with *hollong*, and *amari* (*Amoora spectabilis*) seedlings was discontinued although maintenance of the previously planted areas was carried on. The method is an expensive one involving heavy weeding and extensive filling of blanks by replanting. This year 10 acres have been clear-felled in December 1928 and belts 4 ft. wide 16 ft. apart have been sown broadcast with *Chickrassia tabularis*, *hollock* and *ajhar*, as this method has elsewhere proved to be far more satisfactory and economical.

(xi) *Miscellaneous.*

Considerable damage was again done during the year by frost to the younger *hollock* plantation in the Sadiya Frontier Tract, a very severe hailstorm in January also cut back a considerable number of the seedlings and destroyed a large amount of immature seed on the trees. It was satisfactory that in spite of this, sufficient *hollock* seed was procured for the current year's sowing.

As an experiment *pichola* (*Kydia calycina*) has been sown in belts in some of the younger *hollock* plantation as a check to frost.

Deer have caused a lot of damage in the *bola* plantations in Sadiya and to the *cham* (*Michelia Champaca*) *poma* and *gomari* plantations in Sylhet.

Calopepla Leayana caused defoliation in the *gomari* plantations in Sylhet: collection and destruction of the beetles was recommended by the Assistant Forest Entomologist who visited the plantation at Lawacherra. This is being attempted.

II.—WORKING PLANS AND STATISTICS.

(i) *Working Plans.*

Progress has been made in the preparation of the Working Plans for the Hill evergreen forests of the Lakhimpur and Sibsagar Districts,

and also in the revision of the Plans for the sal forests of Goalpara and Kamrup.

(iii) *Volume and Form Factor Tables.*

Owing to the shortage of staff it was not found possible to make much progress in the compilation of data for the evergreen forests, but it is expected that practically complete statistics will be given in the two Sal Working Plans.

BENGAL.

I.—EXPERIMENTAL SILVICULTURE.

(i) *General.*

The post of Provincial Silviculturist was held by Mr. C. K. Homfray, Deputy Conservator of Forests.

The Silviculturist toured in all divisions except the Sundarbans, and attended the Silvicultural Conference held at Dehra Dun in March 1929.

The Silviculturist was asked to complete the Jalpaiguri and Buxa Working Plans which for several reasons had been delayed for 2 or 3 years. Mr. J. N. Sen Gupta, Extra Assistant Conservator of Forests was posted to this office to help with the plans. It was at first thought that the Plans were practically ready for the press and that only a few modifications would be required to finish them off. The Jalpaiguri Plan was found to be most inaccurate and all figures had to be checked and many corrections and additions made. The plan took five months to complete and has been sent to the press. The Buxa Plan was taken up in December 1928 and it was found that enumeration figures for about 10,000 acres in the Sal Working Circle were missing and Stock-mapping had not been done over the greater portion of the division. The field work was taken up in January and the enumerations were finished by the end of March, all Stock-mapping and collection of necessary data was completed by the end of May 1929. The Plan is being completely re-written in view of facts brought to light when going over the different types of forest in the division. This has meant that during the year a great deal of time has been spent on Working Plans and the Silvicultural side has suffered accordingly, as the Silviculturist's staff has been employed on enumerations and general work required in writing up the Plans.

(ii) *Natural Regeneration.*

(a) *Sundarbans species*.—The seedlings of *Heritiera Fomes*, *Excoecaria Agallocha*, *Amoora cucullata*, *Cerlops Roxburghiana* in Experimental Plot No. 3, Chora Betmore, which was fenced against deer, continue to grow satisfactorily.

(b) *Dipterocarpus*.—With reference to the Plots mentioned in last year's report which were laid out in the Cox's Bazar Division to discover methods of obtaining natural regeneration of *gurjan* (*Dipterocarpus costatus*, *pilosus*, *alatus* and *turbinatus*) the following is the work carried out and results obtained :—

Experimental Plot No. 1.—Dipterocarpus costatus.

Area 1.8 acres.—All bamboos and undergrowth were cut and burnt in strips 19' wide, leaving uncut jungle 8' wide in between each strip. The cleared lines were completely hoed before seed fall. Enumeration of seedlings was carried out in December 1928, and again in June 1929 after the hot weather. The results are as follows :—

	Seedlings.
December 1928	218
June 1929	156

Loss of 62 or 28 per cent. of the seedlings. The seedlings were more numerous and healthier in appearance in lines where the mother trees in the dominant canopy were giving a light shade and a light undergrowth was present. In June 1929 the seedlings still looked healthy but did not seem to have grown much.

Work to be carried out this year.—Lines 1 to 9 will be re-hoed and broadcasted with seeds of *D. turbinatus*. Lines 10 to 17 will be re-hoed only before seed fall. Enumerations will again take place in the following December and June.

Experimental Plot No. 2.—Dipterocarpus costatus.

Area 1.4 acres.—Light burning was done in January 1928. Enumeration of seedlings was done in December 1928, and again in June 1929 after the hot weather. Results are as follows :—

	Seedlings.
December 1928	415
June 1929	269

Loss of 146 or 35 per cent. of the seedlings. Seedlings were mostly found in groups where the dominant canopy was fairly dense and the undergrowth was consequently light. The undergrowth consists mainly of *Kaliserra* bamboos which give a dense shade, and no seedlings were to be found underneath them, but in areas in which the undergrowth was light groups of seedlings were to be found. Seedlings were dense on the earth thrown up in making the boundary ditches where the undergrowth had been cut. From the above it may be assumed that a fairly dense shade given by the dominant canopy and a consequently light undergrowth is most suitable for the germination of *gurjan*.

Work to be carried out.—The plot will be sub-divided. In one half the undergrowth will be cut and removed. In the other nothing will be done, and it will be used as an Indicator Plot to see if the presence of a fairly dense dominant canopy and the removal of undergrowth is one of the necessary conditions for the germination of *gurjan*.

Experimental Plot No. 3.—Dipterocarpus costatus.

Area 1.8 acres.—All trees in the dominant canopy were felled except *gurjan*. All the understorey and undergrowth was cut. The idea being to do a sort of seed-felling. The plot was burnt in February. Enumerations of seedlings were made in December 1928, and again in June 1929 after the hot weather. The results are as follows :—

	Seedlings.
December 1928	250
June 1929	155

Loss of 95 or 38 per cent. of the seedlings. The area is divided by a path and it was very noticeable that there were many seedlings south of the path and few on the north. The dominant canopy was much denser in the south and consequently the undergrowth was light, whereas on the north the dominant canopy was light and the undergrowth was dense and consisted of a prolific growth of coppice and grass. The seedlings in both parts were to be found in groups where the dominant canopy was dense and the undergrowth light. The observations made here again seem to indicate that a fairly dense canopy and light undergrowth is most suitable for the regeneration of *gurjan*.

Work to be carried out.—The plot will be divided into two. The undergrowth in the northern half will be cleared and burnt. The southern will remain as it is and the development of the seedlings will be watched.

Experimental Plot No. 4.

Area 1 acre.—There were only a few small mother trees on the area, so it was decided to aid natural regeneration by broadcasting. The trees both in the upper and lower stories were evenly distributed and there was a fair shade all over the Plot. All undergrowth was cut and burnt. Light hoeing was done before seed fall. Seeds of *Dipterocarpus alatus* were collected as they ripened and broadcasted on the area.

In June the Plot was carefully inspected and no germination of *D. alatus* was found. Seeds on the ground were examined and were found to be dried up and attacked by insects. It is surprising that even under shade *D. alatus* will not germinate. We have the same difficulty in our *Taungya* Plantations and *D. turbinatus* is the only species with which we get any success. It is presumed that the seed of this species remains on the tree so long that most of the seed is insect-attacked, whereas *turbinatus* only takes a short time to ripen and is therefore not so badly affected. One maund of *Dipterocarpus turbinatus* seed was broadcasted over the area in June at the cost of Rs. 6-8-0. Some seed was sown 7 days and some after 10 days of collection.

Seedlings were enumerated in December 1928, and in June 1929 just after the hot weather. The results are as follows :—

	Seedlings.
December 1928	831
June 1929	726

Loss of 105 or 13 per cent. of the seedlings. The seedlings were evenly distributed over the area and the plot may be considered fully stocked. The mother trees were all *Dipterocarpus costatus*, whereas the seed broadcasted was *Dipterocarpus turbinatus*. At the time of enumeration no attempt was made to distinguish between the two species but it was noticed that there was a difference in appearance. The leaves of some seedlings were light green, small, pointed and very hairy, these may be *D. costatus*. The others, and they were far in the majority, had large dark green leaves, broad, with no hairs, these may be *D. turbinatus*. No further cultural operations will be carried out but the seedlings will be watched and their development noted.

Experimental Plot No. 5.—Dipterocarpus pilosus.

Area 1.7 acres.—The undergrowth was cut and burnt. As only a few mother trees exist it was decided to aid regeneration by broadcasting seeds of *D. alatus* and *pilosus*. Seeds were broadcasted as they ripened from March to May. Seedlings were enumerated in December 1928 after the hot weather and June 1929. The results are as follows :—

	Seedlings.
December 1928	65
June 1929	7

Loss of 58 or 89 per cent. of the seedlings. The area was damp and would appear excellent for *D. alatus* which prefers a fairly damp ground. The area was well shaded by a dominant canopy and undergrowth was light. Seed was collected and sown from March to May as it ripened. No reason can be seen for failure to germinate. *D. alatus* did not germinate in Experimental Plot 4, and neither has *D. alatus* or *D. pilosus* given more than 5 per cent. germination in our plantations. The seed of both these species are usually heavily attacked by grubs, the existence of which can be noted by the presence of a small spot of gum on the seed, all such seed should be discarded.

Work to be carried out.—Area will be again lightly hoed and seeds of *D. pilosus* and *alatus* broadcasted after they have been examined for the presence of grubs and affected seeds discarded.

Experimental Plot No. 6.—Dipterocarpus pilosus.

Area 1.6 acres.—20' broad lines were cut and burnt leaving 10' wide uncut jungle between each line. Seeds of *D. alatus* and *pilosus* were broadcasted from March to May as they ripened. Seedlings were enumerated in December 1928, and after the hot weather in June. Results are as follows :—

	Seedlings.
December 1928	180
June 1929	21

Loss of 159 or 80 per cent. of the seedlings. Seedlings were mostly found in groups where there was a light pole-crop shade and little undergrowth. In open exposed places no seedlings were found.

Work to be carried out.—Soil will be lightly hoed and seeds of *D. pilosus* again broadcasted as they ripen.

(c) *Dipterocarpus pilosus*.—The following is a note on the area in Cox's Bazar Division mentioned in last year's report, laid out to study the effect on young *gurjan* regeneration by the sudden removal of overhead cover :—

The area is damp and the natural regeneration of *gurjan*, which is in all stages from seedlings to poles, was profuse. The overhead canopy was dense and the *gurjan* regeneration was very slender and delicate having been pulled up towards the light. Felling was done in December, 1927. All overhead cover was completely removed and creepers and undergrowth interfering with the *gurjan* poles and saplings cut.

On visiting the area in December, 1928, the saplings and poles were found to be very healthy and sturdy and standing on their own and had greatly benefited by their exposure to the light. This year only a little creeper cutting was required at the time of inspection.

(iii) *Seeds.*

Seed was supplied to different Divisions and Provinces by indent through this office. Provinces requiring seed from Bengal should send their indents at least 6 months before the seed is expected to be ripe.

Eucalyptus Naudiniana.—Seeds were received from Inspector General of Forests, Australia. They were tried in nurseries in the Buxa and Chittagong Hill Tracts Divisions, but although the seed was carefully sown in boxes with very finely sifted soil, no germination was obtained.

(iv) *Nursery Work.*

The following species were tried in experimental nurseries in the Chittagong and Cox's Bazar Divisions.

Sterculia alata.—Sown in May. Seeds were broadcasted and watered—No shades were used. Germination 100 per cent. Plants 8" high in 7 months. Direct sowing in "thalis" in plantations also successful 90 per cent. germination. Not necessary to raise in nursery. Should be sown direct in Plantations.

Michelia Champaca.—Sown end of May. Seeds broadcasted and watered. One half of the bed unshaded and the other shaded. No difference in germination in either half, 60 per cent. germination.

Lagerstræmia Flos-Regina.—Broadcasted and watered. Beds not shaded, 100 per cent. germination. Also sown direct in "thalis" in plantations with complete success. Not necessary to sow in nursery and should be sown direct in plantations.

Eugenia Jambolana.—Seed ripens from end of May to beginning of June. Seed sown immediately after collection in June and broadcasted under shade with a layer of earth sprinkled over the seed. Germination 100 per cent. Height in following November 3". Should be tried sowing direct in plantations.

Vitex peduncularis.—Seeds ripen in June. Untreated seeds sown in beds under shade in 1927 resulted in no germination. In 1928 seeds were (i) soaked for 24 hours and gave 10 per cent. germination, (ii) soaked and baked alternately for 3 days and gave 15 per cent. germination. Seeds were then sown broadcasted under shade with a layer of earth sprinkled over them. Further experiments in treating the seed will be made. Height of seedlings in November was 3".

Swintonia floribunda.—Seeds ripen in May and were collected in the third week. Seeds were dibbled in the nursery under shade. Germination in 20 days, only 2 per cent. Seedlings about 3" high in July. Further experiments will be made.

Dipterocarpus alatus, costatus, turbinatus.—The following statement shows the results of nursery experiment carried out at Jaliapalong, Cox's Bazar Division, to study the germination per cent. and mortality of young seedlings of *Dipterocarpus alatus, costatus, and turbinatus*. It will be noted that the germination per cent. of *Dipterocarpus turbinatus* is much greater, and the mortality amongst seedlings is much less than *D. alatus* or *D. costatus*. Also that the germination per cent. of *D. costatus* and *D. turbinatus* is much less when not sown immediately after collection. This experiment is being carried out again this year.

Name of species.	Date of collection.	Date of sowing.	Date of first appearance of radicle.	No. or quantity used.	WEEKLY OBSERVATIONS.			Mortality.	REMARKS
					Date.	No. of seedlings.	Height. Inches.		
<i>Dipterocarpus alatus</i>	20-2-28	20-2-28	1-3-28	100	3-3-28	4	3	..	4% germination. 100% mortality.
					10-3-28	4	3	2 died	
					17-3-28	2	4	1 "	
					19-6-28	1	5	1 "	
<i>Dipterocarpus costatus</i>	11-5-28	11-5-28	5-6-28	100	20-6-28	..	..	..	23% germination. 91% mortality.
					19-6-28	3	3	..	
					26-6-28	15	3	..	
					3-7-28	20	3	..	
Ditto	18-5-28	18-5-28	12-6-28	100	10-7-28	23	3 1/2	13 died	27% germination. 63% mortality.
					11-9-28	10	4 1/2	8 "	
					12-12-28	2	9	..	
					19-6-28	10	3	..	
Ditto	18-5-28	25-5-28	20-6-28	100	26-6-28	15	3	..	22% germination. 100% mortality.
					3-7-28	20	3 1/2	12 died	
					10-7-28	27	5	5 "	
					11-9-28	15	9	..	
<i>Dipterocarpus turbinatus</i>	21-5-28	21-5-28	12-6-28	100	12-12-28	10	3	..	61% germination. 38% mortality.
					24-6-28	1	3	..	
					26-6-28	2	3 1/2	1 died	
					3-7-28	2	5	..	
Ditto	21-5-28	29-5-28	17-6-28	100	10-7-28	..	..	..	15% germination. 73% mortality.
					15-11-28	01	3	..	
					12-12-28	50	3 1/2	8 died	
					3-7-28	48	12	2 "	
Ditto	21-5-28	21-5-28	17-6-28	100	24-6-28	15	3	5 died	..
					3-7-28	10	3 1/2	1 "	
					10-7-28	5	4	1 "	
					12-12-28	4	3	..	

(v) Artificial Regeneration.

(A) *Experiments in regenerating Sal artificially in Bhabar Tract, Buxa Division, without Taungya Cultivation.* (Sau grass area.)

The experiments in regenerating sal artificially in the Bhabar Tract without *taungya* cultivators referred to in the last year's report, are being continued. It is too early to add anything to last year's report.

(B) *Nipa fruticans*.—The following are the subsequent observations since the submission of the last Annual Report with reference to the seeds of *golpata* (*Nipa fruticans*) sown in the spring of 1925 on 2 old timber ghats in a fresh water area in Compartment 29 :—

12th May 1929. Four rainy seasons after sowing :

Number of seedlings surviving 164 (56 more than last year ; some of the seedlings which were probably covered by long *bheti* grass till last year, have come through this year) ; percentage of survival 58.2 per cent.

In congested areas some of the seedlings and some leaves of the others are dying off.

Height of plants varied between 3' and 14' and the number of leaves in each plant varied between 4 and 13.

Average plant 6' 9" high with 6.3 leaves.

104 leaves have been cut off during the year by boatmen and it is presumed that they have all been utilised.

The growth during the last 12 months has been quite satisfactory and it can be reasonably forecasted that most of these plants will yield exploitable leaves next year.

(C) *Regular Plantations in Chittagong and Cox's Bazar Divisions.*

In view of the promising results obtained in 1927-1928 mentioned in last year's report, it was decided to take up these experiments on a larger scale and in most Ranges 2 to 5 acres were taken up.

Dipterocarpus turbinatus, *pilosus*, *costatus* and *alatus* were all sown in lines 6' apart, 2 rows of seeds in each line. In some areas seeds were sown right way up, and in others upside down with wings removed, it was found that the latter way gave a slightly higher germination per cent. but when sown in lines it was so small as to be hardly noticeable, and as the removal of wings is more expensive it has been decided that sowing right way up is the most satisfactory. *Dipterocarpus turbinatus* in all cases germinated extremely well from 80 to 100 per cent., on the other hand *Dipterocarpus costatus* never gave more than 30 per cent., *Dipterocarpus pilosus* 5 per cent. and *Dipterocarpus alatus* seldom any germination. *Dipterocarpus turbinatus* will be put out in our plantations and future and further experiments will be carried out with the others. The areas were cleared and burnt and *bogamedeloa* (*Tephrosia candida*) was broadcasted over the area at the beginning of May, its germination in all cases was 100 per cent. Growth was excellent and by the

cold weather it averaged from 6' to 8' in height and by the beginning of the hot weather was giving a complete shade to the *gurjan*. From 3 to 20 seers of seed per acre were used, and in many cases the *bogamedeloa* was too thick and had to be thinned out, this is expensive and should be avoided, also *gurjan* seedlings under very dense shade are small compared with those that get a diffused light. 3 to 4 seers seem about the correct amount. In order to ascertain the percentage of *gurjan* seedlings that die back during the hot weather, all seedlings on ten lines 100' long were counted once in December 1928 and again in June 1929 after the hot weather. The results are as follows :—

Line No.	NO. OF SEEDLINGS.		Surviving.
	December 1928.	July 1929.	
1	338	231	68%
2	230	185	80%
3	227	171	75%
4	304	212	70%
5	313	219	70%
6	320	214	67%
7	262	159	60%
8	388	275	71%
9	453	306	68%
10	200	145	73%

Average survival 70 %

It can be safely said that *Dipterocarpus turbinatus* can be put out in regular plantations using *bogamedeloa* as a shade crop, it only remains to be seen if the *bogamedeloa* will give shade for a sufficient number of years to enable the seedlings to get their root systems fully established.

(D) *Taungya plantations in Chittagong and Cox's Bazar Divisions.*

The experiments mentioned in last year's report continue to do well. *Dipterocarpus turbinatus* sown in 1927 averaged 3' last December and *Hopea odorata* 2'.

This year experiments were carried out to find a way to combine shade and *jhum* crops so that the shade crop will not interfere with the *jhum* crop.

Experiment I.—*D. turbinatus* was sown in lines 6' apart two rows of seed in each line. In May *bogamedeloa* was scattered in between the two rows of *gurjan* seed at the time of *gurjan* sowing. The "jhumias" paddy crop suppressed the *bogamedeloa* and there was no sign of germination. In the latter part of August the paddy was reaped. A week

later it was noticed that the *bogamedeloa* was germinating and in November was about 1' 6" high and looked as if it would give enough shade to protect the *gurjan* during the hot weather.

Experiment II.—After the paddy had been reaped at the end of August, *bogamedeloa* was broadcasted over the paddy stalks, no soil preparation was made. The *bogamedeloa* germinated well and was from 2 to 3 ft. in November and looked as if it would give sufficient shade to the *gurjan* during the hot weather.

Experiment III.—After the paddy was reaped in the latter part of August the ground between the rows of *gurjan* was completely cleaned and hoed. *Bogamedeloa* was broadcasted. It germinated well and was 2 to 3 ft. high in November. Cost per acre was about Rs. 10. This is far too expensive. Experiment II seems the most feasible and will be tried on a larger scale.

Dipterocarpus turbinatus, *pilosus*, *alatus*, *costatus* were all tried in the plantations and the germination was the same as mentioned under Regular plantations. *Dipterocarpus turbinatus* is always successful, *D. costatus* fairly so and the others were in all cases a failure. Cleaning the *gurjan* lines can be overdone, and the lines must not be so heavily cleaned as to expose the soil or the seedlings will die. All paddy stalks coppice, weeds, etc., should be left to cover the soil and preserve moisture, and only creepers actually interfering with the plants should be cut.

Hopea odorata has done extremely well in line sowings. Germination 80 to 90 per cent. This has been tried with and without *bogamedeloa* but results are not to hand at present.

Suietenia macrophylla, *Artocarpus integrifolia*, *Cedrela Toona*, and *Lagerstræmia Flos-Reginæ* in damp areas, were also tried with success.

(ix) Underplanting.

In the Chittagong Division, experiments were made in undersowing *Gmelina arborea* with *Dipterocarpus turbinatus* and *costatus*.

Experiment I.—*Dipterocarpus turbinatus* was sown in "thalis" 6'×6' in between the lines of the 1925 *gamari* in June. One seed was sown in each "thali". Stocking of the *gamari* was 1.0. In December the seedlings looked very healthy and were from 1'—0" to 1'—6" in height. 537 plants were surviving out of 575 (93 per cent. survival).

Experiment II.—*Dipterocarpus pilosus* was sown in "thalis" 6'×6' in between the lines of 1922 *gamari* plantation in June. In December the plants were about 6" in height and looked healthy. There were 340 plants surviving out of 1,210 (28 per cent. survival), this is quite good as we have never succeeded in getting more than 5 per cent. in our plantations.

Experiment III.—*Dipterocarpus turbinatus* and *costatus* were sown in "thalis" 6'×6' in between lines of 1923 *gamari* in June. Stocking

of *gamari* about 9. Seeds of both species were tried by sowing right way up, and also upside down with wings removed, there is no difference in germination between the two methods of sowing. One seed was sown in each "thali". The plots were inspected in December and the surviving seedlings were healthy, the average height of *turbinatus* was 12" and *costatus* 6". The germination per cent. of *costatus* is exceptionally good. We have never succeeded in getting more than 30 per cent. in our plantations.

(i) <i>Dipterocarpus turbinatus</i> sown upside down.			
Number of thalis originally put out	.	370	95 per cent. sur-
" " surviving in December	.	350	viving.
(ii) <i>Dipterocarpus turbinatus</i> sown right way up.			
Number of thalis originally put out	.	410	94 per cent. sur-
" " surviving in December	.	385	viving.
(iii) <i>Dipterocarpus costatus</i> sown upside down.			
Number of thalis originally put out	.	50	64 per cent. sur-
" " surviving in December	.	32	viving.
(iv) <i>Dipterocarpus costatus</i> sown right way up.			
Number of thalis originally put out	.	160	63 per cent. sur-
" " surviving in December	.	100	viving.

(c) The Experimental Plots in underplanting *Chickrassia tabularis* with *Michelia Champaca* and *Shorea robusta* laid out in 1925 have been kept up, and both species seem to be doing well.

(i) *Michelia Champaca* under *Chickrassia tabularis* :—

Average height of *Michelia Champaca* planted in the open is 17'.

Average height of *Michelia Champaca* under *Chickrassia* is 11'.

(ii) *Shorea robusta* under *Chickrassia tabularis* :—

Average height of sal in the open is 8'.

Average height of sal under *Chickrassia tabularis* is 3'.

(xi) Miscellaneous.

From observations in different sal plantations especially in the older ones, it was seen that the undergrowth was tending to become evergreen and the areas looked very damp. The young sal as a whole is not looking too healthy and there have been many deaths from fungus and several isolated attacks of *Hoplocerambyx spinicornis*. As natural sal was known to have been raised in the presence of annual fires it is through that perhaps our artificial plantations of sal would also profit by burning as soon as the corky bark had been formed. It is also hoped that the climbers will be reduced by burning and so lessen the cost of climber cutting. Three plots of 3 acres each have been laid out in the Buxa Division to study the effect of fire in sal plantations.

Plot 14 A will be burnt annually.

Plot 14 B will not be burnt and will be used as a general observation and Indicator Plot.

Plot 14 C will be burnt every 2 years.

In each plot an Indicator Plot of $\frac{1}{4}$ acre has been laid out, all sal trees in them have been enumerated in $\frac{1}{2}$ " diameter classes and two Sample trees of each diameter class have been numbered and their height and diameter recorded. These Indicator Plots will be remeasured every three years, and will show the effect of fire on the growth of the sal both as a whole and on individual Sample trees. Outside the Indicator Plot the general condition of the undergrowth and any changes in same will be noted. The number and cost of climber cutting will be noted for each plot.

II.—WORKING PLANS AND STATISTICS.

(i) Working Plans.

The Jalpaiguri Plan has been sent to the Press. Darjeeling, Kurseong and Sundarbans Plans are nearing completion.

Buxa Plan is being written up.

(ii) Yield Tables.

(a) The following Permanent Sample Plots were remeasured this year :—

Kalimpong No. 1	<i>Cedrela Toona</i> .
" No. 2	<i>Duabanga sonneratioides</i> .
Jalpaiguri No. 8	<i>Cedrela Toona</i> .

Thirteen New Permanent Sample Plots were laid out, as follows :—

Chittagong Hill Tracts S. P.	No. 9	<i>Swietenia macrophylla</i> .
Buxa Division	" No. 18	<i>Tectona grandis</i> .
" "	" No. 19	<i>Shorea robusta</i> .
" "	" No. 20	<i>Lagerstræmia Flos-Reginæ</i> .
Kalimpong Division	" No. 7	<i>Shorea robusta</i> .
" "	" No. 8	<i>Duabanga sonneratioides</i> .
Darjeeling Division	" No. 22	<i>Alnus nepalensis</i> .
" "	" No. 23	<i>Michelia excelsa</i> .
" "	" No. 24	<i>Cryptomeria japonica</i> .
" "	" No. 26	" "
" "	" No. 27	" "
" "	" No. 25	<i>Bucklandia populnea</i> .
" "	" No. 28	<i>Alnus nepalensis</i> and <i>Bucklandia populnea</i> mixed.

(b) The small Plots of *baen* (*Avicennia officinalis*) and *keora* (*Sonneratia apetala*) laid out in the salt water area, Sundarbans Division, were remeasured this year. The *keora* saplings have been badly damaged by borers.

(c) All permanent Sample Plots in the Sundarbans Division were remeasured by the Divisional Forest Officer, in order to complete data for the Working Plan.

(d) In connection with the Darjeeling Working Plan figures for rate of growth of Hill sal (natural), *Cryptomeria japonica*, *Duabanga sonneratioides*, *Bucklandia populnea*, *Abies Webbiana*, *Alnus nepalensis*, *Quercus lamellosa* and *lineata*, *Tsuga Brunoniana* (Plantations) were compiled in this office and graphs drawn up to illustrate same.

(e) Four old Linear Sample Plots in the Buxa Division were remeasured and several specimens were sent for identification to the Forest Botanist, Dehra Dun.

(f) 202 sal trees in the Buxa Division were measured up to supplement the data given in new Commercial Volume Tables for Sal in the Wet Mixed Forests of the Duars, issued this year by the Research Institute.

(IV).—MISCELLANEOUS.

Specific Ledger Filing has been kept up to date and 24 new files have been added this year making a total of 97.

General Ledger Files have also been started this year.

BIHAR AND ORISSA.

I.—EXPERIMENTAL SILVICULTURE.

(i) General.

The progress of work has followed the same general lines as hitherto. The attachment of two gazetted assistants to the division throughout the year has allowed the Provincial Research Officer to relieve territorial divisional staffs from some of their share in maintenance work. Where possible the touring Research Staff has renewed boundaries, recorded enumerations and generally maintained Sample and Experimental plots in addition to the initiation of new plots which had been their main work in previous years.

The assistance of two gazetted assistants has allowed a better control on work to be exercised. While it is still necessary for the Provincial Research Officer to tour in all divisions each year, one gazetted assistant is now centred so that he may superintend work in the Orissa Divisions (Puri, Angul, Sambalpur East and Sambalpur West), the other gazetted assistant has charge in the Singhbhum Divisions (Saranda, Kolhan, Porahat and Chaibassa).

The problem of co-ordinating experimental plots has continued during the year. In consequence a number of plots were abandoned; in most cases results to date were summarised before the plots were abandoned. The reasons for abandoning plots were that accidents had upset the initial conditions of the experiment, that the objects of the plot were too vague to be attainable, or that results, positive or negative, had been reached.

The list of Experimental Plots now existing in the Province is given below :—

Division.	No. at the beginning of year.	No. abandoned during the year.	No. initiated during the year.	No. in existence at the end of the year.
Palamau	2	..	..	2
Hazaribagh	..	..	..	..
Santal Parganas	..	..	..	..
Porahat	13	2	..	11
Saranda	21	4	14	31
Kolhan	28	9	2	21
Chaibassa	..	..	..	..
Sambalpur West)	35	1	..	34
Sambalpur East)	15	1	10	24
Angul	43	..	..	43
Puri	..	..	..	..
TOTAL	157	17	26	166

No Sample Plots were abandoned during the year. A few that had been previously abandoned were reintroduced during the year. The numbers are given in the Table below :—

Division.	No. at the beginning of the year.	No. abandoned during the year.	No. initiated or reintroduced during the year.	Total No. in existence at the end of the year.
Palamau	9	..	..	9
Hazaribagh	..	..	..	..
Santal Parganas	..	..	..	..
Porahat	21	..	..	21
Saranda	23	..	3	26
Kolhan	13	..	5	18
Chaibassa	..	..	..	..
Sambalpur West)	16	..	3	19
Sambalpur East)	13	..	..	13
Angul	22	..	3	25
Puri	..	..	..	..
TOTAL	117	..	14	131

During the year steps have been taken to improve the connections between the Provincial Research Officer and the Imperial Silviculturist, Dehra Dun, and the other Provincial Silviculturists or Research Officers. To this end the tours of the Provincial Research Officer to Dehra Dun in August 1928, to Bengal in January 1929 and to Dehra Dun again for the all India Silvicultural Conference in March 1929, have been of great benefit. In the Conference the question of relations between Silviculturists was discussed and the means suggested are already being put into force. The procedure suggested entails the despatch of all Experimental Plot files to the Central Silviculturist, Forest Research Institute,

Dehra Dun, once a year for his information. He will extract any generally useful information and give his advice or criticisms. Also when new schemes of research are initiated the outlines of the scheme are sent to the Central Silviculturist for his criticism.

To enable the Research Division to be in a position more valuable to Divisional Forest Officers a thorough filing system is about to be introduced. This system will enable all information to be classified so that it may be available for Divisional Forest Officers whenever it is required. In any case results of experiments are circulated to all Divisional Forest Officers as they are obtained.

The work accomplished during the year is summarised below under the respective heads :—

(ii) *The natural regeneration of sal.*

There are a large number of experimental plots investigating this problem, scattered through various types of forest in the Singhbhum and Orissa Divisions. The problem is twofold, firstly how sal regeneration can be induced, secondly how regeneration when once it appears can be coaxed to establishment. So far experiments have mainly been directed against the latter while fire has been the investigated agent. The experiments are beginning to indicate results and may be summarised as follows :—

- (i) In definitely dry localities fire seems to be harmful to the establishment of sal regeneration ; it decreases the vitality of the sal and increases grassy vegetation.
- (ii) In definitely damp localities fire seems to be conspicuously favourable to the establishment of sal regeneration ; it tends to kill weed growth ; the sal seems to be invigorated so that it attains a commanding position over the weeds by which it was previously suppressed.
- (iii) In areas neither markedly dry nor wet results are as yet very uncertain. Weed growth seems to be reduced by fire, while there is no marked effect on sal.
- (iv) In damp areas one burning at the time of clear felling the overwood has little or no effect upon weedgrowth. Annual burning for at least 5 years before fellings is necessary.

It thus seems clear (though as yet figures to support the above ocular conclusions are not available) that fire protection is essential in dry areas, that one burning at the time of felling is more or less valueless to reduce weeds in damp areas but that annual burning for 5 years previous to any fellings is of great value.

(iv) *Nursery Work.*

Experimental Nursery Work at Doranda.

The most interesting experiments were those with *Aleurites Fordii* (The Tung Oil Tree). Seed was obtained from Dehra Dun. It

was found that seed sown in April was better than seed sown in June ; also that the Dehra Dun seed did not give results nearly as good as seed received from Kew (the results obtained with Dehra Dun seed was compared with results obtained by the Director, Indian Lac Research Institute, Namkum, and by Mr. Bates, Sabaya Tea Estate, who had used Kew seed). On repeating the experiments it has been found that early sowing in January gives better results than April sowing, and that raised beds seem better than sunk beds. All beds were left unshaded and now a number of seedlings are dying, probably from the excessive heat of the direct sun's rays.

It will be necessary to repeat the experiments with and without shading. But results obtained at Sabaya with Kew seed show that this species is capable of growing well and fast in the Ranchi District.

(v) *The artificial regeneration of sal.*

Experimental Plots 105 and 106 in the Saranda Division have proved that in both damp and fairly dry types of sal forest in Singhbhum sal can be regenerated successfully by artificial means by line sowings, if the lines are dug to an initial depth of 12" and if weedings and soil loosenings are done thoroughly for 3 years. This is similar to results obtained in other provinces.

II.—WORKING PLANS AND STATISTICS.

Statistical work has continued on the same lines as last year.

(ii) *Yield Tables.*

As shown in the table on page 42 the total number of sample plots is now 131, of which 83 are of sal. These 83 plots cover effectively the range of quality and age classes existing in the province, though a few more old plots of all qualities would still be useful. During the next year or two steps will be taken to classify all plots under various thinning grades. Each plot will then be treated strictly according to a settled thinning programme so that eventually figures will be obtained for each of the various standardised thinnings. The programme will necessitate an increase in the number of sal sample plots.

At present sample plots are being remeasured every 5 years. In future they will probably be fully remeasured and thinned every 10 years ; the breast height diameters, however, will be taken quinquennially.

(iii) *Volume Tables.*

Figures collected during two previous years in Porahat, Saranda and Sambalpur divisions were sent to Dehra Dun. These figures are being examined and will probably be incorporated in any revision of the present general Volume Tables for sal. If, however, the figures show any marked divergence from sal volume figures in the rest of India, separate tables will be published for Bihar and Orissa.

During the year additional volume and outturn figures were collected in Sambalpur East.

Coppice Coupe Outturns.—During the year more figures were collected in various divisions. When sufficient figures have been collected for each division an attempt will be made to prepare some coppice outturn tables for each division concerned.

BOMBAY.

I.—EXPERIMENTAL SILVICULTURE.

(i) *General.*

The Research Branch in the Chief Conservator's office is doing valuable work in directing the conduct of the research carried out in Divisions, mainly directed towards the satisfactory solution of important problems connected with silviculture. The results of the research work are co-ordinated in the Branch and the consolidated results made available for the benefit of all concerned.

Since inception of this work in 1926, 7 subjects were completed in the previous years. Out of 19 subjects under investigation during the year 5 were completed and are now omitted from the list of current subjects, and 7 were added, making the total of 21 subjects under investigation at the end of the year 1928-29. 9 subjects out of these are concerned with collection of figures of cost or of growth.

The 5 subjects completed during the year were :—

Serial No.	Subject.	Divisions.
14	Propagation of bamboos	Kolaba.
15	The relative value of different species for making charcoal.	Sukkur, Karachi, West Thana, Satara and Belgaum.
22	Comparative costs of and benefits derived from deep and shallow working of the soil prior to sowing and the comparative growth of seedlings obtained from seed sown under a deep and shallow cover of soil.	Panch Mahals.
23	Comparative results of stump planting when stumps are cut before and after removal to the plantation site.	Surat, East Thana, North Khandesh, Kolaba and E. D. Kanara.
24	Sowing teak on "rabs" in lines instead of in bunches to facilitate weeding and removal of excess seedlings for transplanting elsewhere.	West Nasik, East Thana, North Khandesh, Kolaba and E. D. Kanara.

The 7 subjects added during the year were :—

Serial No.	Subject.	Divisions.
27	Reproduction of <i>anjan</i> (<i>Hardwickia binata</i>) by broadcast sowing and sowing in single plough drills in soil prepared according to different methods.	East Khandesh.
28	Effect of early burning on sandalwood growth and regeneration.	Belgaum (Khanapur Range).
29	Value of shrubs as nurses for artificially raised seedlings in scrub forests.	East Khandesh West Khandesh and East Nasik.
30	Artificial propagation of <i>safedmusali</i> (Medicinal) .	North Khandesh (Shirpur East and Shirpur West Ranges).
31	To determine which of the following three methods tends to produce the maximum improvement in case of forked and branchy young transplants or seedlings :— (i) Cutting back the plants. (ii) Carefully pruning the undesirable shoot or shoots. (iii) Breaking the top bud of the undesirable shoot or shoots.	West Khandesh.
32	Determination of correlation between outer girth increment and heartwood increment of sandal.	Dharwar-Bijapur.
33	Determination of— (i) the periodic annual girth increment of <i>simul</i> (<i>Bombax malabaricum</i>). (ii) the average annual girth increment of <i>simul</i> .	Panch Mahals.

The work done and observations made during the year are described in the following pages.

(ii) *Natural Regeneration.*

Subject No. 19.—Coppicing of *anjan* (*Hardwickia binata*) (East Nasik, East Khandesh and West Khandesh) :—

The fresh plots ordered last year are in process of being laid out and felled in East and West Khandesh Divisions.

(v) *Artificial Regeneration.*

Subject No. 2.—Germination tests of teak seeds alternately soaked and dried (i) for a week, (ii) for a fortnight, the process being repeated

three times in each case (Surat, Kolaba, Belgaum, West Khandesh, Panch Mahals and S. D. Kanara) :—

Owing to late issue of orders, the experiment was not repeated except in the Belgaum Division where the seed treated according to the above two methods was collected from two different areas. Seed alternately soaked and dried for a week gave 20 % germination while seed alternately soaked and dried for a fortnight gave 90% germination. The experiment will be continued.

Subject No. 13.—Propagation of *hirda* (*Terminalia Chebula*) (Satara and Poona Divisions) :—

The following may be taken as established facts for the present —

- Seed of *hirda* seems to be very much relished by squirrels, peacocks and crabs. It is, therefore, unlikely that direct sowings can be successful under forest conditions where the seed cannot be protected against squirrels, etc.
- In Poona nursery seedlings require to be protected against land crabs which eat off their cotyledons. This apparently can be secured by filling the crab holes with a mixture of liquid cow-dung.
- In Poona Division the seedlings want protection against hot western winds and should be raised on the northern and eastern sides of bushes.

The experiment will be repeated.

Subject No. 14.—Propagation of bamboos (*Dendrocalamus strictus*), (Kolaba Division) :—

Shoot-planting has proved to be the best method of propagating bamboos. Transplanting of one year seedlings also yields satisfactory results ; but it is and will always be difficult to secure sufficient annual supply of seed for large scale work. The experiment has been discontinued.

Subject No. 21.—Propagation of solid bamboos (*Dendrocalamus strictus*) (Surat, East Thana and Kolaba) :—

Work so far done under the experiment shows that planting of 3" cuttings gives good results. Propagation by sowing or transplanting may be feasible but seed in sufficient quantity is very difficult to secure. The experiment will be continued in the three divisions.

Subject No. 22.—Comparative costs of and benefits derivable from deep and shallow working of the soil prior to sowing and the comparative growth of seedlings obtained from seed sown under a deep and shallow cover of soil (Panch Mahals) :—

The experiment conducted in Panch Mahals shows that soil cover over seed should not exceed $\frac{1}{2}$ " and that digging pits 12"×12"

×12" is too expensive for sowing to be done in such pits on the scale of ordinary regeneration operations. The experiment has been discontinued.

Subject No. 23.—Comparative results of stump-planting when stumps are cut before and after removal to the plantation site (Surat, East Thana, North Khandesh, Kolaba and E. D. Kanara):—

There is hardly any difference in the number of successful strikings as regards burnt and unburnt areas or between stumps cut before and after transport. The experiment has been discontinued.

Subject No. 24.—Sowing teak on "rabs" in lines instead of in bunches to facilitate weeding and removal of excess seedlings for transplanting elsewhere (West Nasik, East Thana, North Khandesh, Kolaba and E. D. Kanara):—

The general opinion of those in charge of this experiment in several Divisions is that line sowing is the most advantageous method in all respects. Line sowing on burnt rabs should be the rule. The experiment has been discontinued.

Subject No. 25.—Regeneration of unburnt patches in regeneration areas with miscellaneous species (North Thana, Kolaba and S. D. Kanara):—

Dibbling of seed of miscellaneous species in burnt rabs with teak seed and transplanting the seedlings from the burnt rabs into the unburnt parts of the regeneration area has given fair results in Kolaba. *Propagation of valuable species in this manner should be a regular regeneration operation in all Divisions of the Presidency proper in coupes where such species are absent or scarce.*

Subject No. 26.—Cost of *semul* (*Bombax malabaricum*) sowings and planting and percentage of survivals. (East Thana, West Thana, North Thana and Panch Mahals):—

Reports so far received show that *semul* can be successfully raised by dibblings on well burnt rabs in felled coupes in the same manner as teak, avoiding heavy soils and marshy ground, at a much lower cost than by cuttings in special *semul* plantations. This method (*i.e.* dibblings in burnt "rabs" in felled coupes) should therefore be adopted widely in felled areas situated within about 12 miles from Railway or Bunders in the Panch Mahals, in the Thana, Surat and Kolaba Divisions. The two species (teak and *semul*) are not to be sown on the same patch and care is to be taken to ensure that the area of the *semul* rabs, in any one coupe, does not exceed 25% of the area occupied by the teak rabs.

It also appears that the number of casualties is discouragingly high, the number of survivals varying from 7% in one area to about 50% in another. Drought, heavy and badly drained soils, and

rats, hares and monkeys in East Thana are the principal causes for this heavy mortality.

Selection of well drained medium soils should be the first consideration while raising *semul*.

Subject No. 12.—Artificial propagation of *rossha* (*Cymbopogon Martini*) grass (North and West Khandesh):—

Definite conclusions arrived at last year were—

- (1) that strip ploughing is the most economical method of working the soil for *rossha*.
- (2) that ill-drained and water-logged localities should be avoided.
- (3) that the effect of burning prior to introduction of seed is negligible.

Observations on the following three points were indecisive:—

- (1) the effect of burning and grazing in plots where *rossha* grass has been established.
- (2) the relative advantages of (i) sowing (ii) planting as means of propagation.
- (3) effect of different soils on germination and growth.

Further definite conclusions drawn are (i) that neither burning nor grazing are particularly harmful to established *rossha* crops, (ii) that equally good germination and growth are obtainable from both burnt and unburnt area.

Northern Division, Kanara:—Owing to the very open nature of some of the Haliyal teak pole areas and the high percentage of teak, there is excessive desiccation and the soil is rapidly deteriorating. Experiments were therefore made to introduce other suitable species in such open places outside burnt patches, those tried being *honne* (*Pterocarpus Marsupium*), blackwood, and *shewan* (*Gmelina arborea*). *Shewan* gave the best result and put on rapid growth, the best plants being about 4 feet in height at the end of the season. *Honne* and blackwood were fairly successful but the rate of growth was much too slow to enable them to compete with the dense growth of coarse grass. The experiment is being continued on a large scale this season and sowings have been made in drills made with a plough.

The *Acacia Intsia* creeper is a great nuisance in some of the high forest plantations of the Virnoli Range. Attempts were made to poison it to death with the use of 'Atlas' tree killing solution but the result was not encouraging.

(vii) Thinnings and Cleanings.

Subject No. 4.—Effect of thinning on teak coppice at different ages (East Thana):—

Original measurements were taken in sample plots 4A, 4B and 4C in September 1926. Thinnings were done in the early part of

1927. Seven additional sample plots were to be laid out in the coupe in which 4A has been laid out in successive years from 1927 to 1933. Two of these 7 additional sample plots were laid out and measurements and thinnings carried out in 1927-28 and 1928-29.

Subject No. 5.—Effect of different degrees of thinning in teak plantations of different ages (West Nasik, West Thana, N. D., E. D., S. D., W. D., Kanara and Belgaum) :—

The next measurements are due in 1929-30 and are to be taken in the same months as the first measurements. The method of measuring and recording employed so far admits of comparison of only mean girths of each sub-plot before thinning at the first measurements and three years after thinning at the first re-measurements. Mean girths of whole sub-plots can hardly be accepted as a reliable basis for comparing the merits of different degrees of thinning. It is, therefore, proposed, while maintaining the present plots, to lay out a fresh series of plots in which measurements will be made and recorded in such a way as to admit of comparison of increments in girth and volume, and arrival at the comparative merits of different degrees of thinning. Underplanting in the most heavily thinned plots, except with *Xylia xylocarpa*, in the Southern Circle, has proved a failure and it is clear that—

- (i) it is far cheaper and more practical to introduce mixtures at the time of creation of the plantation than at any subsequent period, and
- (ii) that nature can generally be depended upon to produce, in the form of seedlings, root suckers, coppice and bamboos, sufficient growth to mix with the teak plants; it is only necessary to see that nature is not unduly interfered with. Underplanting has therefore been discontinued.

II.—WORKING PLANS AND STATISTICS.

The following Working Plans (new and revised) were printed and sanctioned during the year under report :—

1. Bulsar-Chikhli (revised).
2. Teak pole, fuel and sandal wood forests of Khanapur and Nagargali Ranges (including also sandalwood area of Gujnal Range) of the Belgaum Division. (Revised.)
3. Nersol slopes forests, Block XVII, Kanara E. D. (Revised.)

(v) Miscellaneous.

Subject No. 5.—Effect of different degrees of thinning in teak plantations of different ages :—

Subject No. 7.—Annual girth increment of sandal. (Belgaum and Dharwar-Bijapur) :—

The first remeasurements were taken in the sample plots of the Belgaum Division in May 1928.

Subject No. 8.—Increment of *babul* (*Acacia arabica*) under different degrees of thinning (Hyderabad Division) :—

No work has yet been done under this subject. A scheme has been finally drawn up for thinnings in plots of 7 ages, viz., 3, 5, 7, 10, 15, 20 and 25 years, according to two degrees of thinning, viz.—

- (i) Heavy thinning :—Lateral space between the crowns of about one-fifth the height of the crop.
- (ii) Light thinning :—Lateral space of about one-tenth the height of the crop.

Subject No. 10.—Economic age for cutting *bahan* (*Populus euphratica*) coppice (Shikarpur Division) :—

Results up-to-date are summarised below :—

Name of the sample plot.	Area in acres.	Cut during the year.	Age at the time of cutting.	Outturn in poles.	Price obtained.	Money value per acre per annum.
10A . .	$\frac{1}{2}$	1926-27	4 years	712	53-5-0	26-10-0
10B . .	$\frac{1}{2}$	1927-28	5 „	624	55-14-0	22-6-0
10C . .	$\frac{1}{2}$	1928-29	6 „	648	79-2-0	26-6-0
10D . .	$\frac{1}{2}$	to be cut during the year 1929-30 at the age of seven.				

The chief point brought out by the above statement is that in Sind, *bahan* should be cut while quite young. Generally speaking, *bahan* or any other species should be felled at an age when it yields the largest quantity of material of the dimensions most in demand. Four rotations differing by only one year can, however, hardly have much effect on yield, dimensions or prices. More useful results would have been obtained by comparing result of felling at the ages 4 years, 7 years and 10 years. To this end the Divisional Forest Officer has been instructed to lay out two half-acre plots 10D and 10E in the same coupe in which plots 10A, 10B and 10C have been laid out. Each of the two plots 10D and 10E should contain nearly the same number of saplings, i.e., about 650. Plot 10D is to be felled when the growth therein is exactly 7 years old and plot 10E when the growth is 10 years old.

Subject No. 16.—Effect of improvement fellings on diameter growth (Surat Division—Dangs) :—

There is nothing fresh to report.

In N. D. Kanara the Amga sample plots laid out in 1920 to determine the effect of different degrees of thinnings, were maintained in the usual

way. The plots have been well protected and the plants are putting on good growth. The next measurements are due in January 1930.

BURMA.

I.—EXPERIMENTAL SILVICULTURE.

(In the following report the letters E and S followed by Roman numerals refer to the project numbers in last year's report.)

(i) General.

Staff.—It has not yet been found possible to provide an Assistant to the Silviculturist and this condition seems likely to continue.

During the year the staff consisted of one Extra Assistant Conservator, three Rangers and eight Foresters.

Fortunately two Probationary Deputy Rangers were attached for the open season before proceeding to the Burma Forest School. Really two assistants are required, one stationed in Upper Burma and one in Lower Burma.

Recruitment of suitable men for the posts of Foresters still presents difficulties because they must be men who can go through the Forest School and provide a source from which the vacant posts of Deputy Rangers can be filled. It is hoped that increased initial pay may attract more educated men.

The idea at present is that Deputy Rangers should serve three years in this division and then be transferred to a territorial division in exchange for a selected man passing out of the school.

The programme of work has been carried on as projected in the scheme of 1926-27.

(ii) Natural Regeneration.

No new plot was made under any of the projects during the year. Only old plots were remeasured.

E. I.—Experimental plots 5, 6, 7, 8, 9 and 10, Bhamo Division.

So far no definite conclusions can be drawn from any of the plots containing *Pentacme suavis* but there are certain points which seem fairly clear, though by no means certain.

(1) As regards methods of inducing regeneration it seems necessary first to clear the undergrowth and leave only a fairly open high canopy. Fire before the fall of the seed is essential and the burning must be continued for some years until a very large stock of strong seedlings in the whippy stage has been obtained.

(2) A large stock of regeneration is essential if weedings and cleanings are not carried out. *Ingyin* (*Pentacme suavis*) can continue

to exist for many years under grass and low weeds but seems unable to stand the shade of the woody undergrowth, mainly coppice, which comes after the initial clearing is made. Fire will reduce the quantity of undergrowth, but eventually in this reserve the fire-hardy teak becomes safe from damage and establishes itself.

(3) Once an adequate stock of regeneration has been obtained, fire protection is required to enable the plants to pass from the whippy stage to the sapling stage. Here again cleanings will be necessary if other species are numerous.

(4) There seems to be very little hope of success on a large scale unless weedings and cleanings are carried out. Weedings may be expensive but as a set off against this, the rapidity with which a crop becomes established must be given due weight. For example Experimental plot 10, Bhamo Division, was started in 1916. Part of it was regularly weeded, and in 1924 this area of 0.6 acres was formed into a sample plot. It now contains a full stock of trees 25' to 40' and 1' 0" to 1' 6" in girth, whereas in the whole of the rest of the area 5.5 acres there are only 171 (or 31 per acre) over 15' high and very few of these have reached 20'. The plants in Experimental plot 10, 5.5 acres unweeded, have been under observation for 12 years and there seems little prospect that a full stock of trees 20' high will be obtained in less than 20 years; there has in fact been a serious falling off in numbers in the larger classes since 1927, the reason for which is in doubt. The vigour of the undergrowth is, however, probably the cause.

In Compartment 36 all cover was felled in 1924 over a mass of unestablished regeneration and weedings and fire protection were introduced. By 1927 there was a very fairly full stock of saplings, free from danger of weeds, up to 30' high and mostly 20' high and 9" to 12" in girth. There are two small plots which have done well without weedings, No. 6 and No. 5 of Bhamo Division. No. 6 was, however, grazed over heavily and the grass was thus much reduced. No. 5 is a very small plot of one chain square and although it has done well the growth is not so great as in the weeded areas already mentioned.

The importance of obtaining a very large stock of regeneration is brought out by Experimental plot 10. The seed-bearers were removed in 1925 when the fire protected plot contained only 1,840 plants on 2.3 acres, and the burnt plot 16,000 on 3.2 acres. The numbers in the protected plot have now been reduced to only 440 plants and the burnt plot to 10,940. While the stock on the former is very inadequate, that on the latter is little more than sufficient considering that only 540 are 5' and over in height.

Again Experimental plots 7 and 8 of Bhamo Division contain very little *ingyin* and have been converted by clear felling into a mass of weeds with some teak mainly coppice. In this area, a creeper, *mucana*, is

plentiful and is causing much damage to such trees as have come up. Experimental plot 9 of Bhamo Division on the other hand remains in the same state as when it started because all *ingyin* seed-bearers were left and they are sufficiently numerous to keep down the undergrowth. The evil effects of clear felling are also shown by the 50 acre plot felled in 1919. A few, very few, seed-bearers were left. After ten years a large part of the area is covered with teak, mainly coppice, of poor quality and creepers. The canopy is dense and the floor is clean and without grass. There are practically no *ingyin* seedlings and saplings on such areas. In the grass covered areas in spite of very fierce fires there are a fair number of seedlings when a seed-bearer is near. Probably 90 per cent of what was mainly *ingyin* has now become teak forest and teak is, in this reserve, a weed.

E. I(b).—The plots in the Satthwa Reserve, Zigon Division, were remeasured.

No 4.—Clear felled over natural regeneration. The progress of regeneration of *D. tuberculatus* is excellent. The plot is only one year old and yet there are saplings 7' high. There are also some well grown *Xylia dolabriformis*, *Pentacme suavis* and *Shorea obtusa*.

No. 6.—There are numerous poles of *D. tuberculatus* over a mass of regeneration in the "cabbage" stage. The canopy is open but little growth has taken place among the young plants. The difference in effect on regeneration between the clear felling in Experimental plot 4 and the partial felling here is very marked.

Nos. 1 & 2.—These plots were coppiced in 1923 and the growth and stocking of *D. tuberculatus* is excellent. Stems are up to 20' high or more and average about 15'.

In this reserve there is no grass and very little of any kind of weed and all that seems to be necessary for the establishment of seedlings is a clear felling. Fire, apparently, does no harm whatever. The position is very different in the Yinke (Katha), Shwegu (Bhamo) and Indaung (Mogok) reserves where *Imperata arundinacea* grows in dense masses up to 5 or 6 feet high and burns fiercely. In these forests also, fire protection produces creepers and other weeds with numerous other species, including much teak of very inferior type. The teak establishes itself in spite of fire though a little more slowly than with protection.

Experimental plots 11 to 13, Shwegu Reserve, mentioned in last year's report were again burnt in anticipation of a good seed year of *ingyin* (*Pentacme suavis*). Although the seeding was good on the whole, it fell mostly in an immature condition and was attacked by insects.

Experimental plots 6, 7 and 8, Yinke Reserve, Katha Division.

So far regeneration of *in* (*Dipterocarpus tuberculatus*) under clear felling by strips, and seeding felling has not been very successful. This is partly due to poor seed crops during the last two years.

As far as can be seen the wider the strips, the better the establishment of the crop.

In fire protected areas *thekke* grass is very dense up to the 4th year but then disappears as the canopy closes up. Here the poles establish themselves more quickly and look more healthy.

Experimental plot 9, Yinke Reserve, Katha Division.

This was to ascertain the results of fire protection, burning, and improvement fellings, on the natural regeneration of *ingyin* (*Pentacme suavis*) and the associated species of *in* (*D. tuberculatus*) and *Shorea obtusa*.

The best result was from improvement fellings and fire protection.

E. I. (c).—The plots were laid out in pairs so that the effects of fire protection can be studied.

Unfortunately the fire protection was not always successful on such small areas.

E. I. (d).—The plots in Yinke Reserve, Katha Division, which were laid out in 1926 to study the effects of hoeing the soil in dense grass under a canopy where regeneration of *D. tuberculatus* is lacking, failed in their object owing to a poor seed crop.

The plots in Bilumyo Reserve, Myitkyina Division, referred to in last year's report showed excellent germination of *P. suavis* in all cases, i.e.—

- (a) hoeing the soil,
- (b) removing 6" of surface soil,
- (c) clearing to get bare ground.

Unfortunately a large number of seedlings were killed by drip.

E. II. (b).—In the Thaw Reserve, Shwebo Division, the plots laid out in areas over which "Y" fellings and preparatory fellings have been carried out show little variation, with one exception.

Plot 11 was laid out in an area cleared in 1924-25 over ample regeneration of *Xylia*, *Pterocarpus macrocarpus* and *Pentacme suavis*. It is now covered with a dense mass of *Eupatorium odoratum* up to 10 feet high and both *Pterocarpus* and *Pentacme* have suffered. The plants of *Xylia*, which were 6' and over last year, show good progress. The numbers remain much the same, 242 to 236, but whereas there were only 37 plants 10 feet and over there are now 119, four of which are 20' and over. Plants below 6' in height show a loss in numbers of 23 per cent and the average height shows a slight decrease in spite of a decrease in numbers.

It was an exceptional year and no fire took place.

E. III. (b).—*Dipterocarpus turbinatus*.

The results of remeasurement in the Auktaw Reserve plots tend to confirm the statement that opening the canopy over seedlings increases the rate of growth and raises the rate of mortality.

In the case of the Petsut plots referred to in last year's report, results are somewhat conflicting as in two plots, burning before sowing has not produced increased regeneration and subsequent development as noted last year.

E. IV.—Melanorrhoea usitata.

In the Satthwa Reserve, Zigon Division, Experimental plot 6 was laid out to obtain regeneration of *thitsi* (*Melanorrhoea usitata*.) It is not ideal for the purpose as the seed-bearers are small and few in number. All other trees were felled.

There is a fair quantity of young *thitsi* which was there before the felling. There are also several *Xylia dolabriformis*, *Pentacme suavis* and *Shorea obtusa* seedlings.

On the whole development has been satisfactory during the year of the plot's existence and its progress will be worth watching.

*E. VII.—*Plots in Kyaikthin Reserve, Shwebo Division, were measured up to study the coppicing power and rate of growth of coppice shoots of *D. tuberculatus*, *Shorea obtusa* and *Pentacme suavis*, and also the possibility of obtaining better and more numerous shoots by wounding the stumps.

Results showed that wounding the stumps produced no increase in growth or number of shoots.

(iii) *Seeds.*

Collection.—Over six hundred baskets of teak seed were exported to India, chiefly for the Silviculturist, United Provinces, Naini Tal. They were sent off early and have left a shortage for local supply owing to certain divisions failing to collect as much as they promised.

(iv) *Nursery Work.*

*E. X.—*The species which have been tried are *Taraktogenos Kurzii*, *Hydnocarpus anthelmintica*, *Asteriastigma macrocarpa* with *H. verrucosa* and *H. Dawnensis*. The last two were only sown in 1928.

Germination on the whole is found to be better under shade with watering; this seems to be due to the fact that the seed keeps for a year or more when it is kept shaded and damp, while it becomes unsound if kept dry or exposed to the sun. The most satisfactory results have been obtained in 1928 by placing the seeds in heaps on a thick bed of chopped leaves. Practically all the seed that germinated did so within six weeks, the percentage being *Asteriastigma* 23 per cent, *Taraktogenos* 70 per cent, *H. verrucosa* 64 per cent and *H. Dawnensis* 73 per cent. The percentage of survival with shades was slightly better in the beds than in the pots. Growth is better in the beds. The shade requirements with *T. Kurzii* in beds is not great and it could be produced under a fairly open canopy if kept watered.

Transplanting of plants of six months to one year old and six to fourteen inches high, was more successful than sowing seed direct at stake or sowing germinating seed. Stumps were a complete failure.

The seed and young seedlings are liable to so many dangers that direct sowing is unlikely to be successful.

There is little doubt that shade is required during the dry season as well as protection against hot dry winds if seedlings are to remain healthy. Watering also is necessary. Without shade and with watering, the mortality is higher than under shade, but the average height growth of the surviving seedlings appears to be slightly greater without shade. This is possibly due to the fact that the surviving plants were all of early germination, whereas those under shade included many which came up later in the year.

Further figures will be available next June and it is proposed to publish a combined botanical, chemical, and silvicultural note on "*T. Kurzii* and allied species in Burma."

(v) *Artificial Regeneration.*

E. I. (e).—Plots 1-4 and 14-17, Shwegu Reserve, Bhamo Division. These plots were laid out in 1927 to study different methods of regenerating blank areas with *Pentacme suavis*. The methods tried were:—

Plot 14.—Sowing in hoed lines.

„ 15.—Dibbling at stake.

„ 16.—Broadcasting.

„ 17.—Transplanting to stake.

In each case the plots were divided into plots to be weeded and to be left unweeded. Dibbling at stake gave better results than transplanting. Sowing in hoed lines has probably produced the densest stocking because the number of seed sown was far greater, but as 89 per cent stocking has been obtained by dibbling the extra cost of hoeing is not justified.

Weedings were carried out twice a month from June to October and may perhaps have been overdone. The result is that in all three cases the unweeded plot gave better results as regards stocking and survival.

The broadcasting was a failure. Large quantities of seed were used and very little came up. In this case the weeded area gave better results than the unweeded area.

E. I. (f).—Growing season of *Pentacme suavis*. Last year the growth of individual plants at three different stages, i.e., seedlings, plants with formed stems and those with whippy shoots, was studied and showed little growth after June. Further study is being made under various conditions, i.e., weeding, burning and fire protection.

E. XIII.—The Divisional Forest Officer, Insein, reports that experimental regeneration of matchwood species was continued on the area

already cleared. The work suffered from lack of organization and was confined chiefly to patching up the 1927 area with one year old seedlings and in some cases sowing the blanks.

Results show success in transplanting *ma-u-lettanshe* (*Sarcocephalus cordatus*), *setkadon* (*Trewia* sp.) and *yemane* (*Gmelina arborea*) and from seed of *letpan* (*Bombax malabaricum*) and *didu* (*B. insigne*). All efforts to regenerate the higher and lateritic part of the area failed.

(vii) *Thinnings.*

E. XII. (d).—Plot No. 19, Tharrawaddy Division, was thinned on more or less mechanical lines at the age of four years when the crop averaged 29' high and 2.7" in diameter. The trees left after the thinning this year (age 9) are 45' high and average 5.05" in diameter. These trees averaged 2.67" in diameter five years ago, so the diameter increment in five years is 2.38" or very nearly half inch a year.

Plot No. 21, Tharrawaddy Division, was selected to compare with plot No. 19, being left unthinned. The trees were 28' high and 2.6" in diameter so that the difference between the plots was very small. Taking the best 92 trees or 317 per acre, the same number as now left in Plot No. 19, the average diameter was 2.96" five years ago and is now 4.76".

There were originally 1,150 trees per acre on plot 21 and this number has now been reduced by deaths to 1,010. In plot 19 there were 1,120 per acre which was reduced to 560 by thinning. During the five years 23 deaths per acre occurred.

The results here differ from those reported in last year's report in which it was stated that in young teak crops little difference could be detected in the rate of diameter increment between thinned and unthinned plots. In the case of the plots then referred to there was, however, a very heavy mortality in the unthinned plot amounting to 20 per cent of the dominant and 40 per cent of the dominated trees whereas in plot 21 the total mortality was only some 14 per cent.

It is probable, therefore, that the slight difference in the rate of increment noted last year was due to the natural thinning which took place and not, that the dominant trees still had ample room.

(ix) *Underplanting.*

E. X.—In the North Toungoo Division the experiments with underplanting teak plantations with (*Cephalostachyum pergracile*) have given good results where transplanting was carried out. This will be continued in other districts.

(xi) *Miscellaneous.*

In the Sitkwin Reserve, Tharrawaddy Division, a plot was laid out in April 1927 in *Xylia dolabriformis* plantation of 1921 (6' x 6') to ascertain

whether the extra rapid growth is responsible for the curious splitting of the bark. One half of the plot was thinned, 104 stems left standing were measured by diameter and the stems which had split noted. The other half was done in similar manner *without thinning* (197 trees). Both halves were remeasured by diameter and fresh splits recorded in January 1929.

The following figures tend to confirm the general belief that the splitting is caused by the extra rapid growth :—

Plot.	Total No. of trees.	AVERAGE DIAMETER AT BREAST HEIGHT.		Increase in two years. (Inches).	TOTAL NO. OF TREES WHICH HAVE SPLIT.		Increase per cent.
		April 1927 when A was thinned. (Inches)	January 1929. (Inches)		April 1927.	January 1929.	
39 A thinned	104	2.8	4.0	1.2	39	90	131
39 B unthinned	197	2.6	3.2	0.6	94	110	17

II.—WORKING PLANS AND STATISTICS.

(a) *Preparation and Control of Regular Working Plans.*

(i) *Preparation and Revision (Form 11).*

Field Work and Area.

Five parties were employed during the season.

In all an area of 785 sq. miles was stockmapped and enumerated, of which 26 per cent and over of 515 sq. miles, 22 per cent of 107 sq. miles and 20 per cent of 163 sq. miles were enumerated. In addition an area of 356 sq. miles was examined and stockmapped only. Of the area stockmapped and enumerated, compartment boundaries were completely demarcated or old boundaries repaired on 372 square miles and skeleton boundaries, consisting of all compartment junction posts with a short line of blazing near each post, were laid out over 413 square miles.

The average area covered by a party working for the full season and doing over 25 per cent enumeration was 172 square miles which is considered satisfactory.

Cost.—The average cost per sq. mile, exclusive of pay and allowances of establishment and stores, for the area stockmapped and enumerated was Rs. 70. This shows a considerable reduction on previous costs.

Staff.—Of the five officers in charge of parties, three had experience in charge of a division but no previous working plans experience and two had one or more season's working plans experience but no experience in charge of a division. Three of the officers in charge of parties had five years service and over and the remaining two had three and four years

service respectively. It is probable that in future it will usually be possible to obtain officers for the charge of parties who have had experience in charge of a division.

Five Probationary Extra Assistant Conservators of Forests were posted to parties as assistants. None of them had any previous working plans experience. Five University Forestry Students and eight Probationary Deputy Rangers were also attached for training. All the assistant working plans officers were reported to have done well and the posting of Forestry Students and Probationary Deputy Rangers to this Circle for training has now become the regular procedure.

Compilation.

During the year under report new plans for an area of 995 sq. miles and revised plans for 376 sq. miles were sanctioned as against plans for 1,677 sq. miles in 1927-28.

Plans for three divisions with an area of 1,214 sq. miles of original work and 785 sq. miles of revision have been approved of by the Chief Conservator of Forests. One of these plans is now under submission to the Local Government for sanction.

The Bassein Working Plan comprising 722 sq. miles of original work was approved of by the Chief Conservator of Forests after the close of the year.

The position of working plans at the close of the year 1928-29 as compared with that at the close of the year 1920-21 when the Working Plans Circle was first formed is shown below. For the purpose of comparison the figures for the Federated Shan States are included.

	Sq. miles 1920-21.	Sq. miles 1928-29.
Area under sanctioned plans	10,855	20,073
Area for which plans are under preparation	328	6,325
Area for which plans are required	8,236	1,259
TOTAL	19,419	27,657

From the above it will be seen that the area brought under sanctioned plans during the period 1920-21 to 1928-29 is 9,218 sq. miles, an average of 1,024 sq. miles per year. It must, however, be understood that the area includes certain areas put under "Paper" plans pending examination by a working plans party and the whole of the area shown as under sanctioned plans or for which plans are under preparation has not been fully examined with field work.

The following shows approximately the work done or in hand at the close of the year since the formation of the Working Plans Circle in 1920-21.

Plans based mainly on field work.

	Sq. miles.
Original	7,585
Revision	4,510

Paper Plans.

	Sq. miles.
Original	5,140
Revision	2,045
TOTAL	19,280

The total area under examination during the year was as follows:—

	Sq. miles.
Revision	2,903
Original	4,847
TOTAL	7,750

(ii) Yield Tables.

No proper yield tables were worked out owing to lack of material.

The following new plots were formed during the year:—

S. II. Volume increment per acre	Teak	29
S. III. " " " "	Others	8
S. IV. Diameter increment	Others	4
TOTAL	..	41

The following plots were remeasured:—

S. II. Volume increment per acre	Teak	64
S. III. " " " "	Others	7
S. IV. Diameter increment	Others	15
TOTAL	..	86

The remeasurements are now up to date.

(iv) Girth or Diameter Increment.

Plots 1, 2, 4 and 5 Mosit Reserve, Kaukkwe Division, have been remeasured at an interval of five years and figures by girth were worked up over a period of nineteen years. The rate of diameter increment has only been calculated for the last five years since they were taken over by this Division.

NOTE.—Figures may be seen in the printed Burma Report on Working Plans and Silviculture.

CENTRAL PROVINCES.

I.—EXPERIMENTAL SILVICULTURE.

Seed years.—A record has been compiled from reports of divisional officers of the seeding of all important species.

Teak.(i) *Natural regeneration.*

It is proved that once regeneration is established, fire protection, protection from grazing and removal of the canopy will provide the necessary conditions for its further growth. For inducing new regeneration, results obtained confirm the opinion that light burning is favourable to the teak, and that the canopy should be opened somewhat but not enough to permit rank grass growth, controlled grazing being perhaps permitted with the same idea. Coppice regeneration was considerably damaged by severe frost.

(ii) *Artificial Regeneration.*

Taungya operations are progressing well in Yeotmal Division, with cultivation for 7 years on a yearly land assessment of Re. 1 to Rs. 3, tree sowings being in lines 15' apart. It is found that *kunda* grass where it occurs can only be got rid of by cross ploughing. *Taungya* work in Hoshangabad was extended from 10 acres last year to 50 acres this year with good results.

(iii) *Experimental.*

Clear-felling of mixed forest with a certain proportion of teak has resulted in a promising stock of teak saplings and seedlings (North Chanda Plot 1). Methods of raising teak in South Chanda Division were investigated with a view to the possible introduction of *taungya*, with fairly satisfactory results.

(iv) *Statistical.*

Eighteen Sample Plots for crop increment were remeasured during the year and one new one was laid out.

(v) *Nursery work.*

Experiments were tried for accelerating the germination of teak seed and the best method was found to be to spread the teak seed on a well drained bed of sand and gravel built up over a layer of twigs, to cover it with $\frac{1}{2}$ " of manure and soil, and water profusely on alternate evenings.

Shorea robusta.(i) *Natural regeneration.*

The year was unfavourable as there was a long spell of dry weather early in the rainy season, followed by severe frost in the cold weather. In South Raipur, entire removal of the cover over a large area gave excellent results. In Balaghat it was observed that the *chir* pine (*Pinus longifolia*) did not protect the sal regeneration growing under and among it from frost damage.

(ii) *Artificial regeneration.*

Line sowings in Akola Division were a complete failure.

(iii) *Experimental.*

Trema orientalis now appears unlikely to make a good nurse for unestablished sal regeneration as it is itself not very hardy and casts too dense a shade.

(iv) *Statistical.*

Twenty-nine Sample Plots were measured in South Raipur and further data were collected for volume tables to be prepared.

Acacia arabica.—Artificial regeneration of *babul* was carried out under agri-silvicultural operations in Akola, Amraoti and Buldana Divisions. Germination was perfect in almost all the cases, the seedlings attaining an average height of about 10" in Buldana and 18" in Akola. The general percentage of survival was 60 to 80 per cent. For want of suitable cultivators no further progress could be made with the artificial regeneration of *babul* under agri-silvicultural operations in North Chanda. The existing plantations were doing well.

Hardwickia binata.—Contrasting results were obtained from sowings in two localities in Buldana Division, on ploughed II class black cotton soil; the one sowing at the end of the following May—a carpet of seedling averaging 3" high, and the other proving a complete failure; the only reason suggested is difference in percentage of sub-soil moisture.

Pterocarpus Marsupium.—Artificial regeneration in Akola Division was a failure. Two temporary sample plots were measured.

Ougenia dalbergioides.—One sample plot was measured.

Gmelina arborea.—This species is continuing to give eminently satisfactory results in the *Acacia arabica* areas of Buldana and Amraoti Divisions. An area of about 50 acres was sown in Coupe No. 13, Bhongaon Felling Series (Buldana), by way of blank filling. The germination was cent per cent and the seedlings attained an average height of 2 feet at the end of the growing season. A remarkable feature was that no signs of browsing were noticed in the Bhongaon reserve (Buldana) during the year, though the areas were subject to the ravages of wild

cattle as usual. The results of sowings of this species during the year under report, as well as the previous years, have established the fact that it can be confidently relied upon to stock areas where *babul* has failed owing to the borer. The average height of the trees from the sowings of 1925-26 in the Experimental Plot was 18 feet and the average girth 10" at 4½'. This species has also done well in the small plot in Amraoti Division. The average height growth is 15' to 20' after 4 years.

Zizyphus xylopyra.—Efforts at artificial regeneration have failed so far, germination is good but the seedlings die soon after the rains.

Prosopis juliflora.—In Experimental Plot 1, Buldana Division, plants have only reached a height of 3' in 4 years.

Albizia Lebbek.—Experiments are being continued in the Berar *Acacia arabica* areas; germination is satisfactory but subsequent growth very slow.

Bombax malabaricum.—Experiments are being initiated preliminary to raising plantations for matchwood.

Dendrocalamus strictus.—Sporadic flowering and seeding of bamboos is reported from some divisions.

Young natural regeneration in dense patches was noticed in many parts of South Mandla Division. Damage to young regeneration by grazing was noticed in some of the isolated blocks of Jagmandal and Motinala Ranges. Damage by fire to the young bamboos was observed more commonly.

As a result of gregarious seeding in 1922 bamboo regeneration is abundant in Seoni Division. On better soils bamboos of marketable size are already appearing. Regeneration is also satisfactory in South Chanda, North Mandla, Jubbulpore-Narsinghpur and Garhakota block of Saugor Division. The Divisional Forest Officer, North Chanda, draws attention to the occurrence of absolutely solid bamboos in the hilly portions of Mul Range.

Systematic sowing and planting of bamboos are part of the normal routine in Akola and Yeotmal Divisions, and a beginning has been made in Buldana.

Twelve acres in closed coupes were planted up in Akola Division with plants from nurseries with 50 per cent. success, whereas sowings over 50 acres with ploughed lines failed completely. Cuttings were put out over 28 acres with about 35 per cent success. Damage by pig was general.

Thinnings.—Thinnings have been done in almost all divisions, and several Divisional Forest Officers remark upon the excellent results of past thinnings which are already evident. In Akola an area of 417 acres of *babul* (*Acacia arabica*) coupes was thinned at a cost of Rs. 573, i.e., about Rs. 1-6 per acre. The outturn derived from this operation was 17,950 cubic feet of fuel and 13 cartloads of thorns, out of which 8,275 cubic feet of fuel and 10 cartloads of thorns were sold for

Rs. 1,229 and Rs. 10, respectively. It will be seen from the above that the outturn per acre comes to 43 cubic feet of fuel.

Cleanings, etc.—In North Chanda eminently satisfactory results were obtained by removing bamboo suppressing young teak and cutting back the teak regeneration.

(xi) *Miscellaneous.*

Creepers.—*Bauhinia Vahlia* is giving much trouble in Chhindwara and Betul. Experiments are in progress for dealing with the dense growth of *Nyctanthes* in Nimar Division.

Fire.—The results of the system of fire protection are not yet fully established, the indications being that a combination of protection and early burning will prove advisable.

Grazing.—From several divisions overgrazing is reported to be resulting in the disappearance of fodder grasses over large tracts and the cattle then browse on the tree regeneration.

Frost.—An exceptionally severe frost occurred over the major part of the province killing poles up to 12' high in South Mandla where *Salix tetrasperma* is recorded as the only species unaffected, *Cedrela Toona* proving the next hardiest.

General.—Interesting additions were made to the photo collection. The Silviculturist now acts as distributing agent for forest seed to divisions.

The campaign against lantana was continued in the Melghat, Hoshangabad, Betul and Amraoti Divisions. The Melghat has now become so thoroughly infested that clearance by existing methods is hardly an economic proposition. In Hoshangabad all lantana found outside the Mankideo area in Bori was uprooted. The patch at the junction of the Sonbhadra and Denwa rivers where lantana was uprooted last year was inspected. No new shoots or seedlings have been noticed this year. Lantana is spreading rapidly in the civil station of Betul where experiments are being tried with the "Atlas" plant killer.

The following facts as regards lantana may be considered as established from experience in this province:—

- (a) It is fire-resistant and fire definitely opens up areas and renders them suitable for colonisation by lantana. Any lantana shrub that is burnt back one year shoots up the following year with renewed vigour.
- (b) To clear an area effectively of lantana by present methods it is necessary to uproot and burn all shrubs three years in succession. Even then when there are adjacent areas from which the seed can again easily come in, the probability is that lantana will again have established itself as thickly as ever in a further period of three to four years.

- (c) Frost as indicated by the after-effects of the intense cold of December 1926 and January, February 1929 in the Melghat, weakens the shrub cutting it back to the ground. It usually prevents flowering and fruiting until the middle of the following rains.
- (d) It is a definite light-demander remaining stunted or altogether disappearing in dense shade. Vigorous bamboo growth can conquer lantana.
- (e) Although it is reckoned as a soil-improver the fact that its roots tap the same soil-layers as the teak renders it wholly unsuitable as a ground cover in teak forest.

II.—WORKING PLANS AND STATISTICS.

(a) Alterations to existing schemes and working plans.

Amendments to bring working plans up to date were issued for the Akola, Bilaspur, Buldana, Damoh, Melghat, Nagpur-Wardha, Nimar, Saugor, South Raipur (mixed forests) and Yeotmal Divisions. The working schemes of Amraoti, North Mandla and the Khanna Sal Forests of South Mandla were amended. Many of these amendments were necessitated by the Chief Conservator's orders raising the felling cycle of bamboos from 3 to 4 years.

(b) New Working Schemes.

Betul.—The formal sanction of the Local Government to the introduction of this working scheme with retrospective effect from the 1st July 1927 was accorded in October 1928.

(c) New Working Plans.

North Chanda.—The final sanction of Government to the introduction of this plan with effect from the 1st July 1927 having been received in November 1928 the plan was sent to the press for printing. Six of the eight 1" traces accompanying the plan have been received back from Map Office and have been issued.

Hoshangabad.—Certain changes in the prescriptions of the draft plan have been ordered. The plan has been introduced with effect from the 1st July 1928 and it is anticipated that the final draft of the plan will shortly be sanctioned.

North Raipur.—The position as regards this plan is as described above under Hoshangabad.

Seoni.—This working plan was returned for certain corrections after the close of the year. It is intended to introduce the plan with effect from the 1st July 1929.

Jubbulpore-Narsinghpur.—The Special Revenue Officer's enquiry was held in the course of the year and his report was received in June

1929. Certain changes in the prescriptions of the plan were ordered after the close of the year. It is intended to introduce the provisions of the plan with effect from the 1st July 1929.

Chhindwara.—The working plan was received back for correction shortly after the close of the year. The Special Revenue Officer's report was received at the end of April 1929. Preparations have been made to introduce this plan with effect from the 1st July 1929.

Allapilli and Pedigundam, South Chanda.—Field work was completed shortly after the close of the year and the plan will be drafted in the rains.

Bhandara.—A preliminary working plan report was submitted in the course of the year. Stock-mapping was completed in May 1929.

Nimar.—Stock-mapping was in progress from November until the break of the rains no less than three parties being at one time employed. It is probable that field work will be completed by December 1929. In view of the large size of this division and its importance, it is intended to frame the prescriptions of this plan after a more careful study of the forests than has been possible in some of the other recently compiled plans.

MADRAS.

I.—EXPERIMENTAL SILVICULTURE.

(i) General.

(a) Teak.

(i) *Effect of soil aeration*.—Interesting results were obtained from an experiment carried out on an area in Nilambur over which a plantation of 1851 had been felled in 1926 and which had been used as a depot site in 1927. The plot (63) was planted with teak spaced 6' x 6' in June 1928, and given a deep soil working between the plants in September and again at the end of October at a cost of Rs. 26 per acre. Surprisingly good growth resulted, and the plantation presented a very healthy appearance in June 1929, with many plants 12' high. A third soil working on a few plants in February 1929 indicated that the possibilities were still unexhausted. This may prove important, remembering that it was a second rotation of teak introduced without a burn.

(ii) *Effect of weeds*.—Experiments were tried at Nilambur (Plot 67) sowing *Tephrosia candida* and *Centrosoma pubescens* between the teak lines. The results do not appear to indicate that these species are preferable to weeds.

(iii) *Unsoundness in teak plants raised from stumps*.—A limited number of plants up to 6½ years old in various localities were dug up and examined with rather inconclusive results, though there were indications that unsoundness is more likely to develop in the wetter districts, where it is not usually necessary to use stumps.

(b) *Dalbergia latifolia*.

Rosewood.—It has been found that side shade is definitely helpful to this species in its earlier stages, provided adequate weeding is done while the seedlings are still small, and the plants have their leads free all the time.

(c) *Pterocarpus Marsupium*.

The seed may lie dormant for some weeks or months, even during the rains, before germinating. The species is exceptionally tolerant of weed competition and weed growth protects it from browsers and insects.

(d) *Acrocarpus fraxinifolius*.

Transplanting one year old seedlings from the nursery to Plot 61 in Nilambur was a failure. Stumps in Palghat (Plot 43) gave about 50 per cent. survivals after 8 months.

(e) *Mesua ferrea*.

Seedlings from seed collected in Tinnevely and the Silent Valley are of quite different colours. The seed will not keep more than 6 weeks and it is essential to have the nursery out in the open. In the forest also, only seedlings in gaps develop at all well, those under shade stagnating, particularly if the shade is at all dense. Good results have been obtained in Nilambur where 6 months' old *Mesua* was planted out under open 73 years old teak.

(f) *Sandal*.

Notching of germinating seed kept in dumps and watered offers prospects of success.

(g) *Pterocarpus santalinus*.

The Divisional Forest Officer, Chittoor, obtained 66 per cent. success with cuttings of different sizes.

(h) *Strobilanthes*.

Experiments for control of this weed at Top Slip (Anamalai Hills) have shewn that complete uprooting is effective, whereas cutting back has given little result.

(i) *Improvement of poor coppice*.

Satisfactory results have been obtained in Experimental Plot 50, North Coimbatore, with sowings made in July and September on patches after burning heaps of brushwood and working the soil. *Albizia Lebbeck*,

A. odoratissima, *Pterocarpus Marsupium* and *Schleichera trijuga* have done well, and escaped browsing where protected by weed growth, which does not greatly harm them. The method may be useful in dry hot forests with scanty rainfall.

(ii) *Natural Regeneration*.

Plot 41 (Palghat), laid out in 1924 to see whether natural regeneration of evergreen species could be improved before exploitation, has shewn that hoeing of the soil is of no assistance. The development of natural *Mesua* seedlings is being studied as noted above.

(iii) *Seeds*.

Sandal seed stored for a year in three different ways all proved incapable of germination, but earlier experiments (N. Salem, 1924) have shewn that under the right conditions, 2 years' storage is quite possible. *Acrocarpus* seed only gave 1 per cent. germination after a year's storage. The number of seeds per ounce was recorded for 5 species as below :—

Serial No.	Species.	Seeds per Ounce.	Remarks.
1	<i>Lagerstroemia lanceolata</i> . . .	120	Fruit.
2	<i>Swietenia macrophylla</i> . . .	54	Seed with wing.
3	<i>Artocarpus integrifolia</i> . . .	3	
4	<i>Azadirachta indica</i> . . .	270	After removal of fruit, skin and pulp.
5	<i>Acrocarpus fraxinifolius</i> . . .	320	Seed after removal from pod.

(iv) *Nursery*.

The Nilambur nursery was maintained and a larger one was prepared at Dhoni. A special study was made at Nilambur of the importance of the origin of teak seed used in artificial regeneration work, and this formed the subject of a paper read before the Silvicultural Conference at Dehra. Evidence showed that local natural forest seed is best, particularly if it is sown after soaking in water, in sunk beds. Seed from selected trees in the plantations similarly treated, gave however, results but little inferior. Seed imported from Mount Stuart took longer to get under weigh, and so gave poorer final results. Results with seed from selected and random plantation trees were not markedly different. The seedlings were planted out in the forest and formed the subject of the soil aeration experiments reported above: such differences as existed between the sets of different origin are being rapidly eliminated.

(v) Artificial Regeneration.

Calophyllum tomentosum.—Experiments initiated in 1924, shew that dibbling is a failure and patch sowing is very unsatisfactory, whereas pit planting has given upto 56 per cent. success.

Mesua ferrea.—Parallel experiments have given 76 per cent. success with pit planting and 25 per cent. for patch sowing, and a failure with dibbling.

Hopea parviflora.—In Nilambur Plots 13 and 14, *Hopea* pit plantings made in August 1924, shew 79 per cent. survivals (after repeated replacements of casualties in the first 2 years) as compared with 70 per cent. for plants put out without special soil preparation. Direct sowings on the same 2 methods now show 84 per cent. survivals in both cases. Planting out in bamboo tubes was not very successful or economical.

The previous conclusion that older transplants are preferable to small ones is further confirmed, the per cent. survivals in the 3rd year being 5, 49 and 73, respectively, for 6 weeks, one year and two years transplants.

Acrocarpus.—Nilambur Plots 60 and 61. Dibbling seed and planting out one year old seedlings again failed.

Hardwickia pinnata.—Pit planting 6' x 6' shews 50 per cent. success after 3 years with casualties twice replaced, but average height is only 14" and the species is not of much promise in the deciduous forests of Nilambur.

(ix) Underplanting.

Hydnocarpus Wightiana continues to give satisfactory survival per cent. from dibbling (62 per cent.) and planting (74 per cent.) at Nilambur (Plots 28, 37).

Swietenia macrophylla is also proving satisfactory at Nilambur (Plots 29, 38, 39) with 60-80 per cent. survivals and height upto 9' after four seasons.

Hardwickia pinnata, planted out in 1926, when 4" high, under teak of 1854, now shows 71 per cent. survival (Plot 40).

Pericopsis Mooniana planted out in 1927 in the same plantation has not proved successful, Plot 56, nor has direct sowing under 6-year old teak.

Filicium decipiens planted out in the same area suffered many casualties in the hot weather and was not a success (Plot 57). Direct sowings failed (Plot 66).

Carallia integerrima; sowings at stake show 50 per cent. patches stocked, but the plants are weak.

Cedrela Toona sown at stake gave good germination but drip and excessive weeding killed most of the plants (Plot 69).

Vateria indica similarly sown, 3 or 4 fruits per stake, in June 1928 shews plants at 82 per cent. of the stakes, up to 21" high, in June 1929 (Plot 70).

Calophyllum Wightianum sowings failed, germination being very poor (Plot 65).

(xi) Miscellaneous.

Stump planting.—Stump planting with 5 species was tried in Nilambur Plot 71, in July 1928. Stumps were cut with 1" stem and 6" root, and were planted in heavy loam soil in holes made with a pick axe. The following survivals were recorded in March 1929, that with *Artocarpus hirsuta* being important, as sowing and transplanting it have proved very difficult :—

Date of planting.	Species.	Age of plants.	No. of stumps planted.	Survivals in March 1929.	Percentage of survivals.
		Years.			Per cent.
13th July 1928 . .	<i>Hopea</i>	3	145	73	50
Do.	Do.	2	142	40	28
Do.	Do.	1	142	44	30
14th July 1928 . .	<i>Artocarpus hirsuta</i> . .	3	139	125	90
Do.	Do.	1	139	81	58
Do.	<i>Dalbergia latifolia</i> . .	2	142	104	73
Do.	Do.	1	142	99	70
11th August 1928 .	<i>Lagerstroemia lanceolata</i> .	3	252	212	84
Do.	<i>Mangifera indica</i> . . .	3	40	24	60

Bamboo.—The 10-year old investigation with *Dendrocalamus strictus* in Vellore Division has given the following results :—

Method.	Cycle years.	Average annual yield of culms.	Health of clumps.	Remarks.
Felling all mature culms	2	1½	Many died.	
Do.	3	2	Few died .	Better culms.
Do.	4	1½	Many died.	Not recommended.
Felling 50 per cent. of mature culms on one side of clump.	2	2½	Good .	Little damage done.
Do.	3	2½	Do.	
Do.	4	2½	Do.	
Felling 50 per cent. mature culms evenly distributed over the clump.	2	3	Do.	
Do.	4	2½	Do.	

It was also found that with a 2-year rotation, the individual culm lives for a period varying from 4 to 12 years; with a 3-year rotation the culms tended to die earlier and rather more so with a 4-year rotation.

II.—WORKING PLANS AND STATISTICS.

(iii) Volume Tables.

Based on 900 trees felled in the conversion working circle, new Amarampalam Range, Nilambur, the following volume table for *Terminalia paniculata* was compiled by the logging branch :—

Girth at breast height.	MERCHANTABLE LENGTH FOR DOLE IN FEET.									
	Volumes in c. ft.									
	10	15	20	25	30	35	40	45	50	55
4' to 4'—11"	16	22	27	32	36	40	46	..	..	..
5' to 5'—11"	24	30	35	40	45	49	55	..	..	..
6' to 6'—11"	32	39	44	48	52	58	66	73	77	79
7' to 7'—11"	37	45	51	56	60	66	76	83	87	93
8' to 8'—11"	42	51	59	67	73	78	90	95	99	102
9' to 9'—11"	..	59	71	83	91	97	104	110	115	118
10' to 10'—11"	..	71	86	99	106	110	116	123	128	132
11' to 11'—11"	..	84	100	111	116	120	126	131	135	139
12' to 12'—11"	..	..	112	121	126	130	135	139	143	147
13' to 13'—11"	..	..	121	129	135	140	144	148	152	154
14' to 14'—11"	..	..	127	136	143	148	152	157	161	165

NOTE.—Only volumes in classes outlined between 7' and 12' girth inclusive and 20' and 40' height inclusive are based upon a sufficient number of trees to be really dependable. Volumes of other classes are based on only a few trees and obtained mainly by graphic interpolation and extension.

PUNJAB.

I.—EXPERIMENTAL SILVICULTURE.

(i) General.

The Forest Research Institute Sample Plots in the Eastern Circle are reported to be in a satisfactory condition generally. In Hoshiarpur the *chil* (*Pinus longifolia*) Sample Plots were inspected by an assistant from the Research Institute who found discrepancies in the numbers of trees in the Kharal Plot.

In Lower Bashahr the coppice and pollard experiment with *rheons* (*Cotoneaster bacillaris*) was continued with a view to demonstrate to villagers, who make walking sticks for sale in Simla, the large number of straight sticks which can be obtained by proper treatment. The results from both coppiced and pollarded stools are satisfactory.

In Hoshiarpur the 2 Sample Plots laid out to find the most suitable rotation for bamboos were maintained. The time has not yet come to report final conclusions, but from observations, recorded to date, it appears that the bamboos begin to show signs of dryness between the 5th and 7th year.

(iii) Seeds.

In Upper Bashahr *neoza* (*Pinus Gerardiana*) cones were collected from representative forests within the zone of this tree in order to ascertain the output of edible seed. The results are as follows :—

Place.	Situation in Sutlej Valley.	Elevation above Sea Level.	No. of seed per cone.	No. of seed per lb.	No. of cones counted.
		Feet.			
Punang	Left bank near Sholtu bridge	5,800	48	1,280	100
Shoang	5 miles up Baspa from its junction with Sutlej.	6,800	42	1,200	100
Urni	Right bank between Sholtu and Chini.	7,800	37	1,178	50
Chini	Right bank	6,000	62	1,547	100
	Do. . . .	8,000	61	1,547	100
	Do. . . .	10,000	55	1,547	100
Pangl	Right bank 7 miles beyond Chini.	8,500	34	1,536	50
Kanam	Right bank 34 miles beyond Chini.	8,000	57	1,423	50
Jangl	Right bank 23 miles beyond Chini.	7,500	70	1,365	50
Poarl	Left bank opposite Chini .	6,500	76	1,025	97
Purbani	Left bank opposite Pangl .	7,200	70	1,015	89
Rispa	Left bank opposite Jangl .	6,700	72	1,097	94
	Average		57	1,267	

Figures by girth classes for 300 cones, Chini Forest.

4 feet girth	65 seed per cone.
5 " "	64 " "
6 " "	51 " "
7 " "	59 " "
8 " "	59 " "

(iv) Nursery Work.

The nursery sowings of *Abies pectinata* and *Larix europaea* made in Kulu Division entirely failed, while sowing of the latter species in Lower Bashahr had shown no results at the end of the year.

Some difficulty is being experienced in establishing nurseries of the Indian spruce and silver fir (*Picea Morinda* and *Abies Pindrow*); and the problem is about to receive careful attention.

Seed of *Quebracho Colorado* received from the Director, Royal Botanic Gardens, Kew, and sown in the Rawalpindi Division in December and February failed to germinate.

(v) Artificial Regeneration.

No definite results can yet be reported in regard to the artificial stocking of silver fir and spruce forests; but this important subject is

receiving such attention as the multifarious duties of forest officers allow. Investigations into various methods of sowing and planting *kail* (*Pinus excelsa*) and *chil* (*Pinus longifolia*) are also in progress but nothing of definite general interest can yet be reported.

(vii) *Thinnings and Cleanings.*

In Lower Bashahr sample plots have been laid out with a view to study the intensity of thinnings required in *kail* (*Pinus excelsa*) crops; the Divisional Forest Officer advances the opinion that it is unnecessary to thin healthy crops of this tree as such crops appear to thin themselves naturally, the dominating poles usually finding a proper espacement, while the dominated and suppressed poles seem to clean the boles of the dominating poles.

II.—WORKING PLANS AND STATISTICS.

In Hoshiarpur, Lower Bashahr and Upper Bashahr the divisional staffs made some progress in the collection of data for the compilation of local Volume Tables for *chil* (*Pinus longifolia*), *kail* (*Pinus excelsa*) and *deodar* (*Cedrus Deodara*). In the first named division 200 *chil* trees in Hamirpur Range were felled and measured only to see how far the standard volumes adopted in the current working plan for the Kangra and Hoshiarpur Divisions were accurate; it was found that the volumes adopted in the working plan approximated closely to actual volumes of trees in the Hamirpur Range.

UNITED PROVINCES.

I.—EXPERIMENTAL SILVICULTURE.

(i) *General.*

The reorganization of experimental research commenced last year and recorded in last year's Research Report was continued and expanded during the year. At the Silvicultural Conference held at Dehra Dun in March, 1929, a resolution was passed standardising methods of research in experimental silviculture, and a code similar to the present Statistical Code is being written up at Dehra Dun. Meanwhile the recommendations of the Conference are being adopted as far as possible, and standard forms will in future be used in the experimental files both of the Research Branch and in the divisions. The total number of sanctioned silvicultural experiments in the province now amount to 117, i.e., 66 by the Silviculturist and 51 by the Divisional Forest Officers.

The chief lines of research and experiment continue to be :—

- (1) The natural and artificial regeneration of sal forests.
- (2) The natural and artificial regeneration of the miscellaneous submontane forests.
- (3) Research in afforestation of grass blanks and various types of waste land in the plains districts.

(ii) *Natural Regeneration.*

Sal (*Shorea robusta*)—(a) *From seed.*—Experiments on the resistance of sal seedlings to fire were concluded by the Silviculturist and the results have been written up and are being published in Bulletin No. 2 of the United Provinces series. The main result of practical importance is that continuous annual burning even in localities best suited for the development of sal is likely to impede rather than expedite the sal regeneration by killing a very large percentage of the younger seedlings that appear after a good seedling year. The corollary is that young seedlings following a good seedling year should be fire-protected for at least two or three years. A number of experiments have been and are being laid out throughout the province to test the effect of deer-browsing on sal seedling regeneration. The experiments already started have not yet had time to give conclusive results, but the evidence obtained that deer-browsing is a serious adverse factor in sal regeneration justifies large scale deer-proof fences, and during the coming year it is proposed to spend Rs. 12,000 on protecting sal regeneration areas against deer. These large scale fences have been, or will be, erected in six or seven divisions, and it is hoped that within two or three years they will afford convincing proof whether deer protection is necessary or not.

Sal (*Shorea robusta*)—(b) *From coppice.*—Two important large scale experiments have been started in the Pilibhit and the South Kheri Divisions to test the effect of winter irrigation as a protection from frost. There are in these two divisions 30,000 to 40,000 acres of sal coppice, which is cut back to ground level annually or every second year by frost. With the opening of the Sarda Canal, it is now possible to irrigate large areas of these frost-bitten areas. Irrigation channels have been dug and experiments will be attempted next winter.

Controlled burning in Sal forests.—In an experimental area of 25 acres, which has been burnt annually in March for the last eight years, no sal regeneration has become established. This negative result combined with the experiment mentioned above and with general observations on other areas which have been burnt annually for sometime, have led to the general opinion that controlled departmental burning in sal forests can easily be overdone. More especially, after a good seedling year, it will be advisable to protect sal forests showing numerous young seedlings.

Hill forests.—The Silviculturist laid out some experimental areas for testing the coppicing powers of hill oaks, with a view to showing to what extent coppice working circles could in future working plans replace the existing selection working circles.

(iii) *Seeds.*

The General Seed Store under the Silviculturist at Clutterbuckganj has been working very well. The store distributes teak seed obtained

from Burma to different Divisional Forest Officers, and also maintains limited supplies of other seeds for distribution both to Divisional Forest Officers and to private concerns. As mentioned in last year's report our difficulties with germination of teak seed appear to be definitely and satisfactorily solved.

(iv) Nursery Work.

Greater attention is now being paid throughout the province to nurseries, and several of the best managed nurseries have reached a high standard. In the Silviculturist's garden the plant percent of the following species was determined :—

1. <i>Pinus longifolia</i> (Chakrata)	16
2. <i>Acacia arabica</i>	62
3. <i>Terminalia tomentosa</i>	29
4. <i>Butea frondosa</i>	80
5. <i>Treulia nudiflora</i>	5
6. <i>Holoptelea integrifolia</i>	26
7. <i>Stereospermum suaveolens</i>	6
8. <i>Mallotus philippinensis</i>	8

(v) Artificial Regeneration.

Deodar (*Cedrus Deodara*).—An interesting experiment was carried out in the deodar forests of Chakrata by planting out flourishing plants one year and eight months old, instead of at the normal age of two years and eight months, which promise to be very successful, and the Divisional Forest Officer records his opinion that by careful attention to nursery work it will be possible to save one year in nursery beds before the plants are put out in the forests.

Sal (*Shorea robusta*).—The Divisional Forest Officer, Gorakhpur, carried out an interesting experiment in his *taungya* plantation. There was very little sal seed available and it was all blown down in a big storm on the 4th of June, 1928. The storm was accompanied by sufficient rain to moisten the ground thoroughly. The Divisional Forest Officer collected all available seed and sowed it in the prepared beds two to three inches deep. The storm was followed by a complete break of four weeks, which would normally have been fatal to sal seed sown on the surface, but the deep sowing enabled the seed to survive, and by this means 200 acres of *taungya* plantation were successfully sown, and at the end of the year held a good crop of well developed seedlings, the best being up to 15" in height.

Teak (*Tectona grandis*).—Several experiments were carried out by Divisional Forest Officers and the Silviculturist in putting out teak cuttings in February and March instead of at the break of the rains. The results are at present conflicting. In some areas a large percentage of these teak cuttings shot up when the rains broke. In other areas the percentage was small, but in all cases the teak cuttings lay dormant

in the hot weather, and the growth of those that survived was appreciably better than the growth from the cuttings put out in June when the rains broke.

An experiment carried out in the Ramnagar division of introducing teak in the hill forests on the Siwalik sand-stone formation gave promise of success.

Khair (*Acacia Catechu*).—In the Haldwani division the *khair* plantations at Lalkua now cover 150 acres and give every promise of complete success. This work has almost passed out of the experimental stage. In the adjoining Ramnagar division very successful plantations of *khair*, teak, and bamboo covering 88 acres, have been made, and it is hoped that this work will also soon be beyond the experimental stage. It is notable that despite a bad monsoon and partial failure of the rains, the best plants averaged 4 feet high at the end of the year. A remarkable feature of this experiment was the sudden appearance of vigorous natural *khair* seedlings as a result of the burning of the area, combined with enclosure with a deer-proof fence.

Taungya plantations.—Attempts to introduce *taungya* in Pilibhit and Lansdowne divisions did not meet with success. The Divisional Forest Officer, Lansdowne, pointed out that the main essentials for *taungya* work to succeed are :—

- (1) Local land hunger.
- (2) Reasonable climate and absence of frost.
- (3) Absence of excessive game.

And there is little use in attempting to introduce *taungya* work in areas where these three conditions do not hold.

Baib grass (*Ischaemum angustifolium*).—A small experiment carried out in the South Kheri division of grubbing out the local valueless grass and planting *baib* grass gave very promising results, the cost incurred being more than covered in the first year. This experiment of *baib* grass plantation will be expanded and tried in other areas.

(vi) Reclamation and Afforestation.

In the Afforestation division a number of important experiments have been started to try and find the best economic use for various types of waste lands that occur extensively in the plains districts. These include :—

- (1) *Usar* or salt plains. While attempts to plant trees on *usar* have not had much success, it has been found that mere protection from grazing during the rains results in a good crop of fodder grasses amounting to 2,400 pounds and even more per acre. As a result of these experiments extensive areas of *usar* are being taken up for protection during the coming year.

(2) *Bhur* or sandy wastes. The experiments started last year gave, despite the partial failure of the monsoon, distinctly promising results with shisham (*Dalbergia Sissoo*), *khair* (*Acacia Catechu*) and other species, and these experiments are being enlarged.

(3) *Khola* and *Kadir*.—Very extensive areas adjoining the Jumna and the Ganges occur in the north western districts of the province, and experiments are being started to test the possibility of their afforestation.

II.—WORKING PLANS AND STATISTICS.

(i) Working Plans.

(a) Working plans for Bahraich (282 sq. miles), Sohawal range (Gonda division) (49 sq. miles), and Kalagarh (377 sq. miles) divisions were printed, sanctioned and distributed.

(b) Working plans for the Haldwani (394 sq. miles), Chakrata (141 sq. miles), Naini Tal (190 sq. miles) divisions and Pauri Fuel Scheme (12 sq. miles) were approved by the Chief Conservator of Forests and are in the Press.

(c) The field work was completed during the year of the plan for Saharanpur division (304 sq. miles) and the draft plan was submitted after the close of the year.

(d) Working plans were under preparation at the close of the year for South Kheri (165 sq. miles) and Garhwal (257 sq. miles) divisions.

(e) Preliminary working plan report was drawn up by the Conservator of Forests, Working Plans Circle, for South Kheri division and approved by the Chief Conservator of Forests. The report for Dehra Dun division (279 sq. miles) was submitted and sanctioned after the close of the year.

(ii) Yield Tables.

The following permanent sample plots were measured during the year under report:—

Division.	Sal (<i>Shorea robusta</i>).	Sissoo (<i>Dalbergia Sissoo</i>).	Khair (<i>Acacia Catechu</i>).	Deodar (<i>Cedrus Deodara</i>).	Banj (<i>Quercus indica</i>).	Tilong (<i>Quercus dilatata</i>).	Chir pine (<i>Pinus patula</i>).	Kanj (<i>Pinus longi-integri-folia</i>).	Asna (<i>Ternstroemia tomentosa</i>).	Sand (<i>Eugenia dalbergioides</i>).	Total.
Dehra Dun . .	17	5	..	..	..	..	1	..	2	1	26
Saharanpur . .	3	2	..	..	..	..	..	..	..	..	5
Naini Tal . .	..	..	..	..	5	6	3	..	..	..	14
TOTAL . .	20	7	..	..	5	6	4	..	2	1	45

Eight permanent sample plots were abandoned—

The following new sample plots were laid out:—

Division.	Sissoo.	Khair.	Banj.	Chir pine.	Khamar (<i>Gmelina arborea</i>).	Dal- bergia lati- folia.	Lager- stroemia Flos- Reginae.	Asna.	Total.
Dehra Dun . .	..	..	..	..	..	..	..	1	1
Saharanpur . .	..	1	..	..	..	..	..	..	1
Kaunli Experimental garden . .	..	..	1	..	1	1	1	..	4
Afforestation . .	1	..	..	..	1	..	..	..	2
Naini Tal . .	..	..	3	1	..	..	..	..	4
TOTAL . .	1	1	4	1	2	1	1	1	12

That the maximum diameter of a tree seems to be disposed usually along the slope is indicated by the following figures:—

Species.	Division.	Sam- ple plot no.	Eleva- tion.	Aspect.	Slope.	LARGE DIA- METERS.		Equal Dia- meters.	Total.	REMARKS.
						No. of Dia- meters along the con- tour.	No. of Dia- meters along the slope.			
<i>Quercus in- cana</i> .	West Al- mora.	19	5,900	N. E.	30-0	9	33	6	48	Majkhali.
Do.	Do.	20	5,900	N. E. E.	22-25	19	20	2	41	Do.
Do.	Do.	21	5,900	S. E. S.	28-5	25	35	3	63	Do.
Do.	Do.	22	5,900	N. E.	30-30	15	30	4	49	Do.
Do.	Do.	23	5,900	N. W.	18-30	34	47	4	85	Do.
Do.	Do.	24	5,900	E.	34-45	10	44	..	54	Do.
Do.	Do.	26	5,900	W. S. W.	15-0	13	55	4	72	—

(v) Miscellaneous.

An investigation was carried out on *gauj* (or dry rot) in sal. The results have not yet been completely worked out. The research seems to indicate that both frost and suppression are a fruitful source of *gauj* infection.

Bulletin No. 1 of the United Provinces Research Series was published. The resistance of sal seedlings to fire is the subject matter of Bulletin No. 2 which is now in Press.

COORG.

I.—EXPERIMENTAL SILVICULTURE.

Sandal Regeneration Experiment at Meenkolli (*vide* experiment No. 1 of 1926-27).

This experiment has been reported in the Research Report for 1927-28. The observations were continued during 1928-29 and the result at the end of the year is detailed below.

There has been a fall in the percentage of stocking in all the groups of plots irrespective of the treatment in each case and in spite of the re-sowing done during the year. This is more or less typical of sandal when sown under similar conditions. In plots where lantana has been cut back there is a greater percentage of casualties noticed than in those where lantana has been uprooted. This is probably due to the young sandal being killed by suppression in the former case. The tallest plant was one of 9'-7" in plot No. 2, in May 1929.

1927 Experiment.

Plots Nos. 16, 20 and 26 have been transferred to the lantana uprooted group, which now totals 2.87 acres, the non-uprooted group now being 1.71 acres.

There has been a fall in percentage of stocking in both groups, the uprooted group now showing 23 per cent. against 25 per cent. last year, and the non-uprooted group 17 per cent. against 32 per cent. Here again suppression by lantana is probably the cause of the bigger death rate in the second group. The best stocked plot of a year ago, namely, No. 25, which then showed 1,091 plants to the acre, now has only 243. The tallest plant was 9' in plot No. 6 in May 1929.

General Conclusions.

- (i) Uprooting of lantana is better than non-uprooting.
- (ii) The best method seems to be to cut the lantana in March, burn in April or May after showers of rain have removed the danger of fire spreading, dibble the sandal between 15th and 20th May, and eradicate the lantana at any time convenient prior to the end of August.
- (iii) Eradication of lantana may let in grass, and to prevent this, and to provide hosts for the sandal, it is advisable to plant cuttings of fast growing species, such as *Ficus*, *Lithosperma*, *Jatropha*, etc.

Experience with sandal in *taungya* goes to show that equal quantities of *dhall* seeds should be dibbled with the sandal.

Sandal Taungya.

The *taungya* method of raising sandal plantations was tried in 1927 in two areas, a departmental *taungya* at Hudgur in North Coorg, and a jungle tribe *taungya* at Balecove in South Coorg.

The conclusions arrived at are :—

- (i) This method is the most successful one that has been tried in recent years.
- (ii) *Ragi* (millet) makes a very good field crop for the purpose.
- (iii) Very thorough cleaning of the ground is essential in the interest of the *ragi*, and in the interests of the sandal must include eradication of climbers as well as lantana.
- (iv) Sandal is a voracious parasite from the very first and is fully capable of killing off a series of hosts.
- (v) *Dhall* sown with the sandal in equal proportions makes an excellent first host and should always be sown. 100 per cent. germination may be expected of the *dhall*, and 25 per cent. or so only of sandal, thus giving a good proportion.
- (vi) Within the first 24 months the sandal will require additional hosts, and *Erythrina lithosperma* promises well for the purpose as it is leguminous, can be raised easily from cuttings, and will stand unlimited lopping.
- (vii) The quality of sandal seed being so variable, efficient means of testing the seed must be introduced.

Further experiment is required to study—

- (i) The most suitable host.
- (ii) The best spacing to adopt.

Experiment to restore vitality to stagnant sandal trees.

- (i) It is observed that sandal trees if blown over by the wind send up a series of shoots all along their stems.

In many of our old plantations a number of sandal trees are in a stunted and stagnant condition even though host and drainage conditions appear reasonably favourable.

It is thought that the factors of the locality may limit the height growth in some way, and that they may be induced to put on girth and root increment if they can be persuaded to grow several crowns instead of only one.

To test this theory two trees have been levered over into a horizontal position in Kargode plantation.

No conclusions can yet be drawn.

- (ii) It is observed that stagnant trees when lopped are often capable of sending out vigorous new shoots. Experiments in pollarding carried out in the past resulted in killing several of the trees, but it is thought that a lopping in the crown will avoid this risk.

Two trees have been lopped in Kargode plantation. The new leaves are much larger than the old ones, one leaf measured in June was 4½" long and 2½" broad.

Girth measurements will be taken and the appearance of the stem watched to see whether the lopping causes a return to an active state of life.

Teak propagation in South Coorg.

Conclusions drawn from observations of the past years are briefly the following :—

- (a) The burn of the rubbish must be thorough and must be evenly distributed over the whole area.
- (b) Dibbling is preferable to stump planting.
- (c) Sowing of seed must be finished by the middle of April.
- (d) Early germination of the teak is essential and to obtain this 48 hours soaking is not enough. Further treatment to accelerate germination is necessary.
- (e) Regeneration work should be accompanied by the cultivation of a crop of *ragi*.
- (f) Climber roots must be eradicated.

Transplanting Natural Rosewood Seedlings and Root-suckers.

In July 1925, owing to a failure of supply of rosewood seed, an experiment was tried in transporting natural seedlings and root-suckers from a forest 60 miles away, and at an elevation 2,000 feet higher, and planting them at Sampaji and Karike.

About 8,000 plants were put into the Karike 1925 *taungya* and about 2,000 into the Sampaji *taungya* of the same year. The plants varied in size from 4" to 2'. The larger were "stumped" before planting and the smaller ones used as they were. Success obtained was about 60 per cent. and the average height of plants in July 1929 was 9' and girth 4". Some plants are as much as 16' in height and 6" in girth. The general condition of the plants is normal.

Lac Experiment.

The experiment was continued during the year. Swarming was observed on the 16th July. Twigs containing brood lac were removed and transferred to new hosts, but unfortunately heavy rain fell immediately afterwards, and most of the insects were washed off before colonisation was effected. Those that survived during the rains are doing well. The cleaned lac collected from this brood was about 7 lbs. The experiment is still under close observation.

Teak Defoliation Experiment.

The observations in teak defoliation were continued and during the year the damage under this head in plantations and patches of natural teak was very severe, particularly in Tithimatti Range. Solitary teak in the midst of other species were singularly free.

Normally attack occurs almost entirely between October and January but this year a fairly severe attack occurred in May in Tithimatti Range.

The teak plantations of Tithimatti Range were early burnt to see whether the fire would reduce the incidence of attack, by killing off the insects whilst pupating on the ground. It will be interesting to watch the results next year.

Extermination of Reeds (Ochlandra) in Ghat Forests.

The plots which were opened during 1927-28 continued under observation during the year and the following conclusions have been drawn :—

(a) Repeated cutting and burning of cut culms over the root systems in :—

- (1) Pure reed areas.
- (2) Typical reed-infested, but timber-bearing areas.

(1) *Pure reed areas.*—The method proved entirely ineffective. The regrowth is 100 per cent. and clumps exhibit the characteristic thicket appearance with several outstanding shoots to each clump.

After one growing season the average height of the thickets is 5 feet while the individual shoots are as much as 10' to 12' high.

(2) *Typical reed-infested, but timber-bearing areas.*—Where the reed growth was heavy and the canopy open damage caused to the existing trees by the burning is very marked, trees up to 5' in girth showing signs of having been scorched, while trees in the sapling and pole stage were killed out-right.

Possibly, however, this can be controlled to a considerable degree by a more discriminate burn, the cut culms being more or less evenly scattered instead of being collected in large heaps.

Apart from this, the result of the operation on the reed is very encouraging. Under a heavy canopy (anything over about 50 per cent.) the absence of any reed regrowth is conspicuous, reed giving place to "kulangi," a herbaceous plant of the Ginger family, commonly met with as an undergrowth in deciduous forests.

In the more or less open places, where one would expect the reed clumps to show a certain amount of response, the regrowth after one growing season is by no means vigorous, the number of new shoots being limited to 5 or 6 per clump, and these are whippy and unable to support themselves.

This method has so far produced the most promising results.

(b) *Complete uprooting.*—This method of eradication is, of course the most efficient, but the cost works out to Rs. 41-4-0 per acre in a moderately reeded area and until an efficient system of supplementing natural regeneration by artificial means is evolved, such an expenditure would not be justifiable.

The plots, with the exception of the pure reed area, referred to in paragraph (a) (1), are being continued, and it is hoped during the current year (1929-30) to combine them with experiments in artificial regeneration, with a view to investigating the possibility of supplementing natural regeneration, which in reed-infested areas is generally deficient.

Propagation of Bamboos by Transplanting Nursery Seedlings.

After examining a number of nursery seedlings preparatory to transplanting it was found that the rhizomes did not start forming until after the second hot weather, i.e., in the second growing season. It therefore seemed quite safe to plant out 15-month old nursery seedlings just before they commenced their second growing season; and as we had a large stock left over the previous year, it was done. At the same time an acre of 3-month old seedlings was planted out to compare results.

The results are very interesting and indicate that it is better to use 15-month old seedlings for future *taungya* work and of these seedlings we have a sufficient quantity for next year. The following data collected support this theory:—

	Clumps from 3 months old transplants.	Clumps from 15 months old transplants.
Average height . . .	3'—4"	6'—11"
Maximum height . . .	6'—2"	12'—2"
General appearance . .	Backward and showing slow response during recent rains.	Flourishing and showing signs of quick response during recent rains.

It would also appear that 3-month old seedlings are more susceptible to damage by porcupines, the damage is most noticeable from about January to April. Apart from this, the older seedlings are sooner established and require less tending in the second year.

Experiment for the Propagation of the Larger Bamboos by Means of Cuttings.

Four hundred and fifty Burma bamboo cuttings (*Bambusa Brandisii*) and 100 cuttings of *Bambusa arundinacea* were planted out in the 1928 bamboo *taungya* at Kakethodu with a view to ascertaining if it is possible to propagate bamboos in this manner in Coorg.

Cuttings were selected from vigorous culms and prepared to a length of 3 feet to 4 feet. Planting was done so that at least 2 nodes were buried with a third (or fourth as the case may be) at ground level. Cuttings were put in at an angle of 30° with the horizontal, and the top ends trimmed flush with a node (with the partition wall intact) so that stagnation of water within the cutting was avoided.

The operation was carried out early in July, after the establishment of the South West monsoon. Aspects selected were East and South

West. An espacement of 20'×20' was adopted. Sixty per cent. of the Burma bamboo cuttings and 82 per cent. of the other sent up shoots and these were enumerated monthly with the following results:—

Date of enumeration.	No. of shoots.	
	Burma bamboo.	Bambusa arundinacea.
10th October 1928	129	67
1st November 1928	129	59
1st December 1928	124	45
1st January 1929	61	45
1st February 1929	58	27
1st March 1929	57	3
1st April 1929	57	..
1st May 1929	57	..

From the above figures it is seen that the experiment was a failure. It is not being continued.

NORTH-WEST FRONTIER PROVINCE.

I.—EXPERIMENTAL SILVICULTURE.

(i) *General.*

It was a good seed year for *chil* (*Pinus longifolia*) and bad for deodar (*Cedrus Deodara*), blue pine (*Pinus excelsa*) and fir (*Abies Pindrow*).

(ii) *Natural Regeneration.*

Chil.—The germination of the seed was good in the Siran Division and parts of the Periodic Block I area, where regeneration did not exist before, were sown up naturally.

Blue pine.—Blue pine seed from last year germinated excellently in the Siran Division, but mortality from drought was excessive. In the Thandiani Division the germination of the seed commenced in April, and continued till July, but again, as reported last year, the seedlings suffered from insect attacks, heat and drought, especially the latter and almost all the seedlings died. Experiments started last year in Thandiani to determine the method of regenerating blue pine areas were continued in 4 different plots, viz.:—

- (1) Closed to grazing, (2) open to light grazing in autumn and spring only, (3) open to light grazing in rains only and (4) open to heavy grazing. The results were disappointing. In every case the seedlings died.

Silver fir.—The germination of the seed was quite good, but many of the seedlings died owing to the drought.

Deodar.—The natural seedlings are generally prominent in the Kagan Division on the north eastern slopes and in places where grazing is not possible on account of steepness of the slope.

(iii) *Seeds*.

In the Siran Division one maund of blue pine seed was collected and sown on burnt over patches in the forest but the germination was poor on account of drought. 62 acres of the *chil* blanks in the Lower Siran Range were sown with *chil* seed.

Seeds of the following species were collected and supplied to other forest officers in India :—

	Maund	Seer.
Deodar	1	0
Chil	2	32

In addition to above 1 seer of seed of *Ephedra vulgaris* was supplied to the Agricultural Officer, North-West Frontier Province, for supply to the American Consul, Karachi. 5 lbs. of walnut and 1 lb. of *Alnus nitida* seed were supplied to the Forest Economist and the Forest Botanist Dehra Dun, respectively. Some seedlings of *Pinus longifolia* were supplied to the Deputy Commissioner, Kohat, for sowing and planting in Kohat. *Prosopis juliflora* sown in Sarrah Reserved Forest Compartment 1 in the Khanpur Division in 1927-28 was a failure.

(v) *Artificial Regeneration*.

In addition to the clearing and burning of felling refuse which is the usual practice in all the Divisions, artificial sowings were carried out in the following :—

Division.	Forest.	Kind of seed sown.	Area in acres.
Siran	Daddar 2(i)	} <i>Chil</i>	62
	Massar 10(ii)		
	Batrassi 1(ii) 2(i)		
Khanpur	Kotla 1(iii)	<i>Chil</i>	2
	Sir 4(iii)	Blue pine	38
	Do.	Horsechestnut	10
	Sir 6(ii)	Blue pine	37
	Tajwal 2(iii)	Do.	75
	Nagribala 3(i)	Do.	20
	..	Deodar and blue pine.	40

The germination of blue pine and *chil* was good, but the seedlings suffered from drought and almost all died off. Results of the 1927-28 sowings are as under :—

Deodar sowing was successful in the Kagan.

Kail sowing was a failure.

Chil sowing was moderately successful.

(vi) *Reclamation and Afforestation*.

Horsechestnut seed was dibbled in about 18 acres in various forests in the Dungagali Range of the Khanpur Division, and the results were excellent.

(vii) *Thinnings and Cleanings*.

No further cleaning in Periodic Block I area among *chil* seedlings was carried out during the year. The seedlings in the area cleaned last year (1927-28) have grown surprisingly well and their branches are again interlacing. This shows that thinning at the age of 4 or 5 years when the plants have been put in 2'×2' is inadequate. In case of fire great damage would be caused.

(xi) *Miscellaneous*.

During the year 25 acres in Bazkhan forest 1(i) containing *chil* saplings of 6-8 years old were burnt departmentally under control. The mortality was negligible but owing to density of the crop the needle-fall from the burnt-needles and branches was so heavy that, should a summer fire occur, there is danger of the crop suffering heavily. In order to avoid this the only solution lies in thinning the same boldly before firing. A 5-8-year old sapling crop in Bazkhan 1(i) thinned during the previous year to a distance of 3'×3' shows signs of congestion and will need burning departmentally during the winter to be safe from a summer fire. This leads to the conclusion that the thinnings in *chil* sapling woods of 5-8-years old should leave the stock about 4'×4'.

The Assistant Mycologist, Dehra Dun, paid a visit to the forests during the year in connection with his experiments on the "currant fungus" and its appearance on the blue pine saplings and poles. The investigation has not reached any definite stage at present.

II.—WORKING PLANS AND STATISTICS.

(i) *Working Plans*.

The revision of the Working Plan of the Kagan Forests was in progress during the year. Some progress has been made in the collection of statistical data in the Siran Division.

CHAPTER III.

BOTANY.

CENTRAL INSTITUTE.

Systematic.—Duthie's Flora, Palmeæ to Cyperaceæ, is in the press. The final proofs have been passed but have not been printed off pending a decision as to the distribution list. During the year the Gramineæ has been started and about one-quarter finished. At the present rate of progress it will be 3 years more before this family is finished, as only one, or at the most two, days a week can be devoted to it, and the work has to be closed down altogether during the lecture season. In any week in which the monthly accounts, budget estimate, revised estimate, annual report, practical examination of students, correction of herbariums, etc., come, the day which would otherwise be devoted to Duthie's Flora is no longer available.

Tours.—The Forest Botanist toured in Bashahr during May and June to obtain material to be used for exchanges with botanical establishments abroad. Nothing much of local interest was expected from this tour but one tree *Dodecadenia grandiflora*, Nees, and one shrub *Hypericum Hookerianum*, W. & A. var. *Leschenaultii*, Choisy, were found which had previously not been known to occur west of Kumaon. *Asparagus trichophyllus*, Bunge, not previously collected in India, was found in Kunawar.

Identification of Specimens.—Four hundred and seventy-seven specimens were identified during the year for forest officers and others. A considerable number of these were for the Forest Botanist, Burma. Unfortunately it has not been possible to identify all the specimens received from this source and as some had been long pending and were in danger of being destroyed by insects they were roughly referred to their genera and incorporated in the herbarium without further examination.

Herbarium.—Three thousand one hundred eight sheets were added during the year. The most important contribution was a collection of plants from Indo-China received in exchange from the University of California. Valuable contributions were received in exchange from the Arnolds Arboretum; Botanical Museum, Vienna; National Herbarium, Melbourne, and Botanic Gardens, Peradeniya.

Seed Indents.—Fifty-four indents for seed weighing in all about 1,500 lbs. were complied with during the year. As usual this does not include small samples supplied in exchange with botanical gardens in India and abroad.

Arboretum.—The collection of Coniferae, Leguminosae and one or two other families has been extended during the year and several new avenues have been planted but no further attempt at extending the arboretum has been made. During the year a part of the area used

for the Euphorbiaceæ has been built on, and telephone and electric power lines will spoil some of the trees already planted.

Fruticetum.—Five hundred and twenty-five plants belonging to 92 families have been planted. Labelling of the plants is proceeding as fast as possible with permanent labels but this has in many cases to wait till the plants flower and can be identified. There was one night of heavy frost at the end of January previous to which the winter had been very mild. This frost did unexpectedly little damage to plants known to be tender and consequently protected by grass thatch but a number of plants not usually affected by frost and left unprotected suffered severely and were in several cases killed. As usual with frost in India the damage was most irregular and difficult to explain. Two specimens of *Elæocarpus Ganitrus* Roxb. left unprotected in the fruticetum were uninjured but three of the same age in the arboretum were killed in spite of a grass shelter. *Allamanda*, *Tabernaemontana* and *Hamelia patens* in the fruticetum were killed to the ground, or completely, but the same plants in a private garden not far away were uninjured. Two large plants of *Holmskioldia sanguinea*, Retz. were killed to the ground, although this plant is indigenous and fairly common near Dehra.

Of plants making exceptionally good growth in the arboretum the following may be mentioned:—*Erythrina stricta*, Roxb. and *Terminalia myriocarpa* Heurck and Muell. Arg., which are growing far more rapidly than indigenous plants of the same genera, *Acrocarpus fraxinifolius* and *Alseodaphne Keenanii*.

Soil Organisms.—Some experiments are being made to test the effect of soil inoculation on the growth of plants. The growth of *Leucaena glauca*, Benth. in soil inoculated with bacteria from the Philippines is markedly better than in the control plot. On the other hand the growth of *Alnus nepalensis* in soil from its natural habitat is no better than that of *Alnus nitida* in local soil. The possibility that the failure of all pines other than *P. longifolia* may be due to absence of some soil organism is being tested by growing seedlings in soil taken from under pine trees.

Mycology.—Shisham root disease. The investigation is being continued and a preliminary paper is in course of preparation.

Sal thicket fungus disease has been recently taken up in the programme of research. The work is progressing. A preliminary paper on the subject is in course of preparation.

Studies on Indian Peridermiums.—(i) Further observations on the disappearance of the æcidial stage of the bark-inhabiting Peridermium on *chir* (*Pinus longifolia*) just before the monsoon and the appearance of a Cronartium on *Suertia* spp. almost simultaneously supported the possible connection of the two forms. Owing to the difficulty in germinating *Suertia* seeds under artificial conditions, which stood in the way of successful cross-inoculation studies, experiments are to be carried

out during the ensuing monsoon on naturally growing *Sweetias* under control in the forests.

The preliminary results on the investigations of *Peridermiums* on *chir* is in the press, (issued after the close of the year).

(ii) *Peridermium indicum* and *Cronartium ribicola*.—Several inoculations have been done of the two forms to establish their biological relation. The results of these, as well as of those done previously, are being awaited.

A paper on Indian *Peridermiums* has been published in the "Indian Forester" for August 1928.

(iii) Attempts to cross-inoculate *chir*-leaves with *Coleosporium Inulae* and *Coleosporium campanulae* to produce *Peridermium complanatum* having failed, *Pucciniastrum Coriariae* which occurs in abundance on the leaves of *Coriaria nepalensis* in Mussoorie in autumn will be taken up as a possible alternate stage of *Peridermium complanatum* and inoculations will be done to test their relationship.

A *Peridermium* on the leaves of *Abies Pindrow* which has been discovered lately at Hazara requires to be taken up.

Apart from the routine work which includes examination of various specimens of fungi and wood-rots received from outside, answering enquiries on pathological subjects and testing seeds for certification, detailed studies of various wood-rotting fungi have been taken up during the year as a new item of research. The list includes rots of important timber trees, e.g., *Tectona grandis*, *Pterocarpus Marsupium*, *Dalbergia Sissoo*, *Acacia arabica*, *Xylia dolabriformis*, *Shorea robusta* and several garden and avenue trees.

Teaching Work.—A course of three months (3 hours a week) in Forest Mycology and Pathology was given to the Indian Forest Service class students during the year. The syllabus consists of the study of fungi in general, ecology and life history of important species, study of the parasitic fungi with reference to epidemic diseases of forest trees, aetiology of the parasitic fungi, principles of control, specific immunity and forest hygiene.

ASSAM.

BOTANY.

Botanical specimens of the following species were collected and sent to Dehra Dun where they were identified by the Forest Botanist at the Research Institute :—

Vernacular name.	Locality.	Scientific name.
<i>Lilum Lumdung.</i>	Pasighat Reserve Sadiya Frontier Tract.	<i>Canarium Sikkimense.</i>
<i>Champa</i>	Jaipur Reserve	<i>Michelia Montana.</i>
<i>Katal Sopa</i> or <i>Assamiya</i> <i>Tilasapu.</i>	Jaipur Reserve	<i>Manglietta insignis</i> (variety).

Vernacular name.	Locality.	Scientific name.
<i>Tita Sapa</i>	Jaipur Reserve	<i>Talauma phellocarpa.</i>
<i>Gunserai</i>	Jaipur Reserve	<i>Cinnamomum - Cecidodaphne.</i>
<i>Gunserai</i>	Holongapar Reserve	<i>Cinnamomum Cecidodaphne.</i>
<i>Phulsapa</i>	Dibrugarh Range	<i>Michelia oblonga.</i>
<i>Kalarata</i>	Cachar	<i>Chisocheton paniculatus.</i>
<i>Tezia</i>	Do.	<i>Cinnamomum</i> sp. (sent to Kew by Forest Botanist for identification).
<i>Dud Chapa</i>	Do.	<i>Pseudotschubius indica.</i>
<i>Pahari Jam</i>	Do.	<i>Homelum Schlichii.</i>
<i>Rakta Rata</i>	Do.	<i>Sironniera reticulata.</i>

BURMA.

BOTANY.

Staff.—The post of Forest Botanist was held by Mr. C. W. D. Ker-mode, Assistant Conservator of Forests, till the 1st of June 1928 and thereafter till the end of the year under report by Mr. C. E. Parkinson, Assistant Conservator of Forests.

Forest Rangers Po Chin and Su Koe and Deputy Ranger Maung Ba Pe remained attached during the whole year and continued to do good work.

Maung Kan, Curator, held this post during the whole year.

The Forest Botanist took over executive charge of the Maymyo Botanic garden from the month of June 1928.

Herbarium.—During the year an addition to the office building was made to house the herbarium which is now growing in dimensions and suitable accommodation is now available for the work of the Forest Botanist and his staff. The herbarium is generally maintained in excellent condition. At the opening of the year there were 16,254 specimen sheets and the additions during the year amounted to 3,604 bringing the total up to 19,858 at its close. The additions were chiefly from the collections of the Forest Botanist and his staff. Contributions were received from the following :—Mr. R. N. Parker, Forest Botanist, Dehra Dun, specimens from Tenasserim; Mr. A. H. M. Barrington, Conservator of Forests, specimens from Lower Burma; Mr. E. A. Seaton, Deputy Conservator of Forests, specimens from the hills around Mogok at altitudes of from 4,000 to 6,000 feet.

The following specimens were distributed to other herbaria during the year :—

Dehra Dun	86
Kew	140
Calcutta	197

As in former years the Forest Botanist's time has been chiefly employed during the rains season in identifying the heavy collections of herbarium specimens made by him and his staff and in naming the specimens received from other collectors.

The building up of a suitable herbarium with a good representative collection of the plants of the province is necessary before any serious systematic work on the Flora of Burma can be undertaken. We have to rely a great deal on other large herbaria for confirming identifications and naming specimens which it is not possible to name here. Many specimens of which duplicates have been distributed for naming still await identification before they can be put into the herbarium in their proper places.

The systematic study of several of the larger Burmese genera was attempted, but the want of sufficient material was felt, and the work of collecting should therefore be continued.

The study of the Burmese species of the genera *Dipterocarpus* and *Lagerstrœmia* was undertaken during the year and it is hoped to be able to publish shortly a simple illustrated account of these. Specimens and notes of the Burmese bamboos have also been collected with the same object in view, but they present a much more difficult problem on account of the large number of species, and the very wide distribution.

A further paper dealing with the flora of Burma appeared in the "Kew Bulletin of Miscellaneous Information" during the year, in which the new species *Gymnocladus burmanicus*, Parkinson, was described and some amplified descriptions of other Burmese species were given.

An interesting note on the Vegetation of Forest Soils, by Mr. A. H. M. Barrington, Conservator of Forests, was published.

Tours.—The Forest Botanist toured during the month of November in the Katha and Myitkyina divisions and during the months of December to March in the Bassein and South Arakan divisions from Bassein to Sandoway making collections and notes. Good botanical specimens were obtained of *Kanyauing*, apparently an unnamed species of *Shorea* and a tree of some commercial possibilities, and from these it will be possible to name it soon, or to describe it, if it is an undescribed species. Special interest was also taken in the mangrove and seashore flora of the coast of Arakan and many notes and drawings of these plants were made.

Forest Ranger Maung Po Chin toured in the Salween Division, chiefly in the Yunzalin drainage, from the month of November to May and sent in some very interesting collections.

Forest Ranger Su Koe toured chiefly in the Upper Chindwin and Mansi divisions where he made good general collections.

Deputy Ranger Maung Ba Pe toured in the North Pegu and in the North and South Toungoo divisions, and in addition to other general work collected many specimens of the family *Dipterocarpaceæ*.

Timber specimen collection.—The collection of timber specimens for the Utilisation Circle was continued during the year and 231 specimen logs were collected by the Forest Botanist and collectors. It is from these specimen logs, which are linked with botanical herbarium specimens which provide the names of the timbers, that the excellent collection of Burmese timbers in the office of the Utilisation Circle has been made up. 1,100 spare blocks are with the Forest Botanist at Maymyo.

Supply of seed.—About 40 pounds of seed of *kalaw* (*Taraktogenos Kurzii*) was supplied to the Conservator of Forests, Utilisation Circle, and the Silviculturist, Burma. 63 packets of seeds were supplied to the Maymyo Botanic garden and 3 packets to the Forest Botanist, Dehra Dun. Seeds of two species of *Garcinia* were supplied to the Director of Agriculture, Manilla.

Photographic collection.—A number of good botanical photographs, especially of bamboos and *Dipterocarps*, were added to the collection during the year.

Research work on the identity of the various *kalaws* (species of *Taraktogenos*, *Hydnocarpus*, etc., which yield *chaulmugra* oil) is now nearly complete. While collecting seeds of the several species in the Dawnas, Deputy Ranger Maung Ba Pe brought in fruits of an apparently new and hitherto unknown species. It was not possible to obtain further material of this plant during the year so its identity still remains unknown.

CENTRAL PROVINCES.

BOTANY.

The ravages of *Fomes pappianus* are on the increase in Bhongaon Reserve (Buldana) where *babul* (*Acacia arabica*) have been killed. Attacks of the *babul* borer lower the vitality of the young *babul* which consequently become susceptible to the attacks of this fungus. Field observations on this fungus have furnished some useful information as regards the resisting powers of the different varieties of *babul* and preventive measures, but there is no definite information as regards the most important point, i.e., the mode of infection. Attempts are being made to have 534 infected trees in Bhongaon (Buldana) grubbed out. Fungal attacks (*Pythium* spp.) were noticeable on lac in Fatehpur Range (Damoh). Some casualties in sal forests due to fungal attack are reported from Felling Series IV of Sihora Range (Jubbulpore-Narsinghpur). Specimens will be sent to the Mycologist, Dehra Dun.

CHAPTER IV.

FOREST ECONOMY.

CENTRAL INSTITUTE.

1.—GENERAL WORK OF ADMINISTRATION.

The post of Forest Economist was held for practically the whole year by Mr. H. Trotter, I.F.S., except for the month of April 1928, when Mr. C. C. Wilson, Conservator of Forests, Madras, held charge prior to his going on long leave to Europe.

2. The Paper Pulp Section remained under the charge of Mr. W. Raitt up till March 1st, 1929, when Mr. M. P. Bhargava took over from him. Mr. Raitt retired from Government service on this date, after 16 years' service at the Forest Research Institute.

3. Mr. L. N. Seaman continued to hold charge of the Timber Testing Section, with Mr. R. K. Banerjea as his Assistant.

4. The Wood Preservation Section was officially under the charge of Mr. H. Trotter, the Forest Economist, while Mr. S. Kamesam, the Assistant Wood Preservation Officer, carried out most of the routine duties and technical work. The non-appointment of a Wood Preservation Expert has re-acted very seriously on the progress of the work of this Section. Towards the end of the year information was received that an Expert had been selected in England, but that another 8 months were to elapse before he could come to Dehra Dun. It is most regrettable that the delay in the appointment of a Wood Preservation Expert has been so long. Wood Preservation in India has reached a critical stage in its history, and the Railways are taking a keen interest in its possibilities. The Institute is continually being approached for advice on this subject and it is most disheartening to have to inform enquirers that no expert Wood Preservation Officer is available to give the help required.

5. The Seasoning Section was held by Mr. S. Fitzgerald until 12th May 1928, when Dr. S. N. Kapur returned from deputation and took over charge of the Section. Mr. S. Fitzgerald's services have not been lost to India altogether as he has been engaged as Advisory Officer in seasoning to the Ordnance and Railway Departments.

6. In the absence of Mr. K. A. Chowdhury, who is still under training in America, Mr. L. N. Seaman continued to hold charge of the Wood Technology Section. This Section has made distinct progress during the year, and the technique, especially in microphotography, has been greatly improved under Mr. Seaman's able direction.

7. Mr. Nagle remained in charge of the Wood Working Section until he left for England for 8 months' well-earned leave on February 24th, 1928, when Mr. W. Gray, the Expert Cabinet Maker, appointed

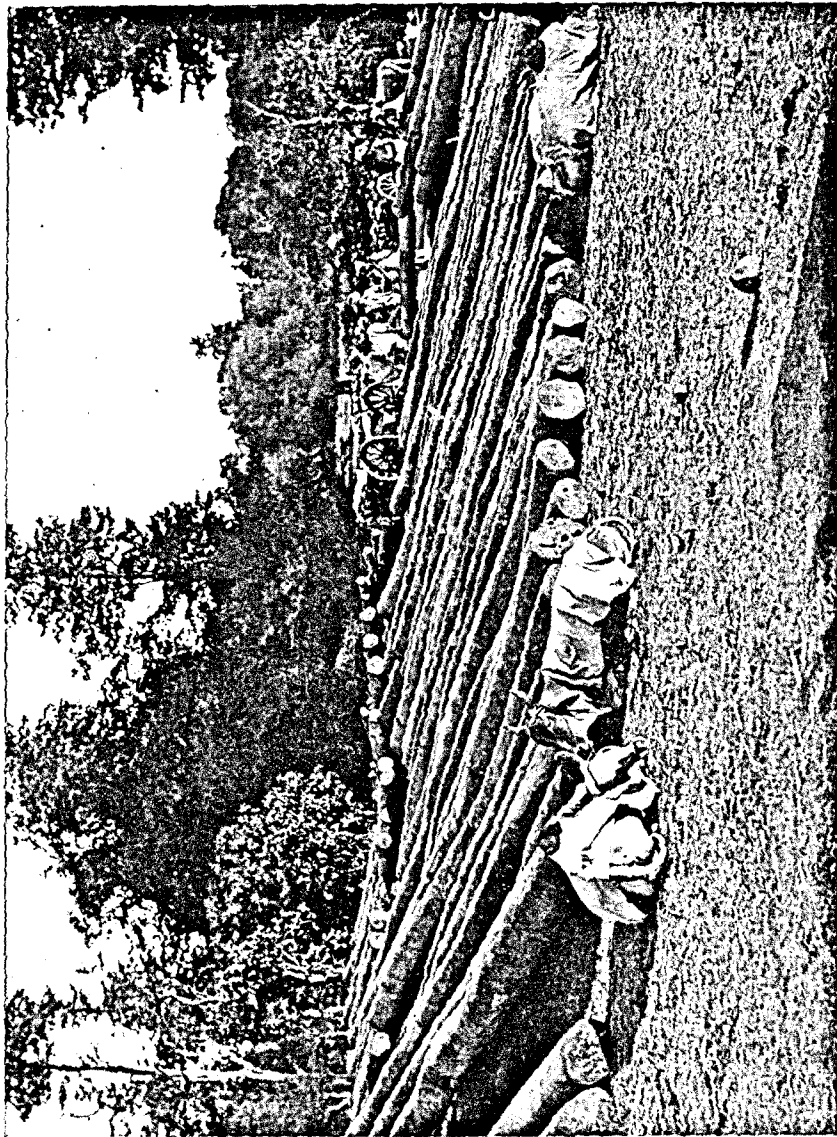


Photo. by H. G. Champion, 2-2-29.

Dungarda timber depôt. Trimmed teak logs, Dangs Division, Bombay.

on 31st August 1928, took over charge of the Section pending Mr. Nagle's return.

It is hoped, now that Mr. Nagle has been relieved of the arduous routine duties of the Section, that he will be able to devote the greater part of his time to research work in veneers, plywood and glues. Mr. Jai Singh continued his training as Apprentice throughout the year.

8. The Minor Forest Products Section was under the direction of Mr. F. D. Ardagh throughout the year, and some very useful work was done by this officer and his small staff. The two semi-portable charcoal kilns, ordered last year, arrived and were put into commission, and from the work already done with them it looks as if there will be distinct possibilities for this type of kiln in India; their chief attraction being that they can be used without water.

9. An important feature of the year under review was the visit of the Forestry Committee which spent a considerable portion of its time enquiring into the organisation and work of the Economic Branch. It is hoped that far reaching benefits will result from this Commission, more especially in connection with the appointment of expert staff, the organisation of the Forest Research Institute as a whole, and the general procedure of investigation and research.

10. A review of the year's work shows clearly that distinct progress was made in all sections. One of the outstanding features is the culmination of Mr. Raitt's life work on bamboo pulp; work which will without doubt have an important bearing on India's pulp and paper industry in the future. It is only befitting, therefore, that Mr. Raitt should be congratulated on his success. He started out to prove, some 25 years ago, that good pulp could be made economically from bamboo. During his researches he encountered considerable difficulties, but each has been overcome in turn. The result of his labours is that first class bamboo pulp can now be manufactured at a cost which can compare favourably with the cheapest chemical pulp on the world's markets. Such an issue deserves the highest praise and Mr. Raitt may well feel satisfied with the results of his labours.

Another important feature of the year under review was the advancement made in the co-operation between the Railways and the Forest Research Institute. Several Works Managers, Assistant Works Managers and others were deputed by their Railways for a short course of instruction at the Forest Research Institute. The credit for this is really due to the Indian Railway Conference Association which met at Dehra Dun in February 1928. The members of the Association were much impressed by the work which was being done at the Institute and it did not take them long to realise the advantages which could be gained by sending their officers for refresher courses in Wood Technology, Seasoning, Wood Working and similar subjects. That they have turned their appreciation into practice is shown by the fact that many Railways have taken advantage of the invitation given by the Institute, and have sent their officers to Dehra Dun for various periods. This

arrangement incidentally benefits the Institute also, as it keeps the Research Officers in close touch with the requirements of the Railways and enlightens them as to the directions in which research work is most needed.

Other visitors during the year included His Excellency the Viceroy and Sir Alexander Muddiman, the late Governor of the United Provinces.

Detailed accounts of the work of each Section are given below under their respective heads.

II.—EXPERIMENTAL AND COMMERCIAL ACTIVITIES.

1. Section of Paper Pulp.

After holding charge of the Section throughout the year Mr. W. Raitt, the Officer-in-Charge of the Section, proceeded on leave preparatory to retirement on the 1st March 1929. Mr. M. P. Bhargava, who returned from deputation to Europe and America on the 2nd January 1929, took over charge of the Section on the same date.

In the hot weather of 1928, a high-lift turbine pump was installed in the digester house to eject pulp out of the digesters after digestion and preliminary washing. This method of ejection has proved very efficient and convenient both for grass and bamboo pulps, with which the Paper Pulp Section is mostly concerned.

The paper and pulp plant was in operation throughout the year. Several tons of bleached and unbleached bamboo pulp were supplied to Messrs. Ironside Son & Co., Ashe's Industries Syndicate, Ltd., the Pioneer Press and other firms, to test the paper-making qualities of bamboo fibre. A consignment of specially prepared bleached bamboo pulp was also sent to Messrs. Celanese, Ltd., London, to test its suitability for the manufacture of artificial silk. Reports on the tests were not received from England upto the end of the year. Bamboo pulp was also supplied to Messrs. Havero Trading Co., Ltd., Bombay, for carrying out experiments on the dyeing properties of bamboo fibre. The firm has reported very favourably on this; bamboo pulp being found equal to the best wood-pulp in its behaviour with organic dye-stuffs of all colours.

Bamboo paper was supplied to the Government Press at Delhi and Simla for the printing of the Administration Report of the Forest Research Institute, and for Mr. Raitt's Report on the Arakan and Tenasserim bamboo projects. Paper was also made for the varied requirements of the offices of the Forest Research Institute and College.

Besides carrying out large scale routine experiments in connection with digestions, bleaching, etc., in the factory, a number of raw materials were investigated on a small scale in the laboratory. A list of the im-

portant investigations in the laboratory and factory is given in the table below :—

The final results of Mr. Raitt's work on Indian bamboos for pulp are summarized in his own work as follows :—

	1902.	1928.
(a) Nodes (or knots)	unusable.	usable.
(b) Soda, or its equivalent, required to digest 100 lbs. dry bamboo, expressed as NaOH.	24 lbs.	16 lbs.
(c) Standard bleaching powder required to bleach 100 lbs. of unbleached pulp.	22 lbs.	8 lbs.
(d) Yield of unbleached pulp	37 per cent.	45 per cent.
(e) Yield of bleached pulp	32 per cent.	42 per cent.
(f) Steaming time of digestion	10 hours.	5 hours.
(g) Digestion temperature (expressed in steam pressure) .	80 lbs.	30 lbs.

These figures speak for themselves and the total result can best be realised when it is pointed out that manufacturing costs have been reduced by £10 to £15 per ton for unbleached pulp at the factory.

The movement towards the establishment of the bamboo pulping industry in India has made distinct progress during the year. A lease for the Angul reserved forests of bamboo was granted to Messrs. F. W. Heilgers & Co., Calcutta, Managing Agents, Titagarh Paper Mills. Plans for putting up a mill at Cuttack are maturing but it is understood that for the present the firm proposes to use bamboo for pulping at their existing mills at Titagarh. Two substantial financial groups in London are maturing plans for the exploitation of the Arakan and Tenasserim areas in Burma for the manufacture of bamboo pulp. It is expected that one company at least will be floated at an early date.

Two students, one sent by the Director of Industries, Bihar and Orissa, and the other from the Punjab, were trained in the chemistry and technology of pulp and paper-making for a period of 6 and 2 months respectively.

Fourteen enquiries for information and advice were attended to during the year, and the usual short course of lecture was delivered, by the Officer-in-Charge, to the Senior Indian Forest Service class at the College.

List.

Serial No.	No. in last year's report.	Subject.	On behalf of	Completed or in progress.	Remarks.
1	1	<i>Eta Ochlandra travancorica.</i>	Chief Conservator of Forests, Madras.	Completed	Awaiting development of the Papanasim scheme.
2	2	Lime-stone analysis	Ditto	Do.	
3	3	<i>Eta</i> for artificial silk	Ditto	Do.	Awaiting report on pulp sent to Messrs. Celanese, Ltd., London.

Serial No.	No. in last year's report.	Subject.	On behalf of	Completed or in progress.	Remarks.
4	6	<i>Melocanna</i> bamboo	Chief Conservator of Forests, Burma.	Completed.	
5	9	<i>Sterculia villosa</i> bark.	....	Do.	
6	10	Survey of Tenasserim area.	Chief Conservator of Forests, Burma.	Do.	
7	11	Analysis of water samples.	Ditto	Do.	
8	12	<i>Alpha</i> Cellulose	Routine research	In progress	To obtain higher yields of <i>Alpha</i> cellulose in bamboo-pulp.
9	13	Survey of Arakan area.	Chief Conservator of Forests, Burma.	Completed.	
10	..	Jute sticks	Director of Industries, Bengal.	Do.	
11	..	<i>Sabai</i> (<i>Ischaemum angustifolium</i>) grass.	Bengal Paper Mills	Do.	
12	..	<i>Oxytenanthera nigro-ciliata</i> (<i>waya</i> bamboo).	Chief Conservator of Forests, Burma.	Do.	
13	..	<i>Sajna</i> wood (<i>Moringa pterygosperma</i>).	Director of Industries, Bengal.	Do.	
14	..	<i>Pinus Khasya</i>	Hispaw Paper and Pulp Co., Ltd. and Forest Economist, Burma.	In progress.	
15	..	<i>Dendrocalamus strictus</i> (n ale bamboo).	Titagarh Mills. Paper	Do.	To see if clean white paper can be made out of mildewed bamboo.
16	..	Perchloron bleaching.	Havero Trading Co., Bombay.	Completed	To test the comparative costs of bleaching with Perchloron as opposed to standard bleaches.
17	..	Analysis of limestones (marble rocks) from Tenasserim river.	Chief Conservator of Forests, Burma.	Do.	In connection with the Burma projects.

2.—Timber Testing Section.

During the year under review testing has been prosecuted vigorously, both for the accumulation of data under routine projects and data required for replies to special enquiries.

One Assistant Computer, one Machine Operator and one Moisture Determinator were added to the staff during the year, and the outturn of work was as follows:—Mechanical tests 40,860 as against 33,537 last year, and Physical determinations 39,024 as against 30,019 in the previous year. 41,109 computations were completed in the computing office as against 35,534 in 1927-28, while technical letters and reports have totalled 116; the former year's output being 102. Special in-

vestigations and technical advice have dealt, among others, with the following subjects:—

1. Hammer handles.
2. Strengths of "half round" sleepers.
3. Aeroplane parts.
4. Plywood.
5. Bobbin woods.
6. Timbers for Railway carriage work.
7. Relative strengths of heartwood and sapwood of different species.
8. Sal (*Shorea robusta*) poles for power line transmission work.
9. Substitutes for *babul* (*Acacia arabica*) for cartwheels.
10. The effect of sap stain fungi on the strength of *Sideroxylon longepetiolatum*.
11. Timbers for steam hammer foundations.
12. Picker arms for jute and cotton mills.
13. Timbers for piles under water.
14. Specific gravity tests on *Terminalia myriocarpa*.
15. Tea chests.
16. Timbers for rifle stocks.
17. Bamboo staves.
18. Timbers for boat building.
19. The oven method of shrinkage determination.
20. A general review of the proposed British Standard Method for testing small clear specimens of timber.

During the year, the following additions were made to the equipment of the Timber Testing Section:—

- One Avery's semi self-indicating balance.
- One torsion balance.
- Two triple beam balances.
- One comptometer.
- One Avery's torsion testing machine.

The last mentioned machine has not yet been put into use, but will be shortly. The drum box testing machine added to the equipment last year was brought into use, and box tests were started to accumulate data relating to the boxes at present accepted as standard in the trade. This information will serve as a reference datum for the test of Indian made boxes. A new type of specimen holder for impact tests has been invented and put into use. It has proved so satisfactory that it has been adopted by other testing laboratories and by at least one manufacturer of impact testing machines.

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An encouraging feature in connection with Timber Testing, was the large increase in the number of enquiries received during the year, for information on the strengths of Indian woods. There is little doubt that the importance of this subject is being realised more and more as the work proceeds. We are now in a position to answer the greater portion of such enquiries with accurate information from our accumulating records, and on more than one occasion we have direct evidence that our Timber Testing work has borne fruit of no little importance.

3.—Section of Wood Preservation.

No Expert having been appointed as Officer-in-Charge, Mr. H. Trotter, the Forest Economist, continued to hold official charge of the Section throughout the year. Mr. S. Kamesam, Assistant Wood Preservation Officer, carried on the routine and technical work of the Section.

The work done by the Section during the period under review may be summarised briefly as follows :—

In addition to the treatment of a few species of sleepers for the Timber Testing Section, most of the experimental work done during the year related to the determination of optimum conditions of treatment for :—

- (i) *chir* (*Pinus longifolia*).
- (ii) blue pine (*Pinus excelsa*).

(v) deodar (*Cedrus Deodara*) sapwood.

The work on the treatment of the other five species had not been completed at the end of the year, but there are distinct indications of improvements on the present treatments being evolved. Some experimental work in connection with the treatment of *chir* sleepers with Wolman Salts, was also completed, and the sleepers so treated have been laid on the East Indian Railway for durability trial in the line.

This work consisted chiefly in treating sal fence posts, paving blocks, battens, etc., for the use of the Forest Botanist, Silviculturist, and other officers. During the year about 1,500 sal fence posts were treated with a 50 per cent. mixture of creosote and earth oil. These posts have been proved to be most satisfactory for fencing purposes. They are cheap and last for many years even in white-ant infested ground.

Numerous enquiries regarding wood preservatives and methods for their injection into wood, etc., were received and answered. Perhaps the most important of these related to the help rendered to the North Western Railway and the Mysore Government, both of which expect to save large sums of money annually as a result of the criticisms and recommendations made by this Section. The Mysore wood preservation plant started functioning in the middle of 1928; the anti-septic used being mainly wood tar creosote from the charcoal factory attached to the local iron works.

(d) *Tours.*

Four tours to Dhilwan and one to Lahore were undertaken by Mr. S. Kamesam in connection with the improvement of the sleeper treat-

ment at the North Western Railway plant. He also visited Bhadravati and Mysore to advise the Mysore Forest and Railway Departments regarding their sleeper supply and treatment. Mr. H. Trotter, the Forest Economist, also visited Dhilwan with the Timber Advisory Officer of the Railway Board.

The experimental sleepers laid near Ferozepore and in Assam were inspected during the year.

(c) *Publications.*

(a) A report on "The Antiseptic Treatment of *Chir* (*Pinus longifolia*) for Railway sleepers" by Mr. S. Kamesam, was accepted for publication as a Technical Paper (No. 271) by the Railway Board.

(b) The following two articles were contributed by the same officer to the "Indian Forester" :—

(i) 'Half-round sleepers of *chir* (*Pinus longifolia*)'—(November 1928).

(ii) 'Note on the Mysore Wood Tar Distillation Plant at Bhadravati'—(March 1929).

A short course of lectures was also given to the Senior Indian Forest Service class, together with practical demonstrations of how to treat wood under existing forest conditions.

(f) *Test yard experiments.*

The experiment, started in February 1926, to determine the relative resistance of untreated Indian timbers to white-ant attack was continued. By April 1929, about 135 species were under observation, and reliable information on the natural termite and fungus-resisting properties of these timbers is accumulating rapidly.

4.—*Section of Timber Seasoning.*

The charge of the Section was held by Dr. S. N. Kapur, who took over from Mr. S. Fitzgerald on the 11th May, 1928, on the latter's departure on leave preparatory to the termination of his contract with the Forest Research Institute. Mr. Fitzgerald has since been engaged as Seasoning Expert to the Railway and Ordnance Departments in India.

General.

The routine work of the kilns was carried on continuously throughout the year with stoppages only for the Easter, Dashera and Christmas holidays. In all, 61 charges of timber were dried in the seasoning kilns, as compared with 48 in the previous year. The procedure of kiln-drying, and, in particular, the determination and control of stresses in wood during the process, was considerably modified and improved. The number of tests taken during the year increased to more than three

times the number taken last year. The methods of observing and interpreting these tests were rationalised, and this has resulted in an all round improvement in the quality of kiln-dried material.

Research.

The experimental kilns now in use were designed about 8 years back, and as the result of numerous special tests carried out in them, it has become abundantly clear that they are not really suitable in their present design for exact research work. The present trend in kiln design is to have one independent blower for each compartment, in the case of external blower kilns, and to pay more attention to the uniformity of the circulation of air in all parts of a kiln. The external blower type of kiln is now being replaced very largely by the internal fan type, in which a number of reversible disc fans, mounted on one shaft, produce the necessary circulation of air in the kiln. This latter type is more economical in initial cost, as well as in operation. Alterations and improvements to the existing kilns were therefore considered essential and one of the blower kilns is at present being modified and, in addition, fitted up for use with the new ozone apparatus which has lately arrived. Modifications in the design of the other kilns will be taken up as soon as possible.

Drying schedules.

Considering the design of the kilns, which is admittedly out of date, and lack of laboratory equipment, very little pure research work was taken in hand during the year. Mr. Fitzgerald left a set of "Kiln Seasoning Process Records" for 30 species of Indian timbers, which were intended to be issued as Forest Bulletins, but, after, due consideration, it was decided that no very useful purpose would be achieved by publishing them in their present form. When further information is collected, it will, perhaps, be possible to classify different timbers into groups, and thus reduce the number of drying schedules to half a dozen or so for all Indian woods. As the result of further trials improved charts for the following species are available :—

Dhup (*Canarium euphyllum*).

Sissoo (*Dalbergia Sissoo*).

Gurjun (*Dipterocarpus turbinatus*).

Pyinma (*Lagerstræmia hypoleuca*).

Lambapatti (*Sideroxylon longepetiolatum*).

Chuglam (*Terminalia bialata*).

Badam (*Terminalia procera*).

Process charts can also be prepared if required for the following species not dealt with before :—

Jarul (*Lagerstræmia Flos-Reginæ*).

Andaman padauk (*Pterocarpus dalbergioides*).

A word of warning is here necessary. These schedules, in most cases, indicate the conditions under which a charge of the particular species was successfully kiln-dried at Dehra Dun. They do not, therefore, always represent the optimum conditions for drying that timber, but they do serve as a reliable guide for kiln-drying that species for the first time in a commercial installation. In due course, it is hoped that we shall be able to determine the optimum conditions of kiln-drying for most of the more important species of Indian timbers.

Co-operative work.

(a) *Railways*.—The experiments on kiln-drying indigenous timbers for use in railway carriage construction were practically completed during the previous year, but it will be some time yet before the final results of the practical tests are available. The experimental coaches are inspected regularly by Railway officers and, when occasion arises, by the Officer-in-Charge, Wood-Working Section, and a careful record of each timber sent out is being maintained. During the year, one lot of *pyinma* (*Lagerstrœmia hypoleuca*) scantlings was kiln-dried for the East Indian Railway, and returned to them for building an experimental carriage.

The seasoning kilns of the East Indian Railway at Lillooah, are under erection, and are expected to start work very shortly. Future experimental and commercial work on the kiln-drying of indigenous woods for railway carriage construction will therefore be carried out at Lillooah, under Mr. Fitzgerald's direction.

(b) *Ordnance Factories*.—As the seasoning kilns at Jubbulpore started working during the year, only a small amount of work was carried out for the Ordnance Factories, including the kiln-drying of a small lot of *kindal* (*Terminalia paniculata*), laurel (*Terminalia tomentosa*) and *ben-teak* (*Lagerstrœmia lanceolata*) for ammunition boxes for the Government Ammunition Factory at Kirkee.

The service tests on *bijasal* (*Pterocarpus Marsupium*) and *aini* (*Artocarpus hirsuta*), as substitutes for walnut (*Juglans regia*) for rifle parts, mentioned in last year's report, have been declared on rather inconclusive evidence, to be unsuccessful, but this matter has not by any means been dropped and it is hoped that with *aini*, at any rate, success will be achieved. *Bijasal*, it is feared, will prove to be too heavy for the purpose in view.

(c) *Andamans*.—The experiment on the kiln-drying of Andaman timbers was completed during the year, and the kiln-dried material was sent to Messrs. Martin & Co., Ltd., Calcutta, for test sales. Their report is awaited.

(d) *Miscellaneous*.—A number of charges of Andaman padauk (*Pterocarpus dalbergioides*) were kiln-dried during the year, for the Imperial Works Division, Dehra Dun. The timber is to be used for the flooring of the library in the new main building of the Forest Research Institute.

One log of *hollong* (*Dipterocarpus pilosus*), was also converted into scantlings for the Assam Railways and Trading Co., Ltd., and the kiln-seasoned material was returned to them for trial purposes.

Air Seasoning.—Considering the diversity of species of timbers available in this country, and the absence of large scale wood-working industries, methods of natural seasoning should find far greater application than the artificial method of drying.

An experiment to determine the effect of water soaking on planks of laurel (*Terminalia tomentosa*) is now in progress.

There appears to be a conflict of opinion among the experts as to the effect of water immersion on the seasoning properties of timber. Data available on the subject are meagre, and as the method does, undoubtedly, reduce the amount of checking to some extent, especially in the case of the more refractory Indian timbers, an investigation on these lines is sure to be profitable.

An experiment on open air-seasoning of *chuglam* (*Terminalia bialata*) was started at the end of the year, and is in progress.

Experiments under Project IV on the air-seasoning of railway sleepers were started in 1926-27 at the following places:—

- (1) Dhilwan, in the Punjab,
- (2) Goikera, in Bihar and Orissa,
- (3) Pollachi, in Madras, and
- (4) Makum, in Assam.

The first two experiments were completed during the year. The last two will be completed during April 1929, and the results will be included in next year's report. So far, these experiments indicate that some useful data will be forthcoming.

The following additions to the equipment of the Section were made during the year:—

- (1) *Ozone apparatus*.—An equipment for ozone seasoning was received from a French Company, and is in course of erection. One of the Sturtevant compartments is being adapted to accommodate it. This method of drying may prove to be suitable for oily and resinous timbers like teak, *gurjun*, sal and *Odina Wodier*.
- (2) *Laboratory dryers*.—Two small dryers, equipped with electric heating elements, blowers, fans, etc., were received from the Sturtevant Engineering Co., Ltd., London, and have been installed. At present, some modifications and additions are being made to make them thoroughly reliable for research work.
- (3) *Band saw*.—One small band saw was erected in the seasoning laboratory, for cutting case-hardening and moisture test-pieces.

Publications.—A small booklet entitled "Instructions for Kiln Operators" was written by Dr. S. N. Kapur, and is in the press, (issued after the close of the year). This Bulletin will be useful to those engaged in kiln-drying in this country.

Tours and Advisory.—Numerous enquiries were dealt with during the year. One very striking feature was the increase in enquiries dealing with air-seasoning, some of the most interesting being those received from :—

The Timber Advisory Officer, Railway Board.

Assam Bengal Railway.

Great Indian Peninsula Railway.

Provincial Forest Research Officer, Ranchi, Bihar and Orissa, and the Divisional Forest Officer, Dibrugarh, Assam.

The Officer-in-Charge paid visits to Bombay and Ranchi in connection with the enquiries from these two districts.

Several short trips were made to the seasoning kiln at the Imperial Works Department Workshops, New Delhi, in order to help them to start and work their kiln efficiently. This kiln is now turning out some excellent work.

The Wood Technologist, Bareilly, United Provinces, also consulted the Officer-in-Charge, about the modernization of their kilns, and the recommendations given have been duly carried out. One of the Tie-mann kilns has now been transformed into a reversible circulation internal-fan type kiln.

In connection with the closure of the experiments under Project IV at Dhilwan (Punjab) and Goikera (Bihar and Orissa), the final inspections were carried out by the Officer-in-Charge himself.

In the course of another tour, the seasoning installation at the Gun Carriage Factory, Jubbulpore, was also visited.

Advice regarding erection of small kilns for drying timber for furniture manufacture was given to two firms, one in Allahabad, the other in Calcutta.

Training.—Increasing numbers of students and visitors are coming to the Seasoning Section every year for training in the theory and practice of kiln-drying and air-drying of wood. The following were trained or obtained information from the Section during the year :—

- (1) Mr. J. W. Helliwell, Works Manager, North Western Railway.
- (2) Mr. T. G. Creighton, Assistant Works Manager, North Western Railway.
- (3) Dr. Ghulam Mohiuddin, Ph.D., Assistant Conservator of Forests, Hyderabad State (Deccan).
- (4) S. Mohan Singh, Foreman, Wood Workshops, Imperial Works Division, New Delhi.

- (5) Mr. Mukand Lal
 - (6) Mr. Pyara Lal
 - (7) B. Poshaki Lal
 - (8) B. Ram Charan Singh
 - (9) Mr. Somayajulu, B.Sc.
 - (10) B. Juggal Kishore
 - (11) Mr. A. P. Ghosh, Assistant Sleeper Passing Officer, Eastern Group.
- } Punjab University Students.
} East Indian Railway.
} Indian Rosin and Turpentine Co.,
} Bareilly.

5.—Wood Technology Section.

During the year, the laboratory work relating to the preparation of the book on Indian Timbers to be published by Mr. R. S. Pearson and Dr. H. P. Brown has been prosecuted by Dr. Brown in Syracuse, United States of America, and the training of Mr. K. A. Chowdhury has also been continued under Dr. Brown's direction. The work in Dehra Dun has been under the able charge of Mr. L. N. Seaman. The staff was increased by the addition of one Field Assistant and one Laboratory Assistant, both of whom are still under instruction. In addition to the large number of routine identifications necessary to the work of the Economic Branch, a considerable number of identifications have been made and advice given in connection with outside enquiries received from different parts of India. Amongst these may be mentioned the identification of timbers and the examination of wood specimens for suspected damage, for several of the Railways, the Inspector of Stores and Clothing, the Rifle Factory (in connection with wood for rifle stocks), the Criminal Investigation Department, the Port Trust, Calcutta, the Air Force, and various Forest Officers throughout India and Burma. The Section has also sent out to inquirers, both in India and abroad, a large number of authentic hand samples of Indian timbers.

During the period under review some important investigations were completed concerning the method of macroscopic identification of some of the *Dipterocarpeae*. Many high power photomicrographs were also prepared for Dr. Brown in connection with his book, and a new technique for the preparation of low power photomicrographs was developed. This technique has proved extremely satisfactory for some species and investigations are being continued, with very promising results, to determine whether it will be applicable to all Indian species. Mr. Seaman's work in this connection, carried out under considerable difficulties, in addition to his duties in the Timber Testing Section, deserves the highest praise. A large number of microscope slides were also added to the collection of authentic material. In addition, many photomicrographs were prepared and filed for reference and authentic wood specimens were added to the Gamble collection as they became available.

The usual course of training in Wood Technology, both theoretical and practical, was given by Mr. Seaman during the rains term to the Senior Indian Forest Service class students of the Forest College.

6.—Wood Workshop Section.

Mr. W. Nagle held charge until the end of February. Mr. W. Gray, an Expert Cabinet Maker, joined the Section in August 1928 and relieved Mr. Nagle of the ordinary routine work connected with the Sawmill and Workshops. Mr. Nagle was thereby enabled to devote himself almost entirely to research work on veneers, plywood and glues, and he had accomplished some very useful work by the time he went on leave at the end of February 1929.

The programme of the routine work carried out in this Section was very similar to that of the preceding year. All other Sections and Branches were supplied with their requirements, and during the year no less than 670 orders for various classes of work were received and 647 were completed. The work included the following articles :—

Panelling for the Museum Show Rooms, specimen furniture, switch boards, file cabinets, book-cases, almirahs, gun carriage poles, tea chests, etc.

Routine work for the Timber Testing Section showed a considerable increase over the previous year ; 41,175 specimens having been prepared for test purposes. These specimens vary considerably, from the standard test-pieces for impact bending, compression, hardness, shear, tension, static bending, etc., to tea chests, hammer handles, golf clubs, and gun carriage poles.

The Section of Wood Technology was supplied with 1,033 hand samples and 21 Gamble specimens, in addition to 201 specimens for specific gravity tests.

A new 'Duco' Aerograph Foot Operated plant for use with Duco polishes was added to the equipment of the Section during the year.

Saw Mills.—This Sub-Section worked to its full capacity during the year under review and kept the Timber Testing, Seasoning, and Wood Workshop Sections supplied with sawn timbers for strength tests, kiln runs and general maintenance work, though some delay was occasioned by a breakdown on the Horizontal Frame Saw. The necessary repairs were carried out by the makers and the Mechanical Engineer, and the saw was running again in September 1928.

During the year this Sub-Section received and disposed of 638 logs and 298 sleepers.

Veneer Mill.—This Sub-Section was only in full work for a short period towards the end of the year, when Mr. Gray relieved Mr. Nagle of his other duties.

Tests were carried out on plywood and glues on behalf of the Amalgamated Dairies, Ltd., Auckland, New Zealand, The Assam Saw Mill and Timber Co., Ltd., and Luward Cold glue from Germany. Detailed reports of the experiments have been recorded in each case.

An enquiry was also received from the Assam Railway and Trading Co., Ltd., Margherita, regarding the general management of their mill

A full report was sent to them after Mr. Nagle had inspected the mill and his recommendations were accepted by the management and acted upon with beneficial results.

Another useful piece of work accomplished was in connection with the peeling of *Terminalia myriocarpa*, a tea-box wood used in large quantities in the Assam plywood mills. It was found, as the result of experiment, that this species could be peeled better and cleaner without preliminary soaking in hot water as had been the practice hitherto. The discovery was notified to the Assam mills, who replied that the new procedure would considerably lessen their manufacturing costs, owing to the saving in time and handling.

A new Project, No. VIII—'Veneers and Plywood' was written up and submitted for approval. It is in course of publication, (issued after the close of the year).

One Manager and one Assistant Manager of the North Western Railway Co. Workshops, Lahore, were attached to the Section for a short period in order to acquaint themselves with our Wood Working machines, Sawmilling and Veneer processes.

A course of lectures was given by the Officer-in-Charge, Wood Workshop Section, to the Indian Forest Service class students. The subjects dealt with were chiefly saw mills, elementary wood working, tools, etc.

Tours were made by the Officer-in-Charge to Delhi and Lahore, for the purpose of inspecting and reporting on the furniture for Viceregal Lodge, New Delhi, and the experimental Railway coaches of the North Western Railway respectively.

7.—Minor Forest Products Section.

Mr. F. D. Ardagh, Deputy Conservator of Forests, Madras, held charge of the Section throughout the year, with only one Laboratory Assistant to help him. Towards the end of the year, however, the appointment of an Upper Grade Assistant was sanctioned for this Section, and a young officer who had just passed out from the Indian Forest Service College was selected for the post. He joined for duty in March 1929.

The chief items of work undertaken by the Section may be summarised as follows :—

Experimental Tapping of Boswellia serrata.—The small scale experiments started in November 1927 were brought to a close in April 1928, and the data obtained were carefully analysed. The analysis showed fairly conclusively that there was little chance of *salai* tapping ever being undertaken with sufficient success to attract commercial interest. The chief factor bearing on this conclusion was the small amount of gum-oleoresin obtained, on an average, over large areas of forest. Some trees gave a good outturn whereas others yielded practically nothing.

Portable Charcoal Kilns.—The two portable charcoal kilns ordered last year as best likely to suit Indian conditions were received during

the year. One of the kilns is a "La Bastia" of 6 steres capacity (manufactured by Andre Colson, France), and the other is a "Trihan Automatic" (Simplex Modele 1927, manufactured by Trihan) of 7 steres capacity. Both kilns are of French manufacture, as France is the country which has made more progress in the design of these portable kilns than any other. On arrival, the kilns were erected and subjected to test in the Institute grounds, use being made of scrap from the saw-mill for fuel. These preliminary trials were quite satisfactory and much useful experience in the erection and working of these kilns was gained from these preliminary runs. In January 1929, it was decided to try the kilns in the local forests under normal forest conditions. They were therefore transported by lorry (each part of the kilns weighs only about 80 lbs.) to one of the Lachiwala coupes where felling was in progress, and arrangements were made with the contractors for the material required to be supplied free of charge, on condition that the charcoal obtained was handed over to the contractors in return for the wood used. The material available had been freshly felled and was very wet. Some difficulty was experienced in working the kilns at first with this material, but these difficulties were soon overcome after one or two trials and very satisfactory results were obtained. Further experiments are required, but the small amount of work done already is sufficient to indicate that this type of kiln is likely to be of use in India, more especially as they do not use any water, a most important factor in many districts in this country.

The Officer-in-Charge had intended to visit Bengal, Bombay and the Central Provinces, to demonstrate the utility of the kilns and to collect data for different localities, but owing to the visit of the Forestry Committee, it was only possible for him to pay a visit to the Hoshangabad Division of the Central Provinces where the question of charcoal manufacture was carefully studied, and correct figures of outturn under existing methods of manufacture were obtained. The result of this visit showed that there is an opening for portable kilns there, and that there is every prospect of the kilns which are now under trial proving suitable.

Briquetting.—Two briquetting machines were ordered during the year under review and it is hoped that the smaller one, a laboratory experimental press, will shortly be received, while that for semi-commercial work may be expected before the end of 1929.

Destructive distillation.—There have been a good many enquiries lately on the subject of destructive distillation of wood, but from the information available we have come to the conclusion that the time is not yet ripe for the introduction of installations of this kind in India, owing to the fact that there are not, at present, markets for the by-products.

Match splints and box veneers.—The shed for housing the veneer peeling and splint chopping machines was erected early in the year and the two machines were erected. Some useful work was done on

them, one of the most important items being the peeling and chopping of freshly felled *Picea Morinda* and *Abies Pindrow*. The results of these experiments showed that it was possible to peel both these species satisfactorily when really green, though cross fibres and resin pockets were evident. The colour of the splints was not however as good as was expected, especially towards the centre of the logs. It is thought that better results might be obtained with material from the Punjab, where the trees are of better growth than the local species. Some splints of *Picea Morinda* were sent to a match factory which very kindly undertook to polish them and to make them up into finished matches. They reported on these splints as follows:—

"From a cursory examination, it would appear that the Himalayan spruce is fairly suitable for match splints. The colour is, of course, very yellowish, and the general appearance has undoubtedly suffered from the splints not being dried and polished before despatch". They also stated that "The colour of the splints is not very good and the Factory also reports that these have proved very brittle in the manufacturing process".

Some logs of spruce were also peeled in front of one of the representatives of the Swedish Match Company while he was on a visit to the Institute and he gave it as his opinion that the colour was an unsuitable factor if this species were to be used for the manufacture of splints. Added to this is the fact that the inside of some of the logs is inclined to be quite reddish, and in such cases this inner wood would never be suitable for the manufacture of splints.

Peeling tests were also made with *Broussonetia papyrifera* (paper mulberry) to determine its suitability or otherwise for the manufacture of match splints. This is a fast growing species white in colour, which is quite easy to cultivate, and it was thought that if it proved suitable it would be eminently suited for plantations. A tree was therefore felled and peeled. It was found, however, that the fibres of this tree were so interlocked that it was not possible to peel it properly and it was thought at first that this species would never be suitable for the manufacture of splints. Another tree with a much straighter stem was peeled later and in this case, most satisfactory results were obtained. The veneers were clean and without interlocked fibre and samples have been sent to a match factory for their opinion. The enquiry will be continued.

Match Factory.—The scheme relating to the erection of a complete match making unit was completed and put up to the Government of India towards the end of 1928. It embodies the recommendations of the Tariff Board and covers the creation of a separate Section for matches. Final rough estimates of cost were prepared and plans of the proposed buildings were drawn out to show the proposed lay out of the machinery. It now remains with the Government of India to decide whether the scheme will be proceeded with or not.

Investigations into the seasonal variation in the ephedrine content of Ephedra Gerardiana.—Analyses conducted by the Biochemist during the previous year showed that the ephedrine content of *Ephedra intermedia* var. *tibetica*, was too low to make this species of commercial value. Attention was, therefore, diverted to *Ephedra Gerardiana* syn. *vulgaris*, and supplies of the crude drug were arranged for from various sources, in order to enable the Biochemist to make a study of the seasonal variation in the ephedrine content. This work is still in progress and arrangements have now been made to obtain monthly supplies from various sources to enable the Biochemist to prove or disprove a theory that he has advanced that the ephedrine content is influenced by rainfall.

Palmarosa Oil.—During the previous year an enquiry was started to ascertain (i) the reason for the large fall in price of this oil in the London market and (ii) the prospects for steam distilled oil. The result of the analysis of some steam distilled oil sent to the Imperial Institute in London was received during the year under review. This oil had been distilled from *plantation* grass, and it was thought that the prospects for oil, steam distilled from wild grass, should be studied also. With this object in view the Central Provinces were asked to send us a consignment of grass from which the required sample of oil could be distilled. It was not possible to obtain the grass required and further correspondence with the Central Provinces showed that they did not think that it would ever be possible to re-introduce steam distillation in the jungles and that they were not keen on the enquiry being proceeded with. The enquiry was therefore dropped, the Central Provinces having informed us that they were more interested in trying to improve the distillation in the ordinary country "degh" by the introduction of false bottoms but no reports have been received as to any progress having been made in this connection as yet.

Helicteres Isora fibre.—Experiments are still in progress, in conjunction with the Provincial Research Officer, Bihar and Orissa, with the object of improving the quality of the fibre that can be produced from *Helicteres Isora* so as to open up a market for this fibre which is common in many parts of India. Some advance has been made, and experiments are in progress under the direction of the Fibre Expert to the Government of Bengal. It is hoped that these experiments may lead to a satisfactory solution of this problem.

Production of good quality fibre from Girardinia heterophylla.—A sample of the fibre produced from *Girardinia heterophylla* was received from the Divisional Forest Officer, Darjeeling, and we were asked whether we could find a market for about 50 maunds of this fibre annually. Advice was given as to the manner in which the quality of the fibre might be improved and the advice of the Fibre Expert to the Government of Bengal was also taken. Further experiments are now in progress on the lines suggested by this officer and the results are awaited.

Finding a market for the III quality turpentine produced by the Bareilly Rosin and Turpentine Factory.—The Chief Conservator of Forests

United Provinces, approached us regarding the advantages to be gained by assisting the Bareilly Factory in finding a market for the III quality turpentine produced by them. They reported that they had been unable to find a market for this turpentine and that in consequence large stocks were accumulating. Attempts were made by the Biochemist to make use of this turpentine in the preparation of an insect protection paint but it was found that oxidation took place too rapidly with the result that the paint hardened in a short time. This rapid hardening made it quite unsuitable for the purpose in view. The Biochemist is studying this turpentine further, and arrangements have been made with the Burma Oil Co. to crack a consignment of 40 gallons of this oil, to enable us to study the pressure distillate, in the hope that it may be possible to obtain some product which will prove of commercial value. The problem is not easy to solve as there is every indication that the molecule is very stable.

Production from chir (Pinus longifolia) tar of a road tar suitable for use as a substitute for "Spramax".—The Conservator of Forests, Kumaon Circle, United Provinces, asked us to assist him in discovering whether it would be possible to produce from *chir* tar, a tar which would be a suitable substitute for "Spramax" for tarring roads.

Attempts were first of all made to obtain the specification of the "Spramax" now being used for this purpose but without result.

The Biochemist has, therefore, taken steps to obtain a sample of the "Spramax" now being put on the roads in Dehra Dun and will make an analysis of its physical properties. Attempts will then be made to drive off the lighter fractions of the *chir* tar and so to produce a tar which will approach "Spramax" sufficiently closely to make it a suitable substitute. It may prove necessary to mix some petroleum residues with the *chir* tar in order to make it similar to "Spramax", but, if this is done, careful consideration will have to be paid to the cost of preparation as the margin of profit is small.

Study of crude drugs.—Arrangements were made with the Biochemist to study the active principles of the following crude drugs:—

- (a) *Taraxacum officinalis*.
- (b) *Senecio* spp.
- (c) *Colchicum luteum*.
- (d) *Aconitum Chasmanthum*.
- (e) *Holarrhena antidysenterica*.

Analyses of (a) and (b) have been completed and reports have been sent to the Divisional Forest Officer, Utilization Division, Kashmir, from whom the supplies were received. Work on the other drugs is still in progress. The bark and seeds of *Holarrhena antidysenterica* are being studied with the idea of its use as a substitute for ipecacuanha and emetine.

Rendering bamboo lance staves immune from the attack of the "shot borer".—The experiments started last year to prevent the attacks of shot borer in bamboos were concluded during the year under review. A complete report on the results obtained was prepared and sent to the Ordnance Department. As the experiment threw doubt on the efficacy of treatment with Rangoon oil, we were asked by the Ordnance Department to undertake further experiments on a large scale, as they consider it of great importance to obtain a satisfactory solution to this problem. Large quantities of bamboos were necessary for these experiments as it was felt that it was not possible to obtain reliable results with less than 200 bamboos for each separate experiment. The Divisional Forest Officer, Lansdowne Division, was asked to supply the bamboos required but he pointed out that it would never be possible to supply 2,000 bamboos up to the specification demanded by the Ordnance Department. As it was not necessary for the purposes of the experiments that the bamboos should be of such high quality, he was asked to supply 2,000 bamboos as nearly solid as possible and of the largest girth available, importance being laid on the fact that the bamboos should be felled in November-December and despatched as early as possible to preclude any danger of attack prior to receipt. The bamboos were duly received and the branches were trimmed off, and each bamboo was numbered and inspected for blemishes and signs of attack by the shot borer. The bamboos were then subjected to the different treatments decided on in consultation with the Entomologist, and as soon as the treatment was completed the bamboos were handed over to the Entomologist who exposed them to shot borers which had been bred for the purpose. In addition to this, the Biochemist analysed the bamboos after the various treatments in order to ascertain whether there had been any appreciable difference in the sugar and starch content on which the beetle is said to feed. The results of these analyses to date indicate that there is very little likelihood of any information of value being obtained from such analyses, as it was found that the starch and sugar content of each individual bamboo varied very considerably and also that the content varied along the length of the bamboo, being greater at the larger end than at the smaller end. Further analyses are being made in order to determine whether any great variations have resulted from the various treatments accorded to the bamboos in each set of experiments, from which it is hoped that conclusions can be drawn as to the efficacy of the treatments in reducing the food supplies of the beetle.

Substitutes for Chinese 'tsinglees' for the manufacture of umbrella handles and walking sticks.—An enquiry was received from the Imperial Institute, London, in connection with the possible supply from India of bamboos suitable for the manufacture of umbrella handles and walking sticks. Samples of several bamboos which were considered likely to prove suitable were obtained and despatched to London for inspection. The firms interested in this trade considered that *Pseudostachyum polymorphum* from Assam, was most likely to prove suitable

and a trial consignment of 5,000 bamboos has been despatched for their use. Arrangements are now being made with the Conservator of Forests concerned to send a further consignment of 5,000 to another firm at the request of the Imperial Institute. It is hoped that a profitable business may result, as these firms are prepared to pay 50 to 60 shillings per thousand c.i.f. Liverpool.

Minor Forest Products Laboratory.—Chemical apparatus for the new laboratory was received during the year and a start was made in determining the calorific value of different charcoals. Arrangements were also made to have each charcoal definitely identified by the Wood Technology Section. A study is also being made of the variation in weight in charcoal in various air humidities.

Minor Forest Products Garden.—Further progress was made in clearing the area for this garden, and the area so cleared has been put under grass which is being mowed and kept in good order for future lawns. Many species were planted out in the new garden and further consignments of seeds have been received from various Divisional Forest Officers. A nursery was started in March 1928 and annuals and other species will be grown there for stocking the garden. The severe cold weather in January 1929 killed off some of the plants and arrangements will now have to be made to replace them.

ASSAM.

FOREST ECONOMY.

1.—General Work of Administration.

The appointment of a Special Forest Utilization Officer was recommended in the Report of the Royal Commission on Agriculture in India in order that the development of forest industries may be made the definite responsibility of one officer in every Province. The shortage of officers in Assam will render this a difficult matter for some time to come.

II.—Experimental and Commercial Activities.

A plant capable of dealing with 3 or 4 lakhs of sleepers annually was started by the Assam Bengal Railway Co. at Naharkatiya, for impregnating miscellaneous sleepers with oil and creosote. The Forest Department has entered into a contract to supply 10 lakhs of sleepers for the above.

The timber seasoning experiment inaugurated by the Forest Research Institute, Dehra Dun, at Makum Junction, in the Lakhimpur Division, has been completed, but the final report on same has not yet been received. The results appear to have been very satisfactory and should prove of great benefit when timber seasoning is taken up in earnest in Assam.

Five thousand pieces of bamboos (*Pseudostachyum polymorphum*) were sent under instruction from Dehra Dun during the latter part of the

year to Messrs. Huxly and Sidebotham for testing the suitability of this species in the manufacture of umbrella handles and walking sticks. It is unlikely, however, that outside firms can be assured of a supply owing to the demands of the local industry, which Government wishes to foster.

Five scantlings of *Trewia nudiflora* measuring 4'-5"×5"×5" were sent to the Forest Economist, Dehra Dun, to determine its suitability for "Bobbin" manufacture as a substitute for beech. The results proved that it was not suitable.

Sleepers of—

Pterospermum acerifolium.

Crypteronia paniculata.

Eugenia praeox.

Kaya assamica.

Stereospermum chelonoides.

Terminalia belerica.

Terminalia citrina.

had previously been sent to Dehra Dun for report as to their suitability for use after being subjected to treatment by creosote. The results have not yet been reported.

Considerable quantities of seeds of—

Nahor (*Mesua ferrea*)

Hollock (*Terminalia myriocarpa*)

Hollong (*Dipterocarpus pilosus*)

Uriam (*Bischofia javanica*)

Paroli (*Stereospermum chelonoides*)

Chikrassi (*Chikrassia tabularis*)

Sia Nahor (*Kayea assamica*)

Bokain (*Melia Azedarach*)

were collected for supply to the Chief Conservator of Forests, South Africa, the Forest Botanist and Silviculturist, Dehra Dun, and others.

The bark of *Terminalia citrina* and *Terminalia myriocarpa* was collected and sent to the Director, Hafkin Institute, Bombay.

BENGAL.

FOREST ECONOMY.

I.—GENERAL WORK OF ADMINISTRATION.

Mr. G. W. Houlding, Forest Engineer, Bengal, held charge of the Utilisation Office up to 15th August 1928; Mr. E. A. C. Modder from 16th August 1928 to end of the year.

The Utilisation Officer arranged for the supply of Rs. 2,05,582 worth of standard size sleepers and Rs. 1,05,108 worth of special size sleepers to the Eastern Group of the Sleeper Control from Northern Bengal. A contract for the supply of bridge piles and timbers to Messrs. Jessop & Co., was also arranged.

II.—EXPERIMENTAL AND COMMERCIAL ACTIVITIES.

Timber Seasoning.

The results of ordinary air seasoning of *sundri* (*Heritiera Fomes*) and *amoor* (*Amoora cucullata*) timbers in the Sundarbans Division indicate that the warpage of these timbers which is so common can be avoided by proper seasoning and the timbers rendered much more durable. A *sundri* tree was felled and left in the forest for about 2 months to dry in the shade with bark on. It was then converted and made into a helm which is being used in the Gengwa Coupe. It has retained its shape and there has been no deformity. The boat-crew always prefer *sundri* helms to the expensive ironwood ones as the former are much lighter and easier to handle.

Some *amoor* poles were also felled and left in shade in the forest for about 6 weeks to air-season. They were then left in the open under the hot sun for about 4 months at Khulna station before some oars and paddles were made out of them and exhibited in the Khulna Exhibition. Of the articles made, some were varnished soon after and some were not. The former show no signs of splitting; of the latter those that were put to use at once warped badly on account of the alternate exposure to sun and water but those that were properly stored in the shade remained in good condition. No conclusive inference can be arrived at from the above, with regard to the warpage in the converted timber on account of the bad storage at Khulna under the hot sun, but it is suggested that warpage in converted *amoor* timber may be avoided by reducing the speed of drying to the absolute minimum immediately after conversion. This subject is still under observation.

Some *sundri* battens 1"×1" have also been sent to the Government Dockyard at Narayanganj to ascertain if they can be bent for use as the ribs of boats.

Timber Testing.

Ten logs of *Cryptomeria japonica* were sent to Dehra Dun for Projects I and II of 1928-29, from Darjeeling Division, and a log of *Sweetenia macrophylla* from Kaptai, Chittagong Hill Tracts Division, was sent for testing.

Wood Preservation.

The narrow gauge oak sleepers sent to Dehra Dun for creosoting tests had not been reported on by the close of the year.

Minor Forest Products.

Experimental tapping of *gurjan* (*Dipterocarpus* spp.) trees for oil, with a view to finding out whether such tapping before felling will affect the timber adversely or otherwise, which was begun towards the close of last year, was continued. After two seasons' tapping (*i.e.*, in the cold season of 1929-30) the trees will be felled and the timber sent to Dehra Dun for testing. It is hoped that this tapping will not only do no harm to the *gurjan* timber for ordinary use; but will render its impregnation with preservatives, such as creosote, etc., easier and more thorough. If this should prove to be the case it will yield a valuable minor product for which there is always a ready sale, and it should be possible to arrange to tap all *gurjan* trees for 2 years before felling and converting them.

Miscellaneous.

Three subordinate officers were deputed to Madras to undergo a course in topo-surveying and timber cruising. It is hoped to utilize their services in the near future in some of the large areas of the Chittagong Hill Tracts which are at present almost unknown quantities as far as their timber contents are concerned.

The Saw Mill at Siliguri in the Kurseong Division continued to show a good profit. A total of 90,101 c.ft. of timber was sawn at a cost of 5.89 annas per c.ft. The total sales from this mill reached Rs. 1,25,943 including proceeds from bye-products such as slabs, etc.

The mill had to face an extremely dull market throughout the year and suffer for some time from deficiency in log-supply. Even then there has been an improvement on output, a substantial increase in sales and a better margin of profit. It may, therefore, be confidently hoped that the mill will prove to be more and more paying and useful.

There can be no doubt that the mill is serving a very useful purpose in enabling us to dispose of a large quantity of defective logs which would ordinarily be unsaleable as such, and in exercising a healthy influence on the log-market by keeping up the prices of round timber. It may be pointed out that even the higher class logs supplied to the mill at full Depot schedule rates, are not without some defect or other, for all logs are first subjected to a strict selection for meeting the demands of log-purchasers, and only such logs as they are unwilling to take, are sent in to the mill.

A large part of the expenditure incurred on cross-cutting logs by hand and handling sawn timber (specially heavy sleepers) can be avoided by providing a steam-driven log cross-cut saw and better loading facilities. Proposals for the installation of a suitable type of cross-cut saw and an overhead travelling electric crane are under consideration.

Machinery required for electrifying the log-hoist has already been purchased. When these are put up, the speed of sawing and consequently the output are expected to be much increased, and the cost of sawing proportionately lowered.

The mill had to depend almost entirely on an ever-changing, inadequate and irresponsible temporary staff maintained on daily labour. The importance of maintaining necessary establishment for adequate supervision of the labour forces, affecting prompt delivery of orders for timber, and keeping accounts (especially of receipts and disposals of sawn and round timber) posted daily, need hardly be emphasised. Besides providing adequate and competent staff, there should be an arrangement for duly relieving even temporarily sick hands. If no such arrangement can be made, at least one whole time extra hand has to be maintained. It will pay the mill even to do this, for the loss suffered through frequent illness of the subordinates and consequent interruptions of work is certainly heavier than the extra expenditure involved by employing a reserve.

BIHAR AND ORISSA.

FOREST ECONOMY.

II.—EXPERIMENTAL AND COMMERCIAL ACTIVITIES.

Timber Seasoning.

During the year all the consignments of timber sent to the Ranchi for the air seasoning shed were sawn into 1" planks and stacked in the shed. The timbers so stacked are:—

- Rosewood* (*Dalbergia latifolia*).
- Asan* (*Terminalia tomentosa*).
- Arjun* (*Terminalia Arjuna*).
- Karam* (*Adina cordifolia*).
- Dhaura* (*Anogeissus latifolia*).
- Irul* (*Xylia xylocarpa*).
- Gamhar* (*Gmelina arborea*).
- Mango* (*Mangifera indica*).
- Salai* (*Boswellia serrata*).
- Toon* (*Cedrela Toona*).
- Indian Cork (*Millingtonia hortensis*).

As these timbers become fully seasoned they will be sold to the Public Works Department and timber contractors at favourable rates to popularise these timbers and show the benefits of good air seasoning.

Timber Testing.

Results were received from the Forest Research Institute, Dehra Dun, on Hazaribagh shisham (*Dalbergia Sissoo*). The strengths were surprisingly low so that an additional quantity has been sent for the

tests to be repeated. From Puri Division some teak logs were sent to Dehra Dun for testing.

Sleepers.

Considerable correspondence arose over the question of second class sleepers such as slab and half-round sal sleepers. It became clear that contractors are not very favourable to either but think there are possibilities in the half-round, especially if their specification is reduced slightly.

Miscellaneous Timbers.

Efforts are being made to introduce timber such as *karam* (*Adina cordifolia*) and *asan* (*Terminalia tomentosa*) on to the market for carriage work. Owing to the delay in the completion of the Lillooah seasoning kilns no timbers have yet been despatched, but it is hoped some 200 tons will be supplied to the East Indian Railway during the coming year.

Minor Forest Produce.

1. *Lac*.—Progress has continued with the Lac Farm Plantation Programme. A detailed report is not given here as a special report is due later. One new plantation was begun during the year, namely Hatibathan in the Santhal Parganas. This brings the total number of farms up to six. Of these six, 3 are approaching the stage when light infection can be made on the young hosts. These 3 are Betla and Mako in the Palamau Division and Bichagutu in the Chaibassa Division.

As these lac farms are destined to produce brood lac in those years when adverse climatic factors cause a general shortage, steps are being taken to bring the farms into the best possible condition. It is believed that soil cultivation and good manuring will go far in this direction and efforts are being made to bring each plantation under full soil cultivation so that eventually the soil will be ploughed or hoed all over the plantation. Steps are being taken to discover the best manures, and a close connection is being kept with the Indian Lac Research Institute at Namkum.

Besides the plantation, areas of Reserved Forest at Jhankerbahali (Sambalpur East) and Ramadega (Sambalpur West) are being converted into Lac Plantations. Of these Jhankerbahali is the further advanced; the Ramadega scheme has been considerably delayed owing to difficulties in obtaining the help of villagers to clear and cultivate the ground. In the Palamau Division areas of forest near Mako are being brought under a scheme of lac cultivation.

In Kundri (Palamau) lac production is more or less beyond the experimental stage and is being brought under a more intensive scheme of control.

2. *Matchwood Plantations*.—The experimental matchwood plantations at Berbera (Puri Division) and Posaita (Kolhan Division) have

not progressed far. In the latter, work has been delayed pending the construction of a well and nursery near the plantation. These were completed during the year and plantation work will begin in the coming year.

At Berbera the area was very strongly refenced against sambhar and bison. Previous fences had not been good enough. The present fence is proving much more effective. No more species were planted owing to lack of seed.

3. *Sabai grass* (*Ischæmum angustifolium*).—Experimental Plot No. 139 in the Kolhan Division has proved that *sabai* grass can be planted easily and that such a plantation will very quickly pay for itself. If planted 3'×3' and weeded thoroughly 3 times each rains and burnt every hot weather a yield of 20-25 maunds dry grass can be expected per acre. This yield is likely to increase to at least 30 maunds per acre. A second similar experiment has been begun to investigate the advisability of planting 2'×2'. It is expected that this closer planting distance will give a larger yield per acre and reduce weeding costs.

These results have been obtained on very poor shale soils on dry slopes where the forest crop is extremely poor and are most encouraging. Moreover it is found that receipts from the grass at the end of 3 years practically balance the total cost of formation, upkeep, harvesting and carriage of the grass to a depot during those years. It is expected that a profit of As. 6 per maund will be possible, which, on a yield of only 24 maunds per acre, gives an annual profit of Rs. 9 per acre.

During the coming year experiments will be initiated to test the feasibility of planting ravine land liable to erosion with *sabai* grass.

4. *Helicteres Isora* and other fibres.—Experiments on *Helicteres Isora* continued in Sambalpur. Favourable results have been obtained. At first it seemed that the fibre was too poor in quality to be of commercial value. But a certain firm (Messrs. George Henderson & Co.) have been able to treat the fibre with a patent process so that they can hold out hopes of a useful market. Experiments are continuing to investigate the best time and method of retting and the yield and cost per maund.

Enquiries from an English firm were made about *Urena lobata*, a very common small shrub, as a possible flax substitute. No satisfactory results have yet been obtained.

BOMBAY.

FOREST ECONOMY.

II.—EXPERIMENTAL AND COMMERCIAL ACTIVITIES.

Tests of Suitability, etc.

The *Oxytenanthera monostigma* bamboo supplied to the Forest Economist, Dehra Dun, for test regarding its suitability for lance staves

was reported to have a certain amount of promise but no very definite conclusion was arrived at.

Half-wroughts of *Grewia tiliaefolia*, *Anogeissus latifolia* and *Ougeinia dalbergioides* were supplied to the Great Indian Peninsula and Bombay-Baroda and Central India Railways for trial for ordinary hammer handles and were reported to be unsuitable for the purpose. The Forest Economist is not satisfied with the Railway report and is making further enquiries into the matter.

Mutti (*Terminalia tomentosa*) keys were supplied to the Bombay-Baroda and Great Indian Peninsula Railway for trial but it was found that there was no business in it. A trial indent for teak keys for the Madras and Southern Marhatta Railway is on hand and is likely to prove of value in disposing of scarp wood.

Stuart's patent sleeper clamps were received during the year from the Madras and Southern Marhatta Railway for use on wooden-track meter gauge sleepers. These clamps are a real good thing and if they are used on all sleepers as soon as they come out from the mill, there should be practically no rejections, provided the sleepers are not cut from obviously unsound and bad timber.

As most of the junglewood logs are susceptible to the attack of shot-borers, if left lying in the forest or depots for some length of time, observations were made to ascertain some practical method of keeping the attack under control and it was found that the most satisfactory thing was to trim the logs free of all bark as soon after felling as possible.

Forest Products (Major and Minor).

Subject No. 15.—Relative value of different species for charcoal making (Sukkur, Karachi, West Thana, Satara and Belgaum):—

The reports received show that for 100 maunds of fuel the yield of charcoal in maunds of 80 lbs. each from different species is as follows:—

**Dhaman*, *karambel*, *babul* and *kandi*:—25 maunds and over.

Dindal, *shemat* and *asana*:—Over 20 to 25 maunds.

Matti, *kalamb* and *jambul*:—Over 15 to 20 maunds.

The above are not absolutely reliable figures because they are based on single experiments except in the case of *babul* and *kandi*. They can, however, be taken as fairly accurate indicative figures.

As for determination of ratio between the volume of unplastered kiln and weight of charcoal, to facilitate calculation of royalty for charcoal on the basis of kiln measurements in Sind, *babul*, which was tried in 3 different localities in Karachi Division, gives fairly uniform results as follows:—

1,000 c. ft. stacked=400 maunds of fuel=1,125 c.ft.

Volume of unplastered kiln=100 maunds of charcoal.

It is, however, doubtful if the above figures can be applied to the whole of Karachi Division with a fair degree of accuracy.

Kandi which was also tried in 3 localities in Sukkur gives divergent results.

The subject has been discontinued.

If it is necessary to determine the relation between the four factors, viz., (i) volume of fuel in c. ft. (stacked), (ii) weight of fuel in maunds, (iii) volume of unplastered kiln in c. ft. and (iv) weight of charcoal in maunds, for any species for any locality, the Divisional Forest Officers can conduct sufficient (about half a dozen) experiments with the required species in the desired locality to admit of reliable average figures being arrived at, communicating the results to the Chief Conservator.

* NOTE.—*Dhaman* (West Thana Division)—*Grewia tiliaefolia*.
Karambel (West Thana Division)—*Dillenia pentagyna*.
Babul (Karachi Division)—*Acacia arabica*.
Kandi (Sukkur Division)—*Prosopis spicigera*.
Dindal (Belgaum Division)—*Anogeissus latifolia*.
Shemat (West Thana Division)—*Odina Wodier*.
Asana (West Thana Division)—*Bridelia retusa*.
Matti (Satara Division)—*Terminalia tomentosa*.
Kalamb (West Thana Division)—*Stephegyne parvifolia*.
Jambul (Satara Division)—*Eugenia Jambolana*.

Subject No. 9.—Propagation of lac on *ber* (*Zizyphus Jujuba*) (Karachi Division):—

Group A.—Contains 10 trees varying in girth from 8" to 17" and in height from 16'-4" to about 28' with small crowns. The trees of this group were lopped in March 1926 and inoculated twice in July and November of 1927. The July inoculation failed while November inoculation was fairly successful. The trees of this group were again inoculated in July 1928 with sticks which varied from 80 to 440 on a tree with an average of 256 per tree. The thin encrustation that resulted from this inoculation was eaten by ants and squirrels with the result that removal on 11th September 1928 yielded only 22½ tolas of *phunki* lac. Two trees yielded as little as 1 and 1½ tolas respectively. The July inoculation having failed, the trees were again inoculated in November 1928 with sticks varying from 165 to 645 per tree with an average number of 287 sticks per tree. The result was good and *phunki* lac removed on 18th December 1928 weighed 214 tolas.

Group B.—Contains 10 trees. Girth varies from 8" to 24". Height varies from 11'-4" to 24'. The trees have small crowns. The trees were lopped in July 1927. They could not be inoculated in 1927 because the shoots were not succulent enough. The trees were inoculated in July 1928 with sticks varying from 100 to 340 on a tree with an average of 202 per tree. The ensuing encrustation was thin and was mostly destroyed by ants and squirrels. *Phunki* lac removed in September 1928 weighed 22 tolas. The July inoculation having failed, the trees were re-inoculated in November 1928 with sticks varying from 105 to 495 on a tree with an average of 242 sticks per tree. The inoculation

was successful and the *phunki* lac removed on 8th December 1928 weighed 172½ tolas or 17.25 tolas per tree.

NOTE.—This group was originally group B and was subsequently numbered C. The trees of original group A subsequently numbered group B having died, this group is re-numbered B.

The experiment is to be continued. So far it appears that July inoculation fails and November inoculation is fairly successful. It also appears from last year's report that shoots take more than a year after pruning for the first time to be ripe for inoculation.

Experiments with propagation of lac in Surat Division (Mandvi Range) :—

The crop from the winter inoculation of November 1927 was harvested on 22nd June 1928 when it yielded 2,481 sticks. Out of these only 300 sticks were of fair quality while the rest were of very poor quality. As soon as the insects began to emerge all the sticks were tied to 58 *palas* trees in coupe 17, Block VI, Luharvad, Paterkui Round, on 6th July 1928, and after the completion of the emergence of the insects and their settlement on the branches all sticks were untied on 6th August 1928 which on scraping yielded 7 lbs. of crude lac. Observations from time to time from July onwards up to October 1928 showed that there were no incrustations on the inoculated branches and the crop was a complete failure and there was no seed in stock to carry on the winter inoculation in November 1928; hence the Divisional Forest Officer, Bhandara, Central Provinces, was requested to supply 2,000 brood lac sticks, which he supplied on 21st November 1928 to the Range Forest Officer, Mandvi.

This time the experiment was carried on in two different localities and 1,441 sticks were tied to 38 *palas* trees in coupe 18, Block VI, Paterkui Round, and 495 sticks to 23 *palas* trees in coupe 17, Block IV, Lakhgaon Round, on 22nd November 1928 and 23rd November 1928, respectively.

The seed supplied was healthy and of good quality. On inspection of both the places a week after inoculation it was found that the insects had completely emerged and settled in large numbers on the branches and it was hoped that the harvest, this time in July 1929, would not be disappointing. Unfortunately a severe frost in the last week of January 1929, completely dried not only *palas* plants but the insects too. Hence the crop that was expected in July 1929 was an absolute failure and to carry on the experiment again for 1929-30, a fresh stock of seed will have to be obtained from Bhandara, Central Provinces.

Experiments with propagation of lac in Dharwar-Bijapur Division :—

Experiments with propagation of lac on *khair*, *wadiya* (*Acacia Senegal*), *shigi* (*Acacia concinna*), *ber* (*Zizyphus Jujuba*), *hodjali* (*Acacia Latronum*) and *tugli* (*Albizzia amara*) in Badami Range were continued without decisive conclusions about the extent of the damage done by predatory insects and the preponderance of male lac insects in summer brood being arrived at.

BURMA.

FOREST ECONOMY.

Wood Technology.

Type timber collection.—Two hundred and eight new specimens have been added during the last two years to this collection which now stands as under, excluding duplicates :—

Specifically identified blocks	509
Generically identified blocks	31
	540

This collection has been of great value to the Forest Economist for the identification of timbers which are frequently sent to him for that purpose by various firms. It has also been the means of disclosing the fact that three different timbers, viz. :—

Thingan (*Hopea odorata*),

Thingadu (*Parashorea stellata*) and

Kaunghmu (*Anisoptera glabra*)

were being confused in the converted form both by the Timber Research Division and by extracting firms. With the help of the Wood Technologist, Forest Research Institute, Dehra Dun, whose advice and instruction in this and other cases have been of great assistance, a practical method of distinguishing these three timbers with a hand lens was evolved and published during the year in a note on the 8 major dipterocarp timbers of Burma written by the Forest Economist.

Teredo Investigation.

Seventeen species named in para 16 of the Annual Reports of Utilization Circle for 1926-27 and 1927-28, have been tested up-to-date, and as a result of those tests it is now fairly certain that no Burma timber which is available in suitable size and quantity for piling is, in an untreated state, anything like immune from damage by the teredo found in the Rangoon river, this teredo is a species of *Xylotrya* (syn. *Bankia*). All species tested including teak (*Tectona grandis*) and *pyingado* (*Xylia dolabriformis*) showed considerable penetration after one year's immersion, and the belief hitherto current that certain species, e.g., *ananma* (*Fagraea fragrans*) and *pyinma* (*Lagerstræmia Flos Reginae*) were immune or extremely resistant has been definitely disproved.

The data giving the results summarised above have been analysed and reported to the Admiralty through the Port Commissioners.

The teak piles of the British-Burma Petroleum Co.'s jetty near Thilawa mentioned in last year's report as being untouched by teredo were badly attacked during the year.

This investigation is being continued in order to complete the experiment with fresh blocks of the following timbers :—

<i>Teak</i> (<i>Tectona grandis</i>)	Both creosoted and untreated.
<i>Pyingado</i> (<i>Xylia dolabriformis</i>)	Three of the least unresistant species previously tested.
<i>Pyinma</i> (<i>Lagerstroemia Flos Regine</i>)	Both creosoted and untreated.
<i>Greenheart</i> (<i>Nectandra</i> sp.)	Supplied by courtesy of the Forest Department of British Guiana.
<i>Kanyin</i> (<i>Dipterocarpus</i> sp. probably <i>alatus</i>).	Creosoted. An allied species (<i>D. grandiflora</i>), creosoted, is the standard wharf timber in the Philippines.
<i>Thakutpo</i> (<i>Stereospermum</i> sp.)	Untreated. Previously tested and again included at the request of the Port Commissioners.
<i>Thande</i> (<i>Stereospermum</i> sp.)	

Paper Pulp.—No field work on bamboos for paper pulp was carried out other than the supply of samples of *kayin* bamboos (*Melocanna bambusoides*) to the Forest Economist, Dehra Dun, for pulping tests, but there was some important correspondence with Dehra Dun on the probable cost of extraction of bamboos from forest to factory in Tenasserim if a paper pulp factory were to be installed there. Considerable trouble with labour is anticipated in the very scantily populated bamboo forests both of Tenasserim and Arakan. Imported labour used on a widely extended and moving front, as it would be in bamboo cutting and extraction, would be much harder to control and keep healthy than labour on concentrated and fixed work like rubber planting or tin mining. The difficulties could doubtless be overcome by adequate expenditure but whether such expenditure would be within the limit dictated by competition with wood pulp is a matter for very careful investigation on the spot by anyone who contemplates embarking on a bamboo pulp enterprise.

Timber Testing.

Specimen logs of the following 5 Burma timbers were sent to Dehra Dun for standard strength tests under Projects I and II :—

- 10 logs of *ygo* (*Schleichera trijuga*).
- 10 logs of *kanyin-byan* (*Dipterocarpus Griffithii* or *grandiflora*).
- 11 logs of *taung-thayet* or *shille* (*Swintonia floribunda*).
- 10 logs of *thitsein* (*Terminalia belerica*).
- 12 logs of *petwun* (*Berrya Ammonilla*).

Accurate weight and strength data are now available for most of the more abundant and important Burma timbers. The printed tables of data furnished by Dehra Dun were distributed to all interested. Messrs. Steel Bros. and others reported that they found these tables of definite value in their efforts to market Burma timbers.

Minor Forest Products.

Work under this head was dealt with by the Forest Economist in addition to his own duties in respect of Major Products.

The principal items of interest are as follows :—

(1) *Chaulmugra* Oil.—The work begun in 1924 on the various *chaulmugra* trees of Burma was continued in the shape of the despatch of seed supplied by the Forest Botanist, Maymyo, to various parts of the world, circulation of results and liaison between the Forest Botanist, Maymyo and Professor D. H. Peacock of Rangoon University who is carrying out chemical analysis of the various Burma *chaulmugras*.

It is hoped to publish the full botanical and chemical results in a joint bulletin about 1930, with an appendix by the Silviculturist, Burma, on nursery treatment of the chief *chaulmugra* tree of Burma. That tree is *Taraktogenos Kurzii* which is much the commonest species, the other six related trees being found in smaller quantities and mostly on the frontiers of the province.

(2) *Lac*.—A tour was made by the Forest Economist in the Southern Shan States and in Minbu to collect the latest information on lac and discuss it with the Forest Officers and traders concerned. The results will be published next year in the form of a short note on the present position of Burma lac and past efforts to foster its development. The outstanding impressions gathered on the tour were :—

- (1) The desirability of persuading or forcing the Shan lac collectors, in their own interests, to delay the collection of their lac until after the emergence of the young insects and consequent provision for natural re-infection.
- (2) The need for teaching or trying to teach the Minbu Chins and Burmans to take more care in the drying and sorting of their collected lac, most of which is allowed to deteriorate greatly by mishandling. The Conservator, Delta Circle, reports that the experimental boiling of cutch in order to ascertain the yield from trees (*Acacia Catechu*) of different girth classes, some results of which were detailed in para 59 of the Delta Circle Annual Report for 1927-28, was continued during the year.

The consolidated figures recorded for both years' working are as under :—

Girth class.	No. of trees utilised.	Average yield of cutch per tree in Viss = 3.5 lbs.
Under 2' 6"	60	4.4
2' 6" to 2' 11"	367	9.8
3' 0" to 3' 11"	282	14.4
4' 0" and over	44	29.3
TOTAL	753	12.2

There is no marked difference between the yield from planted and naturally grown trees.

Other work under this head consisted mainly of correspondence relating to the adulteration of cutch, a matter which it is hoped to investigate further next year, and to enquiries about obscure Aphrodisiacs and medicines which gave more trouble than they are likely to be worth.

No information was received during the year on the progress of Professor Peacock's investigations relating to the colouring matter of the Burmese lacquer varnish (*thitsi*) and of the heartwood of *thinwin* (*Millettia pendula*) which were mentioned in last year's report.

Hardwood Investigation.

(1) *Wood Workshops*.—Both the total value of the outturn of the workshops and the proportion of it realised from sales to the public reached a new high level during the year under report.

The progress made since the workshops were started in 1923 is shown below :—

Year.	Sales to public.	Total sales.
	Rs.	Rs.
1923-24	1,190	1,190
1924-25	11,159	11,159
1925-26	19,324	43,105
1926-27	26,511	50,734
1927-28	29,488	44,706
1928-29	40,983	55,178

The yearly increase in the value of the sales to the public which has been maintained without a set-back since those sales began indicates a steadily growing interest in the utility of local timbers other than teak, even though there is reason to believe that the volume of sales is to some extent influenced by the high standard of workmanship of the articles turned out by the shops under the management of Mr. A. Cogger, Workshop Superintendent.

Forty different kinds of timber, none of them previously untried, were used in the workshops during the year, and 71 species in all have been used for manufactured articles since 1923-24.

The gross consumption in the workshops was 262 tons of converted timber as compared with 306 tons in 1927-28 and 49 per cent. of the gross consumption or 1 per cent. less than in 1927-28 was actually incorporated in the articles manufactured.

The principal orders executed during the year were :—

- Furniture for the new Medical College, Rangoon, chiefly in *aukhinsa-ni* (*Dysoxylum binectariferum*) and *kyana* (*Carapa moluccensis*).
- Panelling and furniture for the Port Commissioners' new offices in padauk (*Pterocarpus macrocarpus*).
- Furniture for the Dufferin Hospital, Rangoon, chiefly in *karawe* and *hmanthin* (*Cinnamomum iners*).
- 9,028 handles of various patterns in *yon* (*Anogeissus acuminata*) for the same consumers as those mentioned in last year's report with the addition of the Public Works Department.
- 1,100 plough frames in padauk for the Agricultural Department.
- 1,000 sucker rod protectors chiefly in padauk and *tamalan* (*Dalbergia Oliverii*) for the Indo-Burma Petroleum Co.
- 56,500 floor blocks in padauk, *pyinma* (*Lagerstroemia Flos Regine*), *in* (*Dipterocarpus tuberculatus*) and *taukkyan* (*Terminalia tomentosa*) for various consumers.

Binga (*Stephegyne diversifolia*) which was first tried for printing blocks in 1926-27 appears to have established its suitability for that purpose, 1½ tons of kiln seasoned timber of that species, planed accurately to size, having been supplied to various consumers for the same use during the year under report.

No reports on the timbers mentioned in last year's report as having been supplied for experimental purposes to the Great Western Railway, Messrs. A. H. Dawood & Co., The Irrawaddy Flotilla Co., and Rangoon Arsenal, have since been received.

The usual furniture exhibit was shown at the Burma Arts and Crafts Exhibition held in November 1928.

Five hundred hand samples (6"×3"×½") of timbers of possible economic importance were made and 260 were issued to enquirers. 36 larger samples (2'×6"×1") of the more important species were made and 29 were issued.

An improved system of marking was introduced by Mr. J. Mackereth, Assistant Conservator of Forests, while in charge of the Timber Research Division, under which the date of conversion and, in the case of kiln seasoned timber, the number of the kiln run are recorded on the job cards of all articles manufactured in the Workshops and the number of the job card is, whenever practicable, marked on the articles. The full effects of this system will not be evident until existing stocks of unmarked timber have been used up, but thereafter it should be possible to connect defects reported in manufactured articles with possible errors in the treatment of the timbers used.

(2) *Sawmill*.—The operations of the sawmill during the year under report and in the two previous years are summarised in the following statement :—

Year.	TONNAGE OF TIMBER.		TOTAL.	Outturn of converted timber (Tons).	Loss in conversion.	NETT COST OF CONVERSION PER TON OF OUTTURN.	
	Converted.	Re-sawn.				Maximum.	Minimum.
					Per cent.	Rs.	Rs.
1926-27 . . .	1,545	79	1,624	949	42	41	12
1927-28 . . .	923	274	1,197	625	48	58	19
1928-29 . . .	1,017	243	1,260	626	50	81	21

The increases in the loss in conversion and in the nett costs of conversion shown against the year under report are due in part to an improvement in the standard of outturn, but in the main to the conversion for beehole countings of 790 teak logs averaging only 18·7 cubic feet each in the round.

The mill cut 37 different kinds of timber during the year none of which gave exceptional trouble in conversion.

A new system of marking converted timber was introduced during the year under which the date of conversion of any piece of timber can be ascertained without unpling the stack in which it is placed.

The Officer-in-Charge of the Timber Research Division remarks on the work of the saws as follows :—

“ The large saw bench was operated mainly with inserted tooth saws which gave satisfactory service, though their kerf waste is large. The consumption of inserted teeth was 9,012, costing Rs. 1,065. On average Burma hardwoods these inserted teeth can be worked for about 4 hours without re-sharpening and can be re-sharpened about 4 times. Solid tooth saws have to be re-sharpened after 2 hours.

In the case of exceptionally difficult timbers, such as *thande*, *thakutpo* (both *Stereospermum* sp.) and *chay* (*Gluta tavoyana* ?) which were converted last year the solid tooth saws refuse completely owing to clogging and blunting, while the inserted tooth saws stand up for about one hour and can be re-sharpened only once.

The frame saw worked satisfactorily and proved specially convenient in the conversion of teak for beehole counting. It was also used as much as possible on the more valuable furniture timbers to reduce waste and improve the standard of cutting.”

The beehole counting referred to in the preceding paragraph was an investigation suggested by Mr. W. A. Robertson when in charge of this Circle.

The work done consisted in the conversion into 1" planks of 790 teak logs, half from natural forest and half from neighbouring planta-

tions, obtained from five localities in the Reserves of the Tharrawaddy District in Lower Burma, and cubing 295 tons in all.

The position of each plank relative to the pith and bark of the log was noted, and the number of beeholes in the plank was then counted and recorded. The linear distribution of the beeholes was also ascertained during the latter part of the investigation by division of the planks into 3' lengths.

The full results of this investigation have still to be worked out and published, but an *interim* report is available in the form of a note by the Forest Economist (Mr. C. W. Scott), which was submitted to the Silvicultural Conference at Dehra Dun in March 1929.

The main conclusions drawn in that report are :—

- (1) The plantation teak trees examined show three times as many beeholes per unit of volume as natural teak trees from adjoining forests.
- (2) The beehole-borer (*Duomitus ceramicus*) appears to have a preference for small girth timber and for the tops of trees.
- (3) As a tree increases in height and girth the beehole attack on that tree appears to move up the stem.
- (4) The higher the girth at which a teak tree is felled the greater will be the proportion of its marketable timber free from beeholes.

NOTE.—It seems possible that the preference of the beehole moth for upper and younger parts of teak trees is connected with an increase of tannin or other unpalatable substances in the lower and older parts of the trees.

These conclusions are of considerable interest and items (1) and (4) in particular are of marked silvicultural and economic importance. The credit for them is due to Mr. Scott, who, but for some unskilled assistance rendered by the staff of the Timber Research Division, carried out this very laborious investigation single-handed.

(3) *Storage Sheds*.—The following statement gives details of the stocks of hardwoods held, so far as these are available, and the value of sales of them made to the public from 1923-24 onwards :—

Year.	TIMBER STOCKS AT END OF YEAR.				Value of sales of unwrought converted timber to the public.
	Tonnage.	Value.	No. of different species.	No. of species held in stocks of 10 tons or over.	
		Rs.			Rs.
1923-24	..	No record		..	590
1924-25	974	1 06,800	90	9	1,707
1925-26	2,036	181,425	98	17	2,475
1926-27	1,581	189,916	96	30	4,403
1927-28	1,233	142,324	80	28	10,677
1928-29	1,050	92,917	60	28	11,003

The sales of the year included timbers of 21 different species and amounted to 184 tons, which fetched an average price of Rs. 65 per ton, the range being from Rs. 15 per ton for scrap *zinbyun* (*Dillenia pentagyna*) to Rs. 295 per ton for *kyana* (*Carapa moluccensis*).

Though the figures for sales show an annual increase in total value examination of the details shows no very definite indication of the growth of a regular demand for any of the species sold, the establishment of which is the primary object of the sales.

This state of affairs is attributed to the following factors:—

- (1) The high specifications and regular supplies usually required by foreign buyers.
- (2) The plentiful supplies of low grade teak available for furniture making, which, apart from match making, is the only wood-working industry in the province that at present absorbs any considerable quantities of indigenous timber.
- (3) The large number of all but unknown species stocked and the poor average quality of most of the timber available for sale.
- (4) Lack of regular sales.

Items (1) and (2) present problems for which no solutions are immediately obvious. Items (3) and (4) can be and are being dealt with by the introduction of new methods of grading, storage and sale.

(4) *Seasoning.*—*General remarks.*—Mr. G. W. Rickard, a Timber Seasoning Expert from the Forest Products Laboratory, Princes' Risborough, took over charge of the Seasoning Section from Mr. H. Barber, Upper Grade Assistant, from the 15th April 1928. No fully trained expert had previously been available since the departure of Mr. Teesdale in September 1923.

The work of the year was mainly of a normal nature, consisting of the continuation of previous experiments with regard to the seasonal variation in moisture content of air dried timbers and to the amount of moisture recovery in kiln dried timbers, and of operation of the three Tiemann kilns for supply of seasoned timbers to the workshops and for such purely experimental work as could be fitted in without detriment to that supply. In addition, however, much was done to better the working of the kilns by replacement of defective parts and to improve the technique of the staff and the recording of results. A small experimental blower type kiln of 5—7 cubic feet capacity was sanctioned and was partly erected during the year by departmental agency under Mr. Rickard's supervision, completion of it being delayed by the want of small fittings and apparatus ordered from England.

A second experimental blower type kiln of 75 cubic feet capacity was also sanctioned during the year for construction in 1929-30.

One sign of awakening interest in the possibilities of artificial seasoning in this country was the receipt from a Burma firm of a request for the design of a kiln capable of taking 40 cubic tons per load. This was

duly supplied, the type suggested being an internal fan kiln estimated to cost Rs. 8,000 with the necessary apparatus.

Air Seasoning.—The recording of the seasonal variation in moisture content of small samples (4'-0" in length $\times$ various thicknesses) taken from green timber sawn in the mill, which was started in 1925, was continued, and there were added during the year five new species, viz. :—

Binga (*Stephegyne diversifolia*),

Thingadu (*Parashorea stellata*),

Yemane (*Gmelina arborea*),

Yinma (*Chickrassia tabularis*) and

Yinzat (*Dalbergia fusca*).

The samples by the end of the year covered timbers of 42 different species, many of which had been continuously under observation for four dry and four wet seasons. The moisture contents of these latter samples will be re-estimated in 1929-30, and the data then available should be sufficient to establish definite conclusions regarding the behaviour of the timbers concerned.

Kiln Seasoning.—The three Tiemann kilns which were completed in 1922 were used throughout the year. The plant gave some trouble in operation, mainly owing to an ancient boiler which broke down twice and thereby caused a loss of 66 working days in each of the three kilns. It was also found necessary to replace the kiln doors, which had ceased to be air-tight, a number of steam pipes in the kilns themselves, the electric wiring, and worn out parts of the circulation pumps.

Some of the limitations inherent in this type of kiln became apparent during runs made with two quick drying timbers, *thitto* (*Sandoricum indicum*) and *sagawa* (*Michelia Champaca*), which gave off so much moisture on the air inlet side that the sluggish circulation of about $\frac{1}{2}$ ft. per second was insufficient to remove it, the result in both cases being a lag of several days between the drying of opposite sides of the pile and an equivalent increase in the time taken to complete seasoning.

Eighteen runs, which included two runs of mixed timbers, were put through the kilns. Of 17 different timbers dealt with 5 were tried for the first time. These were :—

Aukchinza-ni (*Dysoxylum binectariferum*),

Hmanthin (*Cinnamomum iners*),

Kanyin (*Dipterocarpus alatus*),

Karawe (*Cinnamomum inunctum*) and

Oak (*Quercus serrata*).

None of these gave any exceptional trouble in seasoning, but *aukchinza-ni* showed an unusual feature in beginning to shrink as soon as drying

commenced, in much the same way as the blue gum of the United States of America. Kiln dried timber of this species also retained stencil marks so effectively that the planing down of a $1\frac{1}{4}$ " plank to $\frac{5}{8}$ " was insufficient to remove them. Three species, viz. :—

Binga (*Stephegyne diversifolia*),

Teak (*Tectona grandis*) and

Thitto (*Sandoricum indicum*)

were seasoned for the second time.

The results in the case of *binga* confirmed those of the previous run and a satisfactory tentative schedule for seasoning this timber is now established.

In the previous test of teak made in 1923, it was found that the treatment brought the natural oil of the wood to the surface or made it collect in the harder dry season wood of the annual rings, a movement which spoils the appearance of the kiln seasoned timber and which might also seriously affect its durability. The second test showed the same effect, but it is now known that the critical temperature at which it takes place lies below 150° F.

The nine remaining species had all been kiln dried on three or more occasions in other years. The results of the work of the year showed that neither *ananma* (*Fagraea fragrans*) nor *taukkyan* (*Terminalia tomentosa*) were exceptionally difficult timbers to season, as they had previously been believed to be ; also that *ananma* and *thingadu* (*Parashorea stellata*) were so slow in drying that a combination of air and kiln seasoning was indicated as the best method of dealing with them.

The results of all kiln seasoning work done since the kilns were erected in 1922 may be summed up as follows :—

Timbers of 67 different species have been put through the kilns. The data recorded are sufficiently conclusive to make it possible to give tentative schedules for 7 of those species, viz. :—

Binga (*Stephegyne diversifolia*),

Chay (*Gluta tavoyana*?),

Thingadu (*Parashorea stellata*),

Padauk (*Pterocarpus macrocarpus*),

Sit (*Albizia procera*),

Taukkyan (*Terminalia tomentosa*), and

Thitkado (*Cedrela Toona*),

although the optimum schedule has not yet been established for any species.

The records for 28 other species are sufficient to indicate in each case the nature of the timber and the degree of heat and rate of drying which the species is likely to stand, while those for the remaining 32 species, which were put through the kilns in mixed loads, usually to supply timber for exhibition purposes, are of no value as a basis for further experiments.

The progress of the kiln seasoning work has hitherto been retarded, not only by the lack of a trained seasoning expert for 4½ years, but also by the fact that the kinds and sizes of the timbers put through the kilns have been regulated by the demands of the Workshops and not by experimental requirements. It is hoped that the completion of the two new experimental kilns mentioned above will remove this handicap and will with the use of the data already recorded make possible at an early date the attainment of definite results in this line of investigation.

The testing of samples taken from kiln seasoned timbers for recovery of moisture contents were continued throughout the year, at the end of which specimens of 29 different timbers were under observation. The data available will be summarised when the records of the parallel test for seasonal variation of moisture in air dried samples mentioned above are compiled.

The cost of operations of the kilns during the year and the two previous years and other data were as follows :—

Year.	1926-27.	1927-28.	1928-29.
	Rs.	Rs.	Rs.
Expenditure	54,806	* 40,596	50,865
No. of kiln hours worked during the year .	15,675	17,940	19,056
Cost per kiln hour	3.49	* 2.26	2.67
Quantity of timber seasoned, cubic foot .	5,314	5,275	3,845
All-in cost per cubic foot seasoned . .	10.32	* 7.70	13.18

* Figures misleading owing to a saving of Rs. 18,251 due to absence of a Seasoning Officer. Without that saving the cost would have been Rs. 11.15 per cubic foot.

The figures for cost per cubic foot for all three years are also misleading to the extent that in calculating them no credit has been given for the increase in the value of the timber resulting from seasoning. This difference cannot be definitely estimated in the absence of any established local market for seasoned timber, but for audit purposes is taken empirically to be Rs. 25 per ton or 0.5 per cubic foot and the cost figures given above should be reduced by that amount.

The costs of kiln seasoning continue to deserve, from a commercial point of view, the epithet "fantastic" applied to them in paragraph 30 of Mr. W. A. Robertson's report on this Circle for 1926-27. It should,

however, be noted that these costs could be much reduced in any plant built and operated solely on commercial lines by :—

- (1) Improvement in design of the plant, e.g., in the matter of circulation mentioned above.
- (2) Increase in the capacity of the plant, which would be possible without a proportionate increase in the overhead and running charges.
- (3) Abolition of runs of mixed timbers and sizes.
- (4) Utilization of plant to full capacity.

Had it been possible to apply item (4) alone to the plant existing at the Government Timber Depot the gross costs of seasoning given above would have been reduced as under :—

Year.	COST PER CUBIC FOOT.	
	From Rs.	To Rs.
1926-27	10.32	5.44
1927-28	7.70	5.84
1928-29	13.18	5.05

The increase in the gross cost of seasoning per cubic foot from Rs. 10.32 in 1926-27 (the last year for which comparative figures are available) to Rs. 13.18 in 1928-29 is due to the following causes :—

- (1) Decrease in the average load per kiln run from 265 to 225 cubic foot.
- (2) Increase in percentage of thick timber (over 2") put through the kilns.
- (3) Increase in idle time, due to boiler stoppages, and consequent increase in unproductive overhead charges.

Other miscellaneous work done in the Seasoning Section was :—

- (1) Treatment in the kilns of a load of 4 tons of *taungpetwun-ni* (*Macaranga* sp. ?), which had become infested with borers in the air seasoning sheds. This was steamed for 18 hours at 130° F. apparently with successful results, as subsequent examination disclosed dead larvæ and beetles inside the planks and there was no recrudescence of the attack.
- (2) Creosoting of test blocks for the teredo investigation mentioned above by heating in an open tank for 24 hours at 200° F.
- (3) Treatment against attack by shot hole borers of five species of bamboos, viz. :—

Thanatwa (*Thyrostachys Oliveri*),
Tinwa (*Cephalostachyum pergracile*),

Wabo (*Dendrocalamus giganteus*),

Wanet (*Bambusa* sp. ?),

Waya (*Dendrocalamus longispathus*),

which were required for the Dehra Dun Museum collection. The principal item of the treatment, which was given on the advice of the Forest Research Institute, was coating with a mixture of paradichloro-benzene, kerosene and turpentine.

- (4) Steaming and Bending tests, the results of which were as follows :—

Padauk (*Pterocarpus macrocarpus*).—Green wood was found to bend well after steaming for 30 hours at 30 lbs. pressure. Dry wood (1") took from 48 to 72 hours.

Yon (*Anogeissus acuminata*).—Green wood for boat ribs, 2"×1½" was found to bend very well after steaming for 48 hours at 20 lbs. pressure. Seasoned wood does not bend well after steaming.

Sit (*Albizia procera*).—The wood was found to bend very well and further tests are contemplated.

Sandawa (*Cordia fragrantissima*).—The wood broke at every attempt. It is apparently too short in the grain to be bent successfully.

Publications.—In addition to the report on the beehole investigation mentioned above the following papers by the Forest Economist (Mr. C. W. Scott) were printed during the year :—

"Precis of Forest Research Projects in hand in Burma in 1928."

"Note on the major Dipterocarp timbers of Burma."

"Note on the supplies of *thitka* timber (Burma Mahogany), *Pentace burmanica*, available in Burma."

The first of these was prepared for and submitted to the British Empire Forestry Conference held in Australia in 1928 and the last two were published for general information.

CENTRAL PROVINCES.

FOREST ECONOMY.

Lac.—Excessive heat in the hot weather of 1928 followed by a hail-storm in the cold weather occasioned some damage to lac in certain divisions, but the crops showed an improvement in quantity over the figures of last year.

The severe frost which occurred in January-February 1929 caused considerable damage to *ghont* (*Zizyphus xylopyra*) in Damoh, but it is too early to judge its effect on lac.

Dates of swarming are reported to be approximately as follows :—

Division.	Kusum (<i>Schleichera trijuga</i>).		Ghoul (<i>Zizyphus xylopyra</i>).		Palas (<i>Eutea frondosa</i>).	
	Jethwi.	Nagoll.	Balsakhi.	Katki.	Balsakhi.	Katki.
South Raipur	25-6-28 . 18-7-28 .	2-1-29 . 25-1-29 .	.. . .. .	.. . .. .	25-6-28 . 10-7-28 .	24-10-28. 6-11-28.
Damoh	.. .	.. .	18-7-28 .	28-10-28	.. .	.. .
North Raipur	7-7-28 . 20-7-28 .	8-1-29 . 19-1-29 .	.. . .. .	.. . .. .	3-7-28 . 9-7-28 .	24-10-28. 30-10-28.
Bhandara	.. .	.. .	.. .	.. .	.. .	.. .
Jubbulpore-Narsinghpur .	29-7-28 .	19-11-28	13-6-28 .	8-11-28	5-7-28 .	3-11-28.
Seoni	14-7-28 .	22-12-28	.. . .. .	.. . .. .	4-7-28 . 7-7-28 .	3-11-28. .. .
South Mandla . . . .	.. . .. .	.. . .. .	.. . .. .	.. . .. .	8-6-28 . 7-7-29 .	4-11-28. 18-11-28.
Buldana	7-7-28 .	3-1-29 .	.. .	.. .	.. .	.. .
Saugor . . . . .	.. . .. .	.. . .. .	13-7-28 . 22-7-28 .	.. . .. .	.. . .. .	.. . .. .

The branch system of propagation introduced in Damoh last year has proved a success and is being continued. The Divisional Forest Officer, Damoh, has shown by means of a graph that an early or late swarming in *Baisakhi* is followed by a corresponding early or late *Katki* swarming.

Further details regarding lac, and information previously given here about *harra* (*Terminalia Chebula*) *tendu* (*Diospyros Melanoxylon*) leaves and *rusa* (*Cymbopogon Martini*) will in future be dealt with by the Forest Utilisation Officer.

PUNJAB.

FOREST ECONOMY.

II.—EXPERIMENTAL AND COMMERCIAL ACTIVITIES.

In the Hoshiarpur Division an experiment, to determine the best season of felling to avoid insect damage to bamboos, which was started in the autumn of 1927, was continued. The opportunity afforded by the experiment was utilised to find out the rate of shrinkage of bamboos. While the results obtained only, of course, apply to the particular locality (Mukerian Range) in which the experiment was carried out, they are of sufficient interest to reproduce; the bamboos were cut in the Karanpur Reserve Forest and carried to and stored at the range quarters at Pandain; the bamboos being inspected daily.

As regards immunity from insect attack it appears that the best month for felling is May, but in practice, felling at this time is not feasible owing to scarcity of water and labour and the unwillingness of purchasers to buy bamboos just before the rains. The second best month is December, while October, November and January are fairly good months.

It therefore follows that in the Mukerian Range of Hoshiarpur Division fellings should commence late in October and can be continued till the middle of January.

An interesting experiment in resin tapping was carried out in Hoshiarpur. This consisted of comparative tests of the results of "enclosed" tapping with those of the ordinary "open blaze" tapping. It was proved that *chil* (*Pinus longifolia*) resin could be collected by means of holes bored as nearly as possible parallel to the axes of the tree and leading to the mouth of an air tight bottle; it was also demonstrated that trees tapped at the base of the crown gave a higher yield than those tapped near the base of the tree. The yield of turpentine was greater with "enclosed" tapping than with "open blaze" tapping. While these experiments are interesting and go to confirm similar experiments made some years ago with certain pines of the United States of America it is felt that the "enclosed" tapping method is likely to prove too expensive for adoption on a commercial scale.

UNITED PROVINCES.

FOREST ECONOMY.

I.—GENERAL WORK OF ADMINISTRATION.

Mr. R. N. Singh, I.F.S., remained in charge of the Utilisation Division throughout the year. He was also in charge of sleeper passing in addition to his other duties.

II.—EXPERIMENTAL AND COMMERCIAL ACTIVITIES.

Timber Seasoning.

A reference was made in the previous year's report to the kiln seasoning of *kanju* (*Holoptelea integrifolia*) by the Wood Working Institute, Bareilly. This was followed up during the year under report by more extensive trials. A sample wagon load of *kanju* logs was sent to the Superintendent, Gun Carriage Factory, Jubbulpore, for trial for packing cases after kiln seasoning the timber in the form of planks. It was not long before a further order for 10,000 cubic feet of logs was received from the Factory. Arrangements were made to supply the timber from the Haldwani Forest Division.

This has stimulated interest in other quarters also. The Imperial Tobacco Co., Ltd., of Saharanpur, annually require a large number of packing cases, and, if the timber is approved the demand from this company alone is likely to be in the neighbourhood of 40,000 cubic feet annually. The Indian Turpentine and Rosin Co., Ltd., have also become interested in the matter and are reported to have placed an order with a Haldwani contractor for the supply of about 10,000 cubic feet of logs.

Timber-Testing and Wood-Working.

The Superintendent, Harness and Saddlery Factory, Cawnpore, to whom samples of *bakli* (*Anogeissus latifolia*) and *haldu* (*Adina cordifolia*) timbers had been sent during the preceding year for sword and khukri scabbards, considers that the timbers are not quite suitable. He has found that teak is the best for the purpose and has therefore decided to use it for the present.

Five logs of *Lagerstræmia parviflora* and 5 logs of *Aegle Marmelos* were sent from the Haldwani and Gonda Forest Divisions respectively to the Forest Research Institute, Dehra Dun, for timber testing.

Minor Forest Produce.

Experimental propagation of lac was continued in the Banda and Gorakhpur Forest Divisions on *Zizyphus Jujuba* and *Zizyphus xylopyra* trees; but it has not yet been possible to record any definite success.

Extraction of the bark of *Litsæa sebifera* was continued during the year in the Kalagarh Forest Division. No deaths caused by removing the bark have yet been noticed, either in this year or in the preceding year's area.

Miscellaneous.

(a) Match Industry.

During the year under review the Bareilly Match Factory used principally *gutel* (*Treulia nudiflora*) for splints and *semul* (*Bombax malabaricum*) for boxes. *Semul* logs were also purchased during the year by the Mahalakshmi Match Factory, Shahdara, and the Ahmedabad Sultan Match Factory, Ahmedabad, for boxes. Inquiries were also received from the Santa Cruz Match Works for *semul* wood, but on account of prohibitive railway freight, no timber other than a sample log, could be supplied. As for spruce, some more billets were sent by the Divisional Forest Officer, Chakrata Forest Division, to the Forest Research Institute, but the results of the experiments are reported to have been inconclusive.

(b) Sleeper Supplies.

Direct arrangements with railways continued to be an important feature of the activities of the Department. Final results of the sleeper operations during the year under report are not yet available. The following numbers have been reported to have been passed so far:—

Sal Sleepers.

	Nos.
Metro gauge, I class	305,030
Metro gauge, II class	21,243
Broad gauge	44,308
Broad gauge bridge and crossing	12,851
Metro gauge bridge and crossing	11,430
Narrow gauge	5,009

Sal half-round and slab sleepers.

With a view to utilising small logs which are not capable of yielding two rectangular sleepers side by side, the Timber Advisory Officer with the Railway Board has been trying to persuade the railways to use half round and slab sleepers. A trial order of 5,000 metre gauge slab sleepers was therefore taken by the United Provinces, Forest Department, for the Bombay, Baroda and Central India Railway at Rs. 2-4 per sleeper and spread over the Eastern Circle. The order met with very little response. The present specification for such sleepers would appear to be much too strict in the matter of the minimum requirements of heartwood to enable us to supply any appreciable number of sleepers. The only justification for this strict specification would seem to be that the sleepers are to be used untreated. It may, however, be remarked that untreated sal sleepers are likely to create a very unfavourable impression ultimately on account of the rapid decay of the sapwood.

Two hundred broad gauge sal slab sleepers with a minimum of 6 inches of flat surface on top for the rail seat, but without any restriction of sapwood were supplied from the Dehra Dun Forest Division at Rs. 4-9-6 to Rs. 4-10 each to the Forest Research Institute, Dehra Dun, for treatment.

A sleeper treating plant is reported to have been sanctioned by the Railway Board in Orissa on the Bengal-Nagpur Railway, mainly for the treatment of sal half-round sleepers. A similar plant at Bharatpur on the Bombay, Baroda and Central India Railway or some other suitable place would appear desirable.

ANDAMANS.

FOREST ECONOMY.

II.—EXPERIMENTAL AND COMMERCIAL ACTIVITIES.

(a) Five logs of red bombway (*Planchonia andamanica*) cubing 2.58 tons were sent for testing under Project I.

(b) Five logs of padauk (*Pterocarpus dalbergioides*) cubing 5.04 tons were sent for testing under Project II.

(c) Fifty axe handles made of *Diospyros pilosula* were prepared locally and distributed to the leading Indian Railway Companies by Messrs. Martin & Co.

Two of the Companies returned the samples, being unwilling to try them—one Company returned them but stated it would inform us when the samples were required by them.

(d) Seasoned planks of *lambapatti* (*Sideroxylon longepetiolatum*) were sent by the Forest Economist to the Burma Oil Company, Burma, for trial for manufacture of candle boxes.

The initial report was that the wood was too heavy, of bad colour and unsuitable.

The Forest Economist not being satisfied with this report submitted further samples which were approved of as being worthy of further trial, it was considered to be the best indigenous timber the Company had so far received. Meanwhile sample veneers of this wood have been prepared locally by the Swedish Match Company and a report on their suitability is awaited.

(e) Some 71 tons of kiln seasoned planks of the following Andaman woods were received during the year at the Calcutta Depot from the Forest Economist :—

Terminalia procera (Badam).

Dipterocarpus spp. (Gurjan).

Terminalia bialata (White Chuglam and Silvergrey).

Canarium euphyllum (White Dhup).

The object of the experiment is to test the market for kiln seasoned timber and to find out whether the cost of seasoning will be recovered by such timber realising higher prices than unseasoned timber.

No sales were, however, effected before the close of the year.

CHAPTER V.

FOREST ENTOMOLOGY.

CENTRAL INSTITUTE.

Charge of the Branch of Forest Entomology was held by Dr. C. F. C. Beeson throughout the year.

Charge of the Section of the Systematic Entomology was held by Mr. J. C. M. Gardner throughout the year.

I. *Insects attacking Sal*.—(a) *Hoplocerambyx spinicornis*.—Remedial measures were continued in all affected divisions in the Central Provinces. By the rains of 1928 in South Mandla 170,000 attacked trees had been felled and burned at a cost per tree of approximately 11 pies for felling and 10 pies for burning; in addition 17,860 trap-trees of the previous season were burned at 9 pies per tree. The total expenditure amounted to Rs. 19,680, as insurance against an anticipated loss of lakhs. In Balaghat the 1927-28 attack was estimated to affect 245,000 trees of which 71,000 were felled and burned before the rains of 1928.

The trap-tree method, i.e., destruction of beetles at newly felled trap-trees, which was first tested in July, 1927, has proved to be a remedy of great value and has been very favourably approved by local officers. Mr. McDonald considers that beetle destruction is probably the most important remedy, but that it is unwise to fell trap-trees in an area remote from an attacked area as it is a sure means of introducing an attack. In Balaghat 6½ lakhs of beetles were collected in July-August, 1928 at 9,000 trap-trees (against 4 lakhs at 3,150 trap-trees in 1927) at a cost of Rs. 2,650. Although the operations were carried out more efficiently and more extensively than in the previous year, the bag of beetles was proportionately much less, indicating an absolute reduction in the incidence of the pest.

In conformity with the advice given for the control of the sal borer epidemic in Rewa State, 15,380 attacked trees of types A to D were felled and burned in 11,700 stacks before the rains of 1928. The incidence of attack was approximately one tree per 40 acres or 3 per cent. of the growing stock. The operations were carried out over an area of 960 square miles, at a cost of Rs. 2,000, and appear to have been sufficient to ensure complete protection.

The rate of emergence of *Hoplocerambyx* in the Central Provinces, when compared by calendar dates irrespective of climatic conditions, was determined to be more rapid than the average rate, but within the limits possible at Dehra Dun; and, when compared with accumulated rainfall from June 1st, a 95 per cent. emergence was reached in the Central Provinces with three-fifths of the rainfall required at Dehra Dun.

(b) *Natural Enemies*.—The predator, *Alaus sordidus*, which was observed in 1927 to be present in 1.4 per cent. of the borer tunnels in South Mandla and in 4.5 per cent. in Balaghat has considerably increased and forms an appreciable natural control factor.

(c) *Secondary Borers*.—A supposed attack of *Hoplocerambyx* in Haldwani, United Provinces, was investigated in February 1929. The mortality of the sal was found to be entirely due to the work of secondary borers (*Aeolesthes holosericea*, *Dialeges pauper*, and *Diorthus simplex* following on injuries due to departmental burning on weakly resistant trees.

II. *Insects attacking Teak*.—(a) *Borers*.—*Clerodendron infortunatum* has been found to be an alternate food-plant of *Phassus signifer*. But *Cajanus indicus*, which is sometimes interplanted with teak, was found to be attacked by *Dihammus punctifrons* and not *Dihammus cervinus*.

(b) *Defoliators*.—(1) *Hyblæa puera*.—The seasonal history of this species has been worked out for the latitude of Dehra Dun. There are 10 generations in the year, those in the hot months having an average cycle of 20 days and those in spring and autumn having a cycle of 28 days; hibernation occurs during the cold weather for about 150 days as pupa or as moth.

Premna latifolia has been discovered to be an alternate food-plant.

Comparative feeding experiments were carried through on soft and hard leaves of teak and *Premna latifolia* and on *Vitex Negundo*, which showed that first stage larvæ cannot survive on hard leaves of teak or *Premna*, and that the survival to the mature larval stage is greater on *Vitex* in the early hot weather and late rains than on teak. These factors are of considerable importance in determining the rate of multiplication of the pest in teak plantations in so far that *Vitex* and *Premna* provide an alternate food-supply when teak is in old foliage or leafless, while young teak stands, which come into leaf before older pole woods and high forest, provide a further stage for the development of the broods that defoliate high forest.

The elimination of alternate food-plants in teak plantations is a practical preventive measure. Where new teak stands are created alongside older age-classes the most favourable conditions for multiplication exist, but, if the broods in the young and early flushing crops are checked, the necessity for control operations in the older crops is avoided.

(2) *Hapalia machoeralis*.—The seasonal history of this species at Dehra Dun comprises 8 generations with an average cycle of 26 days—a rate of development slower than that of *Hyblæa* in the hot weather. The eighth generation larva hibernates for about 160 days from mid-October to end of March. Under artificially raised temperatures the hibernating larvæ were made to resume activity and a series of broods was reared through the winter. Feeding experiments with soft and hard teak leaves gave indefinite results but suggested a greater survival and shorter life-cycle on soft leaves.

An alternate food-supply has not been discovered.

(3) *Parasites*.—Our knowledge of the identity and distribution of the parasites and predaceous spiders of teak defoliators has been much improved by monographic and systematic work during the year, in



Shisham (*Dalbergia Sissoo*) plantation, Montgomery Division, Punjab, defoliated by *Plecoptera reflexa* showing grease-bands applied to trunks to prevent rescent of the caterpillars to the crown.

particular, on the genus *Apanteles*, and it is now evident that *puera* and *macheralis* have no parasitic species in common. The biology of braconid parasite of *macheralis* (*Micocolus* sp. n.) has been studied and the insect has been successfully propagated under conditions of artificial heat and cold.

(4) *Statistics*.—The patrolling month by month of the Nilambur teak plantations has been continued throughout the year and maps showing the intensity and area of defoliation have been prepared.

Measurements of the increment of defoliated teak plantations have been made in sample plots in Coorg by local officers.

III. *Insects attacking Dalbergia Sissoo*.—*Plecoptera reflexa*.—An insectary in charge of an Upper Grade Assistant was maintained at Chichawatni, Montgomery, Punjab, from April to September 1928 to study the seasonal history of shisham defoliators. The chief defoliator is *Plecoptera reflexa* which is accompanied by *Dichomeris evidantis*, *Leucoptera sphenograptia*, other caterpillars and beetles. *Plecoptera reflexa* has a succession of 9 generations between April 8th and September 23rd and possibly 13 in the year. The life-cycle is completed in 18 to 24 days with a larval feeding period of 10 to 13 days. At Dehra Dun a succession of 10 generations was obtained with the cycle varying from 22 to 30 days and a hibernation period of 130 days partly as larva and pupa.

The serious damage by this pest in the irrigated shisham plantations of the Punjab is largely caused by the cultural and irrigation conditions and could be remedied by an adequate water-supply, formation of open crops by cuttings instead of sowings, increased frequency of thinnings, and use of other species on soils unsuitable for shisham.

Feeding experiments proved that very young *Plecoptera* larvæ require soft shisham leaves and are unable to survive on the tough leaves of more mature foliage. Experiments demonstrated that defoliation can be stopped by grease-banding and shaking infested trees. Funds have been allotted by the Punjab Forest Department for a large scale trial of this remedy in 1929.

The parasitism of *Plecoptera reflexa* has been studied with the discovery of 13 species in Chichawatni of which only 5 have been recovered in Khanewal.

Dichomeris evidantis is a leaf-roller affecting chiefly the more mature foliage. It has a similar seasonal history to that of *Plecoptera* and is most abundant from June to August.

Leucoptera sphenograptia is a leaf-miner destroying the younger leaves mainly in August and September.

IV. *Insects attacking Gmelina arborea*.—The seasonal history of *Calopepla leayana* in Dehra Dun comprises 3 generations. The first commences with oviposition at the end of May and in June and occupies about 40 days, the second about 35 days and the third, which begins in September, produces beetles in October that pass the winter and hot weather in inactivity, sheltering in leaves and rubbish on the ground.

This resting period was investigated in February, 1929, in the *Gmelina* plantations of Bhanugach Reserve, Sylhet, which had been heavily defoliated in the previous season. Beetles were found congregated in the dead bark of trees, dead grass, bamboo stumps, etc., under conditions which suggested that their collection and destruction before the close of the dry weather afforded a simple means of control.

Prioptera punctipennis.—This species has a resting period as beetle from November to April. Two defoliating broods were established in May and June.

Alcides gmelinae.—In Dehra Dun this species has 3 or 4 generations a year. It feeds as beetle and bores as larva on the young soft shoots from the end of March to September during which period a succession of larval broods occurs. For the rest of the year the insect occurs as a beetle, semi-active or in ground shelter. The shoots are either killed back completely or develop woody fissures and galls in the second season.

V. *Insects attacking Acacia arabica*.—No field work was done on *Coelosterna scabrator* in Buldana, but babul plants were established in the Insectary at Dehra Dun and infected. Mr. K. C. Ray made observations on the biology of the insect in Bhongaon Reserve. He found that the normal attack is at the rate of one larva per tree of 2 to 10 inches girth at ground-level, the egg hatches in 3 to 4 weeks, the beetle is long lived, and is active from August to December. By hand collection in August-September, 1928, 19,500 beetles were destroyed over 290 acres at a cost of Rs. 120.

VI. *Insects attacking bamboos*.—*Dinoderus* spp. The seasonal histories of *Dinoderus ocellaris* and *Dinoderus minutus* have been determined. In collaboration with the Minor Forest Products Officer an investigation has been started to determine the liability of solid *Dendrocalamus* and selected lance staves to *Dinoderus* attack after various methods of treatment.

Observations have been made on the life-cycle of *Estigmena chinensis*, a borer of living bamboos.

VII. *Insects attacking Populus euphratica*.—Attempts have been made with the assistance of local officers to study the life-cycles of the insects forming pit-galls, globular galls and cushion-galls and leaf-galls on poplars in the Indus plain, Multan division.

VIII. *Insects attacking Quercus dilatata*.—An investigation has been started to determine the effect of defoliators and other insects on the regeneration of the oak forests at Muktesar, United Provinces. Among the former *Hipparchus flavifrontaria* and *Malacosoma indica* are the more important; defoliation occurs from March to June. A high percentage of the acorns of *Quercus dilatata* and *Quercus incana* were found to be destroyed by *Calandra*.

IX. *Kashmir insects*.—A tour was made in Kashmir in May-June, 1928, to study the palaearctic influence on forest insect conditions and much valuable information on the food-plants and distribution of borers



Persian Lilac in shisham (*Dalbergia Sissoo*) plantation, Montgomery Division, Punjab, showing caterpillars of *Plecoptera reflexa* prevented by grease-bands from ascending to the crown.

was obtained. The defoliation of willows in plantations near Srinagar by *Lymantria obfuscata* was investigated and a remedy based on the winter destruction of egg-masses was advised. Among other pests an outbreak was observed of a periodical cicada, *Paharia casyapa*, causing the death of *Pinus excelsa* by sucking, and injury to numerous other species by oviposition.

X. *Shothole and pinhole borers*.—The survey of the food-plants and distribution of Indian pinhole borers has been much facilitated by recent systematic work in the genus *Xyleborus*. Biological data was collected on the borers of Andamans timbers and the effect of various oil dressings as deterrents to oviposition was tried. All mixtures were ineffective.

XI. *General Insectary Work*.—For general breeding investigations up to 760 cages were in use in the insectary and teak, shisham, babul *Gmelina*, *Vitex* and *Clerodendron* were grown in the out-door cages. Enquiries were accompanied by 251 consignments of material for examination. About 43,200 insects were bred (against 34,800 in the previous year).

Systematic Entomology.

The insect collection has been increased during the year by 760 new Indian species and now contains a total of 12,047 different species. About 21,000 insects bred in the Insectary were permanently mounted and identified.

Numerous specialists have, as before, assisted greatly in the classification of certain groups; in this connection it may be mentioned that large numbers of our highly important parasitic Hymenoptera (many of which have been held up for years by the inability or lack of time of specialists to deal with them) have now been identified by recently appointed specialists on the staff of the Bureau of Entomology.

It is needless to point out that as our reference collection increases the work of identification of adult insects is correspondingly facilitated; it is however important to note that a considerable proportion of the material sent in by Forest Officers consists of Coleoptera and Lepidoptera in the larval stages; very little work has been done on the classification of larvæ in India (or as a matter of fact elsewhere) and therefore the Systematic Entomologist is specialising in this work. As a consequence of research at Dehra the larvæ of a considerable number of economic *Cerambycidae* can be specifically identified and, in addition, numerous larval forms of other families; a collection of identified lepidopterous larvæ is being built up.

A request to Forest Officers.

The collection of this Institute consists almost entirely of insects taken by the entomological staff in Dehra Dun or on their necessarily limited tours; Forest Officers have very great opportunities to collect, and are particularly requested to send all insects (however common

they may appear locally) whether in the adult or immature stages. This collection (and the national collection at the British Museum which receives examples of all rarities) will thus be immensely helped. The Forest Entomologist will be glad to advise any interested officer, and supply a collecting equipment on loan. It should not be assumed that because an insect appears to be common in any one locality, it is represented in the Dehra Dun collection. As an example, casual collection at lights during a period of three weeks in so well-known a collecting area as Mussoorie, resulted in the addition of forty new species of *Geometridæ* alone to our collection.

Tours.—By the Forest Entomologist to Kashmir in May—June; to Montgomery, and Lahore divisions, Punjab, in June and August. By the Systematic Entomologist to Montgomery division in May. By Mr. N. C. Chatterjee to Saharanpur district in November and Muktesar, United Provinces in March. By Mr. R. N. Mathur at Chichawatni Insectary from April to September; to Multan, Montgomery and Lahore divisions during the period. By Mr. B. M. Bhatia to Kashmir in May—June; to the Andamans in November—January; to Haldwani, United Provinces in February. By Mr. S. N. Chatterjee to Fatehpur district, United Provinces, in June; to Sylhet, Assam, in February.

Lectures.—The course in Forest Zoology for the Indian Forest Service classes was conducted by Dr. Beeson and Mr. N. C. Chatterjee and occupied 137 hours of lectures and practical work. The incidental work connected with education requires one-third to one-half of the time of these research officers.

Library.—One hundred and sixty-eight books besides periodicals were added to the Zoological library during the year.

ASSAM.

FOREST ENTOMOLOGY.

The activities of the teak canker grub (*Dihamus cervinus*) are being closely watched in Sylhet, but further experiments have not been made in keeping it down.

Owing to the plants being badly browsed by deer and cattle further study of the *cham* shoot borer (*Margarona cœsalis*) in the 1927 Sylhet plantation could not be carried on.

The damage done by the weevil *Aulelobius puliginosus* to the shoots of *Terminalia myriocarpa* previously reported was not observed to be at all extensive during the year and operations to curtail the damage as suggested last year were not undertaken.

A grub which attacks the seed of *hollong* and causes a very low percentage of germination has been identified as *Alcides crassus*.

BURMA.

FOREST ENTOMOLOGY.

Insects affecting Teak.

Xyleutes ceramicus, Wlk., the Beehole-borer.

Life-history work.—Observations on the life-history of this insect have been carried on mainly in a wire gauze cage, 21'×12'×4', built around five naturally grown teak at Zibingyi, 20 miles from Maymyo. This cage was erected in May 1928, and stocked with some 20 billets containing living borer larvae, collected shortly before in Yanaungmyin Reserve, Pyinmana, and Bilumyo Reserve, Myitkyina. There was not much success and only one moth, a female, emerged, on 11th July 1928. Consequently a visit was paid to Yanaungmyin Reserve plantations (1919 and 1920) in August, and about 50 larvae collected and brought up to Maymyo in their billets, and then transferred to the living trees in the Zibingyi cage. This was successfully accomplished by boring holes about two inches deep into the tree with an augur and inserting the larvae into them. In the great majority of cases this method was quite successful, and the larvae adopted their new homes at once and immediately closed the entrances with the usual silken operculum. It will be a matter of some interest to see what sort of galleries they have constructed in their new abodes. At the same time the original billets were split open, as there was little hope of any further emergence from them, as they were by this time very dry. Surprisingly, in two billets the larvae were found still alive, though they could have had little sustenance for over four months. They were transferred to holes in the cage trees, and though one continued working until the end of October, i.e., for about six weeks, and the other certainly until the end of January and possibly until March 16th, neither had produced a moth by the end of the year, and it is feared that they are both dead. This is particularly unfortunate, as having been taken as reasonably sized larvae in April 1928 the presumption is that they had developed from eggs laid during the previous rains of 1927, and should therefore, on the supposition that the life-cycle is annual, have produced moths during the rains of 1928. Of the other original larvae several had been parasitized by tachinids, which had, however, themselves been parasitized by chalcids, none of which had, of course, been recovered in such a large cage. Several larvae had been destroyed by ants, the billets having been split open at the time of capture and tied together again. In two cases the billets were empty, and it is extremely interesting that prior to the introduction of the second lot of larvae, those that were put straight into the trees, two beeholes, or what appeared to be beeholes, were found suddenly in the cage trees. When first found they obviously contained large larvae, and there were certainly no beeholes in the trees when they were caged. It was then supposed that they must be larvae which had left

the rapidly drying billets and constructed galleries for themselves in the trees. That two billets were found empty, and only two, seems to point conclusively to the above being the case. Of these two larvae one produced a moth on March 30th, 1929, and the other on April 16th, after the close of the year. If these larvae had in truth migrated from billets collected in April 1928, when they almost certainly must have been one year old (from eggs laid in the rains of 1927) then they are cases of the life-cycle being prolonged for two years. This question will be further discussed below:—

As it was soon realized that in such a large cage there was little hope of recovering any parasite that might emerge, the mouth of each bee-hole was covered by a small bottle tied on firmly, a joint being made with plasticine. It was also desirable to have some receptacle to catch the ejected frass, so that records might be kept of the continued work or otherwise of the larvae. These bottles fulfilled both purposes admirably, and continuous record exists for each bee-hole of dates between which work went on and frass was ejected. It is as yet too early to endeavour to arrive at any conclusions.

Of the 50 or so larvae introduced in the beginning of September 1928 only two had produced moths by the end of the year, one on March 21st, 1929, a male, and the other on March 30th, a female. When these fifty larvae were introduced, on September 1st, 1928, and endeavour was made to grade them into six classes, by their size and general appearance and the bee-hole from which they were removed—head measurements, a more reliable index, were not used, as it was desirable to handle the larvae as little as possible, and to get them under cover quickly—Class I, the largest was reserved for larvae $2\frac{1}{2}$ to 3 inches in length, and from almost full-sized bee-holes. At the other end of the scale Class VI applied to the smallest larvae, under $\frac{1}{4}$ inch, whose retiring gallery had hardly commenced. Of the two larvae above referred to, which had produced moths before the end of the year, one was classed at the time of introduction as “approaching Class I” and the other as “approaching Class II” in other words they were both so large on September 1st, that it was almost impossible to suppose that they had originated from eggs laid that season, that is, so far as present knowledge goes, since about the middle of March. This is particularly so when these larvae are compared with others of Class VI, collected on the same date from the same locality, in fact from practically neighbouring trees. The majority of larvae introduced graded as Class IV, *i.e.*, somewhat under half-grown. The above observations appear, therefore, to be a further indication that the life-cycle is frequently prolonged to two years at least.

It was soon realized that this great diversity in size, and apparently also age, combined with the interference to which the larvae had been subjected, made it extremely unlikely that even with about forty or fifty chances we should be lucky enough to achieve a pair of moths in the cage together. A visit was therefore paid to the Thogale plantation

(1921) of Pyuchaung Reserve in South Toungoo, during the middle of March 1929, as a previous observer (Rooke, 1917) had recorded moths as being fairly numerous there at the end of March. It was hoped to be able to collect recently emerged moths and either obtain fertile eggs or, better still, transport the moths to Zibingyi where they could deposit their eggs under natural surroundings. The visit was successful enough in that some twenty newly emerged moths were obtained, of which about six pairs were caged. These populated freely and laid large numbers of eggs, which subsequently proved to be fertile, many little larvae being found in the cage from April 4th to 13th, giving an average incubation period of 20–25 days. The moths, however, did not survive the journey to Zibingyi. Endeavour has been made to transfer as many of these little larvae as possible to the Zibingyi cage. It remains to be seen whether this transfer will be successful.

During the above tour in South Toungoo observations were made on the attraction of the moth to light, and on the attraction of the males to females. Although a Storm-King lantern was actually taken out into the middle of the plantation and the Zoologist's camp was itself situated on the edge only two moths, both males, were taken at light. This in an area in which moths were known to be numerous seems to indicate that there is little attraction to light, and none as far as females are concerned. As regards “calling up” by females only one male was caught fluttering round the cage, and the one male caught at light after there were females in the cage showed no interest in the latter. The above, however, was only so while the females were partnered by an equal number of males. It occurred to the Zoologist to try the effect of removing the males from the cage, and on that evening, between dusk and 11 p.m. at least five moths, and possibly more, were seen flying about the room and settling on the cage—the three caught were males and almost certainly all were. This was not in the plantation, but in natural teak forest three miles from the plantations. There would thus appear to be a definite attraction to the females, and there would also seem to be an indication that the females are able to control this attraction.

Analyses of past attacks.—Trees have been felled and analysed in the following localities, Pyonchaung Reserve, N. Toungoo, Bondaung Reserve, S. Toungoo, Yanaungmyin Reserve, Pyinmana, Magayi Reserve, Insein, Myodwin Reserve, Zigon, Namma Reserve, Northern Shan States, Hmyachaung Reserve, Tharawaddy. Altogether 1,458 bee-holes have been opened and dated. The attacks in the above localities, expressed in terms of bee-holes per 100 tree years, are as follows:—

Pyonchaung 34, Bondaung 171, Yanaungmyin 29, Magayi (Intha-baing) 32, Magayi (Thebyu) 24, Myodwin 119, Namma 127 and Hmyachaung 0.

The difficulty of obtaining a true picture of the past history of a wood with respect to the incidence of bee-hole attack is illustrated by

the following comparison with similar figures obtained by Beeson and Mackenzie ;

Locality.	Beeson.	Mackenzie.	Atkinson.
Pyonchaung, 1873	116 (2)	106 (11)	34 (5)
Magayi, 1872	..	8 (15)	32 (11)
Bondaung, 1905	32 (15)	..	171 (7)

Figures in brackets refer to number of trees analysed. In Pyonchaung, certainly, there has been a definite reduction in the annual incidence since previous analyses were made, but nothing like sufficient to account for such a drop. Similarly in the other two cases. The extraordinarily local variation in incidence has frequently been noticed, and the Zoologist is of opinion that on this account alone it is almost impossible to obtain a true average without taking a very large number of sample trees. In fact, it almost appears that the history of any tree, as revealed by analysis, is merely the history of that particular tree, and gives very little, if any, information as to conditions in the tree next door.

The most interesting point that has emerged from these analyses is the very high proportion of failures. Successful emergences average only about 25 per cent., the highest proportion found so far being in Myodwin Reserve, 36.6 per cent. of attacks having resulted in moths, and the lowest 13.9 per cent. in Yanaungmyin Reserve, Pyinmana. The great majority of these failed galleries show no obvious reason for the failure ; that is to say, there are no signs of parasitism, or of fungoid growths, or of woodpecker attack—the galleries are merely empty. There seems no very obvious reason for supposing that larvae willingly leave their partly constructed galleries only to crawl up the tree and make others, on the contrary one would require very definite proof that they ever do so. It seems more probable that woodpeckers are the cause of these failures, more particularly as very many fail when they are so short as to be within easy reach of the birds beak. This question is more fully discussed below.

As a result of an investigation into the comparative beeholing of plantation and natural grown timber carried on during the year in the Government Timber Depot, Rangoon, the Forest Economist brought forward the following interim deduction ; that beeholing was more numerous towards the heart of the tree, and in top logs, which seemed to indicate that the insects showed a preference for small girth timber. As an outstanding example he quoted two very heavily attacked top logs from an 1862 plantation in Myodwin Reserve, Zigon. The following analysis of a tree from the same plantation is therefore of interest :—breast-height girth 5'—8", total height 106', marketable height 82', producing 162 beeholes, of which 93 were in the lower half of the tree

(ground to 41') and 69 in the upper half (42' to 82'). One cannot of course quarrel with figures, and the final results of the above investigation are awaited with interest, particularly as they will produce a far greater number of beeholes than one can ever hope to achieve by analysis in the forest. The Zoologist is, however, being more and more forced to the opinion that attack is purely fortuitous and that no preference whatsoever is shown for kind of tree, dominant, dominated or suppressed, or for part of tree, upper or lower. There does, however, seem to be some reason for thinking that eggs are not distributed separately, but laid in small masses, and that the larvae on hatching distribute themselves, and always upwards, so that there might be some tendency for beeholes to be more numerous as one proceeds up the tree.

Conditions affecting attack and development so far defy interpretation. How is one to explain the following apparent anomalies ? (a) Far the highest proportion of successful development, 50 per cent., was found in a definitely dominated, almost suppressed tree, in Myodwin plantation of 1862, in which, of 54 beeholes, 27 had produced moths. A further interesting point is that of these 27 successful beeholes no less than 22 dated since 1910, during the whole of which period the tree must have been in the class in which it was found when analysed. (b) A tree of 9'-6" breast girth height felled in Namma Reserve, Northern Shan States, fairly heavily attacked, with 101 beeholes, contained only two living larvae, i.e., attacks of the year. One of these was taken from billet No. 51 (that number of feet from the ground) and the other, an extremely large larva, from billet No. 2, that is, from a girth of about 10'. (c) After several days of tree-to-tree examination in plantation 12 of 1917 in Bilumyo Reserve, Myitkyina, resulting in very few and very scattered larvae, a tree of only 1'-4" girth, i.e., distinctly below the average, produced no less than 5 current beeholes.

Natural enemies.—Two species of *Tachinidae* have been bred from *Xyleutes* larvae, both of which remain unidentified. Of one species a single larva will produce 10—20 individuals, even more. Of the other, a considerably larger fly, only two or three specimens emerged from a single host. Nowhere has either of these species been found numerous, the highest percentage of parasitism being 8.1 per cent. in the Intha-baing plantation (1872) in Magayi Reserve, Insein.

One, possibly two, species of *Hymenoptera* parasitize the borer larva. No living specimens have been obtained.

Of predators, ants are thought occasionally to destroy the larvae. A tree was found in plantation 8 of 1919, Yanaungmyin Reserve, Pyinmana, in which there were 6 current beeholes, none of which was occupied by a larva. In their place a community of ants (as yet unidentified) had constructed a gallery of frass and bits of bark from the ground to each beehole in turn and were occupying the latter. Several other instances of empty galleries, unvisited by woodpeckers, were seen in the neighbourhood.

The fierce red and black ant, *Sima rufonigra*, "kayin-ni," frequently adopts beeholes into its galleries, using them as entrances and keeping them open for years after their original construction. It is probable that it disposes of any living larvae in its tree.

By far the most important enemy of *Xyleutes* larvae is, however, undoubtedly the woodpecker, and the Zoologist does not consider that these birds have in the past been given their due. They have been maligned as worse enemies to the tree than the beehole larvae they are removing, without taking into consideration the fact that they never make mistakes, and that the timber into which they drill has already been ruined by the larva, or that they are removing the prospective cause of numerous beeholes. This damage to the timber, moreover, only occurs when the bird is engaged on a full-sized beehole, containing the mature larva or pupa, which it is unable to reach without this excavation. Even supposing that the bird restricts its diet of borer larvae to the period when other food is scarce, as has been suggested, it has been shown that there is such variation in size of larvae and beeholes that at practically any time of the year there are larvae available within the reach of the bird's tongue inserted through the beehole mouth, and it seems unbelievable to the Zoologist that the bird does not avail itself of these. Further, it should be noted that ants are by far the commonest food for woodpeckers, and at no time of the year are ants so scarce as to drive the bird to sustain itself on *Xyleutes* larvae, with the implication that it would not dream of doing so unless compelled. It has been shown above that on the average 75 per cent. of larvae fail, of which only a very small proportion are accounted for by parasitism or obvious woodpecker attack. The Zoologist is of opinion that the great majority of the other failures are also caused by woodpeckers, the birds having extracted the larvae through the mouth of the beeholes, with a mere pecking at the bark, which leaves no sign when the beehole is occluded. If a case of the ordinary well-known woodpecker attack, into the top of the beehole, be examined, it will be found in all cases that the bird has first tried his luck through the mouth and it is only in cases where he has failed through the mouth that recourse has been had to the familiar excavation. Numerous cases have now come under observation in which the bird has succeeded in its first effort, and all that is noticeable is a slight pecking at the bark over the mouth of the beehole no signs of which would remain in the wood of the tree after occlusion.

Mackenzie places the distance at which larvae are extractable through the mouth of the beehole at $4\frac{1}{2}$ ", but does not connect this with any particular species. Undoubtedly the Great Slaty Woodpecker, *Mulderipicus pulverulentus*, could reach the distance, and possibly also *Chrysocolaptes g. guttacristatus*, but it is doubtful if the smaller species, such as *Dinopicus javanensis intermedia*, a common bird in teak plantations, could reach so far. However, a distance of $3\frac{1}{2}$ " to 4" would cover about 75 per cent. of the failures we are concerned with, and as regards longer galleries than this it is certain that the bird on occasions finds the larva in its sapwood chamber, just waiting to be picked out. The

Zoologist has fairly frequently opened a beehole with a rapid slice with a *dah*, to find the larva engaged in feeding in its sapwood chamber immediately under the bark. In this connection it is of interest that whereas the plate in Beeson's Record shows a half grown larva apparently feeding with the greater part of its body concealed in the heartwood gallery and only the head and thorax protruding into the sapwood chamber, in all cases found by the Zoologist the larva has been completely in the sapwood chamber and on occasions has had to turn round before it could retire into the tree.

In the above connection it is very interesting to note that the area which produced the highest percentage of successful emergence, and in which, on the above argument, woodpeckers have been least beneficial, is the Myodwin plantation. This is a small planted area entirely surrounded by cultivation and in which practically no nesting sites can be available, just the type of area, in fact, in which one would expect woodpeckers to be far from common.

Endeavours have been made by the examination of the stomach contents of birds shot in the rains to prove that the bird does take small larvae. Twenty-one stomachs were examined, but without success as yet.

There being thus strong grounds for thinking that woodpeckers represent the most important natural control for the borer, steps are being taken to encourage the birds, in selected areas known to be heavily attacked, by the provision of nesting boxes during the coming breeding season.

Mechanical control.—(a) Mixtures. Plantation 1 of 1872 (Intha-baing) Magayi Reserve, Insein, displays a heavy mixture of teak with *kanyin* (*D. alatus*) which has come in naturally. The attack here was found to be 32 beeholes per 100 tree years, as compared with an attack of 24 in plantation 23 of 1889 at Thebyu, some six miles further east, where there is no appreciable mixture with other species. The Divisional Forest Officer, North Toungoo, reports that in a 1922 plantation in Gwethe Reserve a mixture of 60—70 per cent. of teak with *pyingado*, padauk and other species and in which weed growth is very heavy, the attack by the borer was found to be much heavier than in other plantations in the reserve. Both these cases seem to show that no protection from attack is likely to be gained by the admixture of teak with other species.

(b) Time of thinning. Living larvae were taken on March 14th, 1928 from trees of plantation 3 of 1868 N. Toungoo, felled in late October or early November 1927. These same trees had also produced moths by the above date. A living pupa was taken on March 14th, 1929 from a 2" branch of a pole felled in December 1928 (Plantation 1921 Pyuchaung Reserve, S. Toungoo). It is remarkable that this insect was able to complete its development in such small girthed timber, which had become quite dry when found. It would appear, therefore, that unless felling takes place before the end of October, there is a great

probability of larvae being able to complete their development, and in the case of large girth trees an even earlier date (for either felling or girdling) is advisable.

(c) Handpicking. There seems a possibility that, ludicrous though it may sound, quite a reduction in the borer population can be achieved in young plantations by this method. Young larvae, about a month old, appear to tunnel very vigorously just under the bark, and as a result cause the ejection of a black semi-liquid mass of frass, which is very noticeable on the light coloured bark. A slight cut with a *dah* at this time easily remove the larva. Ranger Maung San Thwin, as a result of a few days in the Thogale plantation of South Toungoo, brought back his complete stock of tubes full of living larvae, and slaughtered hundreds more in this way. During the hot weather, when the majority of larvae are fairly large, it is very easy to spot attacks by glancing at the ground at the foot of the tree. The little pile of reddish frass are at once noticeable, and with a length of hooked wire it is not difficult to extract the larva or pupa. In the case of the latter extraction is not necessary, as the sound of the brittle pupa cracking is quite audible.

This method will be further tried out during the coming year, as to ensure a result commensurate with the expense involved directions to the divisional staff will have to be explicit.

Hybloea puera Cram.—Individual specimens of this insect have been sent in from several divisions, but no serious case of defoliation due to its agency has been noticed. The Zoologist found cases of complete defoliation, but only of a few trees here and there, in plantation 1896 of Yanaungmyin Reserve, Pyinmana, in August 1928. Parasitism, mainly by a large unidentified ichneumonid, appeared to be high, and numerous specimens, as also of a tachinid, were both collected and bred subsequently.

Hapalia machaeralis Wlk.—This appears to be the species responsible for serious defoliation in Burma. Two such cases were investigated during the year, one in Myohla Reserve, North Toungoo, during December and January, on the report of the Divisional Forest Officer, and a more serious one, in the Letwagyi and Kunsan plantations of Zigon, during January 1929, on the report of the Silviculturist, who had just visited these areas. In Myohla Reserve defoliation was found to be "heavy partial" to "complete" and had resulted in the production of a new flush of leaves, which had, however, practically escaped defoliation. The conditions on January 10th and 11th were that the ground was covered with the completely or partially defoliated leaves of the old flush, each one of which contained several full-grown larvae in their silken cocoons, apparently aestivating. A few had transformed to pupae, and a few moths were seen, but practically no feeding larvae. Parasitism was high, two counts giving a percentage of 31, that by a tachinid fly being much the highest, 22 per cent. of the defoliators being attacked. Both

these percentages were subsequently slightly increased by the collected material, from which the counts were taken, producing further parasites in the Insectary. Unfortunately, however, the tachinids were found to be themselves very heavily parasitized, mainly by a large black and yellow chalcid, which was seen very numerous flying about and at rest on foliage all over the area. This hyper-parasitism was estimated to amount to 80—90 per cent. and the breeding experiments in the Insectary have since shown it to have been 90.3 per cent. The parasitism being thus completely nullified by hyper-parasitism recommendations were made for the immediate burning of the area, so as to destroy the enormous number of insects resting in the litter. This was carried out, and though no report has been received from the division it is fairly safe to presume that little, if any damage can have been done to the plantation. It remains to be seen what effect this action will have had on the numbers of the insect this coming rains.

Large numbers of the apparently aestivating larvae were brought to Maymyo for breeding purposes. The emergence record of this material is very interesting. From material collected during the last week of December 1928 only four moths emerged before January 21st. From that date the emergence was fairly regular but limited to four or five moths a day until the end of February, when the curve starts to rise, culminating with an emergence of 21 moths on March 25th, after which there is a rapid fall to the last moth on April 15th. None of these larvae was of course provided with food during captivity. It is thus apparent that aestivation was indeed taking place but in an extremely imperfect form; at the height of emergence, in the third week in March, the plantation must have been practically leafless.

From the tachinid material collected no less than 14 species of chalcidoid hyper-parasites have been bred, of which about 5 species are multiple parasites many individuals emerging from a single puparium. Of these hyper-parasites the large black and yellow *Chalcis* referred to above is much the most common. A few individuals, as also of some of the other species, have been bred apparently direct from *machaeralis*, that is to say, as primary parasites, but any good they may do as such is far outweighed by the harm caused through their parasitizing the tachinid, the important parasite.

In the areas in the Zigon Division, which will here be considered together, defoliation was more severe, particularly at Kunsan, where according to local information the leaves then on the trees were of the third flush, defoliation having been twice complete. The first leaf-fall was reported to have been complete on July 26th, 1928. The second leaf-fall was not recorded, but the Divisional Forest Officer stated that a new flush, the third presumably, was starting in early December. The result had been that in very many cases the shoot of the year, both the leader and side branches, had been killed, and the young trees resembled bottle-brushes, with whorls of epicormic branches all up the stem. At Letwagyi defoliation had not been so severe; according to reports

premature leaf-fall had been caused only once, and no cases of dead leaders were seen here. A letter from the division states that the larvae causing the first attack were "large and hairy, resembling caterpillars", whilst in the second case the larvae were "small and hairless, resembling worms". This rather implies that the first attack was caused by *Hyblosa*, though at the Zoologist's visit no signs of the latter insect, such as empty pupal skins, were seen.

At the time of the Zoologist's visit, the middle of January 1929, the attack had practically ceased to exist in both areas. Whereas in N. Toungoo every fallen leaf harboured one or two aestivating larvae, here nothing but empty pupal skins was found. A very few small larvae were found feeding on epicormic leaves, so scarce that only about twenty a day were taken. It is thus apparent that in the climate of Zigon aestivation does not take place in any form, and the continuance of the species from year to year is dependent on a few moths of the last generation finding adventitious growth on which to carry on. It is interesting that a difference of one degree in latitude, the Zigon areas being about 18°30' N. and the Myohla area about 19°30' N., should be sufficient to cause this difference in habit. It is probable that as one proceeds further north the faculty of tiding over the leafless period as a resting larva will be found to be more perfect.

In both the Zigon areas parasitism was found to be surprisingly slight, considering the enormous numbers of the hosts. Counts showed that against a successful moth emergence of 500 only 14 hosts had been parasitized by tachinids and 17 by hymenopterous species, braconids mainly, percentages of only 2.6 and 3.2 respectively. In this area also, the majority of tachinid puparia showed evidence of a hyper-parasitic chalcid.

Biological control.—In the Report on Forest Research in India for 1927-28 it is recorded that of the 31 species of parasites which have been bred in India from *machaeralis* only three are known to be common to two or more regions. It is anticipated, therefore, that not only will many of our Burma parasites be of local occurrence, but that also many of the Indian parasites will be found not to occur in Burma, and consequently their importation and establishment free of their own parasites will greatly strengthen our cycle of effective parasitism. This will constitute an important line of enquiry during the coming year, and our series of parasites will shortly be ready for despatch to Dehra Dun for examination and comparison.

Other pests of Teak.—*Aristobia approximator* Th. This handsome black and orange lamiid is the insect responsible for long galleries in the wood of teak, running downwards in the long axis of the tree. It seems usually to commence in a branch or yearling shoot, and thence run into the wood of the tree. It is characterized by a series of ejection holes along the length of its gallery, from which the frass, in very definite oval white pellets, is scattered on the ground below. It appears so far to be a pest of fairly young crops, and has not been taken from

teak of over 10 years, but causes serious damage where it occurs in any numbers, as the work in the wood is considerably more extensive than that of the beehole borer. The insect has also been reared from a pole of *binga* (*Stephygyna diversifolia*), and the adult has been experienced in large numbers in areas far from teak, as for instance in Rangoon town, where it was reported doing damage to ornamental trees and shrubs, such as *Hibiscus* and *Lagerstroemia*. It is probable, therefore, that the insect has some alternate host, very possibly of a gregarious species, as in the case of *Dihammus cervinus*. Endeavours are being made to trace this host, and to discover how the insect makes its way into the teak plantations. The life-cycle appears to be annual.

Dihammus cervinus Hope. This insect appears to be distributed generally all over Burma, though it is not common in the Hlaing Circle. It was, therefore, interesting to rear it from a small plot of *yemane* (*Gmelina arborea*) in the Twante plantations of Insein. It is suspected also to breed in several host plants other than the three well-known ones, teak, *yemane* and *Clerodendron*, though this will require confirmation from Dehra Dun. Several years work on this pest has been done at Dehra Dun, which it is not proposed to reduplicate here, but so far nothing superior to hand-picking, by squashing the young larvae under the bark, has been devised. An insect with several common host-plants is obviously impossible to keep out of teak plantations.

Pests of other species of economic importance.—*Calopepla leayana* Latr. This beetle is the common defoliator of *Gmelina arborea* all over Burma. It is not likely to be of any great importance except in the *yemane* plantations at Namtu, Northern Shan States, where any interference with the increment would be serious. These plantations were visited during July 1928 when defoliation was found to be surprisingly slight as the beetle occurred in the area. It was soon found, however, that the insect was well under the control of its parasites, the most common being a *Chalcis* pupal parasite, very similar in appearance to the species so seriously interfering with the good work of the tachinid parasite of *Hapalia machaeralis*. This insect was so common that it was difficult to find a healthy pupa.

A diverse fauna has been bred from *ingyin* (*Pentacme suavis*) taken in various stages of health, from green to dead, in Mohnyin and Bilumyo Reserves, Myitkyina. The primary pest appears to be a very large cerambycid, identified as *Cyriopalpus wallacei* Pasc. a new addition to the Indian Fauna, which definitely attacks green, apparently healthy trees. This is followed by a complex, in very large numbers, of brenthids, scolytids, platypodids and longicorns, apparently in that order, which rapidly kill the tree, and ruin the timber. It remains to be proved, however, whether the unhealthiness of the trees results from the insect attack, or *vice versa*. The death of the tree certainly results from, or is greatly hastened by, the insect attack. This matter is being gone into further.

General Insectary work.—Eighty-seven cages were in use at the close of the year, mainly in the breeding of woodboring insects. 5,264 insects, excluding large numbers of Fungus Gnats, emerged in the insectary up to the close of the year, and 10,306 insects have been set and mounted. 179 species have been sent to Dehra Dun for identification many of which have not yet been returned.

Miscellaneous.—*Food of woodpeckers.* The Divisional Forest Officer, North Toungoo, Mr. Mackenzie, kindly sent the Zoologist the stomach contents of 13 woodpeckers shot by him in teak plantations, during the rains and a further 8 birds were shot by the Zoologist, also in teak plantations. These stomachs were examined mainly in the hope of finding traces of beehole borer larvæ, but without success. The birds examined were of the following species :—

<i>Gecinulus viridis</i>	2 specimens.
<i>Dinopicus javanensis intermedia</i>	5 „
<i>Picus vitatus viridanus</i>	1 „
<i>Picus chlorolophus chlorolophoides</i>	2 „
<i>Chrysocolaptes guttacristatus guttacristatus</i>	4 „
<i>Mulleripicus pulverulentus harterti</i>	1 „
<i>Picus erythropygius nigrigenis</i>	4 „
<i>Unidentified</i>	1 „
<i>Chrysophlegma flavinucha flavinucha</i>	1 „

Ants formed the commonest food, the genera *Oecophylla* and *Camponotus* being most frequently represented. Termites were also very numerous. Several birds contained cerambycid and lamiid larvæ, and one bird contained fragments of several *Hyblosa puera* pupæ.

Enquiries from Divisions. With a few exceptions divisions have been notable for their complete silence. It is to be hoped that, now that a report on the work of this branch has issued, Divisional Forest Officers will be encouraged to send in specimens and to report cases of insect damage that have been noticed. Insects collected during the course of an officer's ordinary touring, or at light, will always be welcome, and will often include species of interest and scientific value.

The Divisional Forest Officer, N. Toungoo, reports as follows :—

“ Small collections of common mammals were made for the Rangoon University, the Burma Forest School, Pyinmana, and the Forest Research Institute, Dehra Dun. They were dispatched after the end of the year.

A few specimens not represented in the collection mentioned last year were sent to the Bombay Natural History Society, for the British Museum, to work out.”

Staff. The staff consists of two Rangers (Field Assistants), 3 Setters or Fieldmen, 1 Clerk, 2 office peons and 1 Insectary peon. A permanent establishment has not yet been sanctioned and the want of a whole-time Insectary Assistant is felt keenly. The work of labell-

ing and sorting bred insects, writing up records, etc., is consequently much behind-hand.

After several rapid changes among Setters three men have been obtained who are now getting quite adept at the work.

Buildings. Accommodation for this Branch consists of a very good combined office and laboratory for the Forest Zoologist, an Assistant's room, which is also at present occupied by the clerk, and a commodious Insectary and Cage-room. All the above are provided with good lighting and benching. It is hoped that water will be laid on shortly. In addition an out-door Breeding cage, 20'×10'×8', divided into two by a wire gauze partition, has been constructed. This is large enough to take growing trees, and one half is already stocked with *Gmelina arborea*, while the other will be planted with teak during the coming rains.

CENTRAL PROVINCES.

FOREST ENTOMOLOGY.

Eublemma amabilis was observed on lac incrustations on *Zizyphus xylopyra* in Tendukhera Range at the time when the Director, Lac Research Institute, Ranchi, visited these forests last November. In her opinion it did do some damage to the incrustations by tunnelling through them but she considered that no remedial measures were called for. She ascribed its presence to bad weather.

The damage done by *Coelosterna scabrator* continues in alarming proportions in Buldana Division. It is not so bad in Amraoti and Akola Divisions. Operations were carried on in Bhongaon reserve (Buldana) to destroy the borer by handpicking and uprooting the affected plants.

The number of attacked plants grubbed out last year was 23,480 costing Rs. 159-9-0 and the total number of insects caught and destroyed this year was 23,445 costing Rs. 164-0-6. Observations to determine the proportion of males to females show that females exceed males by about 25 per cent.

Indirect methods of control are being tried by the introduction of new species in the *babul bans*. The life-history of this beetle has been worked out and will be published separately.

As a result of the protective measures undertaken against *Hoplocerambyx spinicornis* in the past years it can now be maintained with confidence that the sal borer attack is now almost, if not completely, under control in Balaghat Division and Banjar Range of South Mandla, and has completely disappeared from Karanjia, Dindori, and Motinala Ranges.

In South Mandla during the hot weather of 1928, the borer laid eggs in trees which had been felled and prepared for burning during the previous year. These trees were burnt later on in the hot weather. A

statement showing the number of trees burned per range with cost is given below :—

Range.	No. of trees.	Cost.	Average cost per tree.
		Rs.	Rs.
Motinala	49,450	3,420	1-1-0
Banjar	57,660	3,007	0-0-10
Dindori	32,363	1,649	0-0-10
Karanjia	28,785	631	0-0-4½
TOTAL	168,258	8,707	0-0-10

In Banjar Range the first emergence of beetles was observed on 24th June 1928 and it continued till 15th August 1928. Trap-tree operations were carried out with the following results :—

Range.	No. of trap trees.	Cost of felling trap trees.	No. of beetles collected and killed.	Cost of collection and killing beetles.
		Rs.		Rs.
Banjar.	3,195	220	192,645	282
Motinala	2,957	177	117,018	177
Dindori	3,982	163	64,009	162
Karanjia	5,824	201	96,550	63
TOTAL	15,958	761	470,222	684

During the working season of 1928-29, i.e., from December to March all trees which were observed as attacked were felled and prepared for burning. A statement of these trees is given below :—

Range.	No. of trees.	Cost.	Average cost per tree.
		Rs.	Rs.
Banjar	28,844	1,917	0-1-1
Motinala	3,449	511	0-2-4
Dindori	1,239	63	0-0-10
Karanjia	1,923	229	0-1-11
TOTAL	35,455	2,720	0-1-3

Last year's figures, i.e. for 1927-28, are as below which indicate how the attack has decreased in the year under report :—

Range.	No. of trees.	Cost.	Average cost per tree.
		Rs.	Rs.
Banjar	57,938	3,454	0-0-11
Motinala	51,029	3,416	0-1-1
Dindori	32,343	2,210	0-1-1
Karanjia	28,747	1,104	0-0-8
TOTAL	170,057	10,184	0-0-11

Approximately it is only 20 per cent. of last year's attack.

The trap-trees of 1928 rains and the borer attacked trees felled and prepared for burning during the working season 1928-29 remained for burning at the end of the year, as this will be done in the hot weather of 1929, but it was observed during February and March that many of the trap-trees no longer contained living larvæ and their burning would be unnecessary.

A detailed description of the campaign in the sal areas against the borer with special reference to South Mandla has been written by Mr. Muir and recently published in Indian Forest Records, XIII, Part V.

Similarly a note on the sal-borer attack 1927-28 was published in the "Indian Forester", November 1928, by Mr. Watts, Divisional Forest Officer, Balaghat.

The following statement compares the total number of beetles caught during 1928 with the numbers caught in 1927 in Balaghat Division.

	1927.	1928.
Baihar	252,594	311,847
Supkhar	155,867	342,792
	408,461	654,639

The better "catch" in 1928 should not be taken as an indication of increased severity of the epidemic; it must rather be attributed to more efficient methods and a longer working season.

Teak defoliators caused damage in some divisions. The damage in Amebarwa Reserve (Buldana) and the Sipna valley (Melghat) was severe but later in the year that usual.

ANDAMANS.

FOREST ENTOMOLOGY.

An Assistant to the Forest Entomologist accompanied the Inspector General of Forests on his visit to the Islands in December 1928.

The object of his visit was to study the various borers which attack our timbers before and after conversion with special reference to the pinhole borer which is very destructive in the case of White chuglam (*Terminalia bialata*).

Various borers were collected by him and are still in process of classification. He found that logs shortly after felling, and while in transit, are attacked by a large number of species of pinhole borers.

Complete submergence for a long period in sea water stops the development but the logs must be totally submerged.

Logs half submerged or in rafts continue to be exposed to the attacks.

It was found that the borers continue to breed in the slabs and general waste in the mill yards. The waste stored for fuel and the battens used for stacking planks were found to be a serious source of infestation.

In addition to the pinhole borer trouble, lyctid borers were found in the Chatham Mill Yard but Bonington Mill Yard was found to be free from them.

A number of logs were treated with a view of securing protection from the pinhole borers, but without result, those treated being subsequently found to be attacked to the same degree as the untreated.

Various suggestions were made by the Forest Entomologist for dealing with the attacks of the pinhole borers in the yard but it was decided that, without further detailed examination, final recommendation could not be usefully made and arrangements have since been made for the Forest Entomologist to visit the Islands himself.

CHAPTER VI.

CHEMISTRY.

CENTRAL INSTITUTE.

The following programme of work sanctioned for investigation in the Chemical Branch of the Forest Research Institute was undertaken during the year under report.

1. General study of the chemistry and commercial uses of the Minor Forest Products.—

(a) Isolation and study of the active principles of some medicinal plants—

(i) *Ephedra Gerardiana*, *E. intermedia*, *E. foliata*.

(ii) *Aconitum Chasmanthum*.

(iii) *Taraxacum officinalis*.

(iv) *Senecio* spp.

(b) Study of the so called third class turpentine (Longifolene) from *Pinus longifolia*.

(c) Study of Cutch and Katha.

2. Study of forest soils.

3. Miscellaneous enquiries.

MINOR FOREST PRODUCTS.

Indian Ephedras.—The enquiry in connection with the ephedrine content of the different species of *Ephedras* found in India was continued. It has been found that *E. foliata* does not contain any ephedrine, while *E. intermedia* contains about 0.1—0.3 per cent. and *E. Gerardiana* 0.4—1.25 per cent. *E. Gerardiana* growing in the drier regions of North-West India (Razmak, Kaghan, Plas Kohistan and Lahoul) contains a high percentage of the alkaloid and in certain cases has given a higher alkaloidal content than the Chinese species *E. equisetina* and *E. Sinica*. Those growing in comparatively moist places (Chakrata, Hazara, Kashmir) were found to contain smaller amounts of ephedrine, varying from 0.3—0.6 per cent. Results indicate that there is a connection between the ephedrine content of the plant and the rainfall of the locality. The greater the annual rainfall the smaller the alkaloidal content. For example, *E. Gerardiana* from Phari (near Darjeeling) with an annual rainfall of about 100" contains only 0.10 per cent. ephedrine, whereas a sample from Kaghan with an annual rainfall of about 3" has 1.25 per cent.

Ephedrine is becoming more and more important as a result of its newly discovered uses in medicine, and already a demand for *Ephedras* has been created in India, and elsewhere, notably the United States of America. And if *Ephedras* of high alkaloidal content can be supplied

it is expected that Indian ephedras will soon capture the bulk of the trade in this drug. Work in connection with the best time of collection of the plant is in progress. The chemistry of ephedrine, especially its reactions with certain reagents has been studied and a cheap method for its extraction on a commercial scale has been developed. Many enquiries have been received from the chemical manufacturers in India as to the time and place of collection, storage, and the cheapest method of extraction of the drug from Ephedra. The results so far obtained have been of considerable commercial importance and have formed the subject of two notes published in the "Indian Forester" 1929, p. 215, and the Journal of the Society of Chemical Industry 1929, Transactions p. 67.

Aconitum Chasmanthum.—There are several species of aconites and only a few of these have been adopted for medicinal use. *A. Chasmanthum* occurs widely in Hazara and Kashmir and contains an alkaloid which has been called Indaconitine. *A. Chasmanthum* was for sometime supposed to be the European *A. Napellus*, but is now recognised as a distinct species. The European root was at one time imported into India for use in medicine and this seems to be unnecessary now, as the Indian species can be utilised for this purpose. The amount of indaconitine present in *A. Chasmanthum* has never been reported to be more than 0.4–0.7 per cent. and lately a specimen from Kashmir has been obtained which contains 3.0 per cent. of total alkaloid of which 1.2 per cent. is indaconitine. Two other alkaloids of lower melting point have been isolated and these are now being investigated.

Taraxacum Officinale.—A sample of the roots of *Taraxacum* growing in Kashmir was received from the Conservator of Forests, Utilization Circle, Kashmir. The root is officinal, being alterative, tonic, aperient and diuretic. It has been found that the bitter taste of taraxacum is due to a dark coloured amorphous substance which on hydrolysis gives p-hydroxy-phenyl acetic acid and dihydroxy cinnamic acid and not to any distinct active principle "taraxicine" or "taraxacerine", as hitherto assumed. These results are in close agreement with those of Power and Browning (Journ. Chem. Soc. 1912, p. 2411).

Senecio Jacquemontianus, Benth.—A sample of the leaves of *Senecio* was received from the Conservator of Forests, Utilization Circle, Kashmir. The leaves are said to possess the same properties as the root, which is officinal in Kashmir, being useful for colic. The roots are said to contain about 1 per cent. of senecifoline and senecifolidine but the leaves yielded about 0.001 per cent. only. No further work could be done on this as the quantity of the leaves obtained was too small. This enquiry will be conducted at a later date when further supplies of leaves and roots are obtained from Kashmir.

Longifolene.—India produces annually about 300,000 gals. of turpentine (α β pinene) together with 40,000 gals. of 2nd quality turpentine (Δ^3 Carene) and 40,000 gals. of 3rd quality (d—longifolene). First and second quality oils are sold easily but it is the third quality oil

which the manufacturers have difficulty in selling, d-longifolene is in all probability a tricyclic sesquiterpene and in view of the large quantities that are produced every year it appears desirable to find some use for these. At present there is practically no demand for this oil, and thousands of gallons have accumulated at the turpentine factories. Attempts are, therefore, being made to find some commercial use for this waste product of the Indian industry. Longifolene is a thick high boiling liquid which evaporates very slowly and leaves a sticky residue, and it is therefore useless for the purpose of making good varnish. Attempts are being made to obtain oils of lower boiling points from longifolene by decomposition either by "cracking" or by suitable chemical treatment. Owing to the great stability of the longifolene molecule, experiments in this direction have not yet met with any success, but it is hoped that satisfactory results will be obtained when more light has been thrown on the constitution of longifolene, and experiments are in progress.

Cutch from Acacia Sundra.—The Divisional Forest Officer, North Cuddapah, Madras, is making an attempt to establish the cutch and katha (crude catechin) industry by utilizing the wood of *Acacia Sundra* which grows in abundance in that division. Several samples of cutch were received for analysis and were found to contain 9–14 per cent. of catechin, which appears to be one of the normal constituents in the wood of *Acacia Sundra*. It has, therefore, been suggested that katha should be isolated from the solutions previous to the manufacture of cutch, and this process will, it is hoped, give a better quality of cutch and extra income from the sale of katha. Cutch and katha have, hitherto, been extracted from *Acacia Catechu*.

FOREST SOILS.

Soils from Chichawatni (Punjab).—A number of samples of soil from experimental plots in one of the newly irrigated plantation areas in the Punjab, Chichawatni, were analysed, with a view to find the factors that were particularly noxious and were likely to affect the growth of the plantations. It was found that some of these soils contained an excessive amount of saline matter consisting chiefly of sodium chloride and sodium sulphate. Methods have been suggested to reclaim these soils.

Soils from the United Provinces.—A number of analyses of soils were made, for the Silviculturist of the United Provinces, with a view to ascertain the cause of infertility of the land in certain localities. From the five samples of soils collected at different depths in the same area, it was found that the top layer (to about 3' depth) contained an excessive amount of saline matter consisting largely of sodium carbonate together with small amounts of sodium chloride and sodium sulphate. The cause of the infertility of the soil was, therefore, found to be the "black alkali" which is formed by the solvent action of sodium carbonate on humus. It was suggested that a good drainage and a dressing of calcium sulphate would improve the soil.

Soil efflorescence.—The Silviculturist (United Provinces) sent to this department, for analyses, samples of soil efflorescence, collected from what is known as "Usar" land, near Badaun. The results showed that these contained about 25 per cent. of soluble salts consisting chiefly of sodium sulphate, sodium carbonate and sodium bicarbonate in almost equal amounts.

A large number of analyses were also made for the Silviculturist, Forest Research Institute.

MISCELLANEOUS ENQUIRIES.

Wood Preservatives.—The Officer in Charge, Wood Preservation Section, had a few wood preservatives analysed with a view to prepare these for use in his work. These patent articles were found to be solutions of cheap chemicals which are often sold at a fancy price. Particular mention may be made of two such preservatives :—

- (A) was found to be a mixture of the solutions of sodium arsenite and copper sulphate, emulsified with soap and fat.
- (B) was found to be a mixture of copper sulphate and potassium dichromate solutions.

A paint claimed to be protective against ants and fire, on being analysed, was found to consist of zinc dust, with sodium silicate as a binding material, and a small amount of a crystalline base of the type of creatine or creatinine.

A large number of samples of creosote oils were also examined for the Officer in Charge, Wood Preservation Section.

Preservation of Bamboos from insect attacks.—Experiments are being planned with the object of removing the food material present in bamboos, as it is believed, that bamboos free of food material would be rendered immune from attack by the shot-borer. It is presumed by the Forest Entomologist that it must be the starch and sugar in the bamboos that the shot-borer feeds on, and not the cellulose, for which the stomach of the shot-borer is not designed. These experiments are likely to be of much economic value.

A large number of analyses of various substances were undertaken on behalf of the Officers of the Institute and other Forest Officers. These included the analyses of the following :—

- Terminalia pallida* and *T. Chebula* fruits.
- Wattle twigs (*Acacia decurrens*).
- Boiler feed waters.
- Engine oils.
- Cane juice.
- Pyroligneous liquors.
- Myrobalans.

Saussurea Lappa leaves.

Excoecaria Agallocha wood.

Preparation of a paint for preventing caterpillars from ascending trees.

Preparation of insect sprays, weed-killers, etc., etc.

PUBLICATIONS.

1. *Ephedras*.—The "Indian Forester", 1929, p. 215.
2. *Indian Ephedras*.—Their Extraction and Assay. Jour. Soc. Chem. Ind. 1929, Trans. p. 67.

EDUCATIONAL WORK.

The prescribed lectures were delivered to the students of the Indian Forest Service class and also a course of training in practical work in physics and chemistry. The accommodation and equipment of the students' laboratory continue to be sufficient. The library and the laboratory of this research branch have been improved by the addition of several new books and new apparatus.

TOURS.

The Biochemist paid a visit to the Indian Turpentine Factory, Bareilly, and attended the Indian Science Congress held in Madras.

In April 1928 Dr. J. N. Sen, M.A., Ph.D., the Biochemist, reverted to his post at the Agricultural Research Institute, Pusa, and his place in this department was filled by the appointment of the present Biochemist, Dr. S. Krishna, Ph.D., D.Sc.(Lond.), F.I.C., formerly Professor of Chemistry in the University of the Punjab.

BURMA.

CHEMISTRY.

General Report on Analysis of Forest Soils.—During the period of two years, 25 plots were selected by Mr. A. H. M. Barrington, Conservator of Forests, Hlaing Circle, from Insein, Allanmyo, Prome, Zigon and Tharrawaddy divisions. Samples of soils at various depths, viz., 0—3", 3"—12", 1'—2', 2'—3', etc., up to a maximum depth of six feet were collected. Total number of soil samples representing the 25 plots sent for analysis was 145.

The Forest Chemist carried out the mechanical and chemical analysis of these soils under the guidance of Mr. J. Charlton, Agricultural Chemist, Burma, to whom he is much indebted for his help.

Mechanical Analysis.—This was carried out in order to compare the soil profile, i.e., the constitution of sand, silt, clay, etc., at various depths

and it is not very difficult to understand the influence of such layers on permeability to air, water, tree-roots, etc.

The Agricultural Chemist, is of opinion that "To give the percentage of clay, fine silt, silt, fine sand, coarse sand and gravel conveys little". He therefore follows the practice of expressing the constitution of a soil by its Specific Surface Area. The Conservator of Forests, Hlaing Circle, calls it "Soil Texture Index" and he has fully explained how to calculate this "Soil Texture Index" from percentage of clay, fine silt, silt, etc., in his "Note on Vegetation on Forest Soils".

Chemical Analysis.—The following determinations were made:—

- (1) Moisture, (2) Loss on ignition, (3) Carbon Dioxide, (4) pH value, (5) Organic Nitrogen, (6) Available potash and (7) Available phosphates.

- (1) *Moisture* is the amount of water retained by air dry soil.
 - (2) *Loss on ignition* is a rough measure of organic matter contained by the soil.
 - (3) *Carbon Dioxide*, i.e., CO_2 is liberated from the soil by action of dilute acid and estimated as such.
 - (4) pH value was determined by Gillespie's method.
 - (5) Organic Nitrogen
 - (6) Available Potash
 - (7) Available Phosphates
- } These were estimated by usual standard chemical methods.

Classification.—From the analytical figures four main groups have so far been deduced, viz.,—(1) Indaing, (2) Rangoon Lateritic type, (3) Light and medium soils, and (4) Heavy Calcareous Soils. All the soils fall under any one of the above groups.

- (1) *Indaing.*—This group is an association dominated by *in (Dipterocarpus tuberculatus)*. All the sample plots, viz., 1, 4, 5, 7 and 19 that fall under this group are in Allanmyo and Northern Prome. They are very poor in nitrogen and available phosphates.
- (2) *Rangoon Lateritic type.*—Soils belonging to this group are heavy and the heaviness goes on increasing fairly uniformly below the surface. Loss on ignition and nitrogen are high, but they are very poor in available phosphates. The plots falling under this group are 20, 21, 23, 24 and 25.
- (3) *Light and Medium Soils.*—This group has violent alterations in composition and the range is too wide for classification, at least at present. The plots belonging to this group are 2, 3, 8, 9, 10, 11, 12, 13, 17 and 22.
- (4) *Heavy Calcareous Soils.*—This is a type of very stiff soils. They are rich in CO_2 and pH values are high. The plots under this group are 6, 14, 15, 16 and 17.

All the figures of mechanical and chemical analysis and their graphic representations have been published by Mr. A. H. M. Barrington in his "Note on Vegetation on Forest Soils".

Other Works.—In November 1928, the Forest Chemist was asked to accompany the Conservator of Forests, Hlaing Circle, for collection of soil samples. He joined him on the 16th of November at Kyaukpadaung in Allanmyo division and toured along with him up to 18th December 1928. During this period, the Conservator took the Forest Chemist along with him whenever he went out for selection of sample plots and collection of soil samples.

CHAPTER VII.

FOREST PUBLICATIONS OF 1928-29.

Serial No.	Title of Publication.	Author.	Date of Issue.
	FOREST RECORDS.		
	<i>Issued.</i>		
1	Commerical Volume Tables for Sal (<i>Shorea robusta</i>) in the wet mixed forests of the Bengal Duars.	Parma Nand Suri .	January 1929.
2	Volume Tables for Sundri (<i>Heritiera Fomes</i> , Buch. Syn. <i>Heritiera minor</i> , Roxb.) in the Sunderbans, Bengal.	Do. .	Do.
3	Epidemic attacks by the Sal Heartwood Borer, (<i>Hoplocerambyx spinicornis</i> , Newm. fam. <i>Cerambycidae</i>) in the forests of South Mandla Division, Northern Circle, Central Provinces, with special reference to the period 1924-25 to 1926-27.	Wm. Angus Muir .	March 1929.
4	On some Indian Coleoptera Hemiptera and Thysanoptera, Parts I—V.	R. Kleine; . A. Thery; O. C. Ollenbach; Carl. J. Drake and Dudley Moulton.	Do.
5	Slash in Chir Pine (<i>Pinus longifolia</i>) forests—Causes of formation, its influence and treatment.	J. E. C. Turner .	February 1929.
	<i>In Press.</i>		
6	Volume and Outturn Tables for Blue Pine (<i>Pinus excelsa</i> , Wall.).	H. G. Champion; . Ishwar Dass Mahendra; and Parma Nand Suri.	(April 1929.)
7	Commercial Timber (Katha) and Heartwood Volume Tables for Khair (<i>Acacia Catechu</i> , Willd.) in North India.	Do. .	(May 1929.)
8	Yield Tables for Blue Pine (<i>Pinus excelsa</i> , Wall.).	Do. .	(June 1929.)
9	Denudation of the Punjab Hills	B. O. Coventry .	(May 1929.)

Serial No.	Title of Publication.	Author.	Date of Issue.
10	The Burma Bamboo Pulp Survey.	W. Raitt . .	(July 1929.)
11	Investigations on the Infestations of " <i>Peridermium complanatum</i> ," Barclay, on the needles, and of <i>Peridermium himalayense</i> n. sp. on the stems of <i>Pinus longifolia</i> , Roxb.	K. D. Bagchee .	(September 1929.)
12	Immature stages of Indian Coleoptera (6).	J. C. M. Gardner .	....
	FOREST BULLETINS.		
	<i>Issued.</i>		
13	Note on Weights of Seeds .	S. H. Howard. Re- vised by H. G. Champion.	July 1928.
	<i>In Press.</i>		
14	A List of Trade Names of Indian Timbers.	....	(September 1929.)
15	Instructions for the Operation of Timber Seasoning Kilns.	S. N. Kapur . .	(September 1929.)
	OTHER PUBLICATIONS.		
	<i>Issued.</i>		
16	Forest Flora of the Chakrata, Dehra Dun and Saharanpur Forest Divisions, United Provinces, Third edition, revised and enlarged.	Rai Bahadur Upen- dranath Kanjilal. Revised by Basant Lal Gupta.	December 1928.
17	Progress Report of Forest Research Work in India for the year 1927-28.	....	March 1929.
18	Progress Report of the Imperial Forest College, Dehra Dun, for the year 1927-28.	....	December 1928.
	<i>In Press.</i>		
19	Malaria in Forest Areas . .	Lt.-Col. J. A. S. Phillips.	(May 1929.)
20	Project No. VIII—Testing of Indian Woods for Veneers and Plywood including Tests on Glues.	W. Nagle . .	(September 1929.)

Serial No.	Title of Publication.	Author.	Date of Issue.
21	The Common Commercial Timbers of India and their Uses.	H. Trotter . . .	(November 1929.)
22	Progress Report of the Imperial Forest College, Dehra Dun, for the year 1928-29.	....	(December 1929.)
23	Progress Report of Forest Research Work in India, for the year 1928-29.	....	....
24	Proceedings of the Third Silvicultural Conference held at Dehra Dun during March 1929.	....	(December 1929.)

CONTRIBUTED TO PERIODICALS.

A Preliminary Report on the Peridermiums of India and the occurrence of *Cronartium ribicola* on *Ribes rubrum*, by A. Hafiz Khan "Indian Forester," Vol. LIV, August 1928, pages 431-43.

Box Testing at Dehra Dun, by R. K. Banerjee, "Indian Forester," Vol. LIV, September 1928, page 490-92.

Punjab and United Provinces Sal Seedlings, by R. N. Parker, "Indian Forester," Vol. LIV, November 1928, pages 566-67.

Half Round Sleepers of Chir (*Pinus longifolia*), by S. Kamesam, "Indian Forester," Vol. LIV, November 1928, pages 582-87.

The Trap Tree Method, by C. F. C. Beeson, "Indian Forester," Vol. LIV, November 1928, pages 595-99.

Origin of Seeds, by H. G. Champion, "Indian Forester," Vol. LV, January 1929, pages 1-3.

Note on Mysore Wood Tar Distillation Plant at Bhadarvati, by S. Kamesam, "Indian Forester," Vol. LV, March 1929, pages 156-59.

Ephedra, by T. P. Ghosh, B. L. Gupta and S. Krishna, "Indian Forester," Vol. LV, April 1929, pages 215-26.

A New Species of *Vateria*, by B. L. Gupta, "Indian Forester," Vol. LV, April 1929, pages 231-32.

The Antiseptic Treatment of Chir (*Pinus longifolia*) for Railway Sleepers, by S. Kamesam, accepted by Railway Board for publication as a Technical Paper (No. 271).

Platypodidae and Scolytidae of Samoa, by C. F. C. Beeson, to be published by the British Museum, 1929.

Indian Ephedras, their Extraction and Assay, by T. P. Ghosh, B. L. Gupta and S. Krishna, Journal of the Society Chemical Industry, London, 1929, Vol. XLVIII, No. 12, page 67, Transactions.

APPENDIX I.

Statement showing Officers in Charge of Branches and Sections during the year 1928-29.

Branch.	Officer in Charge.	Section.	Officer in Charge.	From	To
Silvicultural	Mr. H. G. Champion, Silviculturist.	....	....	1st Apl. 1928	31st Mar. 1929
Botanical	Mr. R. N. Parker, Forest Botanist.	....	....	1st Apl. 1928	31st Mar. 1929
		Mycology . . .	Dr. K. D. Bagchee .	1st Apl. 1928	31st Mar. 1929
Economic	Mr. C. C. Wilson, Forest Economist.	....	....	1st Apl. 1928	30th Apl. 1928
	Capt. H. Trotter, Offg. Forest Economist.	....	....	1st May 1928	31st Mar. 1929
		Minor Forest Products.	Mr. F. D. Ardagh, Deputy Conservator of Forests.	1st Apl. 1928	31st Mar. 1929
		Timber Testing .	Mr. L. N. Seaman .	1st Apl. 1928	31st Mar. 1929
		Wood Preservation	Vacant. Mr. Trotter held charge in addition to his own duties.	1st Apl. 1928	31st Mar. 1929
		Seasoning . . .	Mr. Stanley Fitzgerald.	1st Apl. 1928	11th May 1928
			Vacant . . .	12th May 1928	22nd June 1928
			Dr. S. N. Kapur .	23rd June 1928	31st Mar. 1929
		Wood Technology .	Vacant. Mr. Seaman held charge in addition to his own duties.	1st Apl. 1928	31st Mar. 1929
		Wood Workshop .	Mr. W. Nagle .	1st Apl. 1928	24th Feb. 1929
			Mr. W. Gray, Expert Cabinet Maker.	25th Feb. 1929	31st Mar. 1929
		Paper Pulp . . .	Mr. W. Raitt .	1st Apl. 1928	28th Feb. 1929
			Mr. M. P. Bhargava	1st Mar. 1929	31st Mar. 1929
Entomology	Dr. C. F. C. Beeson, Forest Entomologist.	....	....	1st Apl. 1928	31st Mar. 1929
		Systematic Entomologist.	Mr. J. C. M. Gardner	1st Apl. 1928	31st Mar. 1929
Biochemist	Vacant. Mr. T. P. Ghose, Upper Grade Assistant held charge of current duties.	....	....	1st Apl. 1928	22nd June 1928
	Dr. S. Krishna .	....	....	23rd June 1928	31st Mar. 1929

APPENDIX II.

FINANCIAL.

The expenditure of the past two years is compared below.

	EXPENDITURE DURING THE YEAR.		Difference (+) or (—).
	1927-28 (12 months, 1st April 1927 to 31st March 1928).	1928-29 (12 months, 1st April 1928 to 31st March 1929).	
<i>Major Head—8-Forests.</i>	Rs.	Rs.	Rs.
AVI.—Stores, Tools and Plant	15,173	12,962	—2,211
AVII.—Buildings, etc.	2,639	1,459	—1,180
AIX.—Miscellaneous	1,85,046	1,80,446	—4,600
BIA.—Conservators—Non-voted	53,778	39,273	—14,505
BIB.—Superior Officers—Non-voted	1,24,530	1,09,319	—15,211
BIB.—Superior Officers—Voted	1,04,467	1,34,765	+30,298
BIIA.—Subordinate Forest and Depôt Establish- ment.	12,949	12,795	—154
BIIB.—Office Establishment	1,29,668	1,42,062	+12,394
BIIB.—House rent and other allowances	202	..	—202
BIIC. to f.—Travelling allowances	39,642	26,914	—12,728
Cost of passage to America of officers for training	769	..	—769
BIV.—Contingencies	46,248	44,283	—1,965
BV.—Grants in aid, contribution for passages	14	19,429	+19,415
GRAND TOTAL OF ALL EXPENDITURE UNDER 8- FORESTS.	7,15,125	7,23,707	+8,582
<i>Major Head—8-A Forests.</i>			
Share of Capital charges financed from ordinary revenue.	38,617	41,890	+3,273

Explanation of differences between figures for 1927-28 and 1928-29.

AVI.—Decrease due to less stores purchased during the year.

AVII.—Decrease due to less work done during the year.

AIX.—Decrease chiefly due to less timber purchased for experimental work.

BIA.—Mr. C. C. Wilson, Forest Economist, who was a Conservator of Forests proceeded on leave and Capt. H. Trotter, Deputy Conservator of Forests, filled the post and drew pay against BIB.—Non-voted.

BIB.—Non-voted. Decrease due to the reversion of Dr. J. N. Sen, Biochemist, to Agricultural Research Institute, Pusa, in March 1928.

BIB.—Voted. Increase due to appointments of (i) Dr. Sri Krishna, Biochemist, (ii) Dr. S. N. Kapur, Officer-in-charge, Seasoning, (iii) Mr. W. Gray, Cabinet Maker, and (iv) periodical increment of officers.

BIIA.—Decrease trifling.

BIIB.—Increase due to annual increments of non-gazetted staff and to the entertainment of additional temporary establishment in the Economic branch, where work has greatly increased.

BIIB.—House rent allowance was not paid to Mr. W. Nagle, Officer-in-Charge, Wood Workshops, who has been provided with Government bungalow.

BIIC.—Travelling Allowance. Decrease due to less touring undertaken by some of the officers of the Institute.

BIV.—Decrease due to less expenditure on carriage of tents and records, postage stamps and telegrams and other contingencies.

BV.—Increase due to large arrear adjustments made by the Accountant-General, Central Revenues, during the year.

C. E. SIMMONS, for President,
Forest Research Institute and College.

APPENDIX III.

FINANCIAL.

The Revenue of the past two years is compared below.

Serial No.	Details of Revenue.	REVENUE DURING THE YEAR.		Difference (+) or (—)
		1927-28 (12 months. 1st April 1927 to 31st March 1928).	1928-29 (12 months. 1st April 1928 to 31st March 1929).	
		Rs.	Rs.	Rs.
1	Sale of books	857	348	—509
2	Sale of bamboos	91	..	—91
3	Refunds of excess travelling allowances drawn, refunds of railway freight, etc.	2,163	596	—1,567
4	Sale of grass from New Forest	25	6	—19
5	Rent from Cultivators in the Demonstration Area, etc.	642	415	—227
6	Seeds supplied	..	26	+26
7	Miscellaneous	7,653	4,092	—3,561
	TOTAL	11,431	5,483	—5,948

Explanations of differences between figures for 1927-28 and 1928-29.

1. The decrease is due to less sale of books.
2. Bamboos were not sold during the year 1928-29.
3. The decrease is due to less refunds.
4. This is due to smaller sale of grass.
5. The decrease is due to less land being available for cultivation.
6. Price of seeds supplied recovered during 1928-29.
7. Decrease is due to less miscellaneous work being undertaken.

C. E. SIMMONS, for President,
Forest Research Institute and College.

APPENDIX IV.

ANNUAL FORM NO. 24.

FOREST DEPARTMENT, INDIA, FOREST RESEARCH INSTITUTE DIVISION.

Summary of Revenue and expenditure of the different Divisions during 1928-29.

Budget Heads.	President.	Silviculturist.	Forest Botanist.	Forest Entomologist.	Forest Economist.	TOTAL.
(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
REVENUE.						
V.—Miscellaneous—						
(a) Fines and forfeitures	..	..	..	..	..	..
(b) Refunds	..	..	..	2	..	2
Other sources	730	86	265	206	4,193	5,480
Total Revenue	730	86	265	206	4,193	5,482
EXPENDITURE.						
A.—Conservancy and works—						
VI.—Live Stock, stores, tools and plant—						
C. 1 C.—Purchase of stores, tools and plant.	800	975	1,001	5,018	5,108	12,902
C. 2 VII.—Communications & buildings, new works—						
(a) Roads and bridges	..	..	..	..	..	..
(b) Buildings	..	..	..	..	..	..
(c) Other Works	..	..	..	..	..	..
C. 3 VII.—Communications & buildings, repairs and maintenance—						
(a) Roads and bridges	..	..	..	..	..	..
(b) Buildings	..	..	..	..	..	..
(c) Other charges	1,459	..	..	..	..	1,459
C. 4.—Miscellaneous—						
(1) Temporary establishment on daily labour.	933	2,600	3,891	2,621	65,660	75,705
(2) Purchase of timber for seasoning and preserving (including freight and carting charges).	..	..	..	..	21,998	21,998
(3) Purchase of coal, raw materials, chemicals and apparatus.	2,941	..	..	498	23,945	32,384
(4) Other charges	3,023	8,200	2,518	1,147	35,471	50,359
Total A.—Conservancy and works.	9,216	11,775	7,410	9,284	1,57,182	1,94,867

APPENDIX IV—contd.

ANNUAL FORM No. 24—contd.

FOREST DEPARTMENT, INDIA, FOREST RESEARCH INSTITUTE DIVISION—contd.

Summary of Revenue and expenditure of the different Divisions during 1928-29—contd.

Budget Heads.	President.	Silviculturist.	Forest Botanist.	Forest Entomologist.	Forest Economist.	TOTAL.
(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
EXPENDITURE—contd.						
B.—Establishments—						
I.—Pay of Officers—						
Non-voted—						
(a) Conservators . .	..	..	30,155	..	9,118	39,273
(b) Superior officers .	1,400	13,342	..	26,778	67,799	1,09,319
Voted—						
Superior officers . .	13,107	11,632	19,440	9,694	80,892	1,34,765
II.—Pay of establishment—						
(a) Subordinate forest and depôt establishments.	..	2,087	..	5,975	4,783	12,795
(b) Office establishments .	19,763	17,242	8,170	14,719	82,148	1,42,062
III.—Allowances—						
Cost of passage (central) Non-voted.	..	..	..	..	..	..
(b) House rent and other allowances.	..	..	..	..	..	..
Travelling allowances—						
(c) Conservators, Non-voted.	..	..	..	..	..	..
(d) Superior Officers—						
Non-voted	..	1,365	1,042	1,586	2,973	6,966
Voted	1,072	658	2,543	1,040	8,370	13,683
(e) Subordinate forest and depôt establishments.	..	68	..	893	260	1,221
(f) Office establishments .	..	2,046	728	927	1,343	5,044
Cost of passage to America of officers for training, etc.—						
IV.—Contingencies—						
(a) Stationery	113	8	55	..	57	233
(b) Carriage of records and tents.	5	779	670	398	119	1,971
(c) Rents, rates and taxes .	3,315	..	170	19	4,891	8,395
(d) Pay of menials . . .	701	..	32	992	..	1,725
(e) Official postage . . .	600	300	600	501	1,019	3,020

APPENDIX IV—concl'd.

ANNUAL FORM No. 24—concl'd.

FOREST DEPARTMENT, INDIA, FOREST RESEARCH INSTITUTE DIVISION—concl'd.

Summary of Revenue and expenditure of the different Divisions during 1928-29—concl'd.

Budget Heads.	President.	Silviculturist.	Forest Botanist.	Forest Entomologist.	Forest Economist.	TOTAL.
(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
EXPENDITURE—concl'd.						
IV.—Contingencies—contd.						
(f) Sundries	14,515	1,501	2,221	2,181	3,011	23,429
(g) Clothing and uniform .	64	134	100	159	500	966
(h) Telephone	2,334	42	48	116	1,954	4,544
V.—Cost of passage granted under superior Civil Service Rules, 1924 (Non-voted).	..	3,116	2,520	8,484	5,309	19,429
Total B.—Establishments .	57,059	54,320	68,503	74,462	2,74,406	5,28,840
GRAND TOTAL OF ALL EXPENDITURE UNDER 8-FOREST.	66,275	66,095	75,913	83,746	4,31,678	1,72,3707
Major Head 8-A.—Share of capital charges financed from ordinary revenue.	11	3,391	6,005	4,997	27,486	41,890
Surplus or deficit . . .	—65,556	—69,400	—81,653	—88,535	—4,54,971	—7,60,115

NEW DELHI :
The 13th September 1929.S. N. MUKERJI,
Assistant Accounts Officer,
Central Revenues.

Certified that the totals of this form as printed in the Forest College and Forest Research Institute Reports for 1928-29 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.

C. E. SIMMONS, for President,
Forest Research Institute and College.

APPENDIX V.

FORM No. 27.

FOREST DEPARTMENT, INDIA, FOREST RESEARCH INSTITUTE.

Outstandings and Liabilities on account of Contractors and Disbursers for the financial year 1928-29.

Division	DEPARTMENT DEBTOR.	DEPARTMENT CREDITOR.			BALANCE DUE.
	Recoveries in cash and value of supplies and work done during the year.	Opening balance.	Payments made during the year.	TOTAL.	To Department (outstanding).
1	2	3	4	5	6
	RS. A. P.	RS. A. P.	RS. A. P.	RS. A. P.	RS. A. P.
Silviculturist . .	18,445 3 8	65 9 4	18,383 0 9	18,448 10 1	3 6 5
Forest Botanist . .	9,468 5 9	4 11 4	10,230 3 1	10,234 14 5	766 8 8
Forest Entomologist .	10,034 1 6	43 10 7	10,086 14 9	10,130 9 4	96 7 10
Forest Economist .	7,564 10 7	79 15 2	7,545 6 7	7,625 5 9	60 11 2
TOTAL	45,512 5 6	193 14 5	46,245 9 2	46,439 7 7	927 2 1

NEW DELHI:
The 13th September 1929.

S. N. MUKERJI,
Assistant Accounts Officer,
Central Revenues.

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C. E. SIMMONS, for President,
Forest Research Institute and College.

APPENDIX VI.

Details of Revenue of Forest Research Institute for the year 1928-29.

Serial No.	Details of Revenue.	President.	Silviculturist.	Forest Botanist.	Forest Economist.	Forest Entomologist.	TOTAL.
		RS. A. P.	RS. A. P.	RS. A. P.	RS. A. P.	RS. A. P.	RS. A. P.
1	Sale of books (chiefly Troup's Silviculture of Indian trees).	347 11 0	..	..	..	..	347 11 0
2	Sale of bamboos .	..	..	..	..	..	..
3	Refunds of excess travelling allowances drawn, refunds of railway freight, etc.	..	85 11 0	59 0 0	405 9 0	46 3 0	596 7 0
4	Sale of grass from New Forest.	..	..	6 0 0	..	..	6 0 0
5	Rent from Cultivators in the Demonstration Area, etc.	250 0 0	..	165 7 0	..	..	415 7 0
6	Seeds Supplied .	..	..	25 7 0	..	..	25 7 0
7	Miscellaneous .	132 10 0	..	9 11 0	3,787 15 0	161 9 2	4,091 13 2
	TOTAL	730 5 0	85 11 0	265 9 0	4,193 8 0	207 12 2	5,482 13 2

C. E. SIMMONS, for President,
Forest Research Institute and College.

APPENDIX VII.

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. (Out of print)	..	..
2.—Note on the Quetta Borer (<i>Aolesthes sartus</i>), by the same author. (Out of print)	..	..
3.—Note on the Chilgoza (<i>Pinus Gerardiana</i>) Bark Boring Beetles of Zhob, Baluchistan, by the same author. (Out of print)	..	..
4.— <i>Ficus elastica</i> : its natural growth and artificial propagation, with a description of the method of tapping the tree and of the prepara- tion 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. (Out of print)	..	..
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. (Out of print)	..	..
8.—Note on the Life-History of <i>Hoplocerambyx spinicornis</i> (The Sing- bhum Sal Borer), by the same author	0 0 0	..
9.—Note on the Influence of Forests on the Storage and Regulation of the Water Supply, by S. Eardley-Wilmot. (Out of print)	..	..
10.—Note on the Duki Fig-Tree Borer of Baluchistan. (<i>Balocera rubus</i>), by E. P. Stebbing. (Out of print)	..	..
11.—On some Assam Sal (<i>Shorea robusta</i>) Insect Pests, by the same author	1 10 0	..

II.—LEAFLETS—(All out of print).

1.—The Sal Bark-Borer (<i>Sphaerotrypes sicalikensis</i> , Steb.), by E. P. Stebbing	..
2.—The Teak Defoliator (<i>Hylaea puera</i> , Cram), by the same author	..
3.—The Teak Leaf Skeletoniser (<i>Pyrausta macheralis</i> , Wlk.), by the same author	..
4.—The larger Decodar Bark-Borer (<i>Scolytus major</i> , Steb.), by the same author	..
5.—The Blue Pine "Polygraphus" Bark-Borer (<i>Polygraphus major</i> , Steb.), by the same author	..

III.—PAMPHLETS.

1.—Note on Utilisation of Khair Forests in Eastern Bengal and Assam, by Puran Singh. (Out of print)	..
2.—The Attack of the Bark-Boring Beetle in the Coniferous Forests in the Simla Catchment Area, by E. P. Stebbing. (Out of print)	..
3.—A Glossary of Forest Technical Terms for Use in Indian Forestry, by A. M. F. Caccia. (Out of print) (Revised and issued as Bulletin No. 4, New Series)	..
4.—Note on Lac and Lac Cultivation, by D. N. Avasia. (Out of print)	..
5.—Notes on Sal in Bengal, by A. L. McIntire. (Out of print)	..

III.—PAMPHLETS—contd.

	PRICE (exclusive of packing, postage, etc.)	Rs. a. p.
6.—Note on Forest Reservation in Burma in the Interests of an En- dangered 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. (Out of print)	..	..
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>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>Berrya Ammonilla</i> , Roxb.), by the same author. (Out of print)	..	..
13.—Note on Burmese In Wood (<i>Dipterocarpus tuberculatus</i> , Roxb.), by the same author. (Out of print)	..	..
14.—Note on Burma Padauk (<i>Pterocarpus macrocarpus</i> , Kurz.), by the same author. (Out of print)	..	..
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 gran- dis</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 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
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12.—Note on the Bark-Eating and Root-Boring Beetles of Babul (<i>Acacia arabica</i>), by E. P. Stebbing	0 4 0
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" 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>Hyppsiophya robusta</i> , Moore, 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 & C. M. Harlow. (Out of print)		..
" 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

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