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FOREST RESEARCH IN INDIA,

1935-36

PART I.—THE FOREST RESEARCH INSTITUTE.



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FOREST RESEARCH IN INDIA, 1935-36.

PART I.—THE FOREST RESEARCH INSTITUTE.

CHAPTER I.—GENERAL REVIEW.

Work was continued in accordance with the sanctioned programme. A large number of day to day enquiries which were received during the year were also attended to.

A detailed programme of work in each of the Branches for the three years 1936-39 was drawn up at the Institute and sent to the provinces for suggestions. This programme, as finally approved, has been sent to Press since the close of the year. Every effort has been made to include problems of most importance to the Forest departments in the provinces and thus to maintain the closest co-operation with them. It is hardly necessary to emphasize again, as was done by the Board of Forestry, that advancement of Forestry in India depended to a very large extent on the co-operation between the Provinces and the Forest Research Institute.

During the year His Excellency the Governor of the United Provinces and the Hon'ble Sir Girja Shankar Bajpai visited the Institute. There was a large number of other visitors also and it might be mentioned that the representatives of the Gramophone Co., Ltd., Dum Dum, who also paid a visit acknowledged their appreciation of the valuable advice and assistance given and stated that they came away with a great deal of information which they felt sure would be of great use to them in the manufacture of gramophone and wireless cabinets.

Silvicultural Branch.—Experimental work at Dehra Dun has been seriously set back by repeated frost damage drawing additional attention to the fact that frost is clearly a factor which must be taken into account in forest management in this part of the country. Useful progress, however, continues to be made in several lines, especially on the subject of thinning investigations and the connected question of the practicability and advisability of pruning in plantations.

The regeneration and management of moist tropical forests continues to receive special attention. This is a subject which can only be studied on tour in collaboration with Provincial research and territorial officers

but in which there is room and demand for progress. The Silviculturist made an unofficial visit to Malaya in this connection.

The Statistical staff was largely occupied in routine work which included the compilation and publication of stand tables for *chir* pine and volume tables for *sissu* which should be useful in several provinces. The subject of thickness of sapwood and its rate of conversion to hardwood has come into prominence of late and a special study was made on deodar during the year.

A start has been made on the much needed modern text-book on Indian Silviculture and Silvicultural Systems. The chapters on the latter subject have been completed by the Inspector General of Forests, and the Silviculturist expects to complete the rest by October 1936.

Botanical Branch.—The study of the Indian species of *Terminalia* of the section *Pentaptera* has been completed and a draft report with illustrations is in the course of preparation. The systematic study of the *Dipterocarpaceae* was also continued during the year. A paper on some Indian and Burmese *Dillenias* was published and a paper on a new genus of the *Connaraceae* was completed and sent for publication. Two further papers, one on the genus *Psilotum* in India and another dealing with recently introduced or otherwise imperfectly known plants from the Upper Gangetic Plain were published.

During the year 2,636 specimens received from various sources were incorporated in the herbarium and 689 specimens were distributed to various herbaria on an exchange basis. An increasingly large number of specimens (1629) sent in by forest officers and others from all over India were identified and advice on technical botanical matters given. Numerous additions were made to the Botanical Garden and the Arboretum both of which are making good progress. As usual considerable quantities of seed have been supplied to enquirers and institutions in various parts of the world.

The draft report on the work done during the last few years in connection with the investigation on the *shisham* root disease in the Punjab plantations and in the forests of the United Provinces has been completed. The problem of the *Gmelina arborea* die-back disease in the New Forest area has been investigated. *Gmelina arborea* plants have been inoculated with a *Coniothecium* sp., isolated from the diseased shoots of the plants with no useful results. Much progress has been made in the investigation of various parasitic rusts. Investigation of *Peridermium himalayense* on the stem of *Pinus longifolia* has been completed. A large number of inoculation experiments have been conducted in connection with the investigations on various other rusts on coniferous and broad-leaved species. Studies in connection with the wood-rotting properties and pathogenic behaviour of fungi occur-

ing on important timber trees have been continued and numerous inoculation experiments done on pines and deodar in the Chakrata forests.

Entomological Branch.—The investigation of the seasonal history of the *champ* bug, *Urostylis punctigera*, was completed and a cheap and simple method of control by spraying was devised for immediate application in plantations in North Bengal.

The biology of 161 species of hymenopterous and dipterous parasites was published as a first step in the utilisation of these natural agencies in the biological control of insect pests.

Successful work was done on the prevention of borer attack in newly felled logs and converted timber. The pests of plywood factories were investigated and remedies were found which enable the Indian made tea chest to be put on the market with a guarantee of immunity from borer damage.

Economic Branch.—The teak grading rules prepared during the previous year were issued in the form of a small pocket-book early in 1936 and it now remains to be seen whether the buyers and sellers of teak squares will profit by this new venture and will give the rules a fair trial.

Considerable progress was made during the year under review with the exploitation of the new wood preservative Ascu. The North Western Railway had 10,000 softwood sleepers treated with the preservative for a durability trial. The total cost of the treatment (including an extra anti-splitting treatment, depreciation, handling and labour charges) amounted to 7 annas 4 pies per B. G. sleeper. The corresponding cost of their present creosote-crude oil treatment is just over 1 rupee, so that a saving of 50 per cent at least can be anticipated if the new treatment is adopted.

A most welcome advance was also seen in the use of treated wooden poles for hydro-electric transmission lines. Several Indian States were also interested in the possibility of extending the uses of wood by using Ascu, and some have already installed and started to use the new type of pressure plant designed by the Forest Research Institute.

Six Ascu pressure plants came into operation during the year and at least 10 others will be in operation in different parts of India during the next few months.

Another important feature of the year's work was the establishment of definite relations between the Forest Research Institute and the paper mills of India. The paper mills have now allotted to Dehra Dun certain definite items of research and have shown their appreciation of the work being done in the Paper Pulp Section by subscribing to the funds of the Institute. This gesture on the part of the mills is much appreciated

and is indicative of a closer co-operation between research officers and the trade which will, it is hoped, be followed in other spheres.

The Seasoning Section made steady progress with the improvement of the new furnace kiln and it is now possible to say that a kiln of this type can be built in this country for less than Rs. 2,000 and since the kiln is easy to operate and cheap to run it is expected that it will be popular with small cabinet and furniture makers. The Seasoning Section also evolved a new type of electric moisture metre which can be made for about Rs. 150 against imported instruments of this kind which usually cost Rs. 800 or more.

The Forest Economist toured in Calcutta in January 1936. One of the main objects of the tour was to try and persuade some firm to start a plywood mill in Calcutta. The returns will probably be small to start with, but it is beyond question that plywood is foremost amongst the most popular constructional materials of the present day and that any one making a sound beginning now will reap the benefit in ample measure in the not far distant future.

Chemical Branch.—During the year under report the work on the examination of *Derris* species and other plants likely to have insecticidal properties was continued. Analysis of further sample of *Derris elliptica* from different localities of Assam showed that *Derris* roots of average quality, containing about 2·5 per cent. of rotenone, the active principle, are available in certain areas of that province. To establish a regular trade in this important insecticide the present supply from naturally growing *Derris elliptica* will have to be considerably increased by cultivation of suitable strain in localities where this species is indigenous. Search for rotenone and allied insecticidal bodies in other species of plants, has not met with success. Enquiries were made regarding commercial possibilities and probable demand for *Laurinacea* fat as a source of lauric acid which is in considerable demand on account of its being used in the preparation of sodium lauryl sulphate, a new type of detergent superior to ordinary soap in many respects. The replies received showed that there is a ready market for it, one firm expressed the opinion that their demand would be about 5 to 10 tons of the fat per month. Enquiries have been instituted to ascertain how much of the seeds of *Actinodaphne* and *Litsaea* species are at present available and how the present supply can be augmented. A glucoside has been isolated from the leaves of *Vitex negundo* which is probably responsible for the physiological properties of the leaves. Its pharmacology is being studied.

Mr. C. G. Trevor was deputed by the Government of India to attend the British Empire Forestry Conference in South Africa and during his absence Dr. Beeson was in charge of the current duties of the Inspector General of Forests and President.

CHAPTER II.—SILVICULTURE BRANCH.

I.—EXPERIMENTAL SILVICULTURE.

(i) GENERAL.

The following publications dealing with Experimental results obtained at the New Forest were published during 1935-36 :—

1. *A stand table for sal evenaged high forest and coppice.*
2. *Damage by Frost at New Forest.*

Preliminary Survey of the Forest Types of India and Burma has been passed and should appear very shortly.

The revision of Forest Bulletin No. 41 ("A note on the weights of seeds") has not yet been issued as it has been considered advisable to include additional information necessitating extensive revision of the draft prepared last year.

(ii) NATURAL REGENERATION.

The study of annual seed production and fertility of individual *Anogeissus latifolia* trees (Experiment No. 44) was continued for the 8th year. All trees except one produced a good crop of seed.

Seed crop from individual trees of *Shorea robusta*, *Terminalia tomentosa* and *Pinus longifolia* were also recorded. This was a good seed year for *Shorea robusta* but the other two species produced very little seed.

(iii) INVESTIGATION ON SEEDS.

(a) *Seed weighments and germination tests.*—During the year under report 162 weighments were made including 8 new species, and germination tests for 130 species were recorded. The data will be incorporated in the revised Forest Bulletin 41.

(b) *Effect of size of seed on germination and growth of seedlings.*—The experiment (No. 57) was repeated with *Terminalia chebula*. Seeds were graded into 4 diameter classes, from 0.5" to 0.9", and at the end of the 1st growing season, it was found that the bigger the seed the better the result as regards germination and height growth, thus confirming the previous year's conclusions.

(c) *Seed storage.*—Nine species were added for storage during the year.

After 3 years' storage in sealed tins seeds of *Acacia catechu* failed to germinate and those of *Bombax malabaricum* shewed only 1 per cent. germination as compared with 2 per cent. and 37 per cent. after 2 years.

Seeds of *Schleichera trijuga*, stored for 3 years in sealed tins and gunny bags, failed to germinate in either case having given 19 per cent. and 2 per cent. germination after 2 years. *Melia azedarach* seeds, stored for the same period in gunny bags also failed to germinate, but those kept in sealed tins shewed 68 per cent. germination after the same period of storage—practically the same figure as after 2 years.

Seeds of *Dalbergia latifolia*, *Chickrassia tabularis*, *Terminalia chebula* and *Acacia modesta*, stored in gunny bags for 2 years, shewed a germination per cent. of 0, 0, 0·7 and 4, whereas stored in sealed tins for the same period they shewed a germination per cent. of 0, 0, 0·3 and 15 respectively. *A. modesta* shewed 22 per cent. germination after a year's storage in gunny bags, and *Terminalia arjuna* shewed 49 per cent. germination after 2 years' storage in this way.

Seeds of *Acacia catechu* with an initial germination capacity of 56 per cent., stored in 1934 in a sealed tin, dropped to 14 per cent. germination after a year.

(iv) INVESTIGATION ON SEEDLINGS.

The morphological seedling studies as reproduced in Troup's Silviculture of Indian Trees were completed for the following 9 species:—

Eugenia utilis, *Pyrus pashia*, *Pterocarpus macrocarpus*, *Schima wallichii*, *Swintonia floribunda*, *Stephegyne diversifolia*, *Terminalia oliveri*, *Turpinia pomifera* and *Vateria indica*.

13 other species as mentioned below were partly studied:—

Anisoptera glabra, *Alseodaphne owdeni*, *Derris robusta*, *Diospyros tomentosa*, *Ficus glomerata*, *Lagerstroemia parviflora*, *Lophopetalum fimbriatum*, *Olex scandens*, *Olea cuspidata*, *Phoebe hainesiana*, *Sapium baccatum*, *Stereospermum xylocarpum* and *Vitex peduncularis*.

(v) INVESTIGATIONS ON TREES AND CROPS.

(a) *Seasonal course of height growth*.—The investigation was continued for 12 common Indian species.

(b) *Phenological data*.—Observations were continued on 13 species. Preliminary compilation was done last year, and it is hoped to issue a note on the subject before long. Collaboration of the Provincial Silviculturists has been successfully invited.

(c) *Inheritance of individual characters.*—The two experimental plots, planted up with seedlings raised from seeds of figured and unfigured parent trees of *Terminalia crenulata* are fully stocked and promising. Two more *Pinus longifolia* plots were added during the year for determining whether high resin yielding capacity is a hereditary character or not.

(d) *Inheritance of climatic race characters.*—The All India teak seed experiment dealing with 11 origins is still under observation but the majority of the plants were killed back by frost, and it appears that the long term plots will be difficult or impossible to maintain at Dehra Dun. Difference in appearance of the bark and the colour of foliage between the Burma and local origins of *Acacia catechu* still persists, as reported last year.

(e) *Inheritance of physiological race characters.*—The small plantations of *Butea* and *Schleichera* forms, reported to behave differently under lac culture, were again frosted but some of the trees are nearly big enough for the further stages of the investigation.

(f) *Soil quality class indicators.*—The quadrats in plantations of different important species in the Demonstration Area were continued and mapping done as usual.

(g) *Congestion in bamboo clumps.*—During the rains of 1935 two different treatments, namely topping and stripping of new culms, were applied to selected clumps in the Experimental garden to study their effects on congestion in the clumps of *Dendrocalamus strictus*. It is too early yet to draw any conclusions.

(h) *Root competition.*—The investigation in *sal* and *chir* was continued, and new experiments laid out with *Cedrela toona*, *Phoebe lanceolata* and *Holoptelea integrifolia*.

The 1932 experiment with *Cedrela toona* was closed after 2 seasons as trenching had no effect on the plants and iron-sheeting around the plants did more harm than good. There was no significant difference between trenching and control plants but a marked difference with iron-sheeting.

The 1933 experiment with teak (C. 19) was concluded on account of damage by frost. After 2 seasons the trenching at a distance of 8' from the plant gave the best results, and that at 4' the worst. There was practically no difference between the untrenched control and the trenching at a distance of 6'.

(i) *Thinnings in young plantations.*—5 sets of experiments in replicated series have been laid out in the young pine plantation in the Demonstration Area where the rapid rate of growth promises interesting results in a few years' time.

(j) *Pruning versus natural cleaning*.—The experiment laid out in *chir* last year is being maintained and a new set, mainly dealing with frost-caused forking, laid out in *sal*.

(k) *Twist in Pinus longifolia*.—The experiment of inducing twist in 1926 *chir* plantations is being continued. Trees felled last year have been examined for twist and results will be published in due course.

Chir plants raised from X-ray treated seeds are progressing.

(vi) ARTIFICIAL REGENERATION.

Weather conditions affecting the results obtained were as follows :—

The 1934 monsoon arrived early, on the 17th June, and rains were regular up to September. The following cold weather was marked by a fairly good rainfall, but a very severe frost occurred during January 1935 resulting in heavy casualties in teak, *sal*, rosewood, *sain* and other broad leaved species. In 1935, the monsoon appeared rather late, the first showers falling on the 2nd July. Rains, however, were more or less continuous up to the 21st September. A spell of dry weather followed thereafter and there was practically no rain up to the beginning of February 1936, when some of cold weather planting was done. The first frost occurred on the 15th December 1935. It was only severe for the first night or two. However last year's coppice shoots of teak, *sal*, *Terminalia tomentosa*, *Adina*, etc., were not hard enough to withstand this relatively light frost.

(a) *Line sowings*.—The following species were tried in shade as well as in the open in 1935 :—

Holoptelea integrifolia, *Lagerstroemia parviflora*, *Hymenodictyon excelsum*, *Schleichera trijuga*, *Terminalia arjuna*, *T. paniculata* and *Machilus gamblii*; of these *Schleichera*, *Machilus* and *T. paniculata* did not germinate, but others were quite successful. Plants were slightly frosted during the cold weather of 1935-36.

(b) *Rains entire planting in the open*.—The following species were tried in 1935. The survival percent. at the end of the year is given in brackets.

Boswellia serrata (8), *Diospyros tomentosa* (78), *Cedrela toona* (61), *Cordia myxa* (84) and *Terminalia paniculata* (56).

As regards the planting in 1934, the following are the survival percent. at the end of the 1st and 2nd growing seasons respectively :—

Lagerstroemia flos-reginae (99-15), *Terminalia arjuna* (79-60), *Cedrela toona* (75-0), *Mallotus philippinensis* (63-0), and *Pterospermum acerifolium* (97-0). The last three species mentioned

above died wholesale during the hot weather of 1935. The first 2 species were frosted during the following cold weather.

(c) *Rains entire planting in cleared lines.*—The following species were put out in 1935, the survival percent. at the end of the year being given in brackets.

For the species tried in 1934 the following results indicate the survival percent. at the end of the 1st and 2nd growing seasons respectively. *Cedrela toona* (69-25), *Lagerstroemia flos-reginae* (100-73), *Mallotus philippinensis* (83-66), *Pterospermum acerifolium* (91-81) and *Schima wallichii* (13-nil). For no assignable reason, the last mentioned species will not grow well under any conditions tried.

(d) *Winter entire planting in the open and cleared lines.*—The survival percentages for species put out in cleared lines during 1932-33 cold weather for the 1st, 2nd and 3rd seasons respectively were :—

Mallotus philippinensis (46, 43, 42), *Litsaea polyantha* (29, 19, 19) and *Lannea grandis* (76, 75, 76).

The species put out in the open as well as in cleared lines in January 1935 as mentioned in last year's report were all killed by frost shortly after they were planted.

(e) *Winter stump planting in the open and in cleared lines.*—The survival percentage of *Bauhinia variegata* and *B. retusa*, which were tried in cleared lines in January 1933, was 74,71 and 71, and 76,59 and 60 at the end of the 1st, 2nd and 3rd growing seasons respectively.

The following species were put out in January 1934 and their survival percentage at the end of the 1st and 2nd growing seasons is given against each species :—*Ougeinia dalbergioides* (24-22), *Stereospermum suaveolens* (89-92), *Celtis tetranda* (51-23), *Cedrela toona* (38-25).

Ougeinia dalbergioides was also tried in cleared lines in January 1934 and the survival percentage at the end of the 1st and 2nd growing seasons was 21 and 16 respectively.

Of the 7 species put out in the open in January 1935, the following survived, the survival percentage at the end of the year is as shown :—*Acacia catechu* (3), *Acacia modesta* (4) and *Prosopis juliflora* (14). Other species were all killed by frost soon after planting.

The following species were planted in cleared lines in January 1935 and their survival percentage at the end of the year is given in brackets against each species :—

Prosopis juliflora (20), *Chickrassia tabularis* (14) *Acacia modesta* (7), *Pterospermum acerifolium* (8), *Acacia catechu*, *Litsaea polyantha*, *Chloroxylon swietenia* and *Trewia nudiflora* (nil).

(f) *Rains stump planting in the open*.—With species tried in 1934 the following results were obtained at the end of the second growing season, the figures in brackets giving the survival percent. at the end of the 1st and 2nd seasons respectively :—

Olea glandulifera (60-0), *Cassia siamea* (86-4), *Stereospermum suaveolens* (stumps 99-100) and *Chloroxylon swietenia* (83-51) ; *Mallotus philippinensis* (98-49) in one case and (76-nil) in another, *Terminalia chebula* (85-50) and *Prosopis juliflora* (79-57). Root sections of *Stereospermum* tried under the same conditions shewed 98 and 94 per cent. survival.

The species put out during the rains of 1935 are mentioned below with their survival percent. at the end of the year mentioned in brackets :—

Lagerstroemia flos-reginae (100), *Pongamia glabra* (100), *Terminalia chebula* (100), *Bauhinia purpurea* (96), *Juglans regia* (95), *Grevillea robusta* (92), *Prosopis spicigera* (90), *Boswellia serrata* (38), *Terminalia myriocarpa* (12) and *Terminalia arjuna* (4).

(g) *Rains stump planting in cleared lines*.—The two species put out in 1934 showed the following survival percent. at the end of the 1st and 2nd seasons respectively :—

Mallotus philippinensis (89-74), and *Phoebe hainesiana* (70-9).

The following species were tried in 1935, their survival percent. at the end of the season being given in brackets :—*Lagerstroemia flos-reginae* (100), *Pongamia glabra* (98), *Terminalia citrina* (74), *Bauhinia purpurea* (70), *Juglans regia* (45), *Grevillea robusta* (55), *Swietenia macrophylla* (44), *Prosopis spicigera* (36), *Terminalia myriocarpa* (6) and *Canarium bengalensis* (13).

(h) *Storage of stumps before planting*.—The 1934 experiment with teak stumps stored on a cement floor for 0, 4, 8, 13 and 20 days showed the following survival percent. at the end of the 2nd season : 78, 76, 62, 42 and 8 with corresponding average heights of 30·8", 30·2", 29·6", 23·7" and 21·0".

In 1935, *Acacia catechu* and *Eugenia jambolana* were tried under similar conditions.

Acacia catechu.—250 stumps of different diameters prepared on the 20th July 1935 were planted out in comparable sets of 50 stumps after storage up to 13 days in moist sacking under a thatch shelter. Rain was more or less continuous during the whole period of storage. At the end of the growing season the survival percent. was 60, 50, 42, 38

and 26 with corresponding average heights 12.2", 11.7", 10.8", 6.7" and 6.8" for stumps stored for 0, 4, 7, 10 and 13 days respectively.

Eugenia jambolana.—The number of stumps and the initial treatment were the same as for *A. catechu* above, except that the stumps were prepared on the 21st July 1935. At the end of the growing season the survival percent. was 92, 98, 98, 98 and 96 with corresponding average heights 3.5", 3.6", 3.6", 3.3" and 3.3" for stumps stored for 0, 4, 7, 10 and 13 days respectively. This indicates a hardness even surpassing that of teak.

(i) *Early planting of stumps without irrigation*.—The fortnightly planting of teak stumps was started from 15th January 1935 in the open and from 31st January 1935 in cleared lines under shade, the last date of planting being 11th July 1935 for the former and the 26th July 1935 for the latter. The survival percent. after one growing season was *nil* upto the 9th set (mid January to mid May) and 4, 36, 100 and 100 with corresponding average heights 5.0", 5.8", 7.7" and 5.0" for the rest of the sets (end May to mid July) planted in the open. The survival percent. figures for the cleared lines in shade are 20, 12, 12, 12, 16, *nil*, *nil*, 12, 32, 60, 100, 100 and 92 with corresponding average heights 5.8", 5.0", 5.0", 5.7", 5.8", *nil*, *nil*, 5.7", 3.5", 5.3", 5.4", 4.1" and 2.9". The value of the shade is clearly brought out but the survivals are too few for practical purposes. It would appear from the above figures that teak stumps planted one week before the break of rains give the best result, the optimum period extending upto one week after the rains have set in.

(j) *Comparison of nursery stock and natural seedlings*.—The survival percent. of *Eugenia jambolana* originally grown in the nursery and planted out in 1932 has fallen from 90 to 60 in four growing seasons whilst that of natural seedlings planted out the same time varied from 93 to 43. There was no appreciable difference in heights between the two sets.

The experiment was repeated with *Eugenia jambolana* in 1935 and the survival percent. at the end of the 1st season was 96 both for forest and nursery grown seedlings, and there was no significant difference in their heights.

(k) *Comparison of nursery and forest stumps*.—The forest stump percent. of *Eugenia jambolana* put out in 1933 continues to indicate a superiority over nursery grown stumps, survivals now being 76 and 92 per cent. respectively.

Bauhinia variegata was tried in 1935 under this experiment and the survival percent. at the end of the year was 94 for nursery grown stumps and 86 for forest stumps, average heights being 8.1" and 8.0" respectively.

(l) *Comparison of sowings, transplants and stumps.*—The following tabular statement summarises the condition of different species put out from 1932 to date :—

Year.	Species.	Method (sowing or planting).	SURVIVAL PERCENT AT THE END OF THE YEAR.				Average height at the end of 1935 (in inches).	REMARKS.
			1932	1933.	1934.	1935.		
1932	<i>Teetona grandis</i> . .	Entires in pits . .	70	37	37	32	78 3	Was discontinued in June 1935 having attained an average height of 10'.
		Stump planting in standard pits.	98	98	98	95	109.3	
		Stump planting in crowbar holes.	93	92	92	87	109 8	
	<i>Bauhinia variegata</i> . .	Direct sowing . .	100	100	98	98	111 3	
		Entire transplanting . .	95	87	87	87	84.3	
		Stump planting . .	100	98	98	98	107 9	
	<i>Bombax malabaricum</i> . .	Direct sowing . .	95	60	60	55	22 7	
		Entire transplanting . .	95	58	58	48	20 4	
		Stump planting . .	95	88	88	88	38.0	
	<i>Acacia catechu</i> . .	(Vide last year's report)	..	..	..	..	..	
1934	<i>Eugenia jambolana</i> . .	Direct sowing . .	..	..	93	5	6.0	
		Entire transplanting . .	..	..	60	..	..	
		Stump planting . .	..	..	78	33	9.2	
	<i>Stereospermum suateolens.</i>	Entires in crowbar-holes.	..	..	53	8	3.0	
		Entires in standard pits	..	..	60	13	1 6	
		Stump planting . .	..	..	98	100	9.0	
1935	<i>Bombax malabaricum</i> . .	Direct sowing . .	..	..	..	70	1 8	
		Entire transplanting . .	..	..	..	93	2.9	
		Stump planting . .	..	..	..	90	2 8	
	<i>Acacia catechu</i> . .	Direct sowing . .	..	..	..	83	4 9	
		Entire transplanting . .	..	..	..	63	5 6	
		Stump planting . .	..	..	..	78	7 1	
	<i>Pterospermum acerifolium.</i>	Direct sowing . .	..	..	..	88	2 7	
		Entire transplanting . .	..	..	..	100	4.3	
		Stump planting . .	..	..	..	65	2.3	
	<i>Cedrela toona</i> . .	Entire transplanting . .	..	..	..	95	3.7	
		Stump planting . .	..	..	..	100	7.5	

(m) *Araucaria plantations*.—The *Araucaria cunninghamii* plantation is promising and has attained a maximum height of 8'-4" in 4 years.

The survivals in the small plantation of *A. bidwillii* have reached a maximum height of 10'-3" in 6 years, and are doing well.

(vii) NURSERY WORK.

The seed crop on trees in the Dun valley was fairly good during the year. As usual, stock was raised for various species for use in the Experimental Garden and Demonstration Area.

The following experiments were carried out in the nursery during the year under report.

(a) *Experiments with different degrees of nursery bed shades* (Experiment 14) were done with *Adina cordifolia* and *Anthocephalus cadamba* and the following are the results at the close of the year :—

Adina cordifolia.—In the *tin shaded* sections of beds the development of plants was best due to more uniform germination. Plants at the edges of beds were getting more light than those inside and were very much better than the latter. Sections with *thatch shade* had numerically the best germination, but seedlings were slightly inferior in development to those under the tin shade.

There was excessive damage due to drip in the sections with *batten shade* and results were very poor.

In the *unshaded sections*, the seeds were washed together (by surface drainage) and germinated in clumps, but their development was very poor due to intense competition.

Anthocephalus cadamba.—The washing of seeds into heaps was much less than with *Adina*. In the *tin shaded sections*, stocking was poorer, less uniform and growth less than under *thatch shade* owing to much damping off. Effect of drip was, however, nowhere apparent. The *thatch shaded* sections were evenly stocked but development slightly less than under *batten shade*. The sections with the *batten shades* were best of all with fairly even stocking. The *unshaded* sections had practically no germination.

(b) *Seed pretreatment* (Experiment 13).—The experiment was repeated with *Terminalia chebula* in June 1935. 350 seeds of *T. chebula* were subjected to each of the following treatments :—(i) Control, (ii) soaked in cold water and (iii) soaked in slaked lime both for 48 hours before sowing.

The germination percent. at the end of the growing season was 31.7, 48.9 and 34.3 with corresponding average heights 3.9, 4.2 and 4.1 for the three treatments respectively.

(c) *The manuring experiment* (No. 16) in *nursery beds* was carried out with *Cedrela toona* during 1935. The beds selected had the same past history.

Crotalaria juncea, *Cassia tora* and lucerne were used as green manures in 3 different beds whereas farmyard (cowdung) and artificially prepared farmyard manures were added to 4 other beds separately at the rate of 10 and 20 baskets of each manure per bed. The 8th bed was left as a control.

The average height of the best plant per running foot was as follows for each kind of manure :—

	Inches.
Farmyard manure : 10 baskets	4.3
Farmyard manure : 20 baskets	2.8
Artificial farmyard manure : 10 baskets	2.2
Artificial farmyard manure . 20 baskets	2.5
<i>Crotalaria juncea</i>	2.4
<i>Cassia tora</i>	2.3
Lucerne	2.8
The control bed had an average height	2.1

(d) *Best time for seed collection* (Experiment No. 79).—*Terminulia chebula* seed was collected in 5 lots, each lot on a different date, *i.e.*, on 19th December 1934, 3rd January 1935, 14th January 1935, 23rd January 1935 and 2nd February 1935. 250 seeds for each of the first three lots, 200 for the fourth and 100 for the fifth lot above were selected at random and sown in nursery bed in April 1935. The germination percent. was 28, 6.4, 5.6, 6.5 and 6.0 with corresponding average heights 4.7, 2.4, 2.0, 3.2 and 1.3 for first, second, third, fourth and fifth lots respectively at the end of the year.

(viii) MISCELLANEOUS.

No special new experimental work was taken up during the season. A manuscript by Mr. Deogun collecting all available information concerning the silviculture and management of the important bamboo *Dendrocalamus strictus* is still pending publication but is expected to be ready for the Press shortly.

(ix) RECLAMATION AND AFFORESTATION.

Teak and rosewood plantations having proved a failure, owing to frost and fungi, it has been decided to abandon them. Teak is being replaced by *khair*, bamboo, mulberry, *tun*, etc., in different blocks. 3 more compartments in the teak working circle were sown with *khair* in lines 9 feet apart in July, 1935, and although it was affected by frost

during the last cold weather, it is doing well now. The 1934 *khair* is growing well in 2 of the compartments having attained a height of about 8' in the 2nd year. Six more teak compartments, at present under *taungya* cultivation, will be ready for sowing of the above mentioned species in rains 1936.

An area of about 15 acres in the Rosewood Working circle has been leased out for *taungya* cultivation for a period up to the summer of 1937, when this area will be sown with *chir* pine in which a new spacing and thinning experiment is proposed to be carried out.

(a) *Sal working circle*.—Failed patches were again sown with *sal* seeds of Dehra Dun, Haldwani, Hoshiarpur, Kheri, and Gorakhpur origins. Frost again cut back many of the last year's tender coppice shoots.

(b) *Chir working circle*.—There being no *chir* seed available during the year 1935, casualties could not be replaced.

C-grade thinning was done in some of the 1925 and 1926 plantations, and a systematic pruning of selected dominant stems was carried out in 4 of the thinned compartments. One of the 1926 compartments was control-burnt in February, 1936, with the object of following the effects on increment and branchiness.

II.—STATISTICAL SECTION.

(i) YIELD TABLES.

The total number of sample plots maintained this year is 1,537 which shows an increase over last year's figure by 35 plots. Of these, Burma and the United Provinces contribute a greater portion having 331 and 361 plots respectively and the rest are shared by all other provinces including Kashmir State. The necessary computations were done for 323 out of 388 sample plot files received. A stand table for *Pinus longifolia* was prepared and sent to the press. Preliminary work has been begun for the compilation of yield tables for plantation teak for which 346 sample plots and 655 measurements are available.

(ii) VOLUME TABLES.

A standard and commercial volume table for *Dalbergia sissoo* has been compiled and published as an Indian Forest Record. Stump analysis data on 99 stumps were computed for Madras; and calculation was also done for 518 trees for the standard volume and 608 trees for commercial volume for the Punjab.

(iii) MISCELLANEOUS.

Investigations continue to be carried out to examine the possibility of photographic methods of measurement of standing sample trees. The extensible ladder was loaned to Madras for trials there.

Two parties were in the field this year. One party under the direct supervision of the Silviculturist measured 40 sample plots in the Lower and Upper Bashahr divisions. The other party with the Statistical Assistant in the Jaunsar division was engaged on the collection of sap-wood data for deodar and analysed 280 felled trees. The data were worked up later and found to permit of tentative conclusions requiring check with further figures which will be collected in the coming season.

III. MISCELLANEOUS.

(i) PHOTOGRAPHIC SECTION.

The routine work carried out compares with previous years as follows :---

Year.	Negatives made.	Prints made.	Lantern slides made.	Colour Photos.
1932-33 . . .	677	2,276	44	..
1933-34 . . .	1,095	2,271	400	..
1934-35 . . .	932	3,420	130	18
1935-36 . . .	748	2,791	301	6

Of the new negatives 75 were photographs taken in Bashahr, 23 in foreign countries and 8 in the Dehra Dun division all by the Silviculturist.

268 photographs were taken in the Timber Testing Section, and 161 more were taken for other different branches and sections of the Institute.

213 negatives were sent by Provincial Silviculturists of Madras, United Provinces and by the Research Officer, Bihar and Orissa, to be lodged in the Forest Research Institute collection.

The total number of prints in the general series comes to 3,529 and in the specific series 4,341, against 3,372 and 4,203 respectively for the last year.

930 prints were prepared for different Provinces and States, 93 photographs were used as illustration in various publications.

115 lantern slides were prepared for the Forest Research Officer, Bihar and Orissa, and 14 other slides for Silviculturist, U. P. The former for showing at an Industrial Exhibition at Patna and the latter for the purpose of local propaganda.

172 lantern slides were prepared and added to the collection.

The Range Officer of the Demonstration Area of the Institute was sent to Kotdwara with some 40 slides where he delivered a public lantern lecture on the utility of forests illustrated by slides from the collection of the Institute.

The collection of stereos was improved and a beginning made on a collection of cinema films with a copy of a film of forest work kindly loaned by Mr. D. Stewart.

(ii) RECORDS.

No progress can be reported on referencing of arrears of forest literature which have actually increased since last year. The situation will be somewhat relieved by the monthly list of references issued from the Imperial Forestry Institute, Oxford, from the beginning of 1936, but these will not obviate the necessity of dealing with the literature from the special Indian view point. Abstracts of Indian literature were prepared as usual for Biological Abstracts.

The compilation of a book on Indian Silviculture which will summarise the data collected on the General Ledger Files (by subjects) has been commenced and will be completed in 1936, whilst Part II dealing with the Silvicultural Systems has already been drafted by Mr. Trevor.

Forty-one new books were added to the library during the year including 25 Working Plans bringing the total up to 674 volumes and 483 bound periodicals. A list of additions with brief abstracts was circulated as usual.

(iii) WORKING PLANS.

Notes were written on the South Coorg and Melghat, C. P., draft working plans and the suggestions made have been generally adopted in the plans.

(iv) MUSEUM.

The large model demonstrating the influence of forest cover on preventing erosion has been completed and demonstrated to many distinguished visitors. Several readjustments especially of the rainfall arrangements have had to be made to ensure an even and realistic fall, but the model reflects much credit on the Museum Artist (B. Darshan

Singh). Work is being commenced on the ninth of the ten large wall cases, the subject being the influence of local climate on vegetation; the phenomena of altitudinal zonation, succession and retrogression, and the effects of site and soil will all be illustrated. The earlier models have been improved in several respects.

(v) STAFF AND TOURING.

The writer was on leave from 19th April till the end of the year, Mr. M. V. Laurie again officiating during his absence. Mr. J. N. Sen Gupta joined the Branch from Bengal in succession to Mr. P. N. Deogun as Experimental Assistant whilst Mr. Kakazai remained in charge of the Statistical Section. Ranger Hari Krishan Madhwal continued in charge of the Experimental Garden, etc.

The Silviculturist toured with a sample plot field party in Bashahr, Punjab, in May-June whilst the Statistical Assistant collected deodar sapwood data with another party in Chakrata, U. P. The Experimental Assistant made a long tour visiting evergreen forests in Madras, Coorg, Mysore and the Andamans.

(vi) VISITING FOREST OFFICERS.

As usual several officers visited the Branch to discuss their local silvicultural problems and research methods. Among them were Mr. Warren on taking over the post of Forest Research Officer, Bihar and Orissa, Mr. Mitchell, Chief Forest Officer, Coorg, and Mr. Holmes of the Ceylon Forest Service who is taking up the post of Silviculturist in Ceylon and for whom a tour in India was arranged.

CHAPTER III.—BOTANY BRANCH.

1. *Systematic Botany*.—The study of the Indian species of *Terminalia* of the section *Pentaptera* has been completed and a draft report with illustrations prepared; this report is in the course of final preparation for publication. The systematic study of this group has been found to be difficult owing to the absence of well-defined characters for distinguishing the forms and species and some overlapping of characters, difficulties which have hitherto been the cause of difference of opinion in the status of the various groups.

A draft paper dealing with the following five species of forest importance belonging to the family *Dipterocarpaceae* has also been completed with illustrations; three allied species of *Shorea* from Assam and Burma, *S. assamica* Dyer, *S. floribunda* Kurz and *S. sericeiflora* Fisch. and Hutch., and two Burmese *Hopeas*, *H. oblongifolia* Dyer and *H. helferi* Brandis. A paper dealing with five species of this family, including the eleventh species of *Dipterocarpus* from Assam and Burma, *i.e.*, *D. macrocarpus* Vesque, was published in the Indian Forest Records; material of the two remaining Indian species of *Dipterocarpus* occurring in South India, *i.e.*, *D. indicus* Bedd. and *D. bourdillonii* Brandis was obtained and examined for the completion of the study of the Indian species of this genus. A note dealing with the systematic study of some Indian and Burmese *Dilleniaceae* was published in the *Indian Forester* and a paper on a new genus in the *Connaraceae* submitted for publication.

Two further papers, one on the Indian species of the genus *Psilotum* and another dealing with some recently introduced or otherwise imperfectly known plants from the Upper Gangetic Plain—the area covered by Duthie's flora—were published.

2. *Herbarium*.—During the year 2,636 specimens, received from various sources, were incorporated in the herbarium. About one thousand of these represent foreign (non-Indian) specimens obtained by exchange from various herbaria such as the herbarium of the Arnold Arboretum and the Gray Herbarium of the Harvard University, the herbaria of the New York Botanic Garden, the Oxford University and the Royal Botanic Garden, Calcutta. About 500 specimens were obtained from the collections made by the Forest Botanist and his staff, chiefly in Chittagong, Kumaon, Kulu and the Dehra Dun and Saharanpur districts; the remainder was from collections received from Forest Officers from various parts of India, the most notable of these being those of the Botanical Forest Officer, Shillong, 131 specimens; Mr. H. G. Champion, I.F.S., 122 Naini Tal and Pindari specimens; Mr. V. S. Rao, I.F.S., about 100 Chittagong and Northern Bengal specimens,

and Dr. N. L. Bor, I.F.S., 72 Assam specimens. Two small notable collections were received, one by Brigadier C. C. Foss from Maymyo (received through the Forest Botanist, Burma) and the other from Mr. R. Scott, Assistant Commissioner of the Nicobar islands. These incorporations do not include the large number of specimens still in hand which will not be incorporated till the determinations have been completed, such as an extensive collection received from Dr. N. L. Bor from the Khasia hills.

The following specimens were distributed from this herbarium either on an exchange basis or as donations :—

Arnold Arboretum, Harvard University, Jamaica Plain, Mass., U. S. A.	85
Gray Herbarium, Harvard University, Cambridge, Mass., U. S. A.	62
New York Botanic Garden	100
Botanic Garden and Museum, Berlin	198
Royal Botanic Gardens, Edinburgh	64
Naturhistoriska Riksmuseet, Botaniska Avdelningen, Sweden .	78
Smithsonian Institution, United States Department of Agriculture, Washington	46
Maymyo herbarium, Burma	56
TOTAL .	689

The herbarium was visited by Professor Tyozaburo Tanaka of the Taihoku Imperial University for the examination of our herbarium collection of Rutaceae-Aurantioideae in connection with his monographic study of this group.

The herbarium material of *Avicennia* (117 sheets) sent out on loan from this herbarium to Dr. H. N. Moldenke of the New York Botanic Garden has been returned with the annotations of that author and this has considerably increased the value and usefulness of this material. The *Ixora* and *Pavetta* collections of this herbarium have been sent out on loan to Prof. C. E. B. Bremekamp of the University of Utrecht for study. The re-arrangement of the foreign (non-Indian) collections was continued and has progressed as far as the *Polygonaceae*; as in previous years this work has been done by the Herbarium Clerk in addition to his usual routine duties.

3. *Library*.—Thirty-eight volumes as well as the usual periodicals were added to the library during the year. The work of card-indexing references to special subjects in botanical literature was continued but could not be brought up to date for all the periodicals listed for want of time. A manuscript catalogue of the books in the Botanical Branch library was prepared; this has been drawn up into two parts, the first arranged according to a subject index and the second arranged alphabetically according to authors names.

4. *Identification of specimens.*—Owing to the increased attention that is now being given to the study of the soil flora and the determination of plants for the purpose of the preparation of local lists, the Forest Botanist and his assistant are now being called upon to identify an increasingly large number of plant specimens every year sent in by the Silviculturists, Working Plans Officers and others. This number has increased during the last decade from 649 determined in 1925-26 to 817 in 1930-31 and 1629 during the year under report. This work, which takes up a large part of the time of the small botanical staff dealing with Systematic botany, is done in the nature of routine work but is now increasing sufficiently to keep a whole-time systematic botanist well employed. Among the most notable collections that have been examined for determination are those of the Silviculturist of the Forest Research Institute, the Silviculturist, United Provinces, the Divisional Forest Officer, Silvicultural Research Forest Division, Lahore, Punjab, the Divisional Forest Officer, Chittagong Hill Tracts, Dr. N. L. Bor's specimens from Assam, Mr. V. S. Rao's Chittagong and Northern Bengal specimens, and the collections made by the Forest Botanist and his staff. Some of these collections are made in duplicate, triplicate or quadruplicate sets, one of which is retained for the Forest Research Institute Herbarium and the other correspondingly named and numbered sets distributed to various herbaria in exchange for other collections.

Sixty-four specimens were identified at the Royal Botanic Gardens, Kew, and sixteen at the Herbarium of the Royal Botanic Garden, Calcutta, for this herbarium.

Tours.—The Forest Botanist toured for about four weeks during the month of June 1935 in the East Almora division. Herbarium collections, ranging between the altitudes of 4,000 and 13,000 feet, were made for the Dehra Dun herbarium and for exchange with other herbaria. The Forest Botanist was unable to make any winter tour owing to lack of funds.

The Mycologist visited the Agricultural Research Institute at Pusa during the month of April, 1935, in connection with the determination of some fungus specimens collected by him during the previous year in the Chakrata forest division. He toured in the Chakrata division during the months of May to July, 1935, and conducted inoculation experiments in connection with the study of the life history of some *Peridermiums* on coniferous hosts. Inoculations of the roots of *Pinus excelsa* and *Cedrus deodara* with *Fomes annosus* and *Armillaria* sp. were also made to study their pathogenic behaviour on these hosts and *Trametes pini* was also used to inoculate them to study the parasitic nature of that fungus. A second tour was made in the same area in order to collect the results of the inoculation experiments done during

May to July and to make further inoculations with the teleutostages of rusts.

5. *Supply of Seed*.—Enquiries for authentic samples or quantities of seed are received from various scientific departments, institutions and individuals from various countries and these are supplied either on an exchange basis or on payment to approved indentors. Sixteen of these were in the nature of larger indents aggregating about 460 lbs. supplied chiefly to Indian, Colonial and Foreign Forest Departments. These indents were chiefly for *Pinus longifolia* for South Africa and Rhodesia, *Pinus khasya* for South Africa, *Terminalia belerica* for the Kutch State, *Leucaena glauca* for Bengal and the Punjab and teak and *Acacia arabica* for Java. Only a small portion of the quantity of seed of *Pinus longifolia* asked for by the South African Forest Department could be supplied owing to the poor seeding of that species during the year. The list of seeds offered in exchange from the Arboretum and Botanic Garden of the Forest Research Institute was revised and reprinted during the year and distributed generally to the Forest Department in India as well as to the various institutions with which seed exchange relations are maintained.

6. *Arboretum, Fruticetum and Botanic Garden*.—In the Arboretum 70 trees, representing 9 families and 15 genera, were planted out during the year as well as two new avenues, one with *Grevillea robusta* and the other with *Enterolobium timbouwa*, two quick-growing species known to do well in the Doon. For the improvement of the grounds two hitherto untended plots of about an acre in area were fenced in and planted up with ornamental species also known to do well locally.

The plots in the Arboretum south of Hart road, hitherto planted up with trees belonging to the families Malvaceae, Sterculiaceae, Tiliaceae, Rhamnaceae and Anacardiaceae, were taken over by the Silviculturist. The replacing of many of these species has already been done in the plots around the Forest Economist's workshops and elsewhere where better results are expected on account of more suitable soil conditions and the easier watering arrangements during the hot weather. Some bamboos that had also been planted out in the abandoned plots have already been replanted elsewhere.

Growth has been generally good in the Arboretum and most plants have progressed favourably though some species received some set back during the year. The new Gold Mohur avenue was threatened with defoliation during the month of July by several species of *Chrysomelidae* and a species of *Rutelidae*; this attack was, however, successfully overcome by spraying with an insecticide and the plants are now progressing favourably. The avenue of *Phoenix canariensis* south of the Timber Testing offices was completely destroyed by the larvae of a large

Curculionid which attacked the leaf-bases of the plant. It has been necessary to completely replant this avenue with another species. Little or no damage was done by frost as the winter was a comparatively mild one.

Work in the Botanic Garden continues to make good progress and the results obtained already justify the abandonment of the old Fruticetum and establishment of the new garden. About 200 plants belonging to 32 families and 68 genera were planted out during the year. A small lily garden has been established and the success achieved with the rainy season and winter annuals has added greatly to the attractiveness of the garden which is now being visited by an increasing number of visitors. In the nursery and experimental garden about 600 plants were raised for planting out in the Arboretum, the Botanic Garden and in the avenues; in addition to this number about 450 plants were distributed for planting in the residential grounds at New Forest, in the adjoining Indian Military Academy and elsewhere. Several new foreign species were raised from seed obtained from various botanical institutions.

A list of plants (excluding annuals) grown in the grounds of the Forest Research Institute was drawn up and printed during the year. This list has been distributed to various botanical institutions and to the Provincial forest departments and is proving both an interesting and useful record. The preparation of this list took more time than was at first anticipated as it was not merely drawn up from existing records but involved a check of all the plants in the field during which notes regarding the condition of growth at New Forest of all the species were recorded.

The following plants were recorded to have flowered during the year for the first time at New Forest :—*Prunus capuli* Cav., *Millettia pachycarpa* Bth., *Acacia karroo* Hayne, *Gymnocladus canadensis* Lamk., *Feijoa sellowiana* Berg., *Cryptocarya amygdalina* Nees., *Alpinia bracteata* Roxb., *Piptadenia oudhensis* Brandis, *Lonchocarpus neuroscapha* Bth., *Bauhinia hookeri* F. Muell., *Moringa aptera* Gaertn., *Chrysanthemum cinerariaefolium* Vis., *Adenantha microsperma* Teijsm. and Binn., *Cordia tremula* Griseb., *Acacia ferruginea* DC., *Acacia lenticularis* Ham., *Hibiscus costatus* Rich., *Hibiscus coccineus* Walt., *Koelreuteria paniculata* Laxm., *Aristolochia oblongata* Jacq., *Homalium tomentosum* Bth., *Eri-nocarpus nimmoanus* Mast., *Sechium edule* Swartz., *Nauclea sessilifolia* Roxb., *Aesculus punduana* Wall. and *Podocarpus gracilior* Pilger.

7. *Miscellaneous*.—Many enquiries of a technical nature received from forest officers and others from various parts of India were answered and advice given on botanical matters.

8. *Staff*.—The post of Forest Botanist was held throughout the year by Mr. C. E. Parkinson who was assisted by Mr. Mukat Behari Raizada, Lower Grade Assistant.

The mycological work reported on below was carried out by Dr. K. D. Bagehee, Mycologist, Mr. A. Hafiz Khan, Upper Grade Assistant, and Mr. R. N. Chatterjee, Laboratory Assistant.

MYCOLOGY.

9. *Shisham root disease*.—The draft report on the work done during the last ten years in connection with the shisham root disease due to various pathogenes, of which a species of *Fusarium* plays an important part, has been completed.

10. *The die-back disease of Gmelina arborea*.—This problem is receiving the attention of the Mycologist and the Entomologist. Of the three insect pests observed on the *Gmelina* plants in the demonstration area at New Forest, *v.e.*, *Tingid* bugs, *Alcides gmelinae* and *Calopepla leayana*, only the *Tingid* bug was investigated by the Entomologist for the study of its effect on healthy *Gmelina* plants. Inoculation experiments with these bugs did not give any conclusive results as to the extent of damage the insect is capable of doing. The part played by the other insects in this die-back disease is being investigated by the Entomologist.

Cultures of fungus, *Coniothecium* sp. isolated from the diseased twigs of *Gmelina* in the Silviculturist's experimental area at New Forest, were used to inoculate healthy and *Tingid* bug infected plants of *Gmelina* but with no useful results. Cultural work on the *Coniothecium* sp. was continued.

11. *Peridermium* spp. in India.

(i) *Peridermium himalayense* on the stem of *Pinus longifolia* and *Cronartium himalayense* on *Swertia* sp. —The work in connection with the investigation of these rusts has been completed and the biological relationship between these two rusts has been established by proper inoculations. Control measures for this rust (*Peridermium himalayense*) have been suggested. A paper on the results of pine inoculations with *Cronartium himalayense* (teleutostage) is being prepared.

(ii) *Peridermium indicum* on *Pinus excelsa* and *Cronartium* sp. on *Ribes rubrum*.—The leaves of *Ribes rubrum* were again successfully inoculated at Chakrata with cultures of *P. indicum*, and the uredo and *Cronartium* stages were reproduced on the leaves of *Ribes*. The specimens of *P. indicum* were procured from Tonnamarg, Kashmir, for the purposes of this inoculation. The results of these inoculation experiments corroborate those of previous year's, where *Ribes* plants were

successfully inoculated in three different localities in the Chakrata division during May and June 1934 with *P. indicum* received from the Kulu division.

Plants of *Pinus excelsa* inoculated with the *Cronartium* (teleuto) stage from *Ribes rubrum* at Chakrata in 1934 are showing symptoms of infection. A paper on this work is being drawn up.

(iii) *Peridermium orientale* (*P. complanatum*) on the needles of *Pinus longifolia*.—The leaves of *Campanula colorata* were successfully inoculated with the *Peridermium* from the needles of *Pinus longifolia* at Chakrata and the uredo and coleosporium stages obtained on the leaves of *Campanula colorata*. Needles of *Pinus longifolia* were inoculated with *Coleosporium campanulae* (teleuto stage) from *Campanula canescens* and the results are awaited.

(iv) *Peridermium cedri* on *Cedrus deodara*.—A series of inoculation experiments were conducted at Chakrata on eight likely broad-leaved alternate hosts with a view to determine the alternate host for the fungus. The broad-leaved species selected for this experiment are found to bear unrecorded species of *Coleosporium*, *Phakopsora* and *Pucciniastrum*, in nature. The leaves of deodar were inoculated with *Chrysomyxa deformans* (teleuto stage) on *Picea morinda* at Chakrata. As a result of this inoculation only pale spots were produced on the needles instead of the characteristic peridermium pustules.

(v) *Peridermium brevius* on *Pinus excelsa* needles.—This rust was correlated to a new species of *Coleosporium* on *Senecio rufinervis* and this was verified by a large number of successful inoculations of *Senecio rufinervis* with the spores of *Peridermium brevius* at Chakrata. Inoculations of *Pinus excelsa* with the *Coleosporium* (teleuto) stage on *Senecio rufinervis* have also been done and results are awaited.

(vi) *Peridermium thomsoni* on *Picea morinda*.—A search for this rust was made in the Chakrata division but with no success.

(vii) *Peridermium piceae* on *Picea morinda*.—This rust was reproduced by inoculating the needles of *Picea morinda* at Chakrata with *Chrysomyxa himalensis* (teleutostage) from *Rhododendron arboreum*. Inoculations of *Rhododendron arboreum* with the peridermium spores from *Peridermium piceae* have also been done and the results are awaited.

(viii) *Peridermium ephedrae* on *Ephedra vulgaris*.—Inoculations were made on *Ephedra vulgaris* with a *Hyalopsora* sp. on a *Polypodium* (fern), the only rust in the vicinity of the infected *Ephedrae* at Chakrata. The results are awaited.

(ix) *Peridermium* sp. nov. on *Abies pindrow*.—Cultures of this rust were procured from Pulga in the Parbatti range of the Kulu division ;

these were successfully transferred to a fern (*Polypodiaceae*) on which the uredo and teleutostages were produced.

12. *Damping-off of forest tree seedlings in the nursery.*—It was not found possible to do any work in this connection for want of time.

13. *Cultural studies of wood-rotting fungi and their pathogenecity.*—Cultural studies and observations in connection with the wood-rotting properties of the following fungi were continued :—*Ganoderma lucidum*, *Polyporus gilvus*, *Polystictus versicolor*, *Polystictus sanguineus*, *Schizophyllum commune* and *Fomes annosus*.

Inoculations of young shisham plants in pots with pure cultures of *G. lucidum* and *P. gilvus* were repeated. Inoculations of *Pinus excelsa* and *Cedrus deodara* with *Armillaria* sp. were also repeated and *Trametes pini* was introduced for the study of its parasitic behaviour on the two coniferous species above mentioned. Inoculations of *Cedrus deodara* and *Pinus excelsa* with *Fomes annosus* have proved successful.

14. *Sal root disease including Polyporus shoreae, Fomes tricolor and Fomes fastuosus.*—Examinations of the various kinds of rot on *sal* were continued in the laboratory. A large number of sporophores collected from the diseased *sal* trees in Bihar and Orissa were identified. Cultures of *P. shoreae* and *F. tricolor* have been isolated and their cultural characters are being studied.

15. *Routine work.*—(i) The study of diseased *champ* specimens from Kurseong, Bengal, which included the cultural study of the organisms isolated from them and inoculation of healthy *champ* seedlings with these organisms has been completed and the report on the investigation has been submitted.

(ii) Investigations on the canker disease of *Dalbergia latifolia* in New Forest is being continued; the fungus organism associated with canker formations has been isolated and *D. latifolia* plants in pots were inoculated with the pure culture of the organism but with negative results.

(iii) The systematic study of various forest rusts from the Himalayas, which includes the collections from Kagan, Kulu, Chakrata and Kumaon, was continued as time permitted. The collections contain a large number of unrecorded species, some of which are heteroecious, some interesting fern rusts and a large number of others parasitic on the herbaceous hosts in the forests.

(iv) The collection of specimens of macro-fungi of the Himalayas including *Polyporaceae* and *Agaricaceae* has been gradually named at Kew and elsewhere and are being incorporated in the herbarium.

(v) Types of wood rot including those on living trees and timbers of forest importance are being gradually collected, identified, and prepared as museum specimens.

CHAPTER IV.—FOREST ENTOMOLOGY.

Charge of the Branch of Forest Entomology was held by Dr. C. F. C. Beeson throughout the year.

Mr. J. C. M. Gardner was in charge of the section of Systematic Entomology until 16th May 1935 when he proceeded on leave and took over charge of his section from Dr. C. F. C. Beeson on his return from leave on 25th October 1935.

Insects of Teak.

Defoliators.—Special attention was given to the study of parasites of the various teak defoliators based on material from United Provinces, Bengal and Orissa. Numerous experiments were performed and the parasites bred are being classified, many of them being new species. It has been proved that many of the important parasites can attack more than one species of defoliator. Periodical measurements of sample trees to correlate loss of increment and defoliation are being continued by the divisional staff at Nilambur, Madras.

Insects of Sandal.

Reports on the seasonal incidence and distribution of the following groups have been prepared for the press: Lepidoptera, Coccidae, Cica-didae, Coreidae, Berytidae and Chrysomelidae. In this work over 12,000 specimens from the sandal sample plots were identified. These reports add 362 species to the insect fauna of sandal.

Insects of Champ.

In North Bengal an area of about 843 acres, divided into 155 plantations, is covered by pure champ. Of these about one-third have been heavily attacked by the champ bug (*Urostylis punctigera*). The bug is indigenous in these forests and is known to feed on several other species of the Magnoliaceae besides champ (*Michelia champaca*). It is probable that the whole of the plantations will be subject to attack in the future. However a simple method of control by spraying which will check an attack in its early stages has been devised.

Insects of Casuarina.

A preliminary survey of the insect fauna of *Casuarina equisetifolia* was made in the Balukhand plantation, Puri, Orissa. Of numerous species of insects found to attack *Casuarina* the following appear to be the most important: (1) Bagworms (*Clania* sp.), with two life-cycles

in the year attacking both young and old trees. Several species of parasites have been reared. (2) *Zeuzera coffeae*, whose larvae tunnel in and girdle young stems. (3) Coccidae (*Iccanium longulum* and on unidentified species) have been reported as causing considerable damage to young plants. Parasites of both species have been reared.

Arbela tetraonis was common in the plantation but as its attack appears to be limited to mature trees without causing much damage this species is of no great importance.

Insects of Plywood Factories and Sawmills.

As a result of requests for assistance in controlling insect damage, three plywood and packing case factories in Assam were visited in December 1935 and January 1936.

The plywood factory and sawmills at Margherita, engaged in the manufacture of tea-chests of *Dipterocarpus pilosus* (hollong), were found to be hygienically controlled. The sources of infestation by *Lyctus* and *Heterobostrychus* were traced and found to be (a) in planks, scantlings, etc., stored for seasoning in the adjoining sawmill godown and in certain softwoods and the sapwood of hardwoods of various species, (b) in packing cases of *Bombax malabaricum* (semul) and of softwoods imported from Calcutta. These were infested with *Heterobostrychus aequalis*. As remedial measures it was suggested that the softwoods and pieces containing softwood be disposed of as early as possible and the remaining stock inspected at intervals, the attacked pieces to be burned or put in the drying kilns and to insist that sound packing cases from Calcutta should be supplied to the mills. With regard to panels of *Dipterocarpus pilosus* (hollong) it was suggested that they should be classified into "heartwood" and "softwood" and that the panels should be made up (a) entirely of heartwood and (b) entirely of veneers classed as softwood. Whereas the heartwood panels would not be attacked it was prescribed that the stacked sapwood panels should be brushed on all four edges with an aqueous solution of *Sodium silicate* (water glass) to plug up the pores thereby preventing beetles from laying eggs therein. Battens were to be treated with zinc chloride solution by immersing them in a hot 6 per cent. solution for 2 hours and then in a similar cold solution for the same time.

At Murkeong Sellek (Sadiya division, Assam), the plywood tea chest factory showed little evidence of damage by mill pests; *Heterobostrychus* and *Lyctus* were found in some of the old hollong hollock panels and hollong semul plywood boards. Protection against pin hole borers can be obtained by immersion of felled *Terminalia myriocarpa* (hollock) logs in the river at the earliest opportunity after felling. *Bombax malabaricum* (semul) logs are well protected by keeping the

bark alive. The longer semul is kept in water before sawing up the less likely are the shooks to be attacked.

The Assam Match Co.'s factory at Dhubri was examined in the last week of December 1935. It was found that the *Bombax malabaricum* (semul) shooks for cases were liable to damage by *Heterobostrychus aequalis* which at times meant rejection of 10 per cent. to 25 per cent. of old stock. The cheapest remedy indicated was the destruction or disposal of all the old infested shooks on hand and periodical examination (either once in cold weather or twice in October and March), in future, of stacks of shooks, removing those showing an ejection of fine powdery dust. For future protection the company was advised to adopt treatment with zinc chloride.

Damage to Pith Helmets.

The Chief Ordnance officer, Cawnpore, sent specimens of insect attacked pith helmets purchased (under contract) for Army requirements. They were found heavily infested with *Rhizopertha dominica*. The attack had taken place at the time the hats were being shaped and dried before the addition of the layer of varnished gauze and paper. Experiments are in progress to investigate the possibility of using Ascu to control attack.

General Insectary Work.

During the year 150 consignments of attacked material were received from various forest divisions for examination. In the Insectary 543 cages were used. The total emergence of insects was 18,000 the majority of which were set and identified.

Life-history studies were carried out on lepidopterous defoliators of *Gmelina arborea*, *Lantana*, *Dalbergia sissoo* and numerous other species. The life-history of *Tingis beccsoni* and its association with dying back of *Gmelina arborea* were studied.

Systematic Entomology.

The reference collection now contains 15,800 different species of insects, 500 having been added in the year. As in previous years specialists in other parts of the world have assisted very considerably in classifying several families. There are however several lacunae, for example the parasitic hymenoptera, where the number of specialists is quite inadequate to deal with requirements. It is hoped that the Imperial Institute of Entomology may be able to appoint additional systematists to undertake the necessary studies in the near future.

The Systematic Entomologist has made steady progress in the pioneer field of the classification of coleopterous larvae and has pub-

lished several papers on the subject. He has also prepared descriptions of numerous new species of Coleoptera for publication.

Tours.—By Dr. C. F. C. Beeson to Naini Tal in April-May ; to Kurseong divisions Bengal in July ; to Delhi in October, to Dhubri, Kochugaon division, Dibrugarh, Murkong Selek, Pasighat (Sadiya division), Margherita and Lakhimpur division and to Puri (Bihar and Orissa) in December-January 1936 ; to Ranchi (Lac Cess Committee) in March 1936.

Mr. N. C. Chatterjee to Kurseong and Jalpaiguri divisions Bengal in June-July.

Pt. S. N. Chatterjee to Naini Tal in April-May ; to Kurseong Bengal in July. Lala Buta Mal Bhatia to Dhubri and Kochugaon Dibrugarh, Murkong Selek, Pasighat (Sadiya division), Margherita and Lakhimpur division, and to Puri (Bihar and Orissa) in December to January 1936

Museums.—During the year 162 specimens showing damage done by insect pests were added to the entomological museum.

Library.—283 books besides periodicals were added to the Zoological Library during the year.

CHAPTER V.—ECONOMIC BRANCH.

Wood Technology Section.

I. RESEARCH.

(a) Work in connection with the preparation of macroscopic keys supplemented with X 10 photomicrographs for the identification of the more important commercial timbers of Assam and Bengal was continued, but progress was much hampered due to the paucity of authentic wood specimens of representative character. Now with the co-operation of various forest officers in these two provinces, wood blocks from different localities (supported by herbarium material) are being received and it is hoped that before long the work will be well in hand.

(b) Studies on the formation of the growth rings of the woods of *Acacia catechu*, *Bombax malabaricum*, *Eugenia jambolana*, *Pinus longifolia*, *Shorea robusta*, *Tectona grandis*, and *Terminalia tomentosa* were continued. Interesting results have been obtained regarding the growth activities of tropical trees and the consequent formation of growth rings in wood and these will be published shortly.

Further research on the distribution of parenchyma cells in the wood of *Terminalia tomentosa* were completed during the year and a detailed paper on the subject was sent to the *New Phytologist* for publication. The occurrence of parenchyma cells in the early wood of a diffusoporous timber is recorded for the first time, and it is proposed to call these cells "initial," indicating their position in the growth ring. Previously they have been called "terminal" which indicated that they were supposed to be formed at the end of a growth ring. In view of these and other discrepancies in terminology, various types of parenchyma distribution found in Indian woods have been discussed in detail in the article and certain suggestions have been made regarding the restricted use of certain terms to standardise the anatomical description of woods.

(c) Work on the anatomical study of the woods of Indian *Dipterocarps* was continued. Some more specimens were received during the year from several provinces and these have been sectioned and mounted. Some foreign *Dipterocarps* were also received from various sources and these have also been cut, stained and mounted. The macroscopical and microscopical examination of the wood blocks and slides is progressing.

(d) The study of the different varieties of *Terminalia tomentosa* was continued during the year. It has been found that figured wood is not confined to any particular variety of laurel. The presence of figure in different varieties is erratic. Even in the same log figure may be

found in a few growth rings and may be entirely absent in the rest. This investigation is not yet complete. In order to make a comprehensive anatomical study, more varieties of *Terminalia* species have been cut and anatomical notes are being taken.

(e) The preliminary study on the relationship between the anatomical structure and physical properties of *Tectona grandis* was completed last year. As the Burma Forest Department is anxious to continue this work further, suggestions have been made for the proper selection of samples from as many different trees as possible. The work will again be taken up as soon as the new material comes to hand.

(f) The study of the woods of the Indian *Meliaceae* (mahogany family) was continued. Up to date 90 wood specimens from the collection of the Forest Research Institute have been cut and mounted. More specimens will be cut and studied during the current year.

2. IDENTIFICATION OF WOODS.

A very large number of identifications were carried out in response to enquiries from various sources. These included a wide range of materials, including solid timbers, veneers, plywood, match splints, fibres, fossil woods and charcoal.

The identification of the fossil wood from Assam that was started last year, has been finally completed, and a paper on it was sent to the *Annals of Botany* for publication. In this a detailed anatomical description is given and geological notes have also been included which show its affinity to the genus *Gluta*. Critical comments have also been included in the paper regarding the similarity and dissimilarity of this fossil wood with some of the other fossil woods so far reported on from India and other countries.

A large number of other fossil woods were received during the year and some work on some of them has been started but much time cannot be spared for this kind of investigation.

The total number of timbers identified during the year was about 300.

3. EXAMINATION FOR FUNGUS.

Numerous enquirers sent samples of wood suspected of having been attacked by fungus and asked for advice regarding the use of such timbers. Some of the most interesting cases are noted below :—

(a) Samples of Sitka spruce were sent for examination. It was proposed to replace some broken parts of an aeroplane with this wood. It was however found that the samples were badly attacked by fungus. This is a typical example of

how the Wood Technology Section can give valuable help to aircraft authorities. Such expert advice may make all the difference between safety and danger to human lives.

- (b) To settle a dispute about a contract for deodar (*Cedrus deodara*) for the Railway Board, samples were sent in for examination concerning certain discoloured portions in the wood. Under microscopical examination all the planks showed different stages of deterioration and in some cases the woody tissues were completely destroyed by fungus. A report to the effect that it was not safe to use the planks for any purpose where strength was required was sent out.
- (c) Hollock timber (*Terminalia myriocarpa*) from Assam having a curious dark colour in the wood which was responsible for a good deal of waste in conversion was sent in for examination. All the specimens were found to be attacked by fungus. The dark coloured wood in the centre of the trees was possibly the result of the abnormal conditions met with in the early life of the trees.

The number of wood specimens examined in this connection was 77.

4. SPECIAL ENQUIRIES.

Several special problems were taken up on behalf of research officers of the Institute and forest officers in the provinces. Work was also done for many business firms. The following are a few of the more important items :

- (a) The histological study of a dead *Michelia champaca* (champ) plant where death was caused by an infestation of *Urostylis punctigera* insects, which are said to be responsible for the death of many champ trees in Kalimpong plantations, was taken up. In this connection a control healthy plant and an infected plant grown in Dehra Dun were also examined for comparative study. Sections from the original infected plant from Kalimpong, Bengal, showed the formation of cavities as the result of the disintegration of cells and these were always arranged in a concentric row in the wood. Similarly the plant from Dehra Dun, which died after being infected with insects from the Bengal trees, when sectioned showed the same type of cavities in the wood. Moreover it appeared that the formation of these cavities started in the lower part of the stem and went on increasing in size higher up the stem. Fungal hyphae

were abundant all over the stem from the bottom to the top but severity of attack was more at the bottom than in the top portion of the plant.

- (b) An examination of sal (*Shorea robusta*) discs from Ramnagar forest division which contained an unusual proportion of sapwood was made. Usually sal trees of 20" diameter and upwards have about one inch of sapwood but in this case the sapwood was from three to four inches thick, most probably due to particularly heavy fellings in the past in the area from which the trees came. It was found that the entire white portion was actually sapwood but from an anatomical point of view this sapwood was not much inferior to the heartwood, and if further thinnings are postponed the present sapwood will become converted into heartwood fairly rapidly and it will then be of the same quality as the present heartwood.

In this enquiry more than 140 specimens were examined.

5. INDEXING PERMANENT SLIDES, ANATOMICAL DATA AND PHOTOMICROGRAPHS.

In the course of routine work about 1,640 permanent slides were added to the authentic slide collection and these included a large number of species (both Indian and foreign) not previously represented. Whenever possible anatomical data have been taken from these slides and filed for future reference. 128 negatives and 694 photomicrographs were also taken during the year for publication and record.

6. COLLECTION OF AUTHENTIC WOOD SPECIMENS.

(a) *From India.*—A large number of authentic wood specimens from different provinces were received for the standard collection.

(b) *From abroad.*—During the year altogether 132 wood specimens were added to the foreign wood collection. These were received from Zurich (Switzerland), Ceylon, Uganda, Kenya and Japan. To the donors our sincere thanks are due for helping the Forest Research Institute to make its collection of the commercial timbers of the world as complete as possible.

7. DISTRIBUTION OF WOOD SPECIMENS.

In response to requests from abroad and various parts of India, 855 samples of timber were sent out to interested enquirers.

8. GENERAL.

A short course in Wood Technology was given to the following officer :—Mr. B. S. Sindhu, Assistant Works Manager, North Western Railway.

12 lantern slides of important Madras timbers were supplied to the Principal, Madras Forest College, for instructional purposes, and as usual a number of photomicrographs were sent to various persons interested in wood identification.

Timber Testing Section.

SPECIAL INVESTIGATION.

(a) The study of the influence of friction on the results obtained with the standard shearing test tool was continued. Sufficient data have now been accumulated. The analysis of results will be taken in hand as soon as possible.

(b) Tests on teak solebars sent by the Utilization Circle, Rangoon, were made in order to determine the quality of the wood. It had been found that teak solebars often failed when accidents occurred and this had prejudiced the Railways against their use. The specimens sent were found to be extremely slow-grown and porous. A report on the tests was sent to the Forest Economist, Utilization Circle, Ahlone, Rangoon.

(c) The preliminary tests on *Fraxinus micrantha* from Naini Tal Division, U. P., were completed. This species was found to be superior to both English ash and American white ash. It seems to be a promising species but at present it is not available in sufficient quantities to exploit for sports requisites.

(d) Some preliminary tests were made to determine the comparative strengths of sapwood and heartwood of sal from Ramnagar Division, U. P. It was noticed that sal trees in that division produced an abnormal width of sapwood which was a great disadvantage as it had to be removed when the logs were converted into sleepers. In some cases as much as 3" to 4" of sapwood was found. The results of the preliminary tests are not strictly conclusive owing to the small amount of material tested. A further investigation of this matter appears to be necessary.

(e) Special tests were made on billets of naturally and artificially grown pyinkado (*Xylia dolabriformis*) from Bhamo Division, Burma, in order to compare their strengths. No difference of any practical importance was found although the artificially grown timber was a little bit stronger. A report was made to the Forest Economist, Utilization Circle, Ahlone, Rangoon.

(f) Tests were continued in conjunction with the Seasoning Section to find out the effect on strength of different treatments given to wood before seasoning. The species dealt with were *Hopea parviflora*, *Anogeissus latifolia*, *Terminalia tomentosa*, *Xylia xylocarpa*, *Grewia tiliaefolia* and *Stereospermum xylocarpum*.

(g) A study of the effect of corrosive chemicals on wood was also started in conjunction with the Seasoning Section. Some preliminary strength tests were made on deodar. The study is being continued.

(h) Tests on tea chests of hollock and hollong received from Messrs. The Assam Saw Mills and Timber Co., Ltd., were made to find out the strengths of different thicknesses of plywood considered suitable for tea box work. A report was made.

(i) Wood used in aircraft construction and also wood from wooden parts damaged in accidents were tested from time to time as required.

(j) 22 consignments of glue joints submitted by Ground Engineers of the various Flying Clubs in India for their licence examination were examined and reported on to the Director of Civil Aviation.

(k) Work was started on the preparation of grading rules for Andaman padauk. A preliminary tabulation of defects for 675 squares has been done. The work is at present held in abeyance pending the visit of the Officer in Charge, Timber Testing Section, to the Andamans, for making a mill study and obtaining first hand information about the nature of the logs available in the forests.

ROUTINE TESTING.

During the year under report, attention was concentrated on work under Project 1 (standard tests on small clear specimens) as it had fallen in arrears. It will be seen from the following list of species tested that good progress was made. Tests under Project 2 (standard tests on structural timbers) were continued. Other routine testing on glues, plywood, containers, etc., was also kept up-to-date in cooperation with the Woodworking Section.

NUMBER OF SPECIES TESTED DURING THE YEAR.

			Green.	Air dry.	Kiln dry.	Misc.
Project No. 1	.	.	17	13	15	..
Project No. 2	.	.	..	3	..	..
Project No. 0	.	.	..	under all heads		77

The 77 consignments under Project 0 include the 22 consignments of glue joints submitted by Ground Engineers for their licence examination.

NUMBER OF SPECIES COMPUTED DURING THE YEAR.

	Green.	Air dry.	Kiln dry.	Misc.
Project No. 1 . . .	9	12	7	..
Project No. 2 . . .	..	4	..	..
Project No. 0 . . .	..	under all heads		78

About 18,000 mechanical tests and nearly the same number of physical determinations were made during the year. About 4,000 special shrinkage observations were also made in addition to the routine testing.

TECHNICAL NOTES AND ADVICE.

About 100 technical notes and letters were issued during the year among which the following may be mentioned : -

1. Comparison of sissoo (*Dalbergia sissoo*) from different localities.
2. Comments on B. S. Draft Specification for Testing Glues.
3. Comments on B. S. Draft Specification for Testing Timbers (small clear specimens).
4. Indigenous substitutes for Sitka spruce for the manufacture of air craft.
5. Indigenous substitutes for hickory.
6. Indigenous substitutes for boxwood.
7. Indigenous substitutes for cornel wood.
8. Wood for picker arms.
9. Wood for spinning rollers.
10. Wood for reels and bobbins.
11. Wood for shuttles.
12. Wood for comber boards.
13. Wood for brushes.
14. Wood for Army signal sticks.
15. Wood for skating hall floors.
16. Wood for hoops of drums.
17. Wood for musical instruments.
18. Wood for laminated tennis racquets.
19. Wood for boat building and dugouts.
20. Wood for hammer handles and shovel handles.
21. Wood for skis.
22. Wood for bridge chesses for military pontoon bridges.

Wood Seasoning Section.

1. NEW PROCESS OF KILN DRYING.

Experiments on the new process of kiln drying developed at this Institute were continued during the year, and although the number of kiln charges in the large-sized kilns were only six, on account of insufficient supplies of timber for the purpose, the results obtained in all cases were highly successful. Some details about the timbers kiln-dried during the year are given below :-

(i) *Cedrela toona*, toon.—Nineteen logs of this species were received from the Divisional Forest Officer, Buxa Division, Bengal. The logs at the time of receipt were fairly straight and cylindrical, and, except for some slight heart and radial shakes, were in good condition. It was found that shakes, particularly the radial ones, were liable to develop considerably if the logs were stored on land for any length of time, and for this reason it is advisable to convert the logs as soon as possible after felling and to season the converted material immediately. The period required for kiln drying from about 80 per cent. to 8 per cent. moisture content was about 10 days, and the degrade during drying was much less than that which has been experienced with local toon from roadside trees. Bengal toon is not liable to warping and collapse to any noticeable extent and is fairly free from knots, and the seasoned material on the whole presents a much more attractive appearance than local toon.

(ii) *Terminalia bialata*. The sapwood of this species is known as white chuglam, and the heartwood as silvergrey wood. The wood lends itself readily to the process of kiln drying. A charge of one inch thick planks varying in widths upto 25 inches was kiln dried in an internal fan, reversible circulation kiln. The moisture content of the wood was reduced in less than 9 days from 60 per cent. to about 9 per cent., with no increase in degrade, except for some opening out of shakes originally present in the heartwood. The following schedule can be recommended for the kiln drying of this wood :—

Cycle.	AVERAGE MOISTURE CONTENT OF THE WOOD.			
	From green to 35 per cent.	35 per cent. to 20 per cent.	20 per cent. to 12 per cent.	12 per cent. to 8 per cent.
Maximum temperature .	50°C.	50°C.	52°C.	55°C.
Heating with air circulation .	30 min.	30 min.	30 min.	45 min.
Cooling with air circulation .	{ 1 hr. 25 min.	{ 1 hr. 30 min.	{ 1 hr. 30 min.	{ 2 hrs. 15 min.
Exhaust	5 min.	Nil	Nil	Nil

A slight humidity treatment at the end will relieve any stresses produced during the process of drying. Although a maximum temperature of 55° C. is recommended in the above schedule, the timber was found to stand a much higher temperature (up to 80°C.) in the Furnace kiln (see below) without any apparent injury. If higher temperatures are employed, it is essential that the circulating air should be kept well humidified, for which purpose the kiln walls should be built of a material practically impervious to moisture. A small kiln with heating coils, fan circulation, water sprays for humidification, and a metal lining to prevent moisture leakage, is now in course of construction at Dehra Dun, and it is hoped that the effect of drying some refractory hardwoods at very high temperatures will be tested out during the next year.

(iii) *Adina cordifolia*, haldu. Very wide planks of this wood, a little over one inch in thickness, were dried from about 56 per cent. to 10 per cent. moisture content in 10 days, with no appreciable degrade at all. In a few planks, original shakes opened out slightly and some knots were found to have split during the process of drying, otherwise the condition of dried material was noted as very good.

With this wood, a slightly longer cooling period was found to be useful, and a maximum temperature of 61° C. was found to have no adverse effect.

(iv) *Canarium euphyllum*, white dhup. Planks, $\frac{3}{4}$ inch thick, were kiln dried from about 60 per cent. to 10 per cent. moisture content in 8 days by the new process in an internal fan kiln. The condition of dried material was good, and the period of drying could probably have been reduced by making the drying conditions severer. The results on the drying of this wood in the Furnace kiln are described below.

(v) *Terminalia tomentosa*, laurel. A charge of one inch thick planks of this wood was dried in an internal fan kiln by the new process, the timber requiring a period of 14 days for drying from about 80 per cent. to 9 per cent. moisture content. Part of the timber was very dark coloured, from a consignment received from Madras, and this came out of the kiln after drying in an almost perfect condition. The rest of the timber was from Dehra Dun forests and was of a much lighter colour with a large amount of sapwood. This wood had numerous original heart-shakes and knots, and it was noticed that the heart-shakes had opened out in some planks and there was collapse around the knots which had split in almost all cases.

2. SMALL LABORATORY KILNS.

The two small kilns were kept going throughout the year, drying 24 charges of timber of 19 species, mostly for the Timber Testing Section.

Kiln drying of *Shorea robusta* (sal) was tried in two charges, but with no better success than before. Some of the woods like *Schima wallichii*, *Planchonia andamanica*, *Bridelia retusa*, and *Heritiera* spp. were found to be extremely refractory to kiln dry. These small kilns have now been re-designed, and 4 new chambers of the new design are in course of construction.

3. FURNACE KILN.

Seven charges of timber were dried in this kiln, and the results in all cases were highly gratifying. A detailed report on the results obtained with this kiln is in the press (*Indian Forest Records, Utilization*, Vol. I, No. 3), but a short article on the subject was published in the *Indian Forester* of March 1936, as a result of which a number of enquiries were received asking for details of construction of the kiln. A kiln of this type can be built for less than Rs. 2,000 in this country, and since it is easy to operate and the cost of drying is low, it is to be expected that it will become popular with small scale cabinet and furniture makers.

4. AIR SEASONING.

A large number of logs of miscellaneous species, which had been accumulating in the log ponds for a number of years, and which were not required for any particular investigation, were cut up into planks and scantlings and stacked for air-seasoning during the year. In all, 36 species were stacked and are being kept under observation for the determination of air seasoning characteristics.

The experiment on the air seasoning of some highly refractory species, which was started last year, and in which the planks were stacked with thin crossers and even without crossers, in order to slow down the rate of drying, showed conclusively the necessity of using crossers for stacking wood for air-seasoning. The material stacked without crossers remained wet even after one year, except at the ends which showed severe cracking and splitting due to the unequal rate of drying. The use of thin crossers, about $\frac{1}{2}$ " thick, for stacking highly refractory woods for air-seasoning appears to be promising and will be further investigated.

5. WATER SOAKING PRIOR TO AIR SEASONING.

Strength tests on end-matched specimens of various species, which had been air-seasoned with and without previous water soaking showed that in the case of *Anogeissus latifolia* there was a slight decrease in the strength of wood under impact, while there was no marked effect in the case of *Grewia tiliaefolia*, *Xylia xylocarpa*, *Terminalia tomentosa* and *Stereospermum xylocarpum*. Tests on other species are in progress.

6. AIR SEASONING OF RAILWAY SLEEPERS.

A report giving details of and results obtained from the various experiments on the air seasoning of coniferous railway sleepers carried out in the Punjab between 1926 and 1934 was published during the year (*Indian Forest Records, Utilization*, Vol. I, No. 2). This Record contains a discussion on the results and also some suggestions for the improvement of the softwood sleeper situation in North India.

A small experiment was started at Marala in the Punjab, in co-operation with Messrs. Spedding Dinga Singh & Co., to test the effect of girdling standing trees of deodar for 2 years before felling, with special reference to the subsequent cracking and splitting of sleepers during seasoning. Two lots of deodar sleepers were stacked, one from girdled trees and the other from the same forest area but from trees which had not been girdled. The stacking was done in the first week of January 1936, and the final inspection was carried out in March 1936. The results are being worked out, but there appears to be no marked improvement in the seasoning of sleepers from girdled trees.

In order to determine the extent of drying of deodar wood during the period the trees are left standing after girdling, two trees of deodar were girdled in the Chakrata division in the United Provinces, and a detailed investigation will be carried out on the air seasoning of sleepers obtained from these trees.

7. DETERMINATION OF THE MOISTURE CONTENT OF WOOD.

Two papers on this subject were published during the year, one in the *Empire Forestry Journal* (Vol. 14, pp. 43-53, 1935) and the other in the *Indian Forester* (July 1935). From the numerous enquiries that are being received on the subject of rapid methods of determining moisture in wood, it appears that there is a growing demand in this country for electric moisture meters. The imported instruments are very costly, requiring an investment of Rs. 800 to Rs. 1,500 for each meter, and there appeared to be little chance of their becoming popular in this country at such prices.

With the object therefore of devising a cheap and efficient electric moisture content indicator for general and commercial use, various methods of measuring electric resistance of wood have been studied in the seasoning laboratory, and a moisture meter based on the conductivity principle using a thermionic vacuum tube amplifier and a special type of needle contacts has been constructed. The amplifier works at a low voltage and is used under conditions which cut down to a minimum the sources of trouble in the grid circuit, which are usually met with in the amplification of minute currents. An instrument of this type can be built up at a cost of about Rs. 150, most of the components being avail-

able from radio dealers. A detailed note on the subject will be published soon when the new meter has been thoroughly tested.

8. A SURVEY OF THE MOISTURE CONTENT OF WOOD.

No definite information is available at present on the seasonal variations of the moisture content of wood and consequent changes in size due to shrinkage and swelling of wood ; and it was, therefore, considered desirable to collect information on this subject. Matched specimens of six commercially important species were prepared at Dehra Dun, and were distributed to 22 different centres spread all over the country, where the specimens will be weighed and measured regularly every fortnight for a period of two years. The information obtained will be of considerable use to railways, cabinet and furniture makers, and others interested in the use of seasoned wood.

9. SHRINKAGE STUDIES.

Experiments on the effect of high temperatures on the shrinkage and moisture equilibrium of wood were completed during the year, and a report was issued as an *Indian Forest Record* (Utilization, Vol. I, No. 1).

The following treatments have been investigated :—

- i. Kiln drying.
- ii. Steaming of green wood at and above atmospheric pressure.
- iii. Boiling of green wood in water.
- iv. Steaming of air dried wood at atmospheric pressure.
- v. Exposure of wood to dry air at 100°C.

The results are fully discussed in the report, but the main conclusion drawn from the experiments is that within practical limits the use of high temperatures alone is incapable of reducing the shrinkage, swelling and hygroscopicity of wood by any appreciable amount.

A detailed investigation is now in progress on the effect of impregnating wood with various chemical substances on the shrinkage and swelling of wood, but the results so far have not shown any marked reduction in the working of wood with fluctuations in atmospheric humidity, although a large number of treatments recommended in current literature have been tried.

An experiment was carried out on the metal spraying of wood, with a view to finding out how far a film of metal sprayed on a piece of wood would protect it against changes in moisture content and dimensions due to variations in atmospheric humidity. It was found that metals having low melting points, like tin, lead and zinc, reduced this property by about one half to one third, whereas the metals melting at

higher temperatures did not show any appreciable effect. Further, the sprayed metal coatings do not protect wood against the absorption of water during the soaking of such treated pieces in water, and there is a liability of weakening the bond between the wood and the metal due to the swelling and shrinkage of the wood. The results are given in detail in the *Indian Forester* of October 1935.

10. COLLAPSE IN WOOD.

The investigation on the occurrence of collapse in certain Indian woods and methods for its removal was completed during the year and a report was published in the *Indian Forester* of November 1935. With regard to the incidence of collapse in toon, it was found that—

- i. The tendency to collapse varies in different trees even among those growing in the same locality,
- ii. The material from the butt end is more prone to collapse than that from the top of a tree,
- iii. Heartwood from near the sapwood zone has greater liability to collapse than wood near the heart-centre,
- iv. The severity of collapse is increased by drying at high temperatures in a kiln, and
- v. That the first appearance of collapse is noticed at about 50 per cent. to 60 per cent. moisture content and most of the collapse occurs before the wood reaches the fibre saturation point.

Experiments on the steaming of collapsed wood at about 100°C. for periods varying from one to six hours showed that collapse can be removed almost entirely from toon planks, but the same treatment was not effective in the case of *Schima wallichii* and *Quercus lineata* and only partly so with *Acrocarpus fraxinifolius* and *Machilus* spp.

11. END PAINTS.

Various tests are in progress on the suitability of different compositions for use as end-paints on converted material for preventing end-splitting of wood during air seasoning. The results so far show that thick coal tar is nearly as effective as some of the paints specially made for the purpose such as hardened gloss oil, while it costs much less. It is already proving useful for preventing excessive end-splitting of soft-wood railway sleepers in the Punjab.

12. ENQUIRIES.

A large number of enquiries on various subjects relating to air and kiln drying of timbers were replied to as usual. Designs for small timber

drying kilns were supplied to various firms, and a number of enquiries on the design and construction of Furnace kilns are in hand. These will be dealt with as soon as the final plans for this kiln are ready.

13. STAFF.

Dr. D. Narayanamurti, an Upper Grade Assistant in the Section, returned to duty after spending about a year at Danzig University, where he obtained the degree of Doctor of Engineering, on a thesis on the movement of moisture in wood.

Wood Preservation Section.

1. LARGE SCALE FIELD EXPERIMENTS WITH ASCU BY THE INDIAN RAILWAYS.

In accordance with the recommendations of the Raman Committee, the North Western Railway treated under pressure with Ascu 10,000 sleepers of chir, fir and deodar. The sleepers were also given a supplementary dipping treatment with a bituminous suspension of petroleum asphalt and crude oil.

2. RELATIVE COST OF THE ASCU AND ANTI-SPLITTING TREATMENT AND THE PRESENT CREOSOTE AND CRUDE OIL TREATMENT OF RAILWAY SLEEPERS.

The 10,000 sleepers referred to in the previous paragraph were treated by the Ascu Wood Preserving Agency, Dehra Dun, who put up their up-to-date portable Ascu treating and anti-splitting plants in the sleeper treating yard of the North Western Railway at Dhilwan. Half the sleepers were treated with a 4 per cent. Ascu solution in water and the rest were treated with an 8 per cent. Ascu solution. All the sleepers were given, after a few days air-seasoning, a dipping treatment with a hot bituminous suspension.

The Raman Committee has stated (*vide* para. 10 of the Report) that "A 40 per cent. solution of creosote which is usually regarded as an excellent preservative proved wholly unable to resist the destructive agents acting on a sheet of *Bombax* veneer when interred in the graveyard. In the same circumstances, however, a 4 per cent. solution of Ascu showed itself completely effective as a resistant to fungus and insect attacks".

It may be stated in this connection that although the North Western Railway have been employing a 40-60 mixture of creosote and fuel oil for treating softwood sleepers, the quantity actually impregnated is

only 5 lbs. per cubic foot whereas with Ascu, a 20 per cent. larger quantity of 4 per cent. solution is injected. The following estimate of costs has been based on an absorption of 6 lbs. of 4 per cent. Ascu solution per cubic foot into softwood sleepers followed by the anti-splitting treatment. It is due to the courtesy of the Ascu Wood Preserving Agency that the following reliable figures of the actual cost of Ascu and anti-splitting treatment of sleepers have been made available for publication.

Capacity, working only single shift, of the whole plant (using Rueping process) 180 B. G. sleepers.

(Working days in the year—300.)

	Rs.	a.	p.
1. <i>Capital cost—</i>			
Interest on investment at 5 per cent. Depreciation at 7½ per cent.	0	0	3
2. <i>Cost of treating substances—</i>			
(a) Ascu chemicals at 0.7 lb. per sleeper based on an impregnation of 6 lbs. of solution per cu. ft.	0	3	6
	(Will be slightly less for the Railway due to less freight charges.)		
(b) Anti-splitting medium (10 per cent. asphalt in unrefined crude oil 4 lbs. per sleeper)	0	2	0
3. <i>Cost of labour and supervision (including handling sleepers during and between the operations)—</i>			
(a) Ascu treatment	0	0	10
(b) Anti-splitting treatment	0	0	4
4. <i>Power and fuel—</i>			
(a) Power (crude oil and lubrication for oil engine)	0	0	2½
(b) Fuel for heating anti-splitting medium	0	0	1½
5. <i>Miscellaneous Stores</i>	0	0	1
TOTAL	0	7	4

The corresponding cost of the present treatment at Dhilwan with a 40 per cent. creosote—60 per cent. crude oil mixture and using 5 lbs. of the mixture per cu. ft. works out at about Rs. 1-0-8 *excluding* the cost of carriage of sleepers from different places to the central treating plant located at Dhilwan. Even at special railway material rates, the transportation charges are considerable. In the case of the most important kind of coniferous sleepers, namely chir sleepers, the North Western Railway has been paying a freight charge of about 0-9-0 per sleeper on two to three lakhs of chir sleepers treated annually; on blue pine and fir sleepers, the railway also spends annually about two lakhs rupees on freight,

The above facts indicate clearly the superiority of a cold treatment process like that with Ascu which makes an inexpensive portable pressure and power plant practicable. The Ascu Wood Preserving Agency has stated that their complete plant, which can deal by the Rueping Process with about 1,10,000 sleepers a year, cost only Rs. 7,500. It can be carried and installed anywhere at very small expense. No boiler or other heating is required for the treatment. Other smaller plants are available at about Rs. 1,500 and upwards.

3. SPECIFICATIONS FOR ASCU TREATING WOOD POLES FOR ELECTRIC TRANSMISSION.

During the year, detailed specifications for the Ascu treatment and seasoning of wood poles were worked out as there was a considerable demand for the treatment of wood poles with Ascu. Such specifications have since been supplied to the heads of several departments of the different provinces. The Hydro-electric departments of the United Provinces, the Punjab and the North-West Frontier Province, have decided to use for all their 11 K. V. distribution lines only wood poles treated with Ascu. Several towns in the Punjab, United Provinces, and Bihar also have either decided to or will very probably decide to use wood poles treated with Ascu for electric lighting and service.

4. SPECIFICATIONS FOR THE PURCHASE OF WOOD POLES FOR OVERHEAD TRANSMISSION.

Considerable correspondence took place between the Forest Research Institute and several local Governments and public utility concerns regarding the framing of suitable specifications for the purchase of untreated wood poles meant for subsequent antiseptic treatment. Provisional specifications have been drawn up, and considerable help has been given to enquirers regarding the design of wood poles and the framing of specifications for the purchase of wood poles. These specifications will be further discussed in the near future by the Officer in Charge, with the Electric Inspectors of the various provincial governments so that they will, in all probability, have to be modified slightly at a future date.

5. PRACTICAL APPLICATIONS OF ASCU.

(a) During the year, there were six Ascu pressure treating plants under operation. The Ascu Wood Preserving Agency, Dehra Dun, treated nearly 6,000 wood poles under pressure with Ascu for the Hydro-electric Department of the Government of the United Provinces. It is understood that all the poles have been erected, and the department is thoroughly satisfied with them. Compared with the corresponding estimate employing one of the cheapest and most unsatisfactory type

of metal pole (namely steel rails) a saving of over a lakh of rupees has resulted during the year to the Government of the United Provinces, by using treated wood poles. The saving when compared with the usual and more expensive types of imported metal poles is far greater.

The Hydro-electric Department have recently placed a further order with the Forest Department of the United Provinces, for 5,000 more sal poles which will be treated shortly with Ascu under pressure. In a few months' time, therefore, in a single province a high tension transmission line of about 700 miles in length supported on treated wood poles will be an actual fact.

(b) The services of the Officer in Charge of the Section were lent to the Government of Bhopal for examining the timber resources of the State. Several recommendations to the Government for the more economical, extensive and scientific exploitation of the State's timber resources were made. Most of the proposals hinge on the high degree of durability that can be obtained by treating practically any timber with Ascu. It is understood that two of the most important recommendations made, namely the installation of a high tension transmission line from Bhopal to Sehore and the erection of a comprehensive telephone system, (linking the various Tehsil headquarters with the city of Bhopal) have been very favourably considered by the State authorities. By employing treated wood poles, it has been made possible to construct a telephone system of the metallic two-wire type for only Rs. 150 per mile. There is a great field, especially in the Indian States, for the inauguration and extension of economical and efficient telephone lines employing treated wood poles as they cost only a small fraction of the price of metal poles.

(c) As a result of the excellent results obtained with some experimental Ascu treated posts placed in the various harbours of India, the Cochin harbour authorities have decided to put up very shortly an Ascu treating pressure plant, and the harbour authorities of Calcutta, Vizagapatam and Bombay have been considering seriously the question of putting up similar plants to preserve timber for marine construction work.

(d) During the year the Government of Travancore purchased a pressure treating plant and made it ready for preserving with Ascu all the poles required in connection with the Pallivasal Hydro-electric Scheme, and for building construction, etc. One of their officers was deputed to Dehra Dun in July 1935 for two months' training in wood preservation.

(e) The Government of Mysore also treated several thousand cubic feet of timber with Ascu during the year and have decided to continue such treatment for electric poles, sleepers, building timber, etc.

(f) The Hydro-electric Department of Simla treated a few hundred locally obtained coniferous poles with Ascu by a dipping treatment. It is understood that they will use Ascu treated poles in all their future work.

(g) It has already been mentioned that during the year under review six Ascu treating pressure plants were in operation. It is further understood that at least ten more pressure plants will be put up at different points in India during the next few months, so that it is not perhaps too optimistic to hope that commercial wood preservation will very soon become an important industry in this country:

(h) A 2 per cent. solution of Ascu was used to treat *Tamarix* stakes in tomato plantations in the North-West Frontier Province. The annual renewal of untreated stakes due to white-ant attack was costing previously about Rs. 60 per acre. After over a year's experience it has been reported that not a single Ascu treated stake required renewal and the Director of Agriculture expressed the opinion that Ascu was definitely suitable for agricultural requirements.

(i) On the advice of the Forest Research Institute, the Government of the Federated Malay States have finally decided to put up a pressure Ascu plant to treat railway sleepers, and they have placed the order for it.

(j) A pressure plant employing Ascu was also put up by a private firm in Ceylon on the advice of the Dehra Dun authorities.

6. TREATMENT OF BAMBOOS WITH ASCU.

Experiments conducted with split and unsplit bamboo using Ascu under pressure showed that there was hardly any difference in the amount absorbed by the two types. It would appear, therefore, that the penetration in bamboos is practically wholly longitudinal, and that the nodes hardly interfere at all with the penetration.

There is a great field for the extensive use of treated bamboos in India. Very large quantities of bamboos are used in cheap house construction, for mats, partitions, roofing, and ceilings. Untreated bamboos rot or are attacked by insects in a few months. Treated bamboos are durable and resistant to white-ant, insect and fungus attack for a period of over three years when exposed to very severe conditions promoting decay and insect attack, so that under average conditions of use, a far longer average life can be confidently expected.

The importance of the use of treated bamboos and timber can be appreciated from a report that about seven lakhs of bamboos are required for renewal purposes annually in a single sugarcane district in Madras Presidency. It has been computed that the annual cost of renewing bamboo props in sugarcane fields works out at about Rs. 40 per acre,

7. NATURAL DURABILITY OF CERTAIN TIMBERS AND THE TOXIC PRINCIPLES INVOLVED.

Aqueous, ethereal and alcoholic extracts of sal, deodar, teak and jack wood were prepared for treating semul veneers to see whether such extracts have any antiseptic value for preserving timber and, if so, to study the true nature of the toxic principles of the four timbers in question that confer on them the property of resisting decay and insect attack.

One inch cubes of sal, teak, deodar and rosewood were also shaken 20,000 times in a shaking machine with ether, hot water and a 5 per cent. caustic soda solution. Similar pieces were also left exposed to a temperature of 80°C. for 6 hours. All the pieces after the above different treatments were submitted to termite and fungi tests in the antiseptic test yard. The results of these tests will be reported next year.

8. FIREPROOFING TREATMENT OF TIMBER.

Ammonium salts, especially ammonium borate, ammonium sulphate and ammonium phosphate, have been long known as efficient and comparatively cheap fireproofing agents for timber. Efforts to incorporate these with Ascu have not proved wholly successful. Experiments were conducted to examine the effect of the addition of sugar to reduce the corrosive action of Ascu and ammonium sulphate on steel. While there was an improvement the defect could not altogether be eliminated, so that a search has still to be made for an economical and efficient fireproofing composition that can be incorporated with Ascu for pressure treatment in one movement. It may be stated, however, that for short periods of time the addition of sugar has been found to be very effective for making a combined Ascu and ammonium sulphate treatment practicable.

Fireproofing paints of three colours namely white, blue and brown were prepared. These will be improved during the coming year when a special apparatus for testing the relative fireproofing efficiencies of different compositions will be installed.

9. ANTI-SPLITTING TREATMENTS.

During the year under review experiments were conducted to find out the best conditions of moisture content for the anti-splitting treatment of sleepers. The experiments indicated that in the case of softwood sleepers, certain improvements in the reduction of a tendency to split might be expected by employing a dipping or pressure treatment with an aqueous emulsion of asphalt of a penetration of 180 to 200. In the case of hardwood sleepers however an oil or asphaltic treatment is practically of no value as far as reduction of splitting is concerned.

Six different types of petroleum asphalt, air-blown and steam blown, and of different degrees of penetration, were submitted to test to determine their relative water-proofing efficiency. An asphalt with a penetration of 30 to 40 appeared to be about the best. This fact will be made use of for developing water-proof wood shingles, and for water-proofing plywood.

Emulsions of asphalt with water and with sodium silicate solution were tested to find out their relative water-proofing efficiency. Sodium silicate appears to improve the water-proofing efficiency of an aqueous asphaltic emulsion. A classification of condition was made as regards the splitting, of several Ascu treated sleepers of six species, *viz.*, chir, fir, kail, deodar, hollong and hollock. They were given a supplementary anti-splitting treatment by pressure in the case of half the sleepers and by dipping in the case of the rest. The sleepers were then exposed to the elements for 14 months when they were inspected individually and their conditions classified. An independent inspection and classification of the same sleepers was made by the Permanent Way Inspector, Dehra Dun. His classification tallied closely with that of the Institute experts. Both the classifications showed that sleepers dipped in a bituminous suspension of asphalt and crude oil were in a better condition as regards splitting than the corresponding sleepers treated under pressure with the same anti-splitting composition. The fact that some of the pressure treated sleepers containing 3 to 4 gallons of the composition per sleeper split very badly raises an important point as to whether a large quantity of dark coloured oil does not increase the tendency of sleepers to split in the permanent way. This is being investigated.

10. ASCU TREATMENT OF TIMBER IN SITU.

In practice there are several places where untreated timber has been already used, or where facilities for pressure treatment may not be readily available. Experiments to develop a special asphaltic emulsion with Ascu have been inaugurated, and it is expected that during the coming year a painting composition will be perfected which can be applied with a brush to timber already in use.

11. DESIGN OF A CHEAP PORTABLE WOOD PRESERVATION PLANT.

A design for an inexpensive portable wood preservation plant for use with a preservative like Ascu (which requires no heat for its application) was developed during the year and was placed at the disposal of several enquirers who asked for such a plant. A small Ascu pressure plant can be had for as low an investment as Rs. 300. Such a plant can deal with several thousand cubic feet of wood in a year. Its manipulation is very simple. It requires no special technical knowledge and no

power. Manual labour can operate a hand pump which is all that is required for developing the necessary pressure.

12. MARINE TESTS.

All the Ascu treated experimental sticks laid down in the harbours of Calcutta, Vizagapatam, Madras, Cochin, Bombay and Karachi were inspected by the Chief Engineers concerned during the year, and were found to be, *in all cases*, in excellent condition. Some of the treated pieces had been exposed in teredo infested waters for about three years. As the wood in question consisted practically entirely of rapidly perishable sapwood and as even teak heartwood has been known to have been destroyed within a year by marine organisms, the results obtained with Ascu treated sapwood pieces have been very gratifying.

13. GRAVEYARD TESTS.

During the year sticks treated with Cuprinol, Orthodichlorbenzene, Ascu asphalt emulsion and Saun's preservative were placed in the test-yard, and kept under observation. Creosoted bamboos, insulation boards and treated plywood specimens were also laid in the test-yard for tests against termites and fungi. Untreated specimens of the following species were also submitted to test in the test-yard :—

Isonandra spp.

Kaya floribunda.

Amoora rohituka.

14. TESTS BY ELECTRIC INSPECTORS.

Ascu treated posts and untreated controls were sent to practically all the provincial Electric Inspectors in the country for test purposes. In the case of two provinces, tests are also being undertaken by Electric Supply Companies.

Wood Workshop Section.

This Section continued to function on a reduced scale as a supply unit for other sections, while the Officer-in-Charge (Mr. W. Nagle) devoted the greater part of his time to veneer and plywood research and to glue testing.

The Timber Testing Section was supplied with 18,829 wood specimens for test purposes as detailed below :—

Static Bending.—

Aircraft 1-A	195
Research 1-R	198
Regular 1-R	1,279
Vehicle Minor 1 VM	912
Plywood 1 P. W.	239

Impact Bending—											
Special	.	.	.	.	.	.	.	.	.	.	503
Regular 2	.	.	.	.	.	.	.	.	.	.	810
Royal Aircraft 2RA	.	.	.	.	.	.	.	.	.	.	4,102
Compression Parallel—											
Structural 3str.	.	.	.	.	.	.	.	.	.	.	69
Regular 3	.	.	.	.	.	.	.	.	.	.	2,325
Compression Perpendicular—											
Structural 4str.	.	.	.	.	.	.	.	.	.	.	28
Regular 4	.	.	.	.	.	.	.	.	.	.	770
Hardness—5	.	.	.	.	.	.	.	.	.	.	699
Shearing—											
Regular 6	.	.	.	.	.	.	.	.	.	.	3,346
Plywood 6 P. W.	.	.	.	.	.	.	.	.	.	.	661
Glue joints 6 J. B.	.	.	.	.	.	.	.	.	.	.	107
Tension Perpendicular to grain—7	.	.	.	.	.	.	.	.	.	.	826
Torsion—8	.	.	.	.	.	.	.	.	.	.	590
Shrinkage Radial and Tangential—9	.	.	.	.	.	.	.	.	.	.	748
Shrinkage Volumetric—10	.	.	.	.	.	.	.	.	.	.	374
Boxes	.	.	.	.	.	.	.	.	.	.	24
Hammer handles	.	.	.	.	.	.	.	.	.	.	24

The Wood Technology Section was supplied with 34 “Gamble” specimens and 993 hand specimens.

In addition to supplying other sections with converted material for research purposes this Section completed 438 jobs of a varied character including the making of :—

Handles (various).

Packing cases (various).

Ladders.

Parquet flooring.

Drawing boards.

T. Squares.

Switch board covers.

Frames (various).

Sign boards.

Almirahs.

Tables.

Curtain rods and brackets.

Cupboards.

A saw bench.

Veneer and plywood panels.

File cabinets.

Machine platforms.

Tennis racquets (experimental).

Camera frames.

Experimental bridges.

Flooring.

Boxes (various).

Screens.

Glue test joints.

Stools.

Racks.

Veneer boxes.

Trays (various).

Five hundred and forty-four logs of 79 species were converted in the sawmill.

In addition to the above much miscellaneous work was done in the mills such as preparation of crossers for stacking timber planks and scantlings for use in other Sections.

Reports on the working qualities of the undermentioned timbers were recorded during the period under review :—

Bombax malabaricum.

Tectona grandis (Bengal, air dry).

Lagerstroemia lanceolata.

Mimusops elengi.

Morus alba.

Tectona grandis (Bengal, kiln dry).

Anthocephalus cadamba.

Tectona grandis.

Sterculia campanulata.

Dalbergia sissoo.

Dalbergia sissoo (Punjab roadside).

Dalbergia sissoo (knotty sissoo).

Eucalyptus eugenoides.

Dalbergia sissoo (Bengal, air dry).

Dalbergia sissoo (Bengal, kiln dry).

Morus alba.

Cinnamomum iners.

Carallia integerrima.

Chukrasia tabularis.

Tectona grandis (Madras).

Vitex altissima.

Dalbergia sissoo (Nepal).

Amoora rohituka.

Shorea robusta.

Dichopsis polyantha.

Kayea floribunda.

Calophyllum spp.

Heritiera spp.

Tests.

Tests were carried out on a sample piece of plywood forwarded by Messrs. The Expanded Metal Depot, Bombay.

Tests were carried out on a piece of teak which was prepared for the purpose of ascertaining if “ Ducc ” would react in any way to the various chemicals peculiar to photographic work.

Tests and a careful examination were carried out on a folding boat sent to the Institute by the K. G. O. Bengal Sappers and Miners, Roorkee, and the results with advice and suggestions for improvements in the design were given.

Miscellaneous.

At the request of the Officer Commanding, K. G. O. Bengal Sappers and Miners, Roorkee, the Officer in Charge, Wood Workshop Section, visited their works to give help and advice on their sawmill.

Experimental bridges of laminated construction were made in the workshop and are now under observation.

The laurel screen made in the wood workshop of this Institute and exhibited at the Bihar and Orissa Forest Department stall at the Patna Exhibition won a silver medal and a certificate of merit.

Experimental veneer fruit baskets were made at the request of the Marketing Board authorities for trial.

Veneer Sub-Section.

Logs of the following species were peeled for tests under Project VIII :—

Dipterocarpus tuberculatus.

Tetrameles nudiflora.

Gmelina arborea.

Aglaia odoratissima.

Elaeocarpus tuberculatus.

Cedrela toona.

Amoora canarana.

Litsaea wightiana.

Palaquium ellipticum.

Bucklandia populnea.

Ougeinia dalbergioides.

Pterocarpus marsupium.

Tetrameles nudiflora.

Cryptomeria japonica.

Artocarpus chaplasha.

Terminalia bialata.

Shorea assamica.

Canarium euphyllum.

Bombax malabaricum.

Enquiries relating to veneers and plywood received during the year included the following :—

1. The Chief Conservator of Forests, Mysore, regarding a plywood factory in India and machinery for making plywood, etc.
2. Mr. Stanley A. Clarke, Council for Scientific and Industrial Research, Melbourne, regarding details of a plywood plant with sketches and full information on the subject.
3. The Director, Industrial Intelligence and Research Bureau, New Delhi, regarding a plywood plant for the manufacture of packing cases and chair seats.
4. Mr. R. K. Jain, Civil Engineer, Delhi, regarding particulars and sizes of machines for the manufacture of plywood.
5. The Forest Research Officer, Bihar and Orissa, regarding the cost of veneer panelling.
6. The Timber Manager, The Assam Railways and Trading Co., Ltd., regarding lac adhesives.

Visitors to this Section were numerous.

Minor Forest Products Section.

F. R. I. PORTABLE CHARCOAL KILN ("FRIKILN").

The number of enquiries concerning this kiln continued to be large. Thirty-five sets of scale drawings of the kiln were sent out to forest

officers and charcoal contractors who wished to make their own kilns. The forest departments of various provinces and states in India, the Federated Malay States, Mauritius and the United States of America were among those to whom the drawings were supplied.

Experiments were continued to see if it was possible to do away with certain parts without sacrificing the efficiency of the kiln, so that the cost of the kiln could be reduced. It was found however that substantial reductions were not possible without changing the design of the kiln.

2. CHARCOAL BRIQUETTING.

The cost of manufacturing charcoal briquettes using various binders was worked out, and the search for a cheap binder was continued. Of the various binders tried the following gave good results:—(i) 5 per cent. *Bauhinia retusa* gum and 4 per cent. rice, (ii) 5 per cent. rice, (iii) 6 per cent. *Bauhinia retusa* gum. With these binders the cost of briquetting per maund of 80 lbs. of briquettes works out at Rs. 0-8-2 for (i), Rs. 0-3-11 for (ii) and Rs. 0-7-0 for (iii). On a commercial scale (ii) holds out promises of being successful.

Tamarind seeds ground and boiled in water, and prickly pear (*Opuntia* sp.) were also tried as binders. The former gave good strong briquettes which burnt well, while the latter produced weak briquettes which, however, also burnt very well.

Some preliminary experiments were also made on the use of molasses as a binder. The briquettes were very strong but they absorbed moisture during the monsoon. The future line of work will be to find if possible a suitable binder from waste products of little or no value.

3. CULTIVATION OF MEDICINAL PLANTS.

The following species were cultivated in the Minor Forest Products garden:—(1) *Datura fastuosa*, (2) *Ipomoea purga*, (3) *Tribulus terrestris*, (4) *Artemisia maritima*, (5) *Chrysanthemum cinerariaefolium* (*Pyrethrum*), (6) *Derris elliptica*, (7) *Derris malaccensis*, (8) *Solanum indicum*, (9) *Hydrocotyle asiatica*, (10) *Plantago psyllium*, (11) *Plantago obovata*, (12) *Mentha piperata*, (13) *Carum copticum*. Of these, numbers (1), (4) (Kashmir variety), (8), (9), (10), (11), (12), (13) were successful. Numbers (2), (6) and (7) did not like the Dehra Dun climate.

During the year seeds and cuttings of *Artemisia maritima* were supplied to the Silvicultural Research Division, Punjab, for trial at Chichawatni.

Pyrethrum powder, prepared from the flowers grown in the Minor Forest Products garden, was found by the Forest Entomologist to be

stronger in its effects than two commercial samples of pyrethrum. Pyrethrum seeds from Japan and Belgrade were obtained and sown in the Minor Forest Products garden. Germination was good and the plants are growing well. They started flowering after the close of the year.

The growth of *Derris elliptica* and *Derris malaccensis* was very bad ; only three plants of the former were five feet in height ; all the others (of both species) were less than two feet in height at the end of the year, with very few shoots and a poor root system. These two species do not like the dry heat of the summer and require protection against the winter frosts. For these reasons plantations of *Derris elliptica* and *Derris malaccensis* are not likely to be successful in northern India. They should, however, be tried in the forests of Assam and the Western Ghats where the climate is more like that of Malaya where they are grown on a commercial scale.

4. MATCH WOODS.

A publication incorporating all the results of past tests was sent to the press during the year.

5. COLLECTION OF INFORMATION ON DRUGS OF FOREST IMPORTANCE.

As mentioned in last year's report, this work is being carried out in conjunction with the Biochemist and the Forest Botanist. On account of certain changes made in the form of classification, etc., a good deal of additional labour was involved and the work of rearranging the information could not be finished by the end of the year.

6. SUBSTITUTES FOR CORK FOR USE AS INSULATORS IN REFRIGERATORS.

Preliminary work has shown that several forest fibres and flosses could be used, especially semul (*Bombax malabaricum*) floss.

7. OUTTURN OF MINOR FOREST PRODUCTS (DRUGS).

No information is at present available regarding the names and quantities of various minor forest products, especially drugs and medicinal plants, available from the forests of various provinces and states in India. As minor forest products are generally leased out for a lump sum no record is kept regarding the species collected or the quantity. A start was, therefore, made and a circular sent to all forest officers in India through the courtesy of the Inspector General of Forests and heads of Provincial Forest Departments, requesting that such information as was available might be collected from contractors and other sources. The results so far are encouraging, and replies are being received.

ed from all provinces and states. It is hoped that the good work will continue and that all forest officers, including range officers, foresters and forest guards will help to supply what information they can on the forest products available within their jurisdiction. It is only by this means that the information being collected at Dehra Dun will be made complete.

8. ENQUIRIES.

Over 400 enquiries dealing with the supply, collection, marketing, prices, etc., of various minor forest products were dealt with during the year.

Paper Pulp Section.

1. EXPERIMENTAL FACTORY.

(a) *Disintegration of bamboos*.—Experiments on the disintegration of bamboo were continued during the year under report. Feeding and crushing rolls were fitted to the old Norris and Christy machine. The results obtained were a decided improvement on the previous ones. It was found, however, that the rolls were too light and small to deal effectively with the whole stems of bamboos. It was also found that the flattening and partial crushing of bamboos could be effected more completely with pyramidical projections on the surface of the rolls, instead of the ribs previously used. A newly designed set of rolls, for the feeding equipment is now under preparation. With these it is hoped that it will be possible to obtain from the machine the desired results as regards the output of partially crushed chips of a size suitable for efficient digestion.

(b) Supplies of two species of bamboos, viz. : *Bambusa tulda* (*mitenga*) and *Teinostachyum dullooa* (*dolu*), which were tested in the laboratory previously, were received from Bengal towards the end of the year for semi-commercial trials. Tests were at once carried out on *Bambusa tulda* by the sulphate fractional process for determining the yields of unbleached and bleached pulps and the consumption of chemicals. Paper making trials are now in progress. The semi-commercial tests on *Teinostachyum dullooa* will be taken up shortly.

Writing, printing and wrapping papers were made from *Oxytenanthera auriculata* (*kaliserri* bamboo). The paper on which this report is printed is made from this bamboo.

(c) *Pulp for artificial silk*.—Experiments on the purification of bamboo pulp for use in the production of artificial silk were continued. The cuprammonium viscosities of the different samples of pulp prepared were not uniform. A study of the effect of varying the conditions of digestion and bleaching on the viscosity of pulp is now being made.

(d) The following grasses from the New Forest experimental plots were tested for their paper making qualities :—

1. *Saccharum arundinaceum* (ramsar).
2. *Saccharum munja* (munj).
3. *Saccharum spontaneum* (kans).

All the three grasses gave economic percentage yields. Clean and good quality grades of writing and printing papers and boards were also prepared from mixtures of grass and bamboo pulps.

(e) *Manufacture of paper, boards etc.*—About 3½ tons of writing, printing, type and packing papers, and mounting and drying boards were manufactured in the factory of which about 3 tons were supplied to the various offices of the Forest Research Institute and College, to the Government of India Press for the annual report and to the Silviculturist, United Provinces, for a special purpose.

2. LABORATORY.

(a) *Pulp for artificial silk.*—Digestions and bleaching under varying conditions, determinations of alpha cellulose, ash, copper number and cuprammonium viscosity were carried out in connection with the preparation of purified pulp for artificial silk.

(b) As desired by the Paper Mills in the conference held last year, experiments were undertaken to compare the digestibility and bleachability of chips prepared by the different systems of mechanical disintegration of bamboos in use at the various mills. *Dendrocalamus strictus* chips were supplied by the Kankinara Paper Mills, the Bengal Paper Mills and the India Paper Pulp Co. Autoclave digestions of these chips were carried out by the soda, sulphate and sulphite processes under varying conditions. Each set of experiments on the chips from the three mills was carried out under comparable conditions of digestion and bleaching. Unbleached and bleached yields and bleach consumptions were determined in each case. The experiments are still in progress. The results hitherto obtained indicate that the opening out or the partial crushing of chips helps considerably in obtaining uniformly well digested and economically bleachable pulp.

(c) *Nannel* grass, reported to be *Saccharum spontaneum*, was tested for its paper making qualities for Messrs. The Andhra Paper Mills Co., Ltd. The yield of bleached pulp was found to be low.

(d) At the request of the Tariff Board, various methods for determining the relative degree of sizing of papers were tried with a view to finding a method for differentiating between writing and printing papers in the class of cheap mechanical pulp papers imported into the country

from abroad. The method adopted by the Technical Association of the Pulp and Paper Industry, United States of America, was recommended to the Tariff Board as the most reliable.

(e) In connection with the Tariff Board inquiry into the classification of papers, determinations of the percentage of ground wood pulp in newsprint papers were also carried out by the permanganate method.

(f) *Boiler feed water*.—Routine analytical tests in connection with the softening of the boiler feed water were carried out as and when required.

3. TOURS AND ENQUIRIES.

(a) Mr. Bhargava visited, in October 1935, the Paper Mill at Lucknow, to give advice to the firm regarding certain matters in connection with the erection of the new grass cleaning and bleaching plant.

(b) In March 1936, Mr. Bhargava visited the Andhra Paper Mills, Rajahmundry, to advise Messrs. Dayaram & Sons, Managing Agents of the Mill, as to the necessary alterations and additions to the plant, in order to enable them to restart the mill and run it on an economic and profit earning basis.

(c) In March 1936, Mr. Bhargava also visited the Paper Mill at Titaghur to see the new bamboo pulp making plant recently installed there.

(d) Correspondence was carried on with Government departments, commercial firms and private individuals in connection with 67 technical enquiries referred to the Section.

4. TRAINING OF PAPER MILL CHEMISTS AND APPRENTICES.

In October-November 1935, a course of one month's lectures in theoretical and practical paper technology was given to chemists and apprentices from the Titaghur Paper Mills Co., Ltd., the Bengal Paper Mills Co., Ltd., the India Paper Pulp Co., Ltd., the Upper India Couper Paper Mills Co., Ltd., and the Deccan Paper Mills Co., Ltd. All the mills appreciated the training given to their employees as conducive to increasing their knowledge and efficiency and were of the opinion that such training courses should become a regular and permanent feature. In view of the very limited accommodation in the paper pulp laboratory and of the fact that the period of one month was not found adequate to enable the apprentices to derive the fullest benefit from the training, it is proposed to take in future only two apprentices at a time for a period of four to six months for practical training. For the benefit of the other apprentices in the various mills it is proposed to give a course of theoretical lectures in paper technology every alternate year. In this way the apprentices will be able to take full advantage of the facilities available at the Institute.

Visits.

The Indian Tariff Board visited the Institute in the first week of August 1935, to collect information on various points in connection with the enquiry into the classification of papers for tariff purposes.

Mechanical Sub-Section.

Over 500 jobs were completed during the year and a large number of other small repairs which were not booked were complied with in addition.

The Electric installation consisting of 3 D. C. Generating sets with Switch Board and Electric motors, large and small, with their switch gear, fans and lights with their wiring for the supply of current, electric ovens and other electrical tools were repaired and maintained in good order. The Iron Workshop and the machinery attached to it was maintained in good order. The 4 motor lorries, the miniature railway track and trucks, all fire appliances in the main building, workshops, laboratories and insectary were maintained in good order. The boilers and their attachments, steam pipes and fittings and other plant attached to the workshops and laboratories were maintained in thorough good order. Amongst the more important works completed the following may be mentioned :—

The 2nd Internal Circulation Kiln in the Seasoning Section was completed and given a thorough and satisfactory trial.

A new bamboo crushing and feeding device was made and fitted to the disintegrator machine of the Paper Pulp Section. The new device has given very satisfactory results.

A new sinking apparatus was made and fitted in one of the log ponds of the sawmill for keeping logs submerged under water.

A water spraying arrangement was designed and fitted to the erosion exhibit in the Silviculturist's museum.

CHAPTER VI.—CHEMISTRY BRANCH.

The following programme of work was undertaken during the year under report :—

1. General study of the chemistry and commercial uses of the minor forest products.

A.—Drugs :—

(i) Derris species and plants likely to have insecticidal properties.

(a) *Derris elliptica*.

(b) *Derris scandens*.

(c) *Derris robusta*.

(d) *Tephrosia hamiltonii*.

(ii) *Vitex negundo*.

(iii) *Vitex peduncularis*.

B.—Oils and Fats :—

(i) *Actino-daphne hookeri*.

(ii) *Celastrus paniculata*.

(iii) *Xymenia americana*.

C.—Other products :—

(i) Kuth roots.

(ii) East African Sandal wood oil.

2. Study of forest soils.

3. Miscellaneous enquiries.

1. A.—Drugs.

(i) Derris species and plants likely to have insecticidal properties.

(a) *Derris elliptica*.—Further samples of *Derris elliptica* roots were received from Assam and analysed. In making collection of these samples attention was paid to the age and thickness of the roots, since it has been observed that both rotenone and ether soluble constituents decrease with the age and the thickness of the roots. The best time for harvesting derris is said to be when the plants are eighteen to twenty-four months old and thin roots, upto about half inch in thickness, are

generally collected for commercial purposes. The results of analysis of these samples, given below, fully substantiate the above observations :—

Species.	Locality	Description	Moisture in air dry	Ether extract.	rotenone.
			Per cent.	Per cent.	Per cent.
<i>Derris elliptica</i>	Dobaka Reserve, Nowgong division.	(i) Thin roots $\frac{1}{2}$ " to $\frac{1}{4}$ " Age 12-18 months	1.7	4.53	2.41
		(ii) Thin roots $\frac{1}{4}$ " to $\frac{3}{4}$ " Age 18-24 months.	3.9	4.14	2.26
		(iii) Thick roots $\frac{3}{4}$ " to $\frac{1}{2}$ " Age 3 years and above.	5.9	2.66	1.01
<i>Derris elliptica</i>	Kahchhara, Kachar division.	(i) Thin roots $\frac{1}{2}$ " to $\frac{1}{4}$ "	4.9	4.04	2.34
		(ii) Thick roots $\frac{3}{4}$ " to 1"	1.3	3.77	1.92
<i>Derris elliptica</i>	Guma Range, Goalpara division	(i) Thin roots upto $\frac{1}{2}$ "	2.6	2.49	1.45
		(ii) Thick roots $\frac{1}{2}$ " to 1"	4.5	1.18	0.94

The above results show that derris roots of average marketable quality, containing about 2.5 per cent. of rotenone, are available in Assam; but, in view of the low ether solubles content of these roots, they cannot be classed as good quality derris. At present derris root is valued both on the basis of rotenone and ether solubles content, since it has been found that other bodies, besides rotenone, which are extracted by ether, possess definite insecticidal properties. The trade demands a good quality derris root to contain about 5 per cent. of rotenone and about 15 per cent. of ether solubles. Therefore, to establish a trade in this important insecticide, cultivation of suitable strain will have to be resorted to, in order to improve the quality and to increase the output.

(b) *Derris scandens*.—The other species of derris examined was *Derris scandens*. The roots (moisture 5.1 per cent.) gave 2.2 per cent. of total ether solubles containing 0.26 per cent. of a crystalline substance M. P. 253°—54°. No rotenone could be isolated nor did the ether extract give the nitric acid colour test for rotenone and allied bodies. This species, therefore, does not appear to be of value as an insecticide.

(c) *Derris robusta*.—As has been reported previously, this species, although it does not contain any rotenone, contains two crystalline substances the properties and constitution of which are being studied.

(d) *Tephrosia hamiltonii*.—The air dried roots of this species containing 4.7 per cent. of moisture gave 1.2 per cent. of ether extract. The stems containing 3.0 per cent. of moisture gave 1.4 per cent. of ether

extract. No rotenone could be isolated and the ether extracts of neither the roots nor the stems gave any nitric acid colour test for rotenone. Thus none of the Indian tephrosias, examined so far, contain rotenone or allied bodies which have been found in *Tephrosia* (caracca) *virginiana* of American origin. Indian tephrosias, therefore, are not likely to prove useful as an insecticide.

(ii) *Vitex negundo*.—Further work on the constituents of the leaves of *Vitex negundo* showed that the fresh flush of leaves, collected in March, besides containing the crystalline polyhydric alcohol gluco-nonitol and the free acids p-hydroxybenzoic acid and dioxy-benzoic acid, reported last year, contains a glucoside which is sparingly soluble in cold water and comes out from hot water or dilute alcohol as a gel-like crystalline mass retaining good deal of the solvent. Purified by repeated crystallization from ether-alcohol mixture, it comes out as a faintly brown micro-crystalline powder M. P. 154° — 55° C. Boiling with water alone it decomposes into p-hydroxy-benzoic acid, glucose and a dark-brown amorphous substance. Hydrolysis with dilute mineral acid (2.5 per cent. solution) even at room temperature (20 — 25° C) decomposes it into the above products. Hydrolysing it with caustic alkali on water bath it breaks up into p-hydroxy benzoic acid and a second white crystalline glucoside M. P. 173° — 74° . It can readily be crystallized from alcohol or a mixture of alcohol and ether. When this is further hydrolysed with ice cold 5 per cent. H_2SO_4 for five days, it breaks up into glucose and a neutral yellow brown amorphous substance which also decomposes, either by boiling in water or by treatment with mineral acids, into the black amorphous substance. This glucoside was found to be absent in the mature leaves collected in November or December and in its place a water soluble amorphous glucoside was isolated (from the basic lead acetate precipitate) which, as was reported last year, also gave p-hydroxybenzoic acid, glucose and the dark brown amorphous substance on acid hydrolysis. The two glucosides therefore appear to be very closely related. Further work to elucidate the constitution of the glucoside is in progress. A small quantity of it has been sent to the Haffkine Institute, Bombay, for determination of its pharmacological action.

(iii) *Vitex peduncularis*.—The infusion of the leaves as well as of the root bark of this plant is reported to be efficacious in malarial and black-water fever. Nothing is known about the chemical constituents of the leaves excepting that these contain traces of an alkaloid. [Ind. Med. Gaz. (1924), 59, 133.] It was therefore thought desirable to examine once again the leaves and the root bark for their chemical constituents. Samples have been obtained from Bihar and Orissa and Assam and the chemical examination is in progress.

1. B.—Oils and Fats.

(i) *Actinodaphne hookeri*.—In last year's report attention was drawn to the commercial possibilities of fats from the seeds of certain plants belonging to the N. O. Lauraceae, particularly *Actinodaphne hookeri*, *Litsaea sebifera* and *Litsaea lanuginosa* as important indigenous sources of lauric acid, which forms the base for sodium lauryl sulphate, a new type of detergent considered superior to ordinary soap in many respects. On account of this newly found use of lauric acid its demand is on the increase. At present commercial source of lauric acid is restricted to only a few fats such as palm kernel oil and cocoanut oil, which however contain only about 50 per cent. of trilaurin. Hence *Actinodaphne* and *Litsaea sebifera* fats, containing about 96 per cent. of trilaurin, are a much better source of lauric acid. Even *Litsaea lanuginosa* containing 70 per cent. of trilaurin is superior to cocoanut oil in this respect.

With a view to give more precise information regarding cost of producing lauric acid and other lauryl compounds from indigenous source *Actinodaphne* fat, which is the richest in trilaurin, was worked up on a semi-commercial scale. From 205 lbs. of the air dried berries 54 lbs. of the crude fat was obtained and this was converted into the following products :—

						Cost of production.		
						Rs. A. P.		
Crude fat (expressed)	.	.	.	.	.	35	0	0 per maund.
Purified fat (technical)	.	.	.	.	.	1	0	0 per lb.
Trilaurin (crystals)	.	.	.	.	.	1	8	0 „ „
Lauric acid (technical)	.	.	.	.	.	1	4	0 „ „
Lauric acid (crystals)	.	.	.	.	.	1	8	0 „ „
Methyl laurate	.	.	.	.	.	3	0	0 „ „
Ethyl laurate	.	.	.	.	.	1	12	0 „ „

The above figures show that the cost of production of these products is comparatively low specially the cost of lauryl esters, which are at present quoted at a much higher price on account of the low trilaurin content of the raw material used.

Samples of these products were sent to different firms, both in India and abroad, dealing with similar products and their opinion was asked for regarding their commercial possibilities and probable demand. Replies received are very encouraging and clearly indicate that there is a ready market for these products. One foreign concern expressed the opinion that they might take as much as 5 to 10 tons of trilaurin per month. It was therefore thought desirable to institute an enquiry as to how much seeds, not only of *Actinodaphne* but also of other *Litsaea* species, which too contain a fairly high proportion of trilaurin, are avail-

able in India. Accordingly, the Forest Economist has written to different Conservators of Forests in India for the required information and their replies are awaited. If trilaurin is extracted from the seeds of *Actinodaphne* and other *Litsaea* species, at present available in India, and the fat is pushed in the market and if attempts are made to augment the supply by plantation of suitable species, a valuable trade in this product can easily be developed.

(ii) *Celastrus paniculata*.—The chemical and the physical constants of this oil, said to be a sovereign remedy in Beri-beri, were reported last year. A detailed examination of the constituent acids showed that the oil is mainly composed of the glycerides of capric, palmitic, oleic and linoleic acids. No other compound, which can account for its medicinal properties, has yet been isolated.

(iii) *Xymenia americana*, Linn.—The plant grows plentifully in the coastal tracts of Tennasserim, Mysore, and Madras Presidency. The seeds are edible and are generally eaten after roasting, as then they acquire a pleasant almond like taste. The fat from the seed when freshly expressed is highly viscous and is used as a substitute for ghee. The following characteristics of the fat have been determined:—

Moisture in the kernels	3.6 per cent.
Total oil in the kernels, by solvent extraction	49.0 „
Colour	Yellow-orange.
Specific gravity at 20°C	0.9262
Refractive index at 20°C	1.4710
Saponification value	169.2
Iodine value (Hanus)	82.5
Acid value	2.3
Chemical constants of the mixed fatty acids of the fat:—	
Mean molecular weight	319.8
Iodine value	85.0

Further work on the isolation and identification of the constituent acids is in progress.

1. C. Other Products.

(i) *Kuth roots*.—It is a matter of satisfaction to note that *Kuth* (*Saussurea lappa*) grown in British Garhwal by way of experiment, has been found to be of the same quality as Kashmir 'Kuth'. Two samples of roots were received from the Divisional Forest Officer, Garhwal. One was from Bhuna nursery at an elevation of 11,000 ft. from plants four years old. It was found to contain 2.45 per cent. of essential oil (calculated on absolutely dry material). The other one was grown in a private nursery in Badrinath at an elevation of 12,000 ft. The age of the plant was about 14 years. It contained 3.86 per cent. of oil. The oil content

of Kashmir Kuth roots from plants 3 ft. or more in height has been found to vary from 2 to 4 per cent. according to age. Roots from younger plants of less than 3 ft. in height contain less than 2 per cent. of oil. A sample of Kashmir roots from plants about 5 years old has recently been examined here and was found to contain 2.61 per cent. of oil (on dry material). Thus the Garhwal samples compare very favourably with Kashmir products.

Another sample of Kuth root was received from Nepal. It was grown at an elevation of 8,500 to 11,000 ft. and the plants were 5 years old. It was found to contain 1.15 per cent. of oil (on dry material) and is thus distinctly inferior to Kashmir and Garhwal Kuth. However the above results clearly indicate the possibility of growing Kuth of average quality outside Kashmir.

(ii) *So-called East African Sandal wood oil*—In East Africa the wood of *Osyris tenuefoliata* and allied species yield an essential oil, which has an odour similar to Indian Sandal wood oil, but is fainter and more pungent. This oil is often called East African Sandal wood oil but it is altogether different in properties. It is reported to contain a sesquiterpene alcohol of the type of Santalol, the chief constituent of sandal oil, to the extent of about 30 per cent. only; whereas sandal oil contains 90—94 per cent. of Santalol. Formerly the trade in the wood and the oil was very limited, but recently large quantities of the wood and the oil distilled from it are being exported not only to China and Japan but also to India. In view of this, the Inspector General of Forests procured a sample of oil from the Tanganyika Forest Department, which was analysed with the following results :—

	B. P. specification for sandal wood oil.	Tanganyika oil.
Colour	Pale yellow .	Very light yellow.
Odour	Aromatic .	Aromatic, less strong slightly pungent.
Density at 20°C	0.973 to 0.985	0.9574
Refractive index at 20°C	1.498 to 1.508	1.4996
Angle of rotation	—13° to —21°	—47.1°
Ester value after acetylation	..	181.1
Calculated total Santalol content	not less than 90 per cent.	83.0 per cent.

The above results show that, although this oil does not at all conform to the B. P. Standard, it contains a much higher percentage of the Santalol like sesquiterpene alcohol than what has been recorded before for East African Sandal oil (The Volatile Oils, Guildmeister and Hoffman, 2nd ed., p. 351). In this respect it is like the West Australian Sandal oil which has been found to contain about 80 per cent. of Santalol.

2. Forest Soils.

Eight samples of soils were received from the Silviculturist, U. P. and were examined for their total solubles and alkalinity. Some samples of soils in connection with "manuring experiments" of the Silviculturist were examined for nitrogen, nitrates, etc. Besides these a large number of samples from the experimental plots of the Institute were also examined.

3. Miscellaneous enquiries.

Acacia catechu.—An interesting investigation, taken up at the instance of the Silviculturist, was to find out whether Burma grown *Acacia catechu* wood is generally poorer than Indian wood in total extractable matter and catechin content.

The following table gives the results of analysis of Burma grown and locally grown *Acacia catechu* wood:—

Serial No.	Description.	Diameter of billet.	Moisture.	Methyl alc extract.	Water ext.	Catechin.
			Per cent.	Per cent.	Per cent.	Per cent.
1	Heartwood, Burma, large .	2" to 3½"	3.1	13.6	13.0	1.9
2	Heartwood, Burma, small .	¾" to 1½"	1.5	13.2	17.3	1.7
3	Heartwood, local, small .	½" to 1½"	1.4	14.0	14.0	4.3

The sample of the locally grown *Acacia* is comparable to the smaller sample from Burma, the trees being approximately of the same age. Sample from an older tree comparable with the large Burma sample was, however, not available. Even then, it is apparent from the above table that the locally grown *Acacia catechu* wood is richer in catechin content than the Burma grown wood.

Another interesting investigation, taken up at the instance of the Minor Forest Products Section, was the examination of two samples of 'katha' prepared from older trees, girth 4' to 5' and younger trees, girth 2' to 2' 6". It was stated that the katha makers of Palamau Division in Bihar and Orissa preferred younger trees for 'katha' making because there is a "deterioration in the quality of 'katha' when the *khair* tree exceeds a certain maximum age or size". The results of analysis of the two samples are as follows:—

	Katha from trees of girth 4' to 5'.	Katha from trees of girth 2' to 2½'.
	Per cent.	Per cent.
Moisture	10.1	9.9
Ash	5.9	7.1
Catechin	53.8	55.5
Water solubles	83.2	82.2

The above results clearly show that preference for younger trees is a matter of mere prejudice.

Besides the above a large number of analyses were undertaken on behalf of forest officers, officers of the Institute and other Government Departments. Of these, mention may be made of the following :--

Artemisia flower heads, Rosha grass oil, Aconite roots, samples of soap, samples of water, pine soap. copper content of pith helmet, etc.

APPENDIX I.

Publications of 1935-36.

Serial No.	Title of Publication	Author.	Date of issue.
	FOREST RECORDS		
1	A Stand Table for Sal evenaged High Forest and Coppice.		May 1935.
2	Illustrations of Indian Forest Plants, Part III .	R. N. Parker and C. E. Parkinson	June 1935.
3	Immature Stages of Indian Coleoptera (16) (Scarabaeidae)	J. C. M. Gardner	September 1935.
4	Immature Stages of Indian Coleoptera (17) (Eucnemidae)	J. C. M. Gardner .	September 1935
5	On the Biology of Psyllidae	R. N. Mathur	September 1935.
6	Neue Brentiden und Lyciden aus Indien	R. K. K. K. . . .	September 1935.
7	Neue Attelabiden aus Indien (Curculionidae Col.)	Edward Voss . . .	October 1935.
8	Biology of Braconidae (Hymenoptera)	C. F. C. Beeson & S. N. Chatterjee	December 1935.
9	Preliminary Survey of the Forest Types of India and Burma	H. G. Champion . .	(August 1936).
10	A Study of the Soils in the Hill areas of Kulu Forest Division, Part I. An Investigation of Soil Profiles under Deodar, Spruce, Blue Pine and Chr.	E. McKenzie Taylor, I. D. Mahendru, M. L. Mehta and R. C. Hoon.	(May 1936).
11	Immature Stages of Indian Coleoptera (18) Brentidae.	J. C. M. Gardner . .	November 1935.
12	Biology of Tachinidae (Diptera)	C. F. C. Beeson & S. N. Chatterjee.	December 1935.
13	Biology of the Ichneumonidae (Hymenoptera) . .	C. F. C. Beeson & S. N. Chatterjee.	December 1935.
14	Entomological Investigations on the Spike Disease of Sandal, (25) (Lepidoptera).	S. N. Chatterjee . . .	January 1936.
15	New Indian Curculionidae (Col.)	G. A. K. Marshall	February 1936.
16	Experiments on the Air-Seasoning of Softwood Railway Sleepers.	S. N. Kapur & Aziz-ul-Rehman	February 1936.
17	Shrinkage Studies on Indian Woods—Effect of high temperatures on the shrinkage and moisture equilibrium of wood	S. N. Kapur & Aziz-ul-Rehman.	March 1936.
18	Entomological Investigations on the Spike disease of Sandal, (26) Coccidae (Homopt.).	S. N. Chatterjee & T. V. Ramakrishna Ayyar.	March 1936.
19	A Glossary of Technical Terms for use in Indian Forestry.		(May 1936).
20	Distribution of Sesquioxides, Silica and Organic Matter in Forest Soil Profiles of Kulu.	R. C. Hoon	(June 1936)
21	Results obtained with a timber drying kiln heated directly by Furnace Gases.	S. N. Kapur	(July 1936).
22	Standard and Commercial Volume Tables for <i>Dalbergia sissoo</i> .	M. A. Kakazai . . .	(July 1936).
23	A Stand Table for Chir evenaged high Forest . .		(August 1936).
24	Minor Forest Products of Chakrata, Dehra Dun, Saharanpur and neighbouring Forest Divisions; Part I—The Oil Bearing Seeds.	S. Krishna, S. V. Puntambekar & M. B. Raizada.	(In Press).

APPENDIX I—*concl'd.*

Serial No	Title of Publication	Author	Date of issue.
25	Entomological Investigations on the Spike disease of Sandal (27) Chrysomelidae.	N. C. Chatterjee & G. D. Bhasin	(July 1936)
26	A Survey of the damage to teak timber by the Beechole borer throughout the main teak-bearing forests of Burma	D. J. Atkinson	(In Press).
27	Immature Stages of Indian Coleoptera (19) (Anthribidae).	J. C. M. Gardner	(August 1936).
28	Entomological Investigations on the Spike disease of Sandal (28) Curculionidae (Homopt)	N. C. Chatterjee	(August 1936)
29	New Indian Cerambycidae	J. C. M. Gardner	(In Press)
30	New Indian Tingitidae	C. J. Drake & M. E. Pool.	(July 1936)
31	Zwei neue Callirhipis mit ihren Larven (Sandalidae, Col).	Fritz van Emden	(August 1936).
32	A note on Protecting Indian Structural Timbers against fire, termites, borers and lungi (rot).	S. Kamesam	(September 1936)
FOREST BULLETINS			
33	Official List of Trade Names of Indian Timbers	..	July 1935.
34	Damage by Frost at New Forest, Dehra Dun	Bachaspati Nautiyal	September 1935.
OTHER PUBLICATIONS			
35	Rules for the Grading of Teak Squares	L. N. Seaman & V. D. Limaye	(April 1936).
36	Progress Report of Forest Research in India, Part I—The Forest Research Institute, 1934-35.	..	December 1935.
37	Progress Report of Forest Research in India, Part II—Provincial Reports, 1934-35.	.	(May 1936).
38	Annual Return of Statistics relating to Forest Administration in British India, 1933-34.		December 1935.
39	Annual Return of Statistics relating to Forest Administration in British India, 1934-35.	.	(In Press).
40	Classified List of Forest Officers of the Indian and Provincial Forest Services and of the Indian Forest Engineering Service in India and Burma on 1st July 1935	.	February 1936.
41	Indian Woods Tested for Match Manufacture	S. Ramaswami	(June 1936).
42	Forest Research and Indian Industry	.	(In Press).

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- M. V. Laurie . . . *Pinus caribaea* (*Ind. Forester*, February 1936).
- M. V. Laurie . . . Seed origin and its importance in Indian Forestry. (*Ind. Forester*, January 1936).
- H. G. Champion . . . Tour jottings in South Indian States and Coorg (*Ind. Forester*, April 1935).

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- Mukat Behari Raizada The Genus *Psilotum* in India (*Ind. Forester*, October 1935).
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1935, Vol. IV, p. 29).
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Narang and J. N. Ray . The oxidation products of Vasicine with Hydrogen
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of the Indian Chemical Society, 1936, Vol. XIII, p.
115).

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APPENDIX III.

Statement showing Officers-in-charge of Branches and Sections during the year 1935-36.

Branch.	Officer-in-charge.	Section.	Officer-in-charge.	From	To
Silviculture	Mr. H. G. Champion, Silviculturist.	..	..	1-4-1935	18-4-1935
	(Mr. M. V. Laurie)	..	..	19-4-1935	1-1-1936
	Mr. H. G. Champion.	..	..	2-1-1936	31-3-1936
		Experimental	Mr. J. N. Sen Gupta	1-4-1935	31-3-1936
		Statistical	Mr. M. A. Kakazal	1-4-1935	31-3-1936
Botany	Mr. C. E. Parkinson, Forest Botanist.	..	..	1-4-1935	31-3-1936
Economic		Mycology	Dr. K. D. Bagchee	1-4-1935	31-3-1936
	(Mr. W. A. Bailey), Forest Economist.	..	..	1-4-1935	24-10-1935
	Capt. H. Trotter	..	..	25-10-1935	31-3-1936
		Minor Forest Products.	(Mr. W. A. Bailey)	1-4-1935	24-10-1935
			Capt. H. Trotter	25-10-1935	31-3-1936
		Timber Testing	Mr. V. D. Limaye	1-4-1935	31-3-1936
		Wood Preservation.	Mr. S. Kamesam	1-4-1935	11-4-1935
			(Mr. W. A. Bailey)	12-4-1935	11-5-1935
			Mr. S. Kamesam	12-5-1935	31-3-1936
		Seasoning	Dr. S. N. Kapur	1-4-1935	14-10-1935
			(Mr. A. Rehman)	15-10-1935	28-10-1935
			Dr. S. N. Kapur	28-10-1935	31-3-1936
		Paper Pulp	Mr. M. P. Bhargava.	1-4-1935	31-8-1936
		Wood Technology.	Mr. K. A. Chowdhury.	1-4-1935	1-1-1936
			(Capt. H. Trotter)	2-1-1936	31-3-1936
		Wood Workshop	Mr. W. Nagle	1-4-1935	31-3-1936
Entomology	Dr. C. F. C. Beeson, Forest Entomologist.	..	..	1-4-1935	31-3-1936
		Systematic Entomologist.	Mr. J. C. M. Gardner.	1-4-1935	16-5-1935
			(Dr. C. F. C. Beeson.)	17-5-1935	24-10-1935
			Mr. J. C. M. Gardner.	25-10-1935	31-3-1936
Bio-Chemist	Dr. S. Krishna	..	..	1-4-1935	1-1-1936
	(Mr. T. P. Ghose, Officer-in-charge, current duties).	..	..	2-1-1936	31-3-1936

APPENDIX IV.

ANNUAL FORM No. 24.

FOREST RESEARCH INSTITUTE.

Summary of Revenue and Expenditure during 1935-36.

Budget Heads.	Direction.	Silviculture Branch.	Botany Branch.	Entomology Branch.	Economic Branch.	Chemistry Branch.	TOTAL.
1	2	3	4	5	6	7	8
	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
REVENUE.							
V.—Miscellaneous—							
(b) Other Sources . .	703	139	70	6	2,862	..	3,780
(d) Sale of timber and furniture from Seasoning and Wood Workshop Depot.	..	..	..	..	262	..	262
Total Revenue .	703	139	70	6	3,124	..	4,042
EXPENDITURE.							
A.—Conservancy, Maintenance and Regeneration—							
C. 1.—Purchase of Stores, tools and plant.	133	489	817	330	2,244	51	4,064
C. 2 —Communications and Buildings, Repairs and Maintenance.	..	..	..	..	..	..	..
C. 3.—Miscellaneous—							
(1) Temporary Establishment on daily labour.	870	1,087	4,395	2,245	2,430	395	11,422
(2) Purchase of Timber for Seasoning and Preserving (including freight and carting charges).	..	..	..	..	3,485	..	3,485
(3) Purchase of Coal, raw materials, chemicals and apparatus.	..	..	..	211	10,733	1,679	12,623
(4) Other Charges .	81	2,848	1,910	940	14,902	386	21,067
Total A.—Conservancy, Maintenance and Regeneration.	1,084	4,424	7,122	3,726	33,794	2,511	52,661

