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[Despatch Abstract.]

Tanning.-

Forwarding to the Officer in charge of the Department of Industries, a copy of the letter from the Government of India suggesting that certain experiments in tanning may be conducted in the Leather Trade School, Madras.

Cir. No. 570-F-162-12.

Government of India.

Department of Revenue & Agriculture re. (Forests)

From

The Honourable Mr. R. A. Mait, I.C.S.,

Secretary to the Government of India.

To

The Secretary to the Government of Madras,

Revenue Department.

Simla the 1st October 1917.

Sir,

I am directed to forward for the information of the -
Governor in Council and for such action as His Excellency may
think necessary, a copy of the Proceedings (with appendices)
of the Tanning Conference convened by the Government of India
in connection with the supply of tanning materials by the -
Forest Department and the tanning industry generally. The
Conference assembled in the Forest Research Institute at -
Dehra Dun on the 14th and 15th August 1917.

2. The recommendations made by the Conference are shown
in heavy type and the Government of India desire to call your
attention to some of these which are of especial importance -
in connection with the immediate supply of leather for the -
requirements of the British and Allied Armies, and to certain
others which are of importance in connection with the future
development of the tanning industry in India and the fuller -
utilization of the resources of Indian forests and waste lands.

3. The most important of the recommendations made by the -
Conference for immediate war purposes is that on page 4, advo-
cating that immediate steps should be taken to increase the -
supply of tarwad bark (Cassia Auriculata) and to place this -
supply under Government control, and also that artificial culti-
vation of tarwad should be undertaken without delay both on -

waste lands and as an agricultural crop under the control of the Departments concerned. The Conference emphasised in particular the necessity of taking immediate steps for seed collection of tarwad. It may be explained that tarwad bark is the principal tanning material used throughout the Madras and Bombay Presidencies in the production of "rough-tanned" cowhides of which the whole available supply is being shipped to the British War Office under arrangements made by the Indian Munitions Board. These rough-tanned cowhides are the principal source of supply for upper leather for boots for the British and Allied Armies. While other tanning materials are being exploited and experimented with as substitutes for tarwad in the production of upper leather tarwad is and will remain the most valuable tanning material for this purpose, at any rate in Southern India. As the greatly increased demand of the past two years and the demand expected in the coming year are likely to make serious inroads on the available supplies, it is most important, not only for present war purposes but for the future of rough-tanning in India, to take steps as early as possible to give effect to the Conference's recommendations.

I am directed to draw special attention to the suggestion of the Conference that the Madras Government should so far as possible introduce control of tarwad supplies similar to that adopted in Bombay. The Government of Bombay, while adhering to the ordinary method of giving out leases to contractors for the collection of tarwad, have been able to arrange through their district and forest officers that all supplies of the bark are despatched to the Assistant Controller for Hides at Bombay, who arranges in agreement with the bark brokers and tanners for the distribution of the bark to the latter at prices based on the actual quality and condition of the bark arriving. The Government of India recognise that in the Madras Presidency conditions are more complicated owing to the tanneries being scattered over many districts instead

of being located in one area as in Bombay, but they hope that the Government of Madras may be able in collaboration with the Assistant Controller for Hides at Madras and the War Office Representative, who are being instructed to give all assistance in their power, to work out some effective system of control.

The result of the Bombay arrangement has been not only that larger supplies are now forthcoming but that prices for tarwad are from Rs.7/8 to Rs.16/- per palla of 240 lbs., compared with the Madras price of from Rs.25/ to 40/- per 500 lbs., and the latter prices are only with difficulty being maintained by bringing pressure to bear on the tanning bark-merchants in Madras and by rigorously prohibiting the tanning of skins and export of ~~xxxx~~ tanned skins.

The suggestion that other material than tarwad should be used for green manure is also important, since it is understood that very large quantities of tarwad are used up in this way and that substitutes could probably be found. I am directed to invite the attention of His Excellency in Council to this suggestion.

4. Another recommendation of importance is that on page 3, regarding the possibility of increasing the supply of tanning materials by means of plantations along canals and railways. The Government of India consider that in the interests of the large tanning industry at Cawnpore, which depends mainly on babul bark, the suggestion of the Conference that babul should be grown along canals and railways in the neighbourhood of Cawnpore deserves attention. The Government of India agree with the Conference that in Southern India efforts to develop cultivation of tanning materials along canals and railways might be devoted specially to tarwad.

5. I am directed to invite your attention also to the recommendation on page 5 of the Proceedings of the Conference that in giving out new contracts or leases for collection of myrabolams (Terminalia Chebula) it is desirable under present

of being located in the area as is Bombay, and they hope that the Government of Bombay may be able in collaboration with the Assistant Commissioner for Nidra at Madras and the Assistant Commissioner for Nidra at Madras to give all assistance in their power, to work out some effective system of control.

The results of the survey conducted have been that only that paper supplied has been forthcoming and that prices for paper are from Rs. 10/- to Rs. 15/- per bale of 240 lbs., compared with the Madras price of from Rs. 25/- to Rs. 30/- per bale, and the latter prices are only with difficulty being obtained by paying premiums to meet on the same basis. The suggestion that other material than paper should be used for paper manufacture is also important, since it is understood that very large quantities of paper are used in the way of that manufacture could possibly be found. It is suggested to advise the Government of the necessity in Madras to be in a position to advise tanners regarding the use of this bark in the production of upper leather, in order to relieve the strain upon tarwad supplies.

Another recommendation of importance is that on page 3, regarding the possibility of increasing the supply of tanning materials by means of plantations from Madras and Malabar. The Government of India consider that as the interests of the large tanning industry in Madras, which depends mainly on paper bark, the suggestion of the Government of India should be considered in due course. The recommendation regarding a uniform definition and a uniform railway rate for tanstuffs is being considered by the Indian Munitions Board in correspondence with the Railways concerned.

It is suggested to advise the Government of India to be in a position to advise tanners regarding the use of this bark in the production of upper leather, in order to relieve the strain upon tarwad supplies.

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conditions that Government should reserve to itself the right of purchasing the outturn at fixed prices. This suggestion is made in view of the possibility of the Home Government desiring a closer control of outturn and prices of myrabolams, since the British tanners at the present time require the whole of the - however Indian supplies of this article. At present the Government of India have adopted the policy of leaving the myrabolam export trade to be conducted through the ordinary business channels, the Ministry of Shipping in England arranging for priority in regard to freight for a certain quantity monthly.

5a. I am to invite your attention also to the suggestion on page 3 that experiments in regard to the use of Cassia fistula in mixture with tarwad should be carried out at the - Madras School of Tanning. It is desirable that Government - should be in a position to advise tanners regarding the use of this bark in the production of upper leather, in order to relieve the strain upon tarwad supplies.

6. A number of the remaining recommendations of the Conference depend upon the results of further research which is - being carried out at the Government Tannin Research Factory at, Maihar and at the Government Tannery, Allahabad. For instance the suggestion to instal a plant at Kheri or Singhbhum for the extraction of powder from Sal bark depends on the results of - the experiments now in progress, the result of which will be communicated in due course. The recommendation regarding a uniform definition and a uniform railway rate for tanstuffs is being considered by the Indian Munitions Board in correspondence with the Railways concerned.

I have etc.,
R. A. Mant,
Secretary.

Proceedings of the Tanning Conference convened by the Government of India in connection with the supply of tanning materials by the Forest Department and the tannin industry generally, which assembled in the Forest Research Institute at Dehra Dun on the 14th August 1917.

The Conference convened by the Government of India in connection with the supply of tanning materials by the Forest Department and the tannin industry generally assembled in the Forest Research Institute at Dehra Dun on the 14th instant. The following were present :—

PRESIDENT :

G. S. HART, Esq., C.I.E., Inspector-General of Forests.

MEMBERS :

- B. B. OSMASTON, Esq., President, Forest Research Institute and College.
 COLONEL F. C. LANE, R.A., Superintendent, Government Harness and Saddlery Factory, Cawnpore.
 R. G. MARIOTT, Esq., Deputy Conservator of Forests, United Provinces.
 R. M. WILLIAMSON, Esq., Conservator of Forests, Eastern Circle, United Provinces.
 P. M. LUSHINGTON, Esq., Conservator of Forests, Southern Circle, Madras.
 J. A. PILGRIM, Esq., Tannin Expert to the Government of India.
 P. H. CLUTTERBUCK, Esq., Chief Conservator of Forests, United Provinces.
 M. HILL, Esq., Chief Conservator of Forests, Central Provinces.
 BABU KANAHYA LAL, Forest Officer, Panna State.
 PURAN SINGH, Esq., Chemical Adviser to the Forest Research Institute.
 R. D. RICHMOND, Esq., Deputy Conservator of Forests, Madras.
 R. E. MARSDEN, Esq., Sylviculturist.
 J. W. HENDERSON, Esq., War Office Leather Expert.
 R. S. PEARSON, Esq., Forest Economist.
 H. H. HAINES, Esq., Conservator of Forests, Bihar and Orissa.
 W. A. FRAYMOUTH, Esq., Managing Director, Esociet, Mailhar.
 A. C. McWATTERS, Esq., I.C.S., Controller of Hides and Wool.
 BABU SHAM SUNDAR BHARGAVA, Jubbulpore.
 R. S. TROUP, Esq., Controller of Timber Supplies.
 H. G. BILLSON, Esq., Conservator of Forests, Western Circle, United Provinces, (Secretary).

The Inspector-General of Forests opened the proceedings by summarising generally the objects of the Conference, among the most important of which were to interest the Forest Department as a whole in the industry and its possibilities, and to consider the best methods of the collection and despatch of tanning materials. He expressed regret at the unavoidable absence of Sir Thomas Holland, President of the Indian Munitions Board, who at the last moment was prevented from attending by urgent business.

The Conference then proceeded to consider the papers prepared by Messrs. Marsden, Marriott, Pilgrim, Fraymouth and Puran Singh, which are printed as appendices to these proceedings.

2. Mr. Marsden's paper on the sylviculture of the various species concerned was first considered.*

*Appendix I.

Taking the first of these species *Anogeissus latifolia* (dhaura or bakli), Mr. Marsden detailed the most recent results of his investigations. He referred to the difficulty so far experienced in the artificial germination of the seed and stated that as regards shoot production pollarding appeared to be more satisfactory than coppicing and gave the best results if carried out at a height of not less than 5 feet from the ground. The best pollards were trees from 15" to 20" in girth. Pollarding should be carried out before May. Mr. Fraymouth then explained the tanning uses of the leaves and the twig bark with special reference to the preparation of sumach. He exhibited specimens of the leaves at various stages of their development and of the sumach prepared from them and explained how they varied in tanning content. As regards the sumach he stated that his material ran from 20 to 30 per cent. in tanning content and commanded a fair sale in England before freight became prohibitive. He asserted that the commercial success of this sumach was more advanced than that of any of the recently investigated jungle tans, that it should be possible to deliver it in London in peace time at four shillings per cwt. as compared with 10 to 12 shillings, the ordinary price of Italian sumach, assuming pre-war freights. He stated that sumach was mainly of use in mixture with other tanning agents as a bleacher and finisher.

Mr. Henderson informed the Conference that the demand for sumach in England was very large and that a sample of Mr. Fraymouth's preparation had been sent home to the War Office.

On the evidence produced the Conference came to the conclusion that the prospects of successfully developing the utilization of this tan stuff were encouraging. The Forest Officers present agreed that the quantity available in the forests is practically unlimited.

Mr. Marriott pointed out that the present collecting season in Northern India was short, being limited from May to the break of the rains, and that in the event of a very large demand arising it would be necessary to introduce some method of artificial drying in order to render possible collection during the rains.

With regard to the occurrence and available supply of the species, Mr. Lushington testified to its prevalence in Madras in localities comparatively accessible and Mr. Fisher to its common occurrence in the Panch Mahals and Nasik districts of the Bombay Presidency. Mr. Williamson added that in Central India the supplies were very large indeed, mainly in zemindaries and Native States, but considered that owing to the increasing value of the timber for various purposes, such as axe handles, tool shafts, etc., it should not be worked for tanning materials when capable of growing to large size. This view was generally supported. Mr. Fraymouth pointed out that sumach was economically exploitable within a distance of 400 to 500 miles by rail, with a 20-mile road carriage, from tanning centres in India.

The Conference noted that in addition the twig, bark and old leaves were valuable tanning agents, that all three products of the tree can be collected by the same agency, and that bark from the main stem should only be collected when the tree is felled.

3. The next species considered was the *Acacia Arabica*.

Mr. McWatters informed the Conference that as only half tanned leather is exported to England, leather tanned with babul had been ruled out by the Munitions Board for Home purposes. Colonel Lane stated that there would always be a large demand for babul bark in Northern India and that in his tannery it was used with myrabolans in the proportion of two to one. He added, that before it becomes necessary to consider the question of a substitute, the tanneries in Northern India will be able and indeed obliged to obtain babul bark from places hitherto considered outside exploitable limits.

In this connection Mr. Marsden suggested the cultivation of babul in plantations along canal banks. He estimated that after allowing a sufficient width for the production of shade trees there were some 7,000 acres available on the Ganges Canal alone. He added that if these plantations were formed skilled assistance for tending and inspection would be essential.

Mr. Lushington stated that there was no sale for babul in Madras where the bark was not appreciated as a tanning agent though large quantities were available. Mr. Fisher stated that an annual supply of about 2,250 tons could be obtained from the Sind forests. The Conference was given to understand that this was not required for war purposes.

The Conference was of opinion that the possibility of increasing the supply of tanning materials by means of plantations along canals and railways should be brought to the notice of Government. It was considered probable that babul might be usefully grown in this way in the neighbourhood of Cawnpore and Cassia auriculata in Southern India and Bombay.

4. As regards *Lagerstræmia parviflora*, Mr. Fraymouth stated that the bark produced good leather, but that as it had so far only been obtainable in long strips which packed badly, it was not likely to be acceptable to tanners. Mr. Marriott thought that improved methods of collection might perhaps make it more suitable.

5. The Conference then proceeded to consider *Cassia auriculata*, *tarwad*, the bark of which is unrivalled for the production of half-tanned leather. Mr. McWatters stated that from the point of view of the Munitions Board the main essential was to obtain a larger output and an increase in the control exercised by Government over the collection and disposal of this output. In this connection Mr. Lushington stated that the species was very largely used in Madras by cultivators for green manure for their fields, and that if this practice could be stopped the output could be practically doubled. He added that in most places there were plenty of substitutes available for manurial purposes. He stated also that the plant was not very common in reserved forests, but occurred mainly in open lands and that it could be cultivated quite easily on dry soils.

He showed that for the Central Circle, Madras, the revenue derived from leases given for the collection of *tarwad* in the years 1912-13 to 1916-17 was as follows:—

						Rs.
1912-13	..	..	..	..	..	1,77,400
1913-14	..	..	..	..	..	2,17,293
1914-15	..	..	..	..	..	1,61,769
1915-16	..	..	..	..	..	2,34,601
1916-17	..	..	..	..	..	2,79,814

He noted that the bark was not usually collected till the plant was three years old, as earlier collection was found to be economically unsound.

Mr. Lushington also stated that *Cassia fistula* was commonly used in Madras in mixture with *tarwad* and raised the question of the percentage of the former admissible. Mr. Fraymouth expressed his opinion that up to 1/3rd of *Cassia fistula* might be used with safety.

The Conference considered that experiments in this connection should be carried out both at Maihar and at the Madras School of Tanning.

Mr. Fisher explained that in Bombay also the species occurred mainly outside reserved forests and added that the output of the Bombay Presidency was now under complete Government control. He said that since the war began the demand for this bark had increased enormously and instanced that the value of leases for collection in the Nasik district had risen from about Rs. 750 in pre-war years to Rs. 20,361 in the current year and that in the pasture forests of two Nasik taluqas, the Revenue authorities had recently realised Rs. 12,000 for a three-year lease. He estimated the cost of delivery on the line of rail, excluding the price of leases, at from Rs. 30 to Rs. 50 per ton. He was of opinion that the output could be largely increased by artificial cultivation as the species would almost certainly thrive well on poor soils.

Messrs. McWatters and Henderson laid great stress on the paramount importance of increasing the supply of *tarwad* for war purposes. Mr. Henderson stated that the present high price of *tarwad* in Madras was almost entirely due to the operations of uncontrolled contractors and considered that Government control of the output was of the very greatest importance. He estimated that if such control

was exercised and the bark sold to the tanners at Rs. 3-6-0 per maund, a price far below present rates, the result would be as follows:—

Export 7,000 bales of half tanned leather per month, each weighing 600 lbs., each pound of leather requiring 3 lbs. of bark=1,54,000 maunds of bark per month, of which he estimated—

	Mds.	
From Native States 40%	=61,600	
From Madras Presidency 60%	=92,400	
		Rs. A. P.
Cost of collection per maund Rs. 1-5-0, but to cover special cases, say	1 12 0	
Rail freight	0 4 0	
Profit to collecting contractor	0 6 0	

Total	2 6 0	
Sale rate	3 6 0	

Profit to Government	1 0 0	
Monthly profit on 92,400 mds. = Rs. 92,400 or Rs. 11,08,800 per annum.		

The Conference resolved that both for war purposes and in the interests of the future of the rough tanning industry in India, the most important immediate steps to be taken are to increase the supply of tarwad and to place this supply under Government control. It is recommended that this matter be brought to the notice of the Local Governments concerned with a view to immediate action. In particular it is suggested that the Madras Government should so far as possible introduce control on lines similar to those adopted in Bombay and that as regards the increase in the supply its attention should be drawn to the possibility of other material being used for green manure.

The Conference was of opinion also that artificial cultivation of tarwad should be undertaken without delay both on waste lands and as an agricultural crop under the control of the Departments concerned. In this connection the Conference desired to emphasize the necessity of taking immediate steps for seed collection.

6. In connection with *Phyllanthus emblica* Mr. Fraymouth stated that he looked upon the twig bark from pollard shoots as an extremely valuable material in admixture with other tanning agents as a possible substitute for tarwad. He added that it was unlikely to be of much value, used by itself, and that it was only of importance where tarwad was unobtainable. Its present price was about one quarter that of tarwad.

7. Referring to *Terminalia Arjuna* it was noted that this species was comparatively common on the banks of streams throughout the central parts of India.

Mr. Fraymouth exhibited an implement with which the bark of the main stem, which is the chief part that has tannin value, could be removed without injury to the cambium and remarked that the future of this bark depended on the progress made in sole tanning in India. It was useless as a half tan and of no particular value in mixture.

8. In discussing myrabolans, the well known fruit of *Terminalia Chebula*, Mr. Fraymouth remarked that in his opinion the Forest Department was not getting its proper share of the value of this important tanning agent; but it was pointed out by the representatives of Bombay, the Central Provinces and Bihar and Orissa, that only a very small proportion of the output came from Government forests and that as the forest areas producing it were inextricably mixed with private lands it was almost impossible to arrange for collection otherwise than by leasing to contractors. As regards the possibility of increasing the supply of myrabolans the Conference generally was of opinion that nothing very much could be done; but Mr. Lushington stated that there were such possibilities in some parts of Madras. Mr. Troup added a similar remark with regard to Burma, but noted that so far as is known at present the tannin content of the Burma myrabolan is low.

The Conference considered that further research should take place as to the possible utility of the fruits of other *Terminalias*, *Terminalia bellerica*, *Terminalia tomentosa*, etc.

Mr. Fisher informed the Conference that he had been requested by the Government of Bombay to raise the question of pre-emption clauses in contracts for the collection of myrabolans.

The Conference was of opinion that if contracts or leases were given for the collection of this product it was desirable under present conditions that Government should reserve to itself the right of purchasing the output at fixed prices.

9. Mr. Fraymouth then drew attention to the probable suitability for the production of half tanned leather of the fruit of *Zyziphus Xylopyra* and the leaves of *Carissa spinarum* and said that the former was very quick in its action. He admitted, however, that the use of these two materials was still in the experimental stage and that the leather produced had not yet been passed as suitable by the War Office Expert.

10. The question* of the requirements of the Allahabad Tannery during the next collecting season was then discussed.

*Appendix II.

Mr. Marriott urged that the amount of the various products required and the prices to be paid for the same should be notified as soon as possible. To this Messrs. McWatters and Fraymouth agreed and the latter stated that the quantity necessary would be about 2,00,000 maunds.

After some discussion it was agreed that the requirements could be met from the United Provinces, the Central Provinces and through the agency of Esocet Limited, but it was noted that the collection of tan stuffs might be very seriously interfered with as regards labour owing to the large demand for hay for military purposes, which would have to be obtained from more or less the same localities as the tanning materials.

It was agreed that the services of a Forest Officer would again be required to supervise the collection of tan stuffs and, in order that the Allahabad Tannery should be run on a commercial basis, that a reasonable royalty should be charged.

11. The Conference then passed on to consider Mr. Pilgrim's paper†. This being somewhat technical discussion was confined to remarks by Messrs. Purn

†Appendix III.

Singh, Pilgrim and Fraymouth, on the influence, harmful or otherwise, of the presence of non-tannins in tanning materials.

12. Mr. Fraymouth's paper‡ was next considered. He referred to a few alterations and additions rendered necessary by the results of recent research,

‡Appendix IV.

noting the possibilities of the fruit of *Terminalia Arjuna* if collected in a green state, and mentioning the probable value of the fruits of *Zyziphus Xylopyra*. He referred also to the possibilities of the extended use of sal bark and pointed out that the bulk of the bark was a troublesome factor and its tannin content very variable, ranging from 2 per cent. to 22 per cent.

He then explained that he had recently hit upon a method of milling the bark which separated it into a wool and a fine powder, the latter containing almost all the tannin and being only one-seventh of the bulk of the original bark. He added that the powder so far produced contained from 12 to 15 per cent. of tannin and was very satisfactory in its action. He suggested that this process could be carried out in the forests, the apparatus required being an ordinary portable engine and boiler, a disintegrator and a rotary sieve. He exhibited specimens of this sal powder and of a similar powder obtained from the common creeper *Bauhinia Vahlia*, which contained about 12 to 13 per cent. of tannin. He estimated the cost of a small portable plant at about Rs. 5,000 and the cost of milling at from half to one anna per maund.

The Conference agreed that if the powder so obtained from sal bark proved to be a satisfactory tanning agent it might be advisable to instal a plant of the nature

indicated in a suitable locality, Kheri and Singhbhum being mentioned. It was considered also that other common fibrous barks might be experimented with by this method which it is understood is being tried on a fairly large scale at the Forest Products Laboratory, Wisconsin, U. S. A.

13. Mr. Pilgrim then showed the members of the Conference a few simple experiments by which Forest Officers could obtain a rough idea of the presence of tannin in any material by the use of the Iron Alum test.

He also indicated the correct method of taking samples for analysis, laying stress on the great importance of this.

14. Mr. Pura Singh then read his paper* criticising some of the views put forward by Mr. Fraymouth. The latter replied shortly and explained that while

* Appendix V.

he agreed that extracts might ultimately be of great importance he held that their preparation at present was not within the region of practical politics.

After some discussion on future policy in this connection it was agreed that until the war was over the business of the Forest Department and of the Government Tanning Experts was to supply the tanning materials required for the production of leather suitable for war purposes.

Mr. Fraymouth assured the Conference that research as regards the preparation of extracts would be continued at Maihar.

15. The Inspector-General of Forests, referring to page 8 of Mr. Fraymouth's note, asked whether this was intended to mean that research into the possible value of all forest tannin yielding materials should be permanently located at Maihar after the conclusion of the agreement come to between Government and the Esociet Company. Mr. Fraymouth stated that this was not the case and that his suggestions referred only to present arrangements.

16. Mr. McWatters drew attention to Mr. Fraymouth's note regarding railway freight.

The Conference agreed as to the great importance of having a uniform definition for railway tariff purposes to cover all classes of tan stuffs, with a universal wagon mile rate, not only from station to station on the same line but *via* any junction to another system.

G. S. HART,

Inspector General of Forests.

SIMLA,

The 23rd August 1917.

APPENDIX I.

Note on the Silviculture of Tannin-producing Trees by Mr. R. E. Marsden, Silviculturist, Forest Research Institute, Dehra Dun.

ANOGEISSUS LATIFOLIA.

The leaves turn a coppery-red to reddish-brown about November, and in the cold season the trees are very conspicuous with their deep-red foliage; they fall chiefly in February, the tree remaining leafless until April-May, when the new foliage appears. The insignificant greenish-yellow flowers, in small globose heads, appear May to September according to locality. The small dry indehiscent fruits, crowded in globose heads, are 15"-25" in diameter, compressed, with a narrow wing on each side, yellowish-brown, fairly hard. About 3,500 weigh one ounce. They ripen December-March, fall soon after ripening, and may be found scattered all over the ground, round the trees, from February-March onwards.

The tree seeds in great volume, apparently every year, but the fertility of the seed is usually very poor. Fertility tests can probably best be carried out on shaded, well raised, and watered beds of loose sand and gravel, as explained below.

The tree is a decided light-demander, though it can stand a slight amount of shade in early youth. Although it grows in dry types of forest it is sensitive to drought, and suffered much in the abnormal droughts of 1899-1900 in the Indian Peninsula, and of 1907-1908 in Oudh; in the dry years from 1911 to 1914 in Jodhpur many young coppice shoots died back and the stools did not recover. As regards its susceptibility to frost, Brandis notes that it was injured a good deal in Partabgarh. Seedlings suffer a little from frost in the nursery, but the damage is not serious and extends only to wilting of leaves. It may be found flourishing in grass-covered frosty blanks, where tender species could not exist; for example on the flat land fringing the Sivalik Hills, along with other frost-hardy species such as *Stereospermum suaveolens*, *Ougeinia dalbergioides*, and *Acanthia Catechu*; it cannot therefore be considered as a very frost-tender species. Its companions in Central India are—

Boswellia serrata, *Erythrina*, *Stephegyne*, *Acanthia Catechu*, *Terminalia tomentosa*, *Diospyros*, *Garuga pinnata*, *Bauhinia*, and *Cochlospermum gossypium*.

In this locality it suffers considerably from browsing; but in general it suffers less from this form of damage than many other species, even goats not being partial to it. It suffers from fire, and in severely burnt areas it becomes gnarled and hollow. It produces root-suckers. It coppices and pollards well in most localities. But in experiments carried out in North Chanda, Central Provinces, in 1909, only 16 per cent. of trees pollarded produced shoots, while in the case of trees coppiced in different months, the percentage of stools which produced coppice shoots was as follows—

									Per cent.
(1) April	..	..	..	..	..	..	..	..	92
(2) May	..	..	..	..	..	..	..	..	100
(3) June	..	..	..	..	..	..	..	..	50
(4) July	..	..	..	..	..	..	..	..	50
(5) August	..	..	..	..	..	..	..	..	Nil.
(6) September	..	..	..	..	..	..	..	..	Nil.

This indicates that coppicing in the rains is to be deprecated. In North Khandesh, Bombay, in 1905, the percentage of felled trees which yielded coppice shoots was 60, the number of shoots per stool varying from 2 to 7.

The natural reproduction of this tree is not yet fully understood. Seedlings come up naturally, often in abundance, on newly exposed, well-drained ground, on stony hillsides, on land slips, on abandoned cultivation, on open grassy areas, as well as on alluvial ground. Reproduction is always best, however, where drainage is perfect, dense groups of saplings appearing on the well-drained slopes of hills and on sandy or gravel soils. The tree is found typically at the base of hills, on the *talus* at the junction of hill with plain. Light is undoubtedly an important factor in the establishment of natural reproduction, which is often plentiful in open gaps and bare places, but the Bombay experiments described below indicate that shade and moisture are favourable to successful germination. Absence of weed growth is undoubtedly beneficial, and it is worthy of note that good reproduction has been observed to spring up on burnt areas, though its ultimate establishment is favoured by protection from fire and excessive grazing. The want of fertility of the seed does not accord with the fact that reproduction often springs up in dense masses on well-drained hillsides, and Mr. R. S. Pearson has advanced a theory to explain this fact. Having noticed in the Panch Mahals that reproduction appeared

in even-aged masses differing from each other by definite intervals of years as determined by counting rings on cut seedlings and saplings, he ascertained that the years in which reproduction took place were those following on years of deficient rainfall. He surmised therefore that whereas under normal conditions the tree produces no fertile seed, the production of fertile seed is stimulated by years of drought. Mr. A. K. Desai notes that seedlings sprang up in great abundance on flat grass-covered ground in the Panch Mahals as a result of the opening out of the forests by the removal of dead timber, killed by the drought of 1899-1900. If Mr. Pearson's theory is correct, the production of fertile seed as a result of the drought might be considered to be the main factor which induced this reproduction.

Mr. H. Tireman remarks on the profuse reproduction of Anogeissus which springs up in the Coorg Forests on the removal, after burning, of the dense growth of Lantana which infests them. The germination of the seed is evidently favoured by the clean, bare soil under the Lantana, and the rapid growth of the seedlings, when the Lantana is removed, is stimulated by the absence of grass for the first year or two, and by the fact that the Lantana enriches the soil.

Artificial reproduction.

The fruits require to be collected when the heads begin to break up, and not before. The infertility of the seed is a serious drawback to artificial reproduction, and if the theory just referred to holds good, the best results would seem to be obtainable after dry years, when a fertile crop of seed is to be expected. Under ordinary conditions the infertility of the seed would preclude any great success by direct sowings, though in years of fertile seed production they should prove successful on well-drained porous ground. Many years ago Mr. Haines carried out successful sowings at Chaibassa, Chota Nagpur, on heaps of loose earth. Mr. Pearson notes that he obtained successful germination in the Panch Mahals by sowing on well-irrigated, raised beds, the soil being mixed with coarse sand, the seed sown in June and lightly watered daily. Germination commenced after about 20 days; it was successful only where the beds were well shaded by a thick covering of leaves and branches some 18" above the ground; under this shade a large mass of seedlings came up, whereas in beds exposed to the sun, hardly any seed germinated. At Dehra Dun 17 plants were obtained from about 6,000 seeds; they germinated 15 days after sowing; in one year they were 8" to 12" high. Seedlings can be transplanted without difficulty.

Silvicultural treatment.

At present this tree is worked only as a component species of mixed forests, either as coppice with standards or under Selection and Improvement Fellingings, when, however, it is frequently cut out in the interests of more valuable species such as Teak or Sal.

As the leaves and bark give promise of furnishing valuable material for the manufacture of tanning extracts, it is probable that some system will have to be devised before long for working this species for the production of regular supplies of bark and leaves. Twig-bark, being available for exploitation all the year round, may possibly prove to be the most valuable product. The September shoots are richer in tannin than those arising in August, August than July, and July than June (Fraymouth). Whereas the young leaf is water-proof, the mature leaf at end of August is not, and tannin may dissolve out with rain.

The following experiment carried out in Central India is of interest:—

"A trial coupe of 6 acres on the slopes of Sharda Devi Hill, about 2½ miles from Maihar in Central India, was coppiced in January 1916, about 1,500 trees having been cut to ground-level leaving a rounded stool. The trees were all small and badly shaped. The yield obtained from these was—

	Maunds.									
One maund = 82 lbs. approximately.	Dry leaves	..	..	..	..	..	..	..	..	31
	Dry bark	..	..	..	..	..	..	..	..	41
	Dry fuel	..	..	..	..	..	..	..	..	214

Within two months of cutting, strong shoots, of a bushy growth, appeared, covered with fresh leaves rich in tannin. The first flush of leaves was collected and weighed three maunds. The method of working proposed in this tract is to continue the collection of the fresh leaves from the coppice shoots for two or three years, and then to leave one strong shoot on each stool to develop into a pole before any further coppicing is carried out. Fresh new leaves are found to be produced on the young coppice shoots very soon after the shoots have been stripped of leaves."

On one tree, 17" girth, the new leaves were plucked every month from April to October 1915, yielding 1½ maunds of Sumach, value Rs. 6. Fresh leaves sprouted every month except November, December, January, and February. In February 1916 it came into leaf before the other trees, and seemed none the worse for the exploitation.

Another tree suffered 4 pluckings of shoots at intervals of two months with apparently no harmful results.

When coppiced, and stools trimmed in April to leave only one or two shoots per stool, no fresh shoots appeared.

For pollarding, it is perhaps advisable to cut above the reach of a goat, but within the reach of a woman, say at 5' height.

Twenty-five trees were felled on 30th March. Height of felling appears to make no difference. During June the best shoots from 10 trees between 1 to 2' girth grow 27" in length; the best shoots from 10 trees between 2 to 3' in girth, 14"; the best shoots from 5 trees over 3' girth, 13". Only two trees failed to produce shoots; one tree of 16" girth, forked at 8' pollarded at 10', threw out 176 shoots.

Shoots do not all sprout simultaneously; some earlier, some later. Untouched trees are latest, but when they begin, they are covered with a flush, suddenly.

When branchy trees are pollarded by cutting off all branches of 1' thickness or less, numerous young shoots arise, rich in tannin.

The following method of working has been tentatively adopted in Central India:—

During November, December, January, February, March, and April trees may be lopped once; i.e., branches cut down to where the diameter is $\frac{3}{4}$ " on a tree with a breast-height girth of not less than 1'. This is for twig-bark. Leaves to be picked separately.

The lopped trees will produce a flush of shoots in early March (Central Provinces), or April (United Provinces); these should be gathered before the length of leaf exceeds 1' (Sumach). Treat a second flush similarly if it appears before the rains.

In November, take the mature leaf up to half of what is on the tree.

In March, remove any old leaves, and pluck two flushes of young shoots before the rains. No lopping. It is important to remove all the old leaves; more young shoots are thus induced.

The following figures are available of girth measurements in sample plots in high forest:—Rate of growth.

RECORDS OF GIRTH MEASUREMENTS IN HIGH FOREST SAMPLE PLOTS.

Province.	Forest Division.	Locality.	Number of years under observation.	Number of trees under observation.	Girth classes.	Average annual girth increment for the period.
						Inches.
United Provinces	Lansdowne	Chaukhamb ..	17	8	1½-3'	0.29
		Jogichaar ..	12	2	1½-3'	0.14
		Giwain ..	4	2	1½-3'	0.27
		Giwain ..	12	10	1½-3'	0.63
		Haldwani ..	6	1	1½-3'	0.20
		Gonda ..	2	13	1½-4'	0.16
Central Provinces	Balaghat ..	Sakra ..	2	16	1½-3'	0.24
		Baihar and Raigarh ranges.	8	8	1-2'	0.20
Bihar and Orissa	Singhbhum	Tirilposi ..	25	2	3-4'	0.30
				3	4-5'	0.32
				1	2-3'	0.37
		Samta Honda-kuli Road.	11	4	3-4'	0.35
				2	4-5'	0.76

Some of these figures probably under-estimate the rate of growth actually obtainable, since all these plots are in Sal Forests, and their main object is to estimate the growth of Sal.

The annual rings are fairly clear. Gamble's specimens gave an average of 7 rings per inch of radius, equivalent to a mean annual girth increment of slightly less than 1". A cross section in the Silvicultural Museum at Dehra Dun, measuring 8'-9" in girth without bark, has 176 rings, equivalent to a mean annual girth increment of 0.6".

RATE OF GROWTH OF NATURAL SAPLINGS, PANCH MAHALS, BOMBAY.

Age.	No. of plants.	Girth.	Height.	REMARKS.
Years.		Girth at base.		
4	1	..	7'4"	These are measurements of dominant plants: very small plants of the same age were also met with.
5	3	3'4"	8'10"	
5	3	..	2, 5 and 9'	
20	5	Girth at 4, 8, 11, 11, 11½ and 13½ in.	25, 25, 15, 26, 20' respectively.	

The following table summarizes the available results of measurements in coppice coupes:—

RATE OF GROWTH OF COPPICE SHOOTS.

Average girth and height in different localities.

AGE.	SATRA BLOCK KOLHAN, BHAR AND ORISSA (1916).	DEHRA DUN (A. F. BROWN, 1886).	GORAKHPUR, U. P. (C. M. McCREE, 1910).	TIKRI GONDA, U. P. (1911).	BRANDARA, C. P. (1912-13).	NORTH KHANDESH, BOMBAY (1903).
	Girth. Height.	Girth. Height.	Girth. Height.	Height.	Height.	Height.
Years.	in. ft.	in. ft.	in. ft.	ft.	ft.	ft.
1	.. ..	.. ..	.. ..	8	6.2	2.5
2	1.3 4.5	.. ..	.. ..	..	..	..
4	2.5 8.2	.. ..	.. ..	..	..	..
6	3.6 10.8	.. ..	.. ..	..	..	..
8	4.6 13.0	.. ..	.. ..	..	..	..
10	5.5 15.0	.. ..	.. ..	..	..	..
12	6.4 16.8	.. ..	.. ..	..	..	..
14	7.2 18.0	.. ..	.. ..	..	..	..
15	.. ..	.. ..	7.25 22.5	..	..	..

ACACIA ARABICA.

Occurrence and distribution.

Bombay.

	Central Circle.	Acres.
1. East Khandesh Division		4,220
2. Nasik Division		1,910
3. Ahmednagar and Sholapur Division		25,862
4. Poona Division		12,153
5. Satara Division		924
Total, say		45,000 Acres.

Bombay.

Of which the areas in Ahmednagar are reported to be poorly stocked.

Sind Circle.	Acres.
1. Sukkur Division	1,000
2. Naushahro Division	644
3. Hyderabad	90,000
4. Jerruck	80,000
Total, say	172,000

Benar Circle.	Acres.
1. Amraoti District	7,063
2. Buldana	3,467
3. Akola	4,067
Total, say	15,000

Central Provinces.

Outside State Forests in Benar there are estimated to be only 2 lakhs of Babul trees of exploitable size.

The grand total of large tracts of *Acacia arabica* is therefore some 232,000 acres.

Annual demand: 200,000 maunds at Cawnpore @ Re. 1-0-0 to Rs. 1-4-0 in 1911. Now Rs. 1-4-0 to Rs. 1-6-0. In 1914, annas 14.

The old bark is said to be better for tanning, being more astringent; but the unripe pods are preferred to the ripe pod.

Shrinivasulu Nayadu puts the area of land set apart for public purposes, such as cattle stands, threshing floors, etc., in Benar, and suitable for growing Babul at 12,500 acres. The common associates of this tree are:—

<i>Acacia eburnea</i> ,	<i>Balanites Roxburghii</i> ,	<i>Dichroetachys cinerea</i> ,
<i>Acacia leucophloea</i> ,	<i>Prosopis spiciosa</i> ,	<i>Capparis grandis</i> ,
<i>Zizyphus vulgaris</i> ,	<i>Phoenix sylvestris</i> ,	<i>Melia Azadirachta</i> ,

but Babul forms 90 per cent. of crop; the undergrowth consists of:—

Cassia auriculata, *Capparis grandis*, and *Cassia Tora*, and this forms a considerable impediment to natural reproduction. *Acacia arabica* does not grow well on water-logged or badly aerated soil, but benefits by floods provided the water drains off; it will not grow well with an impenetrable layer in the subsoil, as in the Abbaspur Plantation near Unao. In Sind it is a quick-growing, comparatively short-lived tree, while the roots appear to penetrate to great depth. It is probable that the three forms *Telia*, *Kauria* and *Ramlata* come true from seed.

The tree is never quite leafless; new leaves appear early in June, flowers about August, fruit begins to form about September; pods ripen February—March and begin falling to the ground without dehiscing. It seeds profusely every year beginning as early as 7 years of age, but full fertility is not reached till the age of 12 in the Central Provinces, or 15 to 20 in Sind. When young the tree has considerable recuperative power to replace shoots killed by frost. The seedling develops a strong and fairly long tap-root and numerous lateral-roots even at the end of the first season; the tap-root is vigorous and bores into the stiffest soil till a depth is reached where water may be found at any season. With increasing age either all the roots reach the same size, or the side roots die and the tree becomes liable to be blown down. Moisture not too deep in the soil is needed. Spines appear one month after germination and protect the young plant against all cattle except browsers. Under favourable circumstances a height of 4' in one year is attained, but the habit of the species is to remain bushy for some years, indicating considerable density as desirable in early youth.

Natural regeneration from seed is prolific when the soil is prepared and free from grass or undergrowth, but scanty when seedlings are choked by shrubs and grasses. Young growth does not come up when many old trees are present. In Sind, reproduction from seed sometimes fails entirely; the system of clear cutting is thus one of considerable risk in his locality unless supplies of seed from outside sources are available. Given a normal production of seed and sufficient water, natural regeneration in Sind is a certainty but in Jerruck and Hyderabad the pod crop has sometimes failed entirely. Except perhaps in Sind it is rare for the seed to germinate in the pod; generally the pod cracks and rootlets emerge, but protracted heat may cause the pods to warp and be raised above the ground, thus severing connection of seedlings with soil. Occasionally seed reproduction is scanty because the pods are readily eaten by cattle and game.

It seems to be recognised generally, first that natural reproduction unaided takes too long, and second that grazing by non-browsers after the seedlings are two or three months old is desirable to keep down grass. The young crop does not suffer from interlacing of branches of 57R&A

crowns, and although this species benefits markedly by severe thinnings at a later stage, until the crop is 15 years old it is better to confine such work to the removal of dead, suppressed, and diseased stems, interlopers, and climbers, as in youth there is liability to damage by wind.

There has been considerable difference of opinion as to the power of reproduction by coppice shoots. In general it does not coppice well, and old trees not at all. In the Central Provinces and in Northern India, stools under two feet in girth give rise to coppice shoots, which however may develop only into bushes; at the same time a young plant can replace a lost leader or shoot up anew when broken. Reproduction by root-suckers is not known. The method of pollarding, or "branch-coppice" as it is called in Sind, for trees between the ages of 30 to 60 has been practised with considerable success.

In Madras, there are several forests managed on the system of Coppice with Standards, but apparently nearly always in localities which are covered with water for a considerable portion of the year (Bellary, Anantapur, and Chingleput). In such places 75 per cent. of stools 3' to 4' girth have produced shoots, but when the stools are submerged for three or four months they die, and in stiff clayey soils which crack in the hot weather, seedlings are killed too. Mr. Scot has recorded that small stools produce more shoots, but those from large stools have greater vigour. The best size for the stool is 6" to 8" diameter. In 18 years a height of 14' to 26' with girth 10" to 23" has been attained. In one year the coppice shoots should be 2 or 3 feet long and in two years 5 or 6 feet.

In Sind, shoots from small stools are said to die in two or three years, and the stool to be destroyed by white-ants.

Artificial reproduction has been practised with success for some years both in Sind and in Berar. Sowings after clear-felling, either broad-cast without preparation of soil or in patches or furrows, have generally failed, but near stream-banks broad-cast sowing has succeeded, and on water-logged soil mound-sowings have done well, while scattered among existing young growth patch-sowings have proved worth while to fill up gaps. Strip-sowings 2½' wide, the soil being prepared by 3 confluent plough-furrows, the strips 10' apart, have been largely adopted. Double-ploughing or cross-ploughing at a cost of Rs. 10 per acre has been recommended, but experience is showing that some method of afforestation combined with agriculture is cheaper though not less efficient than any of these means.

In Berar after clear-felling, extraction of stumps, and soil preparation, land is cultivated for two seasons with field crops, such as Juar (*Sorghum vulgare*). In the third year in June-July, a mixture of 75 per cent. *Babul* seed passed through goats and sheep with 25 per cent. *Nim* seed is sown in lines 12 to 15 or 20' apart with three lines of cotton between 2 of *Babul*. Cultivation with field crops for two years is found useful in order to get rid of the *Fomes* fungus. The lines of *Babul* seed are kept clear over a width of 1½' on either side. A wide distance between the lines is desirable for protection against the *Calosterna scabrator* beetle, as well as for the convenience of the cultivators. Altogether there is 5 years working with *Juar* and cotton; then the *Babul* forms canopy, and field crops are no longer practicable. For a 15 years' rotation the distance between the lines may be 20' while for a longer regeneration 12' or 15' recommended. It is desirable to encourage the cultivation of cotton as many years as possible for protection against fungi and insects.

The seedlings in the lines should be thinned to an interval of 3'; blanks should be restocked by sowing, and grazing by non-browsers should be admitted to the extent of one head per acre, while the crops are off the ground. It has been found that the accumulation of grass and weeds affords shelter to beetles, and that pruning lower branches to allow grazing close up to the stems reduces the amount of shelter available for these pests.

The *Babul* seed has a hard skin; 250 go to the ounce; after remaining three years in the soil germination has taken place in the 4th monsoon. Long breaks in the rains before germination is complete are likely to destroy vitality; so either sowing must take place only when the monsoon is established, or germination must be forced. Two methods of forcing germination are practised. Firstly by feeding the pods to goats or sheep, and collecting the seed from droppings, and secondly by smearing the seeds with cow-dung and heaping them up for one night. Seeds passed through goats are said to be less liable to attack by weevils and insects. Germination tests in Bombay in different localities have given the following results:—

From goat-pens.										From pods.	
										Per cent.	
13 per cent.	..	..	..	..	..	..	..	..	..	..	6
56 "	"	..	..	..	..	..	..	..	..	..	43
70 "	"	..	..	..	..	..	..	..	..	..	35
51 "	"	..	..	..	..	..	..	..	..	..	31

Prolonged submersion in water for five weeks did not harm the seed. Abdul Ghani states that 50 per cent. of seeds passed through goats germinate in 5 days; in the first month the root grows 18" but the stem only 6". He recommends the following method:—

After collecting the pods at the end of May as they fall, extract the seed by threshing; one-third of the total weight of the pods consists of the seeds. Smear the seeds with cow-dung and

heap for one night; if left thus another day the seeds will germinate, so spread them out in the air for three days, then smear with a paste of clay and cow-dung. Sow 3" apart in dry weather at end of June to mid-July and cover with ½" of fine soil.

For any method of broad-cast sowing, thorough cultivation of the soil is essential; the area may be grazed clean, and at the end of May three maunds of pods per acre scattered, and 24 cows per acre driven on to the land, edible leaves and lopping being strewn about to encourage roaming and dissemination; the cattle should be kept there till the seeds have passed through.

In Sind, the *Babul* seed is sown in strips 3' wide at a distance of 12'; simultaneously with the field crop; in the second year the land is ploughed again, the blanks in the *Babul* are re-sown and another field-crop is started. In practice the *Babul* seedlings do not suffer much; the ploughman avoids large patches of seedlings, and of those uprooted most take root again. Another method is in the second year to sow cotton, but in the third year to reap only the crop of cotton yielded by the stems on the ground; in this case the land is irrigated by lifts for two years. Success depends on water being available once every other year; if there is no water for two years the seedlings die; as with cotton seed, the *Babul* seed may be sown through a bamboo tube. At Sukkur, strips 4' wide and 20' apart have been adopted.

In Sind, unless water is to be found fairly near the surface, or irrigation is available, it is better not to sow *Babul*. June sowings are recommended, and in one year should be 18" to 24" high. In the Punjab and United Provinces *Babul* suffers much from forest, the top 18" being killed annually and small seedling cut back to the ground. Irrigation in the Punjab has stimulated growth, but at Dehra Dun with a rainfall of about 80" this has not been marked. In Madras, it has grown on saline soil where depressions retained water for some time; the roots have been found thriving in salt creeks. Transplanting is not recommended; the long tap-root is very sensitive.

Good results have been obtained in the United Provinces on raised ridges or "bands" on loose soil; the trenches from which the ridges are made hold enough water to keep the earth constantly moist.

Wire fencing is very expensive and need frequent repairs; thorn hedges are probably enough to protect the seedling for two or three months; when the spines have appeared cattle may be let in to keep down the grass.

The plants respond to weeding by an increase of 50 per cent. or more in rate of growth; when unweeded, far less plants survive.

At Dehra Dun without irrigation, seedlings of all three varieties have reached a height of 3' in 4 months, when weeded.

Beadon Bryant has put the costs of formation, maintenance and exploitation in the United Provinces at Rs. 108 per acre for a rotation of 20 years, and the estimated value of produce Rs. 295; in Berar, from large areas the actual returns are 40 to 50 rupees per acre, and the costs of formation and maintenance Rs. 12. In Etawah ploughing costs Rs. 2-4-0, sowing Rs. 1-8-0, weeding Rs. 2-4-0, total Rs. 6 per acre, and in seven months the *Babul* are 15" high; in the same time on ridges a height of 4½' has been reached.

In Berar, severe cleaning and pruning as a protection against the beetle costs Rs. 2-6-0 per acre. Normally the first thinning at 15 years costs 4 rupees and yields 7; the second thinning at 20 years costs Rs. 1-8-0 and yields 5 rupees, the final yield at 25 years about Rs. 40; during the rotation a total revenue of Rs. 25 is obtained from grazing.

Opinions seem to agree that severe thinning is required to obtain an ultimate spacing of about 12' and when possible thinnings should take place in the 6th, 11th, 16th, 21st, and 31st year after formation.

The fungus *Fomes Pappianus* attacks the heart-wood leaving sap-wood intact, and the tree is blown down. It is probably spread through wounds, though it has been suggested that infection is carried through the roots. Water-logged soil and dense cover are found to foster the growth of this fungus. Removal of the sporophores and severe thinning are recommended. Young vigorous stems are not much attacked.

Injuries.

In Sind, the pods are attacked by a fungus known locally as "Rati".

The larva of a longicorn beetle, *Calosterna scabrator*, almost invariably accompanied by a buprestid beetle, *Psiloptera fastuosa*, bores into the stem near the ground. Remedial measures are to increase the distance between the lines, to admit *Nim*, to weed and prune so as to allow grazing close up to the stems, and to thin severely. The larvae appear not to attack large stems.

The *Babul* insists upon well-aerated soil; underlying sheet-rock or beds of *kankar* are fatal; the tree is liable to wind-fall on sand, particularly when the soil is loosened by floods. Soda salts are less injurious to *Babul* than to other trees (Payanghat, Berar).

Grass growth is very inimical, and damage by grazing to *Babul* over six months old is almost negligible.

The crop with interlaced branches affords ideal cover for rats, hares and deer; the deep cracks in black cotton soil favour rats. The Antelope Rat, *Gerbillus indicus*, forms its nest 2' above the ground in a *Babul* thicket.

The *Babul* has small power of resisting fire; hence grazing, cleaning, and thinnings.

Silvicultural Treatment.

Babul is highly light-demanding, and its seedlings are suppressed by grass and undergrowth; hence Clear-Felling with artificial regeneration; the species does not grow well except in even-aged crops. With the exception possibly of Madras, the Coppice System cannot be recommended.

When grown for fuel, a rotation of 30 years has been adopted in Berar; when grown for bark probably 10 to 12 years according to locality, would be enough.

In Sind, when natural reproduction is adopted it has been found that the collection of immature pods for tanning seriously affects the supply of seed for regeneration.

In Berar, Coppice with Standards has been found "fairly satisfactory," but Agri-Silviculture is now usually applied. In Sind, Clear-Cutting, Improvement Fellings, Branch-Coppice and Selections in Groups, have been suggested or practised, the last named in order to avoid exposure to sun, consequent grass-growth, and to provide shelter against frost and wind. In Madras, Coppice with Standards on tank beds or Clear-Cutting are the rule. Shrinivasulu Nayaḍu suggests the retention of selected trees in good localities to be grown for 35 or 40 years to a girth of 6', but isolated trees like Standards, Nurses, or trees held over for a second rotation are liable to be blown down by wind.

In Sind, in the existing forests, removal by alternate strips has been suggested, regeneration being effected both naturally and artificially, with the object of providing shelter and of localising possible fires. In this locality the forests are under water during the monsoon, they are closed to grazing till the mid-December, and the seedlings establish themselves.

Rate of Growth and Outturn.

In Berar, *Babul* attains its maximum height 20' to 30' in 15 or 20 years, and after this there is only lateral expansion. In 10 years the crop is 12' to 15' high. The *Telia* variety reaches 40'. Under average conditions 30" girth is reached in 25 years; in a favourable locality this rate of development is doubled.

Curves drawn from the measurements of 68 trees in Akola indicate a girth of 18" in 20 years, 32" in 30 years, and 50" in 40 years. Another series of 221 measurements in the same locality shows a girth of 10" in 20 years, 15" in 30 years, 21" in 40 years, and 28" in 50 years.

In Sind 15" girth is reached in 15 years, 30" in 30 years.

In Berar the average outturn of green fuel is taken as 470 cubic feet per acre; another authority allows 4 tons.

The portion between bark and wood appears to be 16:84. Kirwan has estimated for a ten year rotation on cultivable land 500 maunds of wood plus 95 maunds of bark. Another estimate gave 150 trees per acre, each yielding 4 maunds at the end of 10 years.

LAGERSTROEMIA PARVIFLORA.

The bark has been employed in tanning chiefly as a black-colouring agent; leaves used for tanning too, collected in March-April usually; 17½ per cent. tannin on the dry, but contains much glutinous matter.

The tree is fairly common in Northern India (except Punjab), Central India, and Burma north of Rangoon, but is found scattered, only very rarely occurring in pure patches. Typically in dry deciduous forests, but in Burma and South India in moist forests too; rare in evergreen forests. Usually on warm aspects, elevation 500 to 1,500. In United Provinces common in Bundelkhand, on red soil tracts of Jhansi, and on flat area of Lalitpur and Manikpur plateau. In Bengal: Jalpaiguri, Buxa, and Kurseong Divisions. In Assam: lower slopes of Garo and North Cachar Hills. In Central Provinces: uniformly distributed forming 5 to 15 per cent. of stock; South Chanda Division. In Burma: Rhamo, Katha, Shwegyin, and North Toungoo Divisions. In Bombay, scattered sparsely throughout the dry forests especially in the Dangs. In Behar: trees are small and irregularly distributed. In Madras: conditions are similar but the tree does not occur in the South.

Lagerstroemia parviflora accommodates itself to most kinds of soil, best on sandy loam or fresh deep clay; grows well on the black cotton and trap soils of Central India; often found on exposed situations; common in the deciduous forests of the Central Provinces, but rarely large. Big trees probably in Bengal and Burma, where a girth of 7 feet and a bole of 40 to 50 feet are found; elsewhere generally girth 3 feet, bole 25 to 30 feet, total height 50 to 60 feet, though 15 feet girth has been reported in Hoshangabad.

The tree is a light demander; leaves drop at the beginning of the hot weather and appear just before the monsoon. Flowers June-July, fruits late autumn, remaining long on tree. A coppice shoot 3 years old with a girth of 8" at the base has been found bearing fruit.

Natural regeneration is fairly good. Seedlings suffer from dense grass, and must be freed, from overhead cover. Good seed years about once in 3 years. The best reproduction is found at the foot of hills or on fairly deep well-drained soils. Coppice reproduction good trees of 5' girth producing shoots. Saplings suffer from cattle treading upon them but are seldom browsed, and recover from fire. Growth is fairly fast, when seedlings are established. In Guntur the trees are saleable at 30 years old for beams.

Broad-cast sowing has been tried and found unsuccessful. In Kolaba, Bombay, dibbling in teak forests gave fair results. For three years seed sown in the experimental garden at Dehra Dun failed to germinate well. The seeds are very small, and weigh between 5 and 6 thousands to the ounce. In 1916 seeds collected on the 18th of May and sown on 6th of July germinated in 6 to 15 days at Dehra Dun with a high percentage of fertility; in two months seedlings were 4" high. The growth in a depression was much inferior to that on higher ground. After one year the seedlings were 12" high, but nearly all succumbed to frost. This is in marked contrast to Coppice shoots, which in the forest suffer from frost scarcely at all, even in localities where other species are killed. The tree is decidedly hardy also against drought. The seedling in its early stages has a square winged stem and is with difficulty distinguished from a seedling of *Lagerstroemia Flos Reginae*.

The only systems recorded for this species are Coppice with Standards or Improvement Fellings, when badly shaped stems are cut back. Line-sowings with side shelter appear to promise well; and Coppice reproduction may be relied upon.

The rate of growth in high forest appears not to be fast. In Coppice the following measurements have been recorded:—

At Ramgarh Gorakhpur ..	Average No. of shoots per stool 2
	Average height in 16 years 21'
	Average girth 7"
	Maximum height 40'
At Thanos in Siwaliks Division, U. P.	maximum girth 13"
	The maximum height for 5 years is 21'; maximum girth 10"; average height 15', average girth 6".
	Coppices better than any other species found
	occurring naturally in the locality.

CASSIA AURICULATA.

This species is common in Southern India. The first crop of bark is obtained usually when the shrub is 5 years old. Gamble states that the shrub is easily cultivated, and suggests a rotation of about 3 years as suitable for regular treatment. The seedling establishes itself easily, and flourishes on hard, dry ground.

Mr. Newman gives 25 to 30 years as the probable age limit of this species in Eastern Khandesh, Bombay when it is not likely to coppice.

In Belgaum the right of collection is sold every third year, one year being allowed for working.

There are 1,125 seeds to the ounce; they germinate well with 75 to 80 per cent. success six to twelve days after sowing. It has been grown on poor lands in Cuddapah; but seeds dibbled in felled coupes under the margins of bushes failed; and again in 1910 sowings at Rajampet in July, August, and September, after clearing the ground and ploughing failed. Mr. F. Lodge recommends sowing in June except where monsoon is very heavy, and then sowings should be deferred till October.

Mr. P. M. Lushington reports that it comes up best if the ground is ploughed, but even this is unnecessary if sown shortly before the rains. It grows equally well on red or black soil. The same authority has recommended this species to be sown, after ploughing the ground in October, to provide a supply of manure plants in Tinnevely. Mr. F. Lodge notes that it prefers red, gravelly, well-drained soil to black cotton soil. Shallow furrows, or harrowed land is best, and no shelter is needed.

In the United Provinces, its introduction was vigorously attempted by the Irrigation Department in some divisions of the Lower Ganges Canal about 1902, but the plantations are said to have been abandoned as a failure.

An experimental plantation was made in Cawnpore by Cooper Allen and Co. in August 1908, area about 7 acres.

	Ra. A. P.
Cost of sowing	.. 21 6 9
Cost of weeding	.. 8 4 0
Cost of irrigation	.. 41 13 0
Total	.. 71 7 9

The hire of bullocks for ploughing, drawing water, and cost of labour is high in Cawnpore. Moreover the land was new and had never been ploughed before.

The rainfall is about 30", and the soil a poor loamy sand. Three methods of formation were tried :—

1. The ground was ploughed twice and seeds sown broad-cast in July 1908; weeded during rains. A similar plantation, started on a former occasion and not weeded, failed. Irrigation by flooding once a month was applied during one dry season. At the age of 16 months it was 7' high and formed a dense crop. An area of 1-5th of an acre was felled at the age of 16 months and yielded 18 maunds wood and bark.

2. Treated as above but not watered. A dense crop resulted, 4' to 4½' high at 16 months.

3. 2½ acres was planted up with nursery plants in holes 2½' deep, 5' x 4', and watering was done by hand with "gharras" for seven months. Result poor.

During February and March the plants used to be pruned, but this has not been done for the past year, and after nine years the bushes are now about 8' high.

Line sowings, or broad cast sowings are most likely far preferable to planting, provided the land is well ploughed.

In June 1917 the price of bark at Bombay was Rs. 15 per maund. In 1913 at Cawnpore it was Rs. 1-8-0 to 2-4-0 landed at factory.

PHYLLANTHUS EMBLICA.

Phyllanthus Emblica is sensitive to drought; it was killed in the Central Provinces by the short rainfall of 1913-14. The stone of the fruit contains 4 to 6 seeds of which 1,800 to 1,900 go to the ounce.

Reproduction by Coppice is fair; the following measurements have been recorded :—

Age.	Height		Girth.	
	Max.	Average.	Max.	Average.
5	13'	8½'	6"	3"
7	14'	10'	8½"	4"
9	25'	..	12"	..
15	..	10'	..	..

For trees in Bombay a girth of 15" is attained in 25 years, and 2' in 40 years.

From observations in the Central Provinces the rate of growth appears to be very slow.

Seedlings grow only a few inches in their first year, reach a height of 12' in their second year, and in their third year develop rapidly.

Weeding seems essential, but not irrigation.

Transplants grow slower than seedlings.

TERMINALIA ARJUNA.

Terminalia Arjuna prefers a loose soil; the fruit is not heavy, and for regeneration bare soil is indicated. The tree flowers April-May, and the fruit ripens one year later February to May. The fruits weigh 80 to 100 per pound; they do not keep well and the germination power is often poor. Seed years occur about one in three, and the crop of fruit is considerable. The seedlings are sensitive to frost and to drought; they grow well in the full sun if the ground is moist; they

stand moderate shade but not dense overhead shade; growth is much stimulated by regular watering and soil-loosening. In the forests, the seedlings grow to a height of 4' and die down for six or seven years, developing a bushy habit and a good root system, after which a strong leader may be expected to arise. In damp places reproduction by seed is not difficult. The seeds germinate in two to three weeks, and seedlings are 10" high after three months when weeded and watered. They should be sown in the nursery April-May, lightly covered and watered regularly. Irrigated line sowings have proved successful, and if the soil is well loosened, irrigation may probably be dispensed with. In Berar, seedlings have reached 18" height in 2 years and 4 months, and at Nagpur, Central Provinces, 3' in 2½ years. Seedlings bear transplanting well during the first rains before the taproot is too long. Plants put in on the edge of *nala* 18" above water level have thriven. *Arjun* is a light-demander and responds well to pollarding. Experiments in Bombay indicate that 47 per cent. of trees felled yield coppice shoots, though trees over 30" in girth do not coppice well; shoots 12' high and 10" girth may be expected in six or seven years.

Bark from the bole yields about 25 per cent. tannin, and from branches 15 per cent. The bark is best chipped off, not peeled, and if so removed it grows thick again in two rains, indicating a three year rotation for working.

TERMINALIA CHEBULA.

Terminalia Chebula is found in Berar on well drained, moist, sandy soil on uplands and plateaux with good rainfall, and not too hot in May and June. The new leaves appear in April; flowers April-June; fruits January-March of the succeeding year. A dry, hot climate is said to reduce the volume of fruit.

In the Western Ghats of Bombay, the tree average 25 feet in height, girth 3½'. The roots are shallow. It is found generally mixed with *Eugenia Jambolana* on laterite at 4,500'. Turner describes it as a marked light demander.

The fruits are sold in the moonsoon, and are collected from October onwards, being dried in the sun for 10 to 20 days. The tree is said to produce fruits after 15 years.

In Belgaum, the right of collection is sold every other year; 2 years allowed for working.

The fruit is much eaten by squirrels and rats. Germination is often poor; at Dehra Dun, fruits sown on prepared soil in the open sun failed to germinate, whereas in the shade results were better, and a height of 16" was attained in 18 months.

In the forest, natural regeneration is good. After germination the seedling soon establishes itself; most of the energy is devoted to root development. Good drainage is essential, and shelter, very possibly from the side, is desirable. Growth in depressions is bad, and 5 or 6 days' heavy rain kills the seedlings. It recovers from fire by putting out a new shoot from the base. Loose soil, liable to sudden shrinkage in the hot weather, has been found unsatisfactory. Copeland states that this species requires less moisture than *Terminalia belerica*.

The stools coppice vigorously.

Those fruits called "Bonga" in Bombay, in which the interior (including the endo-carp) has turned to black powder, perhaps by the action of a fungus, and whose peri-carp has not become ridged when dry, germinate better than the normal fruits, which become ridged when dry.

The ripe fruits should be collected in the hot weather; Turner recommends collecting them off the ground. They should be dried on the ground in shade in order to loosen the grip of the fruit on the stone caused by shrinkage. After soaking a day or two in water, sown in April; the seedlings need water during the first hot season, and the plants may be put out during the rains of the succeeding year. In yearly youth considerable shelter is desirable, and it is possible that covering the seed with dead leaves and debris may be useful.

The fruits weigh 36-40 per pound when fresh, and 64 to 75 when dry.

Much difficulty has been experienced with germination. Mound sowings at Mandla, Central provinces, in 1913-14 failed. Shelter, and loose, well-drained soil appear to be the essentials.

The species is a slow-grower. Trees between 1-2' in girth have a girth increment of about .25" per annum; in Balazhat, Central Provinces, 30 trees between 2-3' in girth showed an average of only .16" mean annual girth-increment; in the United Provinces, 4 trees of this size averaged .29"; in Singbhum, .70" has been recorded for trees over 3' in girth.

In Dehra Dun at 5 years of age, coppice 8' high and 2" in girth has been grown.

TERMINALIA TOMENTOSA.

Terminalia tomentosa is a light demanding tree; but stands a good deal of shade when young, flowers May-August, fruits February-May of the following year; in most localities it seeds

Natural reproduction.

Artificial reproduction.

Rate of Growth.

prolifically every year; it grows fairly fast, and coppices freely. It is one of the few species which grow well on clay. It can stand more frost than the *Sal*; but is not very hardy; the seedlings suffer by death of the leaves and by the loss of a few inches of the leading shoot. It does not stand drought well.

Natural reproduction is found only in open places, along cut lines, or on the edge of old cultivation. Good results may be expected both from seed and from coppice. Fire destroys the fruit, but fire-protection encourages overhead shade which is inimical to reproduction. On moist soil germination is good. Young seedlings often penetrate through coarse grass. Rats eat the roots of seedlings but less so than with many species; cattle and monkeys also eat the seedlings; protection from grazing and from trampling should be afforded.

The main stem is often a sympodium. Numerous shoots are reproduced from the base of the stem which remain small and weak and only a few feet long after several years.

In Bombay, 70% of trees felled coppiced with 1 to 9 shoots; in one year these were 2½' high.

In the Central Provinces, of 249 trees felled in September and October 66% threw out shoots.

In the Central Provinces, coppice appears to be less certain, especially if felling is done in the rains; and it is stated that stems over 4' in girth do not produce shoots.

Artificial Reproduction.

The fruits weigh 170–210 per pound. Early fruits often fail to germinate; collection in May and sowing in June is recommended. The fruits will not keep more than 2 months. They germinate in 10–20 days. Early experiments gave only 30% germination, but in 1916, 78% on prepared beds and 88% on grass was obtained. In one year, irrigated seedlings were 2½' high, non-irrigated seedlings, 15' high. The effect of weeding is considerable, leading to 50% increased growth. A "Bulbul" eats the cotyledons, and a plant-louse, one of the *Peylidae*, kills saplings by inserting eggs in the shoot; the young suck the sap. Deer feed on seedlings, and pigs do much damage by rooting and trampling. In Madras, the sowing of germinated fruits is recommended; and in order to check the tendency exhibited by this species toward bushy growth it has been suggested that all shoots except the strongest should be pruned.

In Bombay, Mr. Pearson recommends sowings on a layer of leaves and grass so as to raise the fruit from the ground and prevent rot; after good rain germination may be expected, and the seedling can be lifted without damage to the roots if sown thus. At Ramgarh in Dehra Dun a plantation formed 1882-83 was 12" high after 4 years, and the proportion of success was 54%. The agri-silvicultural method of formation has given good results in the experimental garden, seedlings 14" high in one year.

Seedlings 3 months old have been transplanted, both entire and with root and stem cut back; they grew, but not so well as the plants raised by direct sowings.

The tree has a long tap-root.

This species has been grown hitherto only as a component of mixed forests under the Selection, Improvement Felling, or Coppice with Standard systems.

Rate of Growth.

Irrigated sowings were 4' to 7' high in 3 years; not irrigated, 4' to 6' high.

The result of measurements from 260 trees in the Dehra Dun forests shows that a girth of 4" may be expected in 90 years and 6" in 124 years; in early youth these trees were probably suppressed, and the normal rate of growth may reasonably be expected to exceed this. Measurements of 100 trees in Kheri yield similar results.

In the Central Provinces growth is considerably slower.

In Bombay, Thomson allows 60 years for a diameter of 1'; Pearson and Aitchison 150 years for a diameter of 2'.

In Madras, a diameter of 2' appears to be reached after about the same length of time.

In Belgaum, coppice 40 years old was 50' high, with a diameter of 9'.

APPENDIX II.

The collection of Indian tan-stuffs, with an account of the methods and costs of packing and despatch, by Mr. R. G. Marriott, B.A., Indian Forest Service, Special Collecting Officer for tan-stuffs under the Indian Munitions Board, 1917.

This paper is little more than a record of first impressions and mistakes with suggestions as to how the work may be carried out more successfully next year, for my experience only dates from the middle of April, when I got a wire ordering me to collect tan-stuffs in Central India, and I then knew nothing about tan-stuffs and had never been in Central India. I hope therefore that I may be forgiven for drawing attention to some points which may seem almost too obvious to be worthy of mention.

I shall try to give such information as will guide Forest officers in starting collection of tan-stuffs in their own districts, and I would emphasise first that the best qualification for undertaking the work successfully is to have no preconceived ideas on the subject whatsoever. For instance, I started with a mistaken notion, which is possibly shared by some other Forest officers, that all leaves or barks with more than a given percentage of tannin contents must be of practical use as tan-stuffs. The question of analyses of tan-stuffs and tests on leather is outside the scope of this paper: it is only necessary to say here that operations during the past few weeks had to be concentrated on the collection of twig-bark of Aonla, Seja and Dhawa; bark of Kahua, Säl, Dhawa and Mauhrain, leaves of Dhawa and Säl, and Dhawa shumac.*

The first few days were spent in visiting with Mr. Fraymouth the Maihar Factory and some of the likely collecting centres. Without his help and knowledge of Central India nothing could have been done in the short time available before the rains. The mistake was made at first of depending too much on contractors, partly because several men expressed their readiness to take up contracts and partly because Forest officers in the Central Provinces already had their hands full with the departmental collection of grass for the Army. But there was not time to get agreements drawn up with contractors. Their promises to supply tan-stuffs on the rail had to be accepted for what they were worth, and unfortunately they were worth very little because it was very difficult to induce them to take up entirely new work energetically at a season when labour was not only scarce and mostly employed on the collection of grass for the army but also scared by the labour corps recruitment campaign. Moreover, a point on which Mr. Fraymouth laid special emphasis, it is of the utmost importance that tan-stuffs should be supplied in a thoroughly dry condition: from May 1st to May 14th it rained every day in the districts where I was touring, and the weather remained unsettled until the break of the monsoon.

My object in drawing attention to these difficulties is to lay stress on the most important point of all in collecting tan-stuffs, that is, that in future most of the work ought to be stopped at just about the time when it was started this year. Operations ought to be spread over the period from the end of the rains to the middle of May. The short time between the middle of May and the break of the monsoon should be used for packing and railing the material still left at the collecting centres, instead of continuing work in the forests and running the risk of damage from rain. The only exception to this is in the case of Dhawa shumac, which is only obtainable in May and June unless some method can be adopted of treating the trees so as to get shumac from them at other seasons.

The rest of this paper deals with:—

- (i) The comparative cost of collecting various classes of tan-stuffs from different types of forest.
- (ii) Methods of collecting and preparing the tan-stuffs that were asked for this year and the prices that ought to be offered for them.
- (iii) Dirty or adulterated tan-stuffs.
- (iv) Packing and transport.
- (v) Agency of exploitation.
- (vi) Suggestions for collecting the tan-stuffs required next season.
- (v) THE COMPARATIVE COST OF COLLECTION OF THE VARIOUS CLASSES OF TAN-STUFFS FROM DIFFERENT TYPES OF FOREST.

The suitability of different types of forests for tan-stuff exploitation is primarily a question to be dealt with by the Silviculturist, but as the cost of collection of the different classes of tan-stuffs is considerably affected by the character of the forests some reference to it is necessary here.

*Scientific names of these trees are given in the Appendix.
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As a general guide to forest officers who have to collect tan-stuffs the following points may be noted :—

- (a) *Stem bark of full grown trees* is always expensive to collect unless it can be worked as a by-product of timber contracts (e.g., Sál bark) or can be cut off the base of the stems of living trees without damaging them (e.g., Kahua bark).
- (b) *Twig barks, fruits and leaves.*—
 - (i) Leaves and fruits are cheaper to collect than twig bark.
 - (ii) Gregarious species are cheaper to exploit than sporadic species.
 - (iii) Scrub jungles and coppice are cheaper to work than high forest.
 - (iv) In mixed forests the exploitation of one or more sporadic species is much cheaper if the forest is open than if it is dense.

These may seem to be self-evident facts and therefore hardly worth mentioning, but there is a logical conclusion to be drawn from this which needs emphasising because the Indian forests offer an enormous field for research, but the research officers are few. It is that tannin research in India should at first be directed as much as possible towards inventing mixtures mainly or entirely composed of (a) common fruits, (b) the leaves of common gregarious under-shrubs, (c) leaves of common gregarious shrubs and trees found in open scrub jungles, (d) barks which can be utilised for tanning as a by-product of timber contracts, (e) barks of common trees, such as Kahua, which can be cut from the base of living stems without damaging the trees.

These would be the cheapest tan-stuffs to buy, and to them may be added (f) the bark or leaves of some common trees, shrubs and parasites which are actually harmful to forests and could, therefore, often be bought from the Forest Department at a price which would not include the cost of looking for them and cutting them (e.g., the parasite *Loranthus* and trees cut out of high forests in cleanings).

Two of the very first things that must strike a forest officer employed on such work as I have been doing the last few weeks are :—

First.—That so much information has been gathered in the past about the tanning contents of comparatively uncommon species which cannot possibly be utilised as tan-stuffs on a practical scale.

Second.—That no experiments ever seem to have been made on many of the commonest gregarious shrubs and trees which forest officers have always been trying to exterminate.

This seems to be because there had been very little practical co-operation between chemists, forest officers and tanners. The coming season will afford the best opportunity of discovering cheap but valuable Indian tanning mixtures that has ever presented itself. If every forest officer is asked to submit a list of the most common, and, according to our present knowledge, most useless species in his Division samples of each may then be analysed in Mr. Pilgrim's laboratory and then tested on leather in the Maihar factory if the analysis is promising. To show that this may lead to practical results I will give a special instance. Supposing every forest officer in the Tarai Divisions of the United Provinces were asked to submit a list as suggested it is practically certain that all the lists would include Mauhrain (*Bauhinia Vahii*), Karaunda (*Carissa spinarum*) and Bhand (*Clerodendron infortunatum*). Mauhrain bark has been tested during the past few weeks, and, when used in mixtures appears to be one of the most valuable tan-stuffs ever discovered in India. Karaunda leaves were first tested a few weeks ago and are giving very promising results. *Clerodendron infortunatum*, the leaves of which would perhaps be the cheapest of all forest products to collect, has so far never even been analysed.

If forest officers co-operate with the Maihar research factory in this way it may not be long before the Indian tanneries can depend entirely on easily collected tan-stuffs the supply of which will greatly exceed the demand. If so the price will depend only on the cost of collection and may be brought down to as low as 0-8-0 or 0-10-0 a maund on the rail on the average. But the tanners must recognise that cost of collection is not always limited merely to the wages paid for collecting. The value of the tree for other purposes has to be taken into consideration and must be added to the cost of collecting the tan-stuffs if it is destroyed thereby. In this respect trees may be placed in three categories :—

- (i) Those which are too valuable for other purposes to be exploited for tan-stuffs except as a by-product (e.g., bark of Sál or Mango). The tan-stuffs in this class are very cheap to collect but the supply, though regular, is limited.

- (ii) Those which are worthless or almost worthless for other purposes but not actually harmful to the forests (e.g., Aonla (*Phyllanthus Emblica*) in many parts of the country). In this class the cost may often be taken as the actual wages paid in collecting the tan-stuffs, or the combined value of the wood, fibre and tan-stuffs may make exploitation practicable where the tan-stuff or the wood or the fibre alone would not be worth collecting.

- (iii) Trees or shrubs which, being harmful to the forest, are usually cut out by the Forest Department, sometimes at considerable expense (e.g., *Loranthus* and the produce of cleanings where they cannot be sold). The price of tan-stuff of this description would not necessarily be the full cost of collection. The Forest Department would doubtless be glad to get back only part of it.

There still remains the question of tan-stuffs which are so valuable that the Forest Department might find it worth while to plant them in pure crops like the oak and chestnut coppice woods in Europe. In collecting Aonla bark for example I have seen coolies wandering through dense thickets of *Helicteres Isora* and thorny shrubs and sometimes passing within a few yards of an Aonla tree without noticing it. In other forests they have spent more than half their time climbing big Aonla trees in order to reach the young branches. Two hundred acres of pure Aonla coppice or pollard forest would yield as much bark as 50,000 acres in some of the forests where it has been collected this year. If plantations of Aonla were made close to the Railway in a district within easy reach of a tannery the cost of Aonla bark delivered at the tannery might be nearly halved.

- (iv) METHODS OF COLLECTING THE TAN-STUFFS THAT WERE ASKED FOR THIS YEAR AND THE PRICES THAT OUGHT TO BE PAID FOR THEM.

The tan-stuffs collected this year consisted of (a) barks and (b) leaves.

- (a) There are four classes of barks.

(1) Stem bark of full grown trees removed as a by-product of timber contracts. Collection this year was restricted to Sál and Dhawa. Sál bark is generally removed by timber contractors and left lying in the forest; the cost of collecting it as a tan-stuff is consequently low. It is to be hoped that the tannery can accept it tied up into bundles or bales. It was asked for in bags this year because it was thought at first that the tannery could only deal with it in that form, and some Forest Officers consequently had a great deal of trouble in cutting, or crushing, and bagging it. Chopped Sál bark can be collected and loaded on the railway from the Tarai Divisions at 0-4-0 to 0-6-0 a maund. Dhawa logs are not usually barked by timber contractors. The Divisional Forest Officer of Gonda supplied some Dhawa bark this year and it cost him 0-15-3 a maund loaded on the rail; this included cost of barking the logs.

(2) The stem bark of Kahua (*Terminalia Arjuna*) is in a class of its own because it can be removed from the living trees without apparently harming them, and because the bark nearest the base of the stem, and therefore within easy reach of the collector, is the richest in tannin contents. If left to his own devices, however, the ordinary contractor does a great deal of harm to the tree because he lets his coolies cut it with axes, and in so doing they cut into the cambium layer. Mr. Fraymouth has invented a Kahua bark cutter which, if properly handled, cannot cut into the cambium layer. These cost about Re. 1 each and can easily be copied. Any forest officer who wants one as a pattern should write to Maihar. The Kahua tree is commonly found along streams in Central India or planted in roadside avenues. Where it is plentiful the cost of collecting the fresh bark on the spot should not exceed 0-3-0 or 0-4-0 a maund, green, that is to say, one man can collect a maund a day. The bark is reduced in drying to about half its original weight. It is not easy to tell at first sight whether it is thoroughly dried or not: the test is to break it with the fingers: if it is thoroughly dry it breaks easily in any direction like a hard biscuit. It should be broken up into small bits when dry to save space in packing. Annas 10 to 12 a maund, packed in bags and loaded on the rail, has been offered for Kahua bark this year; and contractors are found willing to supply it at that price.

(3) The third class of tan-bark collected this season was the twig bark of Aonla (*Phyllanthus Emblica*), Seja or Asidh (*Lagerstroemia parviflora*), and Dhawa (*Anogeissus latifolia*). These twig barks especially Aonla are very important constituents of the mixtures to be used at the Allahabad Tannery, and they are unfortunately much the most troublesome to collect.

Twig bark means young bark from small branches and coppice or pollard shoots. The exact age of the bark or size of the branches from which it should be collected needs further investigation. We fixed the limit this year at a max-diameter of 2" at the thick end. The difficulty in collecting it through contractors lies in the fact that there is only one right way of removing the bark from the wood and it is not the way that naturally commends itself to them or to the coolies they employ. Practical demonstrations of the right method have no effect at first, but they learn by experience after starting work in the wrong way and losing money over it. It is entirely new work, and, therefore, if contracts are given for twig bark next season, it is essential that high prices should be offered at first to induce contractors to take the work up

seriously; and it is advisable that it should also be done departmentally in several Divisions as a demonstration.

The method of removing the bark is simple. A young freshly cut branch, stripped of side twigs, is held by one end in the left hand and laid on a flat stone or plank. It is then beaten from one end to the other with a fairly heavy mallet held in the right hand. The mallet should have a broad flat striking surface. By this means the bark is loosened in strips, and either falls away from the wood, or can easily be picked off by hand. From the Forest Officer's point of view it will be best if the tannery can accept it in this form, tied in bundles or baled, but if not, fibrous barks like *Seja*, which are difficult to break up when dry, should be crushed with the mallet as soon as they are taken off the branch. Barks, like *Aonla*, which can be broken easily when dry need not be crushed. As the value of the twig barks, as tan-stuffs, depends to a great extent on the light colour they give to leather it is important that iron should not be allowed to come into contact with them while they are green because it reacts on the tannic acid and causes discoloration. It is not practicable to enforce this rule for the collection of all barks but in the case of twig barks there is no need to use an axe except for cutting the branch off the tree.

As soon as the bark is removed it must be spread out to dry thoroughly in the sun, a process which may take from three days to a week. The reduction of weight in drying is very variable; the thick juicy bark of coppice or pollard shoots, which weighs when fresh about $\frac{2}{3}$ of the weight of the shoots before barking, loses nearly $\frac{2}{3}$ of its weight in drying while the thin bark of branches from the crowns of old trees loses much less. But as coppice and pollard shoots are more accessible and easier to bark they will probably always be found the cheapest source of twig bark. One man can remove from 30 seers to 1 maund of fresh bark a day, if he is employed only on this work and not expected to cut the branches in the forest as well. In drying this will be reduced to from 10 to 15 seers, so allowing for a daily wage of 0-3-6 or of 0-4-0 the cost of removing the bark alone should come to about 0-10-0 to 0-14-0 a maund dry. Breaking or crushing the bark into small bits and packing into bags should not cost altogether more than 0-1-0 a maund. As the cost of cutting the branches in the forest, and carting the bark to the railway depend on the character of the forest and its distance from the railway it is not possible to fix the cost of delivering on the rail, but as a rule it is not likely to be less than Re. 1, and in some cases it may reasonably amount to Rs. 1-2-0 or Rs. 1-3-0. When contractors first start the work they generally say it costs them Rs. 2 or Rs. 3 a maund, this is partly because they start by doing it in the wrong way and partly because the cost of new work is always high. In one district where the average daily wage was 0-4-0 the practice was to let coolies go into the forest to cut the branches and remove the bark on the spot, and they were paid 12 annas a maund for the dry bark brought to the depot at the edge of the forest: they dried the bark at their own homes. This is a practice that should only be allowed where plenty of supervision can be exercised as there is a risk that the bark will very often be removed with axes. It is better to have the branches brought to be packed at collecting centres where the work can be inspected from time to time by Rangers or Forest Guards. The price offered for twig bark this year was not high enough to attract contractors, and it ought to be decided at this conference how much is to be offered for it next year.

(4) The fourth class of bark is the bark of creepers. *Mauhrain* (*Bauhinia Vahlia*) is the only creeper that was exploited this year. *Mauhrain*, like most creepers, is more common in the Tarai forests than in the Central India, and I have no experience of collecting it. Further investigation is necessary to decide exactly what part of the bark is required, how it should be removed from the stem and in what form it should be supplied to the tannery. The cost of collecting depends a good deal on the result of these investigations. The bark of most climbers is very fibrous and therefore difficult to break or to cut up when dry. As climbers are usually cut because of the damage done by them to the forest it might be thought at first that the Forest Department would be glad to supply their bark or leaves as tan-stuffs at less than the full cost of collection. But this is not so because ordinary climber cuttings only consist of cutting through the stems near the roots and leaving the climbers to die on the trees the cost of which is practically negligible. Almost the whole expense incurred on their exploitation as tan-stuffs consists of pulling them down from the crowns of high trees, barking them, and cutting crushing or baling them for despatch to the tannery. I understand from Divisional Forest Officers who have supplied some *Mauhrain* bark this year that it costs about Re. 1 to Rs. 1-8-0 a maund chopped and loaded on the rail in bags supplied by the Munitions Board, the cost varying according to the character of the forest and its distance from the rail.

(b) *Leaves*.—The only leaves collected in large quantities this year were those of *Dhawa* (*Anogeissus latifolia*). A small quantity of *Sál* leaves was collected in one or two Tarai Divisions, but their value for tanning on a large scale is still to be proved. *Dhawa* leaves are utilised for tanning in two forms, *Dhawa* leaf and *Dhawa* Shumac:—

(1) *Dhawa* leaf can be collected at the edge of the forest for about 0-6-0 a maund dry excluding the owner's royalty. It is probably collected for less in some places, because the cost is naturally lower in a pure *Dhawa* forest than where the tree is scattered. Some contractors

purchase it from the owner of the forest at 0-8-0 a maund, the owner making his own arrangements to collect it and paying about 6 a maund for the work. These rates are for scrub jungles where the trees are small enough for the leaves to be reached from the ground. *Dhawa* also grows in high forest in the Tarai and elsewhere but it is impracticable to collect large quantities of the leaf there because the trees are too high. A few hundred maunds however can be collected every year from the crowns of trees felled by timber contractors.

In the scrub jungles of Central India there is a practically unlimited supply of *Dhawa* leaf, and there are plenty of small contractors who are willing to collect it if they are satisfied with the price offered.

During the past year 0-12-0 a maund has been offered for the material loaded on the railway, i.e., 0-4-0 more than the rather liberal estimate that was just given for cost of collection at the forest depot plus royalty. There is so much *Dhawa* that it is unnecessary to collect at a great distance from the railway and including cost of cartage, packing in bags and loading it never ought to cost the contractor more than 0-10-0 to 0-12-0 a maund loaded on the rail. Contractors who have had time to get used to the work seem satisfied with 0-12-0 a maund, and there are several stations on the East Indian and Great Indian Peninsular Railways within 300 miles of Allahabad where arrangements could almost certainly be made for the supply of 20,000 to 30,000 maunds a year, provided that the agreements are drawn up and signed before the end of the rains so that the contractors know exactly where they stand and may make arrangements accordingly. It is true that in some places the contractors say that they cannot do it at 0-12-0 a maund, but whenever they have had any experience of the work they seem satisfied with that price.

There are two or three difficulties that will arise, especially during the first year. First the chaimars in Central India have for centuries used *Dhawa* leaves in small quantities for tanning, but they have been accustomed to collect it mixed with woody twigs and have made no attempt to keep it clean. No matter what specifications are written in agreement deeds, no matter how carefully instructions are given on paper, the first lots of *Dhawa* leaf collected next season will be mixed with sticks, stones, mud and dust. Contractors and forest subordinates alike will pay little attention at first to written counsels of perfection, which upset the custom of centuries; they argue to themselves that the local chaimars had found out how to make leather with *Dhawa* leaf long before the British came to India and that these new-fangled methods of collection are merely the results of our inexperience. The point, of course, is that woody twigs contain very little tannin but may affect the cost of freight enough to kill the industry, and that unclean material is useless to a tannery that aims at producing leather of uniform colour and quality.

Another difficulty, which is likely to make itself felt especially during the war, is that big orders are sometimes placed with tanners at Cawnpore and elsewhere for leather to be supplied within a very short period. This sometimes compels the tannery companies to send out agents with instructions to buy tan-stuffs at all costs, and a few wagon loads of moderately clean material may be purchased at double its real value. During the past season as much as 1-8-0 a maund at the Forest Depot has sometimes been paid for *Dhawa* leaves in this way. These abnormal prices for small consignments make the local contractors think that Government is not dealing fairly with them in trying to buy at 0-12-0, but it is a difficulty that can probably be avoided altogether by making contracts for several thousand maunds from each contractor before the beginning of the working season. Let the contractor know in plenty of time that he will be paid 0-12-0 a maund for 20,000 maunds and he will not waste much time dreaming of the possibility of selling 200 maunds at Rs. 1-8-0.

For collecting *Dhawa* leaf the following rules must be observed:—

- The leaves must not be too old. They must be green leaves collected from the tree, not dead leaves picked up from the ground after the leaf-fall. In Northern and Central India therefore collection ought to be stopped before the middle of February at latest.
- They must consist only of leaves and the very small sappy twigs. There should be no twigs thicker than the lead in an ordinary black lead pencil.
- They must be quite free from stone, sand and mud. It may sometimes be necessary to winnow the material in the same way as grain is winnowed in order to clean it.
- They must be absolutely dry when packed.
- They must be slightly green in colour even when dried. The presence of brown leaves is an indication that the material must have either been picked up from the ground after the leaf-fall or else stacked while damp, allowed to ferment, and afterwards dried again.

(2) *Dhawa* Shumac is made by pounding and sieving the young tender leaves and shoots of *Dhawa*, plucked when they are only a week or two old. In Central and Northern India,

therefore it can only be obtained, during the last part of April and in May and June, when labour is scarce and expensive and when the risk of damage from rain has to be taken into consideration in fixing the price.

It is new work and contractors therefore will not take it up unless they are first shown how to do it and then offered a fairly liberal price.

The method of collection is as follows:—

First the soft young shoots and leaves are pulled off the trees and laid out to dry in the sun. In one district this year contractors were buying this material at 0-10-0 to 0-12-0 a maund, dried, from zamindars, who paid their coolies 0-6-0 to 0-8-0 a maund for collecting it, but in another district the material was collected departmentally at 0-6-0 to 0-7-0 a maund dry from private forests whose owners only charged 0-1-0 a maund royalty. One man should collect a maund of the fresh material a day in scrub jungle where Dhawa is common. The loss of weight in drying depends on the proportion of woody twig collected with the fresh material; if properly collected there should be a loss of 20 to 25 seers per maund.

The dried material is then pounded up with sticks. This should be done on a cloth or sackmg or on a specially prepared clean floor, and care must be taken that no stones or bits of mud are pounded up with the leaves.

After being pounded it is sieved. The sieves generally used this year were designed at Maihar. They are made of perforated iron sheeting and wood with two handles at each end and are worked by two women or boys. The perforations should not be wider than an ordinary match head. At present it is difficult to get perforated iron sheeting, so, small round sieves made of bamboo basket work and costing only about 0-6-0 each were used successfully in places. The objection to the latter is that the size of the holes can easily be altered. Wire sieves are not satisfactory because even the finest wire sieving lets through small bits of stick. The cost of pounding and sieving is about 0-3-0 to 0-4-0 per maund of shumac produced or 2 to 2½ annas per maund of shumac residue. If properly collected in the forest and then thoroughly pounded one maund of the dried leaves and shoots should yield about 25 seers of shumac and 15 seers of residue. About 6 pies to 1 anna a maund must be added for cost of packing in bags and loading the bags on the train. Rs. 1-8-0 a maund was offered this year for the shumac packed and loaded on the rail and 0-12-0 for the residue, provided that it only contained bits of leaf and stick not thicker than the lead in an ordinary black lead pencil. The contractor therefore gets about Rs. 1-4-0 a maund for shumac and residue together, which seems to be quite acceptable to those who have had time to get accustomed to the work.

Great care is necessary to ensure absolute cleanliness. If there is any mud or sand in a sample of shumac it can be detected by taking a handful and gently blowing away the bits of leaf and leaf-dust until nothing is left but the sand or mud. It can also be detected by putting a handful of the shumac into a glass of clean water.

A difficulty that may arise is the adulteration of Dhawa shumac with other kinds of leaves. The only way to guard against this is to inspect the contractors' collecting depôts frequently.

(iii) DIRTY OR ADULTERATED TAN-STUFFS.

The importance of collecting thoroughly clean, pure material cannot be over emphasised because the tan-stuffs will be required for making high-class leathers of uniform colour and quality in Indian tanneries, or for export to England. Adulteration of tan-stuffs with worthless barks and leaves can only be prevented by frequent inspection of the collecting centres, but cleanliness can easily be ensured by insisting on the observance of a few very simple rules. Bark and leaves usually get mixed with mud, sand and stones when they are swept up after being spread out to dry or after being pounded up for packing. In the hot weather again if they are stacked in the open they get covered with dust by the strong winds that usually blow then.

To ensure cleanliness, therefore, they must always be spread out for drying or pounding on a cloth or old sacks, or on a specially prepared floor, made of clay and cording like a threshing floor, or on bare flat rock. And if the material has to be stored for some time before despatch to the tannery it should be kept in a shed with walls that can be depended upon to keep out dust. If these rules are not observed and the material is found to be dirty it must be cleaned by winnowing. In no case should any bags be issued for packing material that is not thoroughly clean; this should be made quite clear to contractors before they start work.

(iv) PACKING AND DESPATCH OF TAN-STUFFS:

Tan-stuffs should be packed and railed as soon as they are ready, that is to say, as soon as they have been cleaned and dried and crushed, broken, chopped or sieved into the shape in which the tannery can utilise them. If bags have to be used the number required should be estimated at least two months in advance because they often take weeks to reach their destination. Bark and leaves should if possible always be reduced before despatch to the form in which

the tannery utilises them because this is also the form in which they can be bagged most tightly; and with special railway freights per wagon load the importance of close packing is obvious. If the material is baled in a baling machine it can be packed much more tightly than in bags but it cannot be broken or crushed or cut up until arrival at the tannery.

As there is no railway siding to the Allahabad Tannery the material required there cannot be loaded loose into the railway waggons but must be packed in bags or baled or tied up in bundles. Bagging and loading costs about 6 pies a maund on the average but varies for the different kinds of tan-stuffs. Baling was only tried as an experiment this year and I have no reliable figures to show the cost. It is undoubtedly the best method of railing fibrous barks, and may possibly be found more satisfactory than bagging for leaves too.

Last year experiments were made by Esocet, Limited, to find out what size of bag should be used, if bags were necessary, in order that the maximum quantity of tan-stuffs might be loaded into one wagon: a small bag measuring 18" x 28" was found the most suitable from this point of view. The contractors who collect the tan-stuffs often ask that larger bags may be supplied because they think they will be allowed to take them out into the forests for bringing in the bark and leaves to their collecting depôts. This is a practice that should never be allowed. The bags supplied by the Indian Munitions Board should be kept in the charge of officers of the Forest Department or Munitions Board until contractors can show their stocks of material ready for packing and despatch to the tannery. If they want bags for carting the stuff in from the forest they should buy them. Experience has shown that our bags if lent to the contractors disappear in large numbers owing to accidental fires, or suffer so much from damp and white ants that after a few weeks they appear to be ten or twenty years old. The bags belonging to the Munitions Board should be marked I. M. B. They should also be marked by the officer who sees to the despatch of a consignment of tan-stuffs with letters to indicate the material they contain, because if this is not done they are certain to get mixed up at the tannery: thus bags of Dhawa leaves were labelled D. L. this season, Aonla twig bark A. T. B., etc. For marking it is advisable to have stencils made, and a useful dye for the purpose is made by boiling a mixture of Aonla, Bahera and Harra fruits in water. Another mark that is required is a figure at one corner of each bag to indicate the number of journeys it has done and thereby give data for estimating the average life of a bag. It will be better to make this mark at the tannery. When tan-stuffs are baled marking is unnecessary as the kind of material can be seen at a glance.

All the labour and trouble connected with packing and marking would be avoided if the tannery had a siding. The cost of the bags supplied this year was from 0-4-0 to 0-5-0 each. As one bag holds half a maund of tan-stuffs on the average, and lasts for about ten journeys, the cost of bags alone on each maund is about 0-1-0. The tannery is expected to require about 800 maunds a day next year, so a siding would effect a saving of Rs. 50 a day, compared with the present system of bagging the tan-stuffs, or over Rs. 18,000 a year, on cost of bags alone. After adding to this the cost of packing and marking the bags, cartage at Allahabad from the railway station to the tannery and the cost of the bags lost annually, we get total saving of about Rs. 40,000 a year.

There are several questions connected with the supply of bags, and payment of freightage on tan-stuffs which ought to be decided before next season. But this will presumably be in the hands of the Superintendent of the Tannery, so he and the Storekeeper ought to be consulted on the subject.

(e) AGENCY OF EXPLOITATION.

A most important question is the agency by which the forests should be exploited. There are three alternatives:—

- (1) Departmental collection of tan-stuffs by the Forest Department, the tannery purchasing from the Divisional Forest officers.
- (2) Direct dealings between the tannery and contractors.
- (3) Collection of tan-stuffs by the Forest Department through contractors, the tannery purchasing from the Divisional Forest Officers.

Of these three alternatives number (1) is undoubtedly the ideal from the tanner's point of view because departmental work would ensure a supply of clean material, properly dried and packed. But as it is quite useless thinking of departmental collection on a large scale with our present forest staff, I would only recommend that small quantities of twig bark and shumac should be collected departmentally in some divisions next season—merely as a practical demonstration of the best methods of collection and preparation.

Direct dealing between the tannery and the contractors may some day become the regular practice, but it is impracticable now because local contractors need persuasion to make them take up work to which they are unaccustomed, and the only people who are likely to meet with any success in dealing with them are local officers who know them and have employed them

before for other work. Moreover most contractors have very little capital behind them and require advances. This at once lets in the money-lending middleman with the inevitable result that the tanneries as a rule have to deal with money-lenders just as railway companies now have to deal with money-lenders when they want sleepers. In India a Bania of some kind is apparently an indispensable party to all transactions between the producers and consumers of raw produce, and it is, therefore, important in the interest of both producers and consumers that the Bania should be reliable. This has been recognised by Government in its agricultural co-operative schemes and in the arrangement for supplying sleepers to the Railway Companies in Haldwani Division. In both these cases the Bania is Government itself. I am of opinion that a similar arrangement is the only satisfactory method of supplying tan-stuffs from the Indian forests. The Forest Department should collect the material through its own contractors, making advances to them if necessary, and the Forest Department should sell it to the tanneries. It will probably be found necessary to have one or two Deputy Rangers or Foresters on special duty in each district to inspect contractor's work and to pass the material supplied by them, for the Forest Department ought to be responsible for the quality of the tan-stuffs. It would in fact be a very similar arrangement to that by which the Forest Department collects grass for the army in the Central Provinces with the one important difference that the Forest Department would have an opportunity of making revenue out of it.

I understand that in some of the districts which could supply most tan-stuffs the collection of grass for the army keeps all the available staff and contractors too fully occupied for them to be able to deal with tan-stuffs as well. If this is so, it ought to be decided now whether to discontinue grass collection in certain divisions or ranges, so that the required quantity of tan-stuffs may be collected.

It may be objected that this system of working tan-stuff collection through the Forest Department's contractors would only be applicable to government forests, whereas I have already emphasised that it is to the open scrub jungles outside the reserved forests that we must look for the best supply of tan-stuffs. In point of fact however it has been found this season that the Forest Department can deal quite easily with contractors for the supply of tan-stuffs from private forests, the contractors making their own arrangements with the forest owners as regards royalty, etc. In drawing up a contract which leaves the contractor free to collect either in Government forest or in private forest the price offered for the material from the private forest must be one anna or two annas a maund higher to allow for the royalty.

As the whole object of any scheme of this kind is to supply clean, pure tan-stuffs properly collected, the chief obstacle to its success would come from those consumers who do not care what kind of material they buy. For instance the Forest Officer of a certain district might refuse to pass 10,000 maunds of Dhawa leaf on the ground that it was below the standard fixed in the contract deed. Now, if that is the standard really wanted at the leading tanneries in India the Forest Officer's refusal to pass the stuff ought to be enough to ensure that it won't be sold at all except at a low price to local chammars or small native tanneries. But if the agent of some big firm comes along and buys the rejected material at the price originally offered by the Forest Officer for clean material the latter will find difficulty in getting contractors to work for him in the following season. Probably therefore the Forest Department would not find it worth while to supply tan-stuffs of guaranteed quality on a large scale unless all the leading tanneries would agree to give it a monopoly for the supply of all their requirements in Indian forest tan-stuffs.

It is possible that a reliable contractor with capital behind him might be found in one or two districts, but he would not be of much use until he had learnt the work. In Jubbulpore district, for instance, there is an enterprising land-owner who is willing to take up the work seriously provided that he is given a monopoly for 3 or 4 years at least for the supply of tan-stuffs from all the forests along the Jubulpore-Katni line. Without the promise of a monopoly he does not think it is worth his while to take up the work.

(ii) SUGGESTIONS FOR COLLECTING THE TAN-STUFFS REQUIRED NEXT YEAR.

The first thing to be done is to settle what prices are to be offered for each kind of tan-stuff and the total quantity required so that Divisional Forest Officers can begin to look around for contractors at once.

The prices should allow for some profit to be made by the Forest Department, and Forest Officers will probably find it advisable to offer a bonus to contractors who collect more than a fixed quantity. Dhawa leaves, which are common nearly everywhere, should be collected as far as possible in districts at no great distance from the tanneries. The twig barks will have to be collected from much further afield as the quantity available in each forest is limited, and a price must be fixed for them which will allow for cartage from forest 20 or 30 miles from a railway, and for a high railway freightage.

A little departmental collection of twig bark may be carried out as a demonstration, and the Sāl and Mauhrain bark in the Tarai forests may perhaps be most conveniently collected by the Department, but all other tan-stuffs are likely to be exploited through contractors and the sooner the agreements are drawn up the better.

Another question to be settled is as to what restrictions are to be put on the exploitation of tan-stuffs in government forests. Are contractors, for instance, to be allowed to cut Aonla and Seja coppice for twig bark, and may Dhawa leaves be collected throughout the season from the same Dhawa trees? In some cases working plan prescriptions may be affected, but the working plans were not written with an eye to the requirements of tanneries, and it is quite possible that some of the scrub forests of Central India may get a much larger revenue out of tan-stuffs than out of major produce.

It must also be decided soon whether the Allahabad Tannery is to have a siding next year, and, if so, what proportion of the tan-stuffs asked for next year is to go to Allahabad and what proportion elsewhere, and how much is to be packed in bags and how much can be sent loose. All this should be decided in time for Forest Officers to make their indents for bags several weeks before they are actually wanted. It sometimes takes a month to get an order for new bags completed and another month to get them railed to their destination, but, quite apart from this, Forest Officers will want to know before they give the contracts whether they are to offer prices that include cost of packing or not. If it is impossible to decide this now, Forest Officers will have to word the agreements in such a way that they may retain the option of compelling contractors to bag the tan-stuffs at a fixed price.

When it has been decided what tan-stuffs are to be collected from a certain district the Divisional Forest Officer should have stencils made for marking the bags, if bagging is necessary. He should enquire of the Superintendent of the Allahabad Tannery as to the abbreviations to be used for indicating the different kinds of tan-stuffs.

For making Dhawa Shumac, sieves will be required, and there is likely to be some difficulty in getting them made. To ensure uniformity of quality it is advisable that they should be made by the Munitions Board at Allahabad or elsewhere and lent or sold to those Forest Officers who indent for them. If they are made locally it is practically certain that different meshes will be used, in which case the quality of the shumac will be variable. As it is difficult to describe clearly in writing exactly how shumac should be made a small sample parcel should be sent from Allahabad to every division when it is to be collected.

As I said before, this paper is mainly based on first impressions and first impressions are often apt to be misleading. The experience gained in extensive well-thought-out operations may show that most of what I have written here is wrong but as far as my short experience goes I believe it to be right. At any rate I am right on one point, and that is that if tan-stuffs are wanted in large quantities next year a plan of campaign should be decided upon several weeks before the working season begins.

R. G. MARRIOTT,

Deputy Conservator of Forests.

APPENDIX.

VERNACULAR AND SCIENTIFIC NAMES OF TREES REFERRED TO IN THIS PAPER.

Vernacular names.	Scientific names.
Aonla (Aula, Onra)	<i>Phyllanthus Emblica.</i>
Dhawa (Dhao, Dhaura, Bakli, Banji)	<i>Anogeissus latifolia.</i>
Kahua (Arjun)	<i>Terminalia Arjuna.</i>
Mauhrain	<i>Bauhinia Vahlia.</i>
Sal (Sakhua)	<i>Shorea robusta.</i>
Seja (Asidh, Dhauri)	<i>Lagerstroemia parviflora.</i>

APPENDIX III.

The Analysis of Tanstuffs, Preparation of Samples, and Methods in use in the Laboratory of the Esociet Tannin Research Factory, by Mr. J. Aldred Pilgrim, M.I.A.L.T.C., Tannin Expert to the Government of India.

The method of tannin analysis adopted by the International Association of Leather Trades Chemists as official is sufficiently well known to need no detailed description here.

Speaking very broadly, it consists of:—

- (i) Absorption during agitation of the tannin in an infusion prepared from a given weight of tanstuff, by means of chromed hide-powder.
- (ii) Subsequent evaporation of the resultant non-tannin liquor for deduction of its weight—when thoroughly dried—from
- (iii) the total solubles—obtained by the evaporation and weighing *dry*, of an equal volume of filtered but otherwise untreated tannin infusion, in order to arrive at the tannin removed, *by difference*.
- (iv) A correct estimation of the moisture in the sample.

As thus described the method appears as a very simple one, but to ensure reliable and concordant results, a close attention is required to all the details of the process.

The vegetable tannins as a class owe their principal industrial importance to their property of converting the animal skin into leather and the method of hide-powder analysis was devised, as being likely to give the most valuable figures of analysis to the tanner, in that it imitated (within certain limits) the practical process of tanning, by converting the hide-powder into leather-powder at the expense of the tannin principle of the tanstuff under investigation.

At a later date it was found that stability was given to the hide-powder without in any way impairing its affinity for natural tans, by a preliminary chroming treatment in which basic chromium chloride— $\text{Cr}_2\text{Cl}_4(\text{OH})_2$ —was employed. The chroming rendered insoluble certain gelatinous matters in the hide-powder, which had at times given trouble by dissolving out in the “non-tannin” liquor thus giving a result too high in non-tannins and consequently too low in tannin.

When chroming was adopted by the I. A. L. T. C., in 1908, they also adopted the American method of shaking the tannin liquor with the chromed powder, in place of the upward percolation hitherto employed whilst using the unchromed powder. The advantage gained in point of time was considerable: with the old unchromed powder, shaking would have been too dangerous an expedient.

I have already implied that hide-powder analysis involves in some degree a miniature tannage, and it must be regarded rather as an approximate measure, of the amount of matter that we call tannin, which the hide will absorb during conversion into leather, than as an estimation of any one definite chemical constituent.

Viewed in this light, the method, if carefully carried out, gives results of surprising accuracy, and the duplicate analyses insisted on by the I. A. L. T. C. are, as a rule, an extremely close check.

That they are, however, an exact criterion of the amount of tannin in a tanstuff, which would actually prove absorbable into the hide on the practical scale, is at least doubtful. To begin with, hide-powder is, as its name implies, in a sub-divided condition, so that the hide fibres should be reached by the tannin very much more easily than in the case of the ordinary pelt. On the other hand, there are probably conditions in the tan-pit more favourable to the absorption of tannin than those which obtain in hide-powder analysis, and it is at least likely that a proportion of the matter reported in analysis as “non-tannins,” plays its part in the formation of leather-substance, indirectly or directly.

We know that tanning materials rich in non-tannins often produce superior leather to those with but little soluble matter other than tannins. And yet that these, in practical tanning absorbable, non-tannins are merely an obstinate form of *tannins* is very much to be doubted. If this were so, other gravimetric methods of tannin estimation should give higher results, but this is not noticeably the case.

In hide-powder analysis, the hide-powder is simply employed as a reagent used in excess, as a precipitant (within itself) of all, or as much as possible of the tannin matter to be extracted, and only differs essentially in principle from other gravimetric methods in the fact that the precipitant employed is skin-substance for which reason the results obtained ought to be at any rate nearer than any other to those obtained in practical leather-making processes.

Tannin analysis :
Description.

Relationship to
practical tanning.

Chroming.

Shake method.

Character of the
analysis.

Accuracy.

Discussion.

Manipulation.

On the other hand details of manipulation are essentially different from those of other gravimetric methods, in that these latter generally comprise an actual weighing of the precipitated tannin, while in the hide-powder method the difference in weight of treated and untreated portions is the measure of the tannin absorbed into an excess of precipitant, the resultant tannin-hide-powder product not being actually itself weighed.

Time required.

To obtain the result with hide-powder is naturally a longer and more complicated process than where direct weighing of a tannin precipitate is concerned.

To begin with, the hide-powder contains a percentage of moisture which must be allowed for in weighing the quantity required. This is generally just so much as is wanted for the number of analyses being started on one day. Chromed hide-powder cannot be kept, but must be put into use as soon as possible after chroming and washing.

Reagent for chroming.

The chrome solution used is a basic chromium chloride $\text{Cr}_2\text{Cl}_6(\text{OH})_4$, a stock solution of which is prepared by the addition of the calculated quantity of sodium carbonate to the salt $\text{Cr}_2\text{Cl}_6 \cdot 6\text{H}_2\text{O} - 2\%$ of the basic chrome salt reckoned on the dry hide-powder, is used in chroming.

Chroming process.

The hide-powder is chromed in 10 times its weight of water, plus the chrome, for one hour and is then squeezed free from residual liquor and repeatedly washed and squeezed with distilled water on linen in the fruit press until 50cc. of the filtrate give a permanent brick-red colouration with one drop of 10% potassium chromate (K_2CrO_4) and not more than 4 drops of decinormal silver nitrate (AgNO_3), when practically all traces of chlorides from the chrome solution will have been removed. At Esociet stirring through the linen and subsequent squeezing repeatedly, 4-5 times, always occupies more than one hour.

Finally the hide-powder is squeezed to contain about 70% moisture and weighed, an amount being taken for analysis which corresponds to $6\frac{1}{2}$ grams of dry hide-powder.

De-tannisation.

The squeezed hide-powder is now to be utilised to de-tan an aliquot proportion of the tannin solution, but as it contains an excess of moisture which would dilute the tannin solution, this must be allowed for. It is usual to bring this amount of water of dilution up to a definite amount, and allow for it in evaporating the non-tannin liquor.

Thus if 6.5 grams of the dry hide-powder is found to contain 14.5 grams of moisture, a further 5.5 cc. of water will be added, and the 100 cc. of tan liquor added will become 120 cc. of diluted liquor, so that 60 cc. evaporated to dryness will count as 50 cc.

Agitation is carried on by hand at Esociet by violent shaking under supervision for 20 minutes in special bottles reserved for the purpose. Mechanical shaking is recommended but the hand work has not affected our results adversely.

Filtration.

After shaking the mass is poured on to linen filters and squeezed by hand. The hands should be washed with distilled water just previously and dried on a clean piece of linen. The filtrate from the linen is shaken up with kaolin and filtered through No. 605 extra-hard filters, and at Esociet where we have to do, so far, entirely with raw tanstuffs, and not with extracts, we have often been faced with the difficulty that the non-tannin liquor either would not filter clear, or even would not filter at all owing to the presence of certain waxy materials in the tanstuffs.

On one occasion in our extremely dry, hot weather, a non-tannin filtrate which was filtering very slowly was left overnight, and next morning I found a dry filtrate and no filtrate, the latter having preferred evaporating from the paper to forcing its way through! It was of course an error not to have covered the filter, but this illustrates the impossibility of filtering such a liquor.

It has, however, been my practice for months to filter so much of the original liquor prepared for estimation (by evaporation and weighing), of the "total solubles," as to have a further 100 cc. left over for de-tannisation, in determining the "non-tannins." The filtration is carried out through Berkefeld filter-candles, under vacuum, and is as a rule very perfect, though slimy liquors give a good deal of trouble. However, once filtered, if this liquor is used for the non-tannin estimation there is very seldom any further trouble in the filtering later on.

But in the case just mentioned, an analysis of Mauhrain fibre (*Bauhinia Vahlia*), the filtration through the candles had been so troublesome, that in spite of repeatedly wiping the slime from their surface with clean cotton cloth, I could only get enough liquor for the total solubles, and had therefore used the original unfiltered infusion (as is laid down in the I.A.L.T.C. method) for my non-tannin determination. I afterwards repeated the analysis, continuing the filtration through the candles until I did get enough filtrate for both total solubles and non-tannins, and then the trouble in filtration of the final non-tannin filtrate was of course done

away with, and a result of 24.7% total solubles, 15.03% non-tannins, and, consequently, 9.67% tannin obtained.

The occurrence of glutinous slime or gummy matter is common with a number of Indian tanstuffs, and a difficulty I once had with a sample of Soja leaves (*Lagerstroemia parviflora*) leads me now to the method of extraction of the raw tanning material.

Extraction.

In the Esociet laboratory, Procter's form of extractor is in use. It consists of beakers in a special shape of narrow, rectangular, water-bath with brass, cork lined, clamps for supporting inverted thistle-funnels, bent twice at right angles, which act as syphons. They are fitted with pinch cock and delivery tube. The bulb of the funnel is covered with muslin and buried in about $\frac{1}{2}$ inch of silver-sand washed free from iron.

Our extractor-baths each carry 4 beakers and syphons.

The tanstuffs, previously ground to pass through a sieve of 10 wires per c.m., is weighed into the beakers on top of the sand. Such a quantity should, if possible, be taken as is likely to give an extraction-liquor of about 4 grams tannin in the litre. The beakers are of about 400 cc. capacity, but obviously with a very bulky (feathery), or a weak tanstuff, there is less room available for the water, than with a dense or concentrated one.

Grinding ;
Weight taken.

At Esociet, the tanstuff is weighed out in an evening and the beakers are filled with water and heated to 45°-50°C., then left overnight. This preliminary warming is necessary with many of our tanstuffs, to completely wet them out. The following morning the soak-liquor is syphoned off and poured into labelled litre flasks. It usually amounts to about 250 cc. The beakers are at once filled up and heat applied till at a temperature of 45°C., in the beakers, another 250cc. are withdrawn from each; the temperature of the bath is then raised to Boiling Point (about 97° C. in the beakers), when a further 250cc. is run off, the remaining 250cc. being withdrawn after an hour at the boil. The flasks are cooled under running water and made up to one litre, and though in hot weather the temperature is considerably higher than the 17.5°C. prescribed by I.A.L.T.C., the error is a slight one which for our comparative purposes may, I think, be left out of account. The method of extraction we employ is simple, and nearly always gives very concordant results, but on the occasion I have hinted at, when analysing some leaves producing a very great deal of slime, the syphon entirely refused to work. The liquor was in this case so slimy that it could not be squeezed through linen in a fruit press. I was therefore obliged to raise the temperature to the boil and maintain the water at that temperature for some time before the syphon consented to work. This fact was of course reported on the analysis.

Process.

The initial preparation of raw tanning-materials for analysis has already been touched upon. To ensure thorough grinding (if the nature of the bark does not entirely prevent this), the samples are always thoroughly air-dried, a matter of no difficulty at Malhar during the greater part of the year.

Sampling.

It is most essential that samples should be so taken as to be thoroughly representative of the whole bulk.

It may be objected that I have worked backwards from the central principles of tannin analysis, leaving this initial consideration to the last, but "last is not always least" and my desire is to draw special attention to this subject, to which great care is devoted at Esociet, with very close results in duplicate analyses as the result. Both the I. A. L. T. C. and the American Leather Chemists' Association set forth rules as to sampling of raw tanning materials, which may be read of all men, and the rules of the latter body are more particularly complete, on account of the number of raw tanning materials produced in America. But these rules apparently have regard chiefly to tanning materials delivered to the dealer or consumer, and an analysis of samples taken in accordance therewith should be a correct average analysis of the whole of the particular bulk or batch. It would, however, be less correct to say that it was typical generically, of the particular bark, fruit, leaves, or pods — as the case might be. More especially in the case of barks and leaves, the tannin-content not only varies in different parts of the tree but may also vary in different trees in the same locality; according to aspect, elevation or other local circumstances. Thus a typical sample of bark should be taken from different heights of the same tree, and from a number of trees.

Local variations
in tannin strength.

This is most difficult if these strips are of a fibrous texture such as Mauhrain. They should, in that case, be split vertically, into three parallel pieces, and —

Sampling of
fibrous and brittle
barks.

- a) a third of the left hand strip should be taken from one, and then
- (b) the middle third should be taken from the centre strip, and finally
- (c) the third of the right hand strip which is at the end opposite to (a).

If still sufficiently large (12" length), the strip may be further divided, either with a single vertical split, taking opposite halves, or as before with two vertical splits, again taking the three thirds.

In this way a representative sample of the bulk will be obtained.

If, on the other hand the bark comes away in brittle chips as is the case with *Kahua* (*Terminalia Arjuna*), these chips may be quickly dried where collected, then beaten much smaller with wooden mallets, and sampled down to say 10 lbs. by repeated mixing and quartering. In the laboratory this sample can easily be reduced to powder of the necessary fineness, but where fibrous barks or other substances are concerned, they have to be ground as far as possible, and the amount of powder and fibre weighed separately, after which they are weighed out for analysis in this proportion.

Sampling of leaves.

Leaves should be taken with due regard to the season of the year and the age of the leaf. For instance leaves—

- (1) on a young shoot, or
- (2) on a shoot from which a previous flush has been gathered, or
- (3) on a mature branch,

are all liable to differ in tannin-content.

If an average sample of all the leaves of any tree is to be taken, some effort should be made to gather proportionate quantities of the old and new leaves. These should then be beaten with bamboos on a clean surface, say sacks laid upon the ground, and mixed and quartered down to a few lbs.

In taking an average sample from a very large heap of leaves or other ground up or small tanning materials, these should, if possible, be spread out on a clean surface to uniform depth, say 12", and samples taken right through from top to bottom, approximately from each 3' square in the layer. These should then be beaten with bamboos and quartered down to small bulk as previously described.

Seeds pods and fruit.

Pods and fruits should be dried, and broken up and mixed and quartered as above.

Speaking generally—from the standpoint of "nature and quantity of tannin contained,"—there is every difference between the seed or stone and its envelope of pod or pulp. When the unripe pod or shell is taken, it would be well to remove seeds or stones before drying the envelope, and to send in a separate sample quartered down from these. Mr. C. G. Rogers, the Chief Conservator of Forests, Burma, has found that in the case of *Caesalpinia diyna*, the green pods can be easily and cheaply shelled by hand: and in this case, as in the case of the Babul pod, and probably also of *Caesalpinia coriaria* (Divi-divi), the seed must be rejected since it contains an injurious ferment and but little tannin.

Wood.

Lengths of young wood may be sampled in the same way as strips of bark, but they should be sawn, not broken, and the sawdust carefully collected. In the case of large numbers of bundles, sticks should be taken from 5 per cent. of these, and sawn through in 4 places. Sawdust alone, in this case, to be carefully collected and mixed and quartered down to suitable bulk for analysis.

Mature wood: Cuts must be taken from different sections of the log and all sawdust carefully collected as with the young wood.

So far but little work on wood has been done at Maihar, and that with negative results, as regards tannin value.

Finally, where a tanstuff or reputed tanstuff is sufficiently abundant to justify investigation, we look for samples to be taken on the above lines, at successive periods during the year.

My work at Maihar has largely had, so far, to do with preliminary analyses of many tanstuffs, and some of these are to be very fully studied by Mr. Fraymouth, Mr. Chowdry, and myself. The *Anogeissus latifolia* has already been under observation for some years by Mr. Fraymouth and the full knowledge of it he has gained has already borne fruit, especially coupled with the knowledge of other tanstuffs for suitable admixture, obtained during the co-operation between Messrs. Fraymouth, Marriott, Chowdry, and myself.

Colour measurement.

Much useful work however yet remains to be done on these tanstuffs, and among other things I intend to continue some work barely begun, on colour measurement of single tanstuffs and mixtures, in the early colouring stages of tannage.

Relative affinity of different tanstuffs for skin substance.

Further work lies in the determination of the degree of exhaustion in various tanstuffs after tannage.

A weak tanstuff, yielding all its tannin to the fibre, may obviously be more useful than a strong one which holds more tenaciously to its tannin. Some of our tanstuffs which are relatively weak in tannin, such as Maulrain bark, give the best results, while Mangroves with upward of 45 per cent. tannin give a most inferior tannage, although I have hopes of a suitable local

admixture with bleaching and softening properties being found for them. We have a tremendous number of samples sent us by various Forest officers, awaiting preliminary investigation now, and with those I have still left over from Belgium District and from Burma, they must number some hundreds.

It therefore has become an urgent matter to increase the analysis-output of the Escot laboratory and more apparatus has already been purchased. At present a batch of analyses in hide-powder put in one evening, are through the manipulation and evaporated to dryness the evening following, but it requires the greater part of the third day to get them constant in the water-oven. Some tanstuffs with appearance and smell of sugary constituents, such as Maulrain bark and S&L (twig) bark, are difficult to get constant, but the projected introduction of a vacuum-oven will effect considerable economy of time.

Even then, the hide-powder process cannot be regarded as a very quick one, and that is doubtless the reason why certain chemists prefer a direct gravimetric method, such as the precipitation with nickel hydrate put forward and used by Mr. Puran Singh, F.C.S., and the lead acetate method constantly used by Dr. David Hooper, F.I.C., F.C.S., for routine checks, and adopted at Escot by Mr. S. P. Chowdry, F.C.S., the Assistant Manager there.

With the permission of the Conference I will now read a brief note on the method, by Mr. Chowdry:—

Note on the direct estimation of Tannin by Gravimetric method (Precipitation with lead Acetate)
by S. P. Chowdry, F. C. S.

"The method was regularly used in the Government Economic Laboratory of the Indian Museum, Calcutta, by my previous chief Dr. David Hooper, F.I.C., F.C.S., late Economic Botanist to the Botanical Survey of India, where I worked and studied same, for several years, and this method has been introduced, in the Escot Laboratory, for quick estimation of percentage of tannin, and found to be extremely useful from the point of view of saving of time. It is of the utmost importance in the first instance that the sampling should be properly done and in cases where sufficient care has not been taken, in this first procedure, my experience has been to find a variation in the results.

Sampling—With a wagon load of stuff, the sampling is done in the following way:—

One handful is taken out of each bag; after mixing this it is quartered down to about 40 lbs. This is ground to 4" mesh, and after thorough mixing is quartered again and this second quarter is ground, passed through a 60 mesh sieve, and after mixing is ready for analysis. It is interesting to note that as good results have always been obtained from an infusion of 2 grams, as from one of 10 grams and even more, by the lead method, so long as the sampling is done with sufficient care. I usually take 5 grams for the infusion, and an aliquot part representing 1 to 2 grams according to the percentage of tannin roughly guessed, is taken and precipitated with lead acetate. The lead tannate is filtered off and washed. In its semi-dry state, the precipitate is removed from the paper, from which it comes away easily, and is put into a small porcelain crucible, which is then dried until constant in a water-oven.

The precipitate is then weighed as lead tannate.

This is then ignited to lead oxide over low flame, care being taken to prevent formation of metallic lead. The difference between the weight of lead tannate and the weight of lead oxide is calculated as Tannin. The whole operation is accomplished within 3 to 4 hours.

The following comparative results of some analyses carried out in the Escot Laboratory, J. A. Pilgrim, Esq., M. I. A. L. T. C., Tannin Export to the Government, carrying out the hide-powder I. A. L. T. C. method and the lead method being adopted by me, will show that the difference in each case is practically negligible.

	By Hide-Powder.		Lead method.	
	Tannin.		Tannin.	
Spent Turwad Bark (<i>Cassia auriculata</i>)		6.98 per cent.	6.9 per cent.	
Fresh Turwad Bark (<i>Cassia auriculata</i>)		21.10 "	20.93 "	
Silai Bark (<i>Boswellia serrata</i>)		13.09 "	12.9 "	
Arhar Dal Bark		3.47 "	3.39 "	
Khajra (<i>Bridelia retusa</i>) Bark		9.72 "	10.3 "	
Aonla (<i>Phyllanthus Emblica</i>)		19.01 "	18.92 "	
Maulrain (<i>Bauhinia Vahlia</i>) crushed, interior of stem		10.17 "	9.63 "	
Soja Bark (<i>Lagerstroemia parviflora</i>)		10.31 "	10.50 "	
Shishum Pods (<i>Calbergia Sissoo</i>)		1.62 "	1.80 "	

The method adopted by the I. A. L. T. C., after long experiments and careful research, is most accurate, and is the only method accepted by the trade. Other methods are regarded as giving inexact results; but where one has to analyse many samples a day it is very useful to adopt a short and easy method like the above for rough and quick estimation of tannin percentages, rather than spend the time and trouble necessary in the Hide-Powder method.

Few industries labour under such peculiar and difficult conditions as the tanning trade, being subjected, as it is, to rapid destruction of its raw materials, and quick fermentation and decomposition of tanstuffs and liquors during the processes, and there are so many other factors determining the quality of a tanstuff, beyond the mere estimation of the tannin percentage, that small differences in the results of analysis by different methods, may very well be neglected.

It has been noticed that there are certain tanstuffs indicating a fair proportion of tannin, when analysed in the Laboratory, which, however, develop certain defects inherent with them, during the process of tanning, thus producing such leather as to demonstrate their unsuitability for practical application."

Closeness of check between duplicate hide-powder analyses.

I have been much struck by the close concordance of results in nearly every instance between the two methods in spite of the greater accuracy that one would expect from the hide-powder method.

I now append a number of duplicate analyses selected to shew the close checks obtainable, even under tropical disabilities, with the hide-powder method :-

Date.	Name of Tanstuff.	1st duplicate analysis, calculated to air-dry sample.	2nd duplicate analysis, calculated to air-dry sample.	Averages calculated on the absolutely dry material.
		Per cent.	Per cent.	Per cent.
14th February 1917	Dhawa (<i>Anogeissus latifolia</i>) Twig Bark.	12.02	12.78	13.48
14th February 1917	Dhawa (<i>Anogeissus latifolia</i>) Mature Bark.	14.20	14.39	15.50
25th March 1917	Dhawa (<i>Anogeissus latifolia</i>) Mature Leaves.	13.10	13.12	14.35
20th April 1917	Dhawa (<i>Anogeissus latifolia</i>) Sumac.	23.88	23.00	25.06
16th February 1917	Spent Turvad (<i>Cassia auriculata</i>) Bark from Bombay.	6.23	6.47	6.98
3rd March 1917	<i>Anogeissus acuminata</i> .—Mature bark from Burma.	13.32	13.48	14.36
2nd April 1917	Teak Bark from Burma	0.35	0.45	0.42
23rd April 1917	Seja (<i>Lagerstroemia parviflora</i>) Bark.	9.25	9.45	9.88
2nd May 1917	Sai (<i>Terminalia tomentosa</i>) Twig Bark.	11.53	11.55	12.30
21st May 1917	Pyingadu (<i>Xylia dolabriformis</i>) Bark from Burma.	13.57	13.64	14.45
22nd May 1917	Myrabolans crushed (<i>Terminalia Chebula</i>) fruit.	46.20	46.38	49.95
24th May 1917	Ma-hrain Bark (<i>Bauhinia VahlII</i>).	16.30	16.35	17.25
1st June 1917	Karaunda Bark (<i>Cassia spinarum</i>).	4.69	4.80	5.05

The figures in the first two columns above illustrate closeness of check, but all figures of analysis issuing from Escocet are calculated on the absolute dry weight, as in column 3, above.

It is not possible to obtain in every case, results as close as the above, and as I may be accused of emulating the apple-woman's tactics of "putting the best fruit on top," I may mention that the rules of the I.A.L.T.C., allow a margin, between duplicate analyses of liquid extracts, of 0.5 per cent. and between those of solid extracts, of 1.5 per cent. With raw tanning materials a greater divergence than this might easily be expected, without the greatest possible care in sampling.

The following analyses are interesting in that the nett amount of tannin was within the proper limits, although the difference between the "Total solubles" and "non-tannins" was too great.

(i) Aonla (*Pylaglanthus Emblica*) ; fruit dried and ground without kernel.

						A.	B.
						Per cent.	Per cent.
Total solubles	..	..	..	..	..	43.00	41.04
Non-tannins	..	..	..	..	..	24.24	21.96
Tannin by difference							18.76 19.08

Ratio between total solubles and non-tannins not seriously disturbed when the extraction in both cases was not equally complete.

(ii) Salai Bark (*Boswellia serrata*).—

						Per cent.	Per cent.
Total solubles	..	..	..	..	..	31.83	33.10
Non-tannins	..	..	..	..	..	19.90	20.77
Tannin by difference							11.93 12.33

In each of these cases part of the same bulk sample was used ; the difference lies in the amount of total extractive matter.

In the case of the Salai, the difference between analyses A and B, is probably due to the existence in this material of "reds," soluble with difficulty rather more of which have been dissolved in the one case than in the other, though this ought not to have occurred since duplicate analyses always are carried on, in parallel. Separate estimation of these "reds" in the sample shewed, approximately, 3½ per cent.

It is more difficult to account for the difference in the amount of extractive matter in the case of the Aonla fruit ; but this may have been due to some undiscovered fault, in mixing, during sampling.

It is curious that in some instances such as the Teak Bark Analysis quoted, bodies with an infinitely small amount of tannin shew very concordant results, but a permissible difference of the hide powder with a material containing say 2 per cent. of tannin, and I feel that when a sample sent for examination shows by preliminary qualitative tests that it only contains a very small proportion of tannin, resource should be had if estimation be still deemed desirable—to the gravimetric lead acetate method, which is equally accurate for very small percentages.

There are a number of qualitative tests for tanstuffs from which their tanning properties may be guessed at, with some degree of accuracy, though of course there is only one way of obtaining the ultimate verdict, and that is by a series of practical tests on the tannery scale.

It is perhaps hardly within the scope of this paper to enlarge on the skill and devotion to this work, "in season and out of season" of both Mr. Fraymouth, and Mr. Chowdry, but the new leathers they have turned out "are their own epistle" which need only be seen, to earn them a full meed of recognition.

It may be of interest here, to mention a preliminary test for tanstuffs, mainly for the guidance of Forest officers, and others, who are good enough to send us samples for investigation. If a liquor prepared by boiling a small portion of the broken-up material in water for 10 minutes, gives no blue-black, violet-black or green-black colouration or precipitate, on addition to a portion, of a few drops of a 1 per cent. solution of iron alum, it is doubtful if it is of tanning value. But the remainder of the infusion should then be examined as to its condition with litmus paper :-

Acids turn blue litmus paper red.

Alkalies turn red litmus paper blue.

If the solution is neutral there is no change of either.

If the paper shews the infusion to be acid, a solution of soda should be added, drop by drop, with stirring, until the solution no longer reddens a fresh piece of blue paper, but not long enough for it to turn the red paper to blue.

The iron alum is then added, and if no colouration ensues the alleged tanstuff may be discarded.

There are, as already stated, a number of other more or less definite qualitative tests applicable in our laboratory, but as a rule the class of tannin may be prejudged from the nature of a raw tanning material, and the tests have been mainly devised for the examination of mixed extracts a much more difficult problem.

In writing of our methods at Escocet, if I lay myself open to the charge from brother members of my Society, of having departed in some small matters from the standard practice, I would venture to point out that our work is designed to get results, with all possible speed, and of sufficient accuracy to guide us in the ultimate practical application of a multitude of new tanstuffs and tanstuff-mixtures.

In this we have certainly succeeded and, e.g., in certain cases where a new tanstuff has shown that the guessed quantity taken, made an infusion stronger than 4½, or weaker than 3½ grams used, to avoid tannin per litre, the strength prescribed for an analysis, and easy to get at with a tanstuff of generally known tannin-strength, but impossible to estimate with a new tanstuff, we have found

Reds.

Unsuitability of the hide powder method for traces of tannin.

A rough preliminary test for tannin.

Lead (Pb.) check analysis shews

that infusion is not by a lead check, that the result was, none-the-less, quite accurate, and so avoided the necessity—of prescribed tannin where time is a consideration—of repeating the analysis.

I may point out that the cost of such lead checks is practically infinitesimal, whilst hide-powder is an expensive reagent which requires to be specially imported from certain recognised dealers in England. Further the cost of the additional time required cannot be left out of account.

I think it will be recognised that the difficulties of carrying out our work, in a country laboratory in the tropics, are in every way greater than those experienced in a tannin-chemist's laboratory at home, and in a country where even the operation of accurate weighing—especially by lamp-light—is at any time likely to be jeopardised by some such trifling cause as the gyrations of a minute but persistently migratory fly hopping from side to side of the beam refusing to be dislodged and finally settling on the sticky surface of the "Total solubles" basin being weighed, I think it will be conceded that we have not done ill, to obtain the consistent series of close analytical checks which are on record in our laboratory.

Need for, and essential characteristics of, a complete classification of Indian tanstuffs.

In conclusion, if it be urged, not without some reason perhaps, that the above is a dry subject to the lay mind in these "matters tannic," I would crave the indulgence of any such hearers, in reminding them that a tannin analysis is *one* of the important means to an important end, and that this "end" is a full and complete classification of Indian tanstuffs, such as should be an invaluable guide to the tanner requiring to produce any kind of vegetable-tanned leather with local tanstuffs, in any part of India.

In this, I am aware that I am looking pretty far ahead, since any single promising new tanning-material needs even years of a study covering all the ground between forest and finished leather before it is fully qualified for a place on such a class-list, or in such a compendium, as I indicate.

It is at any rate something, that at Maihar such work should have been begun; it is our hope that in due course the necessary number of willing co-workers may be found, to carry it through to successful completion.

MAIHAR, C.I.;

The 12th July 1917.

J. ALDRED PILGRIM.

APPENDIX IV.

Results of recent Research on Central Indian and other Tan-stuffs and their application to Leather Manufacture; Suggestions for Collaboration in Research on Tannin between the Esociet Tannin Research Factory and Forest Officers, by Mr. W. A. Fraymouth, Esq., F. C. S., Director, Esociet Tannin Research Factory, Maihar, under the Indian Munitions Board.

Before describing the results of five years' research on the application of several Indian tan-stuffs to the manufacture of leather, I wish to acknowledge the value that I have found in the work of earlier researchers and to describe the principles that have guided me to what has been achieved.

When I first became interested in the subject of indigenous tan-stuffs, I found that the local chamars knew how to make leather of sorts from many barks, leaves and fruits. I availed myself of all information that these people could give, watching their methods and processes. Indigenous tanners' information.

Several careful investigations of local indigenous methods are on record. I mention particularly the description of indigenous tanning in the Central Provinces by the Hon'ble Mr. C. E. Low, I.C.S. (see Central Provinces Industrial Survey). This could only have been written after the most careful investigation. The particulars given of costs and profits are most valuable.

I found that Mr. David Hooper, F.I.C., F.C.S., late Economic Botanist to the Government of India, had made a most thorough and extensive survey of those vegetable products of India which contain tannin (see The Agricultural Ledger 1902, No. 1, Indian Tanning Materials), and I would say now, after five years constant reference to this little book, that we have found only one important tan-stuff that was not known to Hooper. Hooper's Researches.

It is regrettable that, after this thorough preliminary survey of the subject, efforts were not made to follow up this information by practical large-scale tests of the tan-stuffs and their application to leather manufacture, thus applying the information that Hooper had amassed. On reference to page 2 of this work, the reader will find a history of tannin conferences which were spread over the years 1886 to 1899, and which resulted in little else than further analyses and this preliminary survey. It is noticeable that, instead of setting out to make leather from the tan-stuffs of India, the programme was to make extracts.

During the last nine years the Forest Research Institute have examined many hundreds of samples and have afforded every information in their power to such of the tanning traders who have asked for help. Many a Forest Officer has done his best by getting samples, and the United Provinces Forest Department have succeeded in persuading big tanning firms to try several new barks on a large scale.

The study of all these efforts will show that undue importance has been given to the percentage of tannin in small-scale samples, and, above all, that the ultimate leather to be got from each tan-stuff has not been given its proper place as a factor of importance. It was a study of this factor that produced the certainty in my mind that practically no single tan-stuff contains all the properties necessary to make good leather. I found however that by admixture of these natural tan-stuffs, almost any quality of leather can be produced.

I set before me the following factors governing the getting of tan-stuffs in their order of importance as below:— Factors governing tan-stuffs collection.

- (a) It must be possible to collect the tan-stuff without destroying the trees; or the tan-stuff must be available after the tree has been felled for other reasons.
- (b) The trees must be very widely distributed all over India.
- (c) The bark, or leaf, or fruit must be easily collected, dried, packed tight and delivered on rail at a low cost (for this I have later suggested a maximum cost, which will allow of sale on rail at one anna for each one per cent. of tannin per maund, to which may be added a bonus for special qualities desired by the tanner).
- (d) The tannin must be easily soluble in cold water and must produce good leather alone or in admixture with other tannins.
- (e) Lastly the tannin analysis may be considered. This must be estimated with close attention to sampling and with a close study of the tree and its habits. The result must always be calculated to percentage on the dry weight. All analyses, figures in this paper are so expressed.

I believe that these principles, which are original, have led to such success as has been achieved.

The consideration (a) has not been easy to uphold as a principle, but I am quite certain that it is the most important factor in making a success of Indian tan-stuffs.

Quite early in my researches I was led to try the bark of the smaller branches that are cut when one pollards a tree. I found that in almost every case the tannin in the tender bark of the branches and twigs is relatively more soluble, more gentle in action on the hide, will produce paler colour, and in some cases is richer in proportion to that contained in old bark from the bole. I have named such bark "Twig Bark," for if one named it "Branch Bark" too much of the bark from the bole would result. I mean by "Twig Bark" any bark from a branch with a bottom diameter not exceeding two inches, and which can be taken without destroying the tree.

Difficulties in
tan-stuff collection.

The greatest difficulties that I have experienced are such that will hamper any new efforts in other parts of India and are therefore worth setting down.

- (a) *Season and climate*.—With the usual delays of India, it is extremely difficult to organise a proper campaign to collect and despatch any particular jungle product.

I recommend the most detailed programme to be arranged for many months ahead.

- (b) *Railway freights*.—Perhaps the greatest factor in such success, as we can claim, is due to the liberal views of the East Indian Railway Company and particularly their District Traffic Manager, Cawnpore (N. A. Bond, Esquire, who gave us a wagon-mile-rate 0-2-6 up to 300 miles), thus allowing us to work 12 per cent tan-stuffs, which otherwise would have been unworkable. I am pleased to say that other railways have lately granted rates which, although not so favourable, are yet workable. I am very anxious to persuade the railways of India to classify all tan-stuffs as one class with a universal wagon-mile-rate, from any station to any station, *via* any station, on the broad gauge, just as grain is treated. On this depends the future of tanning in India.

- (c) *A new industry*.—The jungle contractor and the forest owner are both frightened of incurring preliminary losses. I advocate paying high rates at first. Competition brings these down within a very short time.

The Forest Department must be prepared to lose money during the first few years.

- (d) *Adulterant*.—The usual Indian contractor and jungle man has had such hard times that, feeling at war with the world, he cannot grasp the principle of supplying pure goods to gain a good name.

Almost every parcel of tan-stuffs that we have purchased has contained some adulterant; has been dosed with stick, stone, sand or water to make weight. I would impress upon every one that tan-stuffs must be collected and delivered as dry, clean, perfect products, or else the tanner will spoil his leather and refuse to use the tan-stuffs. Let it be a first principle that the tan-stuff must be collected with the greatest care; it must be dried thoroughly; no adulterant of any kind is permissible. The tan-stuff must be broken or compressed to the last degree, packed in bags, and delivered with a guarantee of tannin contents and purity. Take more care with tan-stuffs than with grain!

- (e) *The tanner's conservatism*.—I would impress upon all that the tanner has a most difficult job. Nothing whatever is known of the reactions that take place in the making of leather. The chemist is almost powerless, and even the experienced tanner is at a loss when some complicated reaction spoils a batch of hides. It is only natural that the tanner never wishes to try new tanning agents.

I would here express my thanks to the Director of Industries, United Provinces, who gave me the greatest help in placing large-scale samples of tan-stuffs with the United Provinces tanneries. The Hon'ble Mr. A. H. Silver has further helped me in every way in his power.

- (f) *Silviculture and Utilization*.—Practically nothing is known of the habits of the trees that yield the tan-stuffs. Generally speaking, experience has shown that the best tan-stuffs can be got from just such trees as have been regarded as useless up to date. In some cases just those species which are most valuable from a tannin point of view have been deliberately cut out as nuisances. It is not possible to determine immediately whether a certain mode of collection will or will not damage a tree. It is only after three to five years' study and after large-scale experiments that any regular method can be proven. The Inspector General of Forests realised the importance of this factor when, nine months ago, he moved the Silviculturist to Government to begin to study the *Anogeissus latifolia*; and we have to thank the latter officer for much valuable advice received already.

If I may venture a suggestion into a sphere which is not my own, it will be that one Utilization Officer for the whole of India will not suffice to study tannin trees alone. Had we a

Utilization Officer in every division, the Esocet Tannin Research Factory could rely on a series of samples from each species, which would be properly taken, and which, after a year or so, would lead to a complete knowledge of the trees in which we are, and will be, interested.

As a non-official with a long knowledge of the Indian jungles, I may express my opinion that unless such samples are taken by an experienced Forest Officer, who has specialised in utilization, such samples are of little use, and it is waste of time and money to take them into the laboratory.

It will be useful here to describe very broadly and very cursorily the several classes of leather that are made, and the consequent classes into which the tannin from various sources fall naturally according to their individual qualities as "leather-makers."

The so-called East Indian "half-tanned leather," long produced in Bombay and Madras, shows an extremely pale colour, is light and porous, very flexible and even elastic. This leather is tanned right through and perfectly preserved, but in order to use it for such work as boot uppers or harness, it has to be treated with more tannin and fats; in fact "curried." The home tanner demands this leather, because he can detect any faults at once, and by simple processes can produce almost any kind of finished leather. It would be more proper to call this stuff "tannin-preserved hide," for there is no doubt that this method preserves the hide in a most perfect manner, in a short time, at what should be a low cost, and what will be a low cost, when the tan-stuff business is properly developed.

It is only certain "light" tannins that will produce this leather.

It is possible in my belief to arrive in one operation at the density and firmness necessary for the boot upper or for harness by using a mixture of light and heavier tannins, which will produce a leather usually of a slightly darker colour than half-tanned leather, but which will show a "denser" section, when cut.

When it is desired to produce sole leather or a hard, firm, thick leather, colour becomes unimportant. Only those heavy tannins that will produce a dense, compact leather are of use here.

It has been customary to classify tannins, calling them Catechol or Pyrogallol tannins, etc., such classification being based mainly on certain doubtful qualitative tests with reagents, such as Sulphate of Iron, Bromine, etc. My experience leads me to think that almost every tannin has different properties, and that for practical purposes we are nowhere near a proper chemical knowledge of tannins. On the other hand, I find that if I carry out one, two or twenty empirical experiments on the leather-making qualities of any given tannin, I find myself in a position where I can give useful hints to the tanner. The following information is offered with the clear statement that it is the result of empirical experiments, and that my chemistry has only taught me to eliminate, nearly all chemical considerations in the study of leather-making tan-stuffs.

Put as simply as possible, the process of tanning a hide consists in —

The tanning
process.

- Wetting down and washing the hide.
- A Lime-bath, which removes flesh and hair and prepares the hide to receive tannin.
- An Acid-bath, which removes the lime, called the bate or drench.
- The Tan-bath.
- Drying and oiling or dressing the leather.

Cassia auriculata.—Turwad, Avaram, etc. I would have been glad to have made a much deeper study of the twig-bark of this species. So far I have not been able to study the trees, nor the getting of the bark, but I am of opinion that proper cultivation, above all systematic collection and bigger output, would reduce the present high cost of this material. The Forest Research Institute recommended the cultivation of this bush for its bark many years ago.

Tan-stuffs.

I must state at once that the leather-making properties of this bark are quite exceptional, and I doubt if any other tan-stuff can be found to provide a complete substitute for Turwad.

In practice the tanner receives a product containing from 20% to 22% tannin, the last 8% of which does not extract easily, and is not used by the tanner.

As supplied to the tanneries it contains much dust and dirt which the tanner removes by sieving. The price of the bark used to be so low, that the tanner could afford to lose all the powdered bark, containing much tannin, which is thrown away with the mud, dirt and sand. This constitutes an expensive loss at present.

No attempt is made to crush the bark before sending by rail, simply because the tanner can only judge of purity by seeing the individual pieces of bark, and therefore insists upon large,

clean pieces. At least one-half of the rail-wagon-space is lost now by such loose packing. If the bark could be properly prepared and broken down, packed in small bags and filled into the rail wagon properly, I believe that a saving equal to one to two annas per lb. of leather could be made.

After the raw hide has been soaked and limed to remove hair, flesh, etc., and after a slight washing in water, the Bombay and Madras tanners use half exhausted Turwad bark with some weak liquor from a previous batch, as the next treatment and thus "bate" their hides. In this respect, Turwad is quite exceptional. Every other tan-stuff that we have examined requires a bating of the hide, as a preliminary treatment, if soft and elastic-grained leather is to result.

The second and third parts of the process consist in laying down the hide with layers of uncrushed bark.

In Bombay all of this is done in leaky old tubs, except in one or two better run tanneries. After about one month the hide is completely tanned, and as far as I have seen, no particular care is taken throughout the process; apparently it is almost impossible to produce bad leather. A final treatment from two to three days consists in packing the leather in strong Myrobalsams. This and a final oiling of the hide is to produce weight. The extremely pale colour of Turwad leather allows of a very heavy dose of oil being absorbed without shewing on the dry leather.

I know of only one fault in Turwad. If the leather is exposed to the sun it rapidly turns to a bright red.

Although the manufacturer at home must find this most disconcerting (for one can imagine what would be the effect of dyeing such leather with a bright blue and then exposing the blue leather to the sun), yet I have been assured that this does not detract from the value of the leather. I have found that the addition of the young leaves of the *Anogeissus latifolia* modifies this fault, and produces a leather which darkens to a light brown, instead of the ugly red tinge.

My old Madras tanner-mistri tells me that Turwad used to cost between Re. 1 and Rs. 1-8-0 per maund, but that the price began to rise before the outbreak of war.

As soon as efforts were made to increase the output of Turwad-tanned leather for the Home War Office needs, the price rose, until I believe as much as Rs. 11 per maund was paid by some tanneries.

The tanner has had to calculate on a charge of 4 as. to 5 as. per lb of leather produced as the cost of tan-stuff, and had it not been for the efforts of the Controller of Hides and Wool to reduce prices, the consequent cost of leather would have been prohibitive.

Practically nothing has been done to produce Turwad twig-bark on a large scale. The bush is very common in the peninsula, and will grow as far north as Gorakhpore and Cawnpore. I understand that it will grow from seed, and only requires a small amount of water in its early years.

Thus I urge most strongly that this valuable bush should be cultivated. I cannot imagine any change in the tanning trade that would cause the value of this twig-bark to drop below Rs. 2 per maund, delivered at any railway station in India. Even if pure Turwad leather should not be in demand, every tanner could use some Turwad in admixture with other tan-stuffs to improve every kind of leather.

I am of opinion that a Turwad planting syndicate, privately financed, could earn good dividends, firstly by working natural areas now under the plant, which would later be replanted and worked intensively. Sales would be made in the first instance to Indian tanneries and later an extract could be made that would sell well in Europe.

I believe that the railway and canal organisations could add to their revenue by the planting of *Cassia auriculata* on their banks and waste lands.

As soon as the tanner can be supplied with quite clean twig-bark, guaranteed free from adulteration, he could be persuaded to use it in a powdered form, thus saving freight charges, and above all getting more of the tannin out of the tan-stuff.

The Government Hides Inspector at Dharavi has collected some thousands of maunds of the bark, as thrown away from the Bombay tanneries, which has been dried and sent up to Central India. This reject bark, containing some 8 per cent. tannin, has been crushed and applied in admixture with other tan-stuffs, to produce leather with the qualities of Turwad leather. This proves that the original twig-bark should be crushed to pass a $\frac{1}{2}$ mesh sieve before application to the hide.

We have found only one other tan-stuff (Gothar) the tannin of which strikes through the hide as rapidly as that of Turwad.

Cassia Fistula.—The bark from all fellings of this tree should be taken off, dried, and offered to neighbouring tanneries. It mixes quite well with the twig-bark of the Turwad. As the bark cannot be taken unless the tree is felled, and as so little bark is available, we are not paying much attention to this otherwise quite valuable tan-stuff, at present. If there are forests which contain sufficient trees, I recommend that a large sample (50 maunds) of twig-bark should be collected by pollarding the trees, and this sample should be sent to Malhar for investigation.

Anogeissus latifolia.—Dhawa. The young spring leaves of this widespread species have long been used by chamars. No "bate", except the old sour liquors from previous batches, is used, and in consequence a very harsh leather is produced. When this tan-stuff is used alone the leather has an objectionable pale-yellow-green colour. The chamar will never use any but the fresh young leaves; he finds the mature leaves too poor in tannin.

I found that many analyses had been done on these leaves with results varying from 6 per cent. up to 40 per cent., which had led investigators to expect that the large scale output of the leaves would vary considerably in value. The result of these adverse conditions was an almost universal condemnation of this tan-stuff.

A prolonged study of the tree with constant samples taken at different times of the year, from a forest close to my bungalow, soon shewed me exactly where the tannin lies in the tree, and that for practical purposes, the leaf products resolve themselves into two quite distinct tan-stuffs with different properties. The twig-bark has been found most valuable also.

"DHAWA LEAVES."

Directly after the rains the mature and partly immature leaves should be gathered without sticks or petioles. These may be collected until the leaf withers or becomes spotted.

In Central India the work must be stopped in mid-January.

The average tannin value of these old leaves is about 12 per cent., although with careful collection a 15 per cent. product can be obtained.

I have found that this tan-stuff can be used in admixture with almost any tanning bark. It will greatly hasten the time of tanning; it has the effect of bleaching leather during the process of tanning.

It yields its tannin with the greatest ease in water at temperatures under 50° C. Its supply is almost unlimited, and after collecting over 40,000 maunds and selling this really large scale output, I am convinced that it will be produced at less than 12 annas per maund f. o. r. in the future.

"ESOCIET SHUMAC."

The leaves of the *Anogeissus latifolia* do not fall early in the ordinary course of events, but I have found that whenever one plucks all the leaves of a tree, the result is that a fresh "flush" of leaves appears within a month. It is only between December and February that the tree fails to respond to such plucking.

If the trees are pollarded in February, a big yield of young leaves appears in March. If these are taken, a fresh "flush" appears in April, and if this plucking is continued, as many as four large crops of leaves can be collected and dried before the rains commence.

I have continued such plucking experimentally once every month throughout the rains until October, with the result, that the group of trees that were thus forced to yield seven monthly crops are now the healthiest in the locality.

I have set before me the problem of drying these leaves during the rains, and I do not despair of being able to devise methods of drying that will allow at least six crops of leaves to be taken in each year.

The dried leaves if beaten and sieved on a 10 mesh sieve, result in a coarse Shumac which we have proven to average 30 per cent. tannin, when collected on the large scale.

This I have named "Esociet Shumac," for my concern was the first to produce some 4,000 maunds in 1915-16, and to sell this to London and other tanners as "Shumac." The tanners, who used it, came back for more, but unfortunately high sea freights have for the present killed what will be a fine business later.

For the present this Shumac may be used by Indian tanners for all uses that Italian Shumac is put to. In addition it will entirely "kill" the red colour in other tan-stuffs, when used in admixture.

"DHAWA TWIG-BARK."

In pollarding or coppicing the *Anogeissus latifolia* much of the bark can be saved. We have found that the tannin in this bark, particularly in the twig-bark, gives a pale coloured leather

and gives weight to leather. Mixed with the Shumac from its own leaves it gives a most valuable tan-mixture. The average of the twig-bark shews 15 per cent. tannin.

Phyllanthus Emblica.—Aonla fruit and leaves have long been known to contain a high percentage of tannin. So far, I have nothing good to say of either fruit or leaves, although we may find methods of application of these in the future.

The twig-bark however, that is the bark from all branches taken in pollarding the tree, has proven of great value as a "light" tan-stuff. It carries some 20 per cent. tannin, nearly all soluble in cold water. A slightly pink colour is imparted to the leather when wet, which can be modified by admixture with Dhawa leaves. Above all the grain of the leather remains extremely smooth during tanning, and the hide remains plump until the process is complete. The resultant leather is extremely tough, will not tear easily and shews a grain which is elastic. This tan-stuff is the nearest in qualities to Turwad that we have found among those that have been tried. The twig-bark should be collected wherever it can be delivered on rail at prices below Rs. 1-8 per maund, for it may be used to take the place of a third of the Turwad which is used now, while Dhawa leaves will take the place of another one-third.

It should be easily possible to plant and grow Aonla.

Permalia Arjuna.—Kahua. The bark of the bole of this tree peels off in big flakes every hot weather. I have designed a hooked cutter which when used with a hammer-like blow causes a chip of the bark to jump out. It is almost impossible to cut into the cambium layer if this tool is used, with the result that one may strip the whole of the bark of the bole in October—November, removing $\frac{1}{4}$ " to $\frac{3}{4}$ " of the outside layers of the bark.

By the following April the wounded top layer dries up and flakes off, leaving the tree completely healed and having suffered no damage. Within two years the bark will be found to have thickened up to its original thickness.

The chips when dried pack closely and afford a rich tan-stuff (up to 24 per cent.), which has been used in large quantities during the last two years (over 30,000 maunds in Cawnpore alone). In my belief this tan-stuff will prove of extreme value in the production of heavier and denser leathers. It is possible to retain lighter leathers like those of Turwad and Aonla with Kahua bark, thereby producing great weight. Forest Officers may make considerable revenue by working those trees of this species which are situated near enough to the rail to allow the bark to be delivered at prices below Rs. 1-4-0 at a railway station. All bark from felled trees should be stripped and dried. I have found that this tree may be easily raised from seed, and that its growth is very rapid. It is a fine shade tree, and the attention of cantonment authorities and district boards should be drawn to the value of the bark if taken as described above. I have remarked that this tree constitutes a fine buttress or protection against erosion, if planted along streams which flow through cultivated ground.

The leaves of the Kahua are valueless as a tan-stuff, in fact the tannin is richest in the bole and the lower branches of the tree. The fruit is valueless, if taken when it drops, but we propose making a careful study of the fruit taken at earlier stages.

Zizyphus xylopyra.—The fruit of this species known as Gother in Central India is rich in tannin. Taken at the right time it may yield as much as 20 per cent., but we are yet uncertain as to its average value in the large scale. The solution in cold water contains a quantity of sticky matter which causes some fermentation. I intend to attempt to separate this matter, for we have been able to produce excellent, light leather from this fruit. The colour is pale, and the grain elastic. I believe that this fruit constitutes the cheapest tannin in India. It can be collected for 4 annas per maund, and at 20 per cent. this represents only one-fifth of an anna for each one per cent. of tannin per maund. Compare this with 5 annas for each one per cent. of tannin per maund in the case of Turwad!

Bauhinia Vahlia.—Mauhrain. The bark of this creeper, carrying about 12 per cent. of tannin (although we have had richer samples), has most valuable leather-making properties, a very pale colour and with extreme softness and elasticity. Used alone the bark causes stains during tanning, but these stains have never appeared when used in admixture.

This bark, the whole creeper and other Bauhinias will be subjected to much closer study.

Shorea robusta.—Sál. The extremely large quantities of bark that are available from annual fellings have induced us to try this bark in admixture. Our results so far indicate that with both Dhawa and Aonla, very fine, pale, soft leather can be produced. We are a little uncertain as to what tannin contents this bark will shew in bulk; our results vary from 10 per cent. to 15 per cent. and we have heard of higher percentages. One sample of the young leaves shewed 20 per cent. Beyond proving that the dark red colour usually associated with Sál leather can be avoided by admixture, particularly with Esocet Shumac, we may consider that we have only commenced what promises to be a most interesting research on this tan-stuff. I look upon this tan-stuff as the most likely raw product for extract manufacture in Central and Northern India.

The great shortage and consequently high prices for Turwad bark has hampered the efforts of the Controller of Hides and Wool, and the War Office Representative, to turn out the number of rough-tanned cow hides that are urgently required by the tanneries in Great Britain under the control of the War Office. Our earlier researches which were directed towards extract-making were dropped some six months ago, when the Controller of Hides and Wool made a request to the Tannin Expert to Government, and to me to search for such tan-stuffs as could be used in place of Turwad. We knew that it was unlikely that any other single tan-stuff would be suitable. We therefore attempted to reach the desired effect by modifying certain mixtures that had been discovered in the Esocet works, previously. After an inspection of the Dharavi Turwad tanneries, I became convinced that whatever substance we wished to introduce must be applied in direct contact with the hide. Finding that the Turwad tanner did not crush his bark, and that he threw away a "reject," still containing 7 per cent. to 8 per cent. tannin, we started to use this reject, after crushing to a fine powder. Some Dhawa leaves were added, which had the effect of bleaching out the dark colour produced by the old reject bark. Every tanner that I talked to, said that the application of finely powdered tan-stuffs in direct contact with the hide would fill up the pores and cause ugly marks on the leather. After many hundreds of large scale experiments, we can definitely contradict this assertion.

Further, being able to crush finely, it is possible to make a most intimate mixture of several tan-stuffs, and making a "porridge" of these with water to pack the hides in layers with beds of the tan-stuff "porridge."

Although, based on very old methods, this contact tanning with "porridge" mixture is a new method, and it has been extremely successful. I am persuaded that it is the most suitable method for Indian tanneries.

The liquors never become strong in tannin, for as soon as the tannin is yielded to the water, it is at once absorbed by the hide. The process of feeding the hide with tannin is very gentle and gradual. The intimate admixture of several tan-stuffs allows each special quality of each tannin to affect the hide simultaneously.

Practically no plant or machinery is required, and consequently there are no heavy capital charges. We are confident that special local tan-stuff-mixtures can be worked out for each large town in India, and we hold before us the ideal of innumerable small tanneries each to be fed with tan-stuffs from neighbouring jungles. I have hopes that there is a solution to the question of stopping part of the export of raw hides to Europe, and the consequent loss to India of her proper profit accruing from the tannage of her own hides with her own tan-stuffs.

We have found an ideal mixture for Malhar, consisting of one third Dhawa leaves, one-sixth Dhawa twig-bark, one-sixth Mauhrain creeper, and one third Aonla bark. We find that we require to use 4 lbs. of this to produce 1 lb. of leather, and we are sure of sufficient quantities of these barks and leaves to tan all the hides that come from the Esocet States. We are now working out tan-stuff-mixtures for Allahabad and Calcutta. The first will probably eventually be a Sál bark, Sál leaves, Dhawa leaves, Aonla or Mauhrain bark-mixture, while the second may probably be a Sundri bark-Dhawa leaves-Aonla bark-mixture.

Our ambition is to work out such mixtures for each locality where a tannery may be established. It is here that the Forest Officer can help us. It is only he that can ascertain how much of each tan-stuff can be produced annually from each district. I urge that all such estimates should include not only the produce from reserved forests, but also the tan-stuffs that can be got from unclassified forests, and such as are privately owned forests.

If the Forest Department will adopt the policy of assembling its own tan-stuffs with the output of other producers, it could give that careful supervision in central depôts, preferably at railway stations, which will assure to the tanner clean material.

If this work can be done by the Forest Department, it will be possible to keep prices at a fair standard and thus make proper revenue for the department and for other forest owners.

It will not be necessary to do all the work departmentally, although better results will be achieved in this way, or by employing local petty contractors.

The Forest Officer may study each tan-stuff, considering the factors that I have given above and then, collecting large samples, he may send these to Malhar, with detailed descriptions, when we will investigate any problems that arise.

We do not want samples from any trees of which there are insufficient quantities.

I now wish to submit to the conference my ideas for an ideal organisation, whereby the maximum revenue from tan-stuffs would accrue to the Forest Department and to other forest owners. I would ask for criticism of these ideas, which may have to be modified.

The extract solidification plant that was purchased by Government, and which was brought out by the Tannin Expert to Government, and which has been erected at Malhar with

Methods of application.

Local tan-stuff mixtures.

Tannin extracts.

some modifications, has been set down in connection with Esociet's crushing and extraction plants. The whole arrangement now constitutes a practical testing plant in which large samples (a rail-wagon-load or so), of each of the many likely tan-stuffs, can be crushed, and extracted, and from which extract can be solidified.

The Directors of my Company greatly appreciate the honour conferred upon us in being trusted with this Government plant, and we still more appreciate the generosity of Government in trusting us to carry out important research under the latest arrangements. After the Tannin Expert to Government and I have carried out extraction and solidification tests on those tan-stuffs, which we think will produce suitable solid or semi-solid extracts in the above plant, we expect to be able to put forward a complete scheme with full estimates for a large scale tan-extract plant. I am strongly of opinion that this first plant should be owned by Government.

The Tannin Expert to Government and I intend after the Reserach Factory has worked out the lines on which the leather is to be produced, to manufacture extract in sufficient quantity to enable several large tanneries to make leather with it.

We will aim to produce from tan-stuffs, which exist abundantly, such types of extract, as are likely to suit the consumer. I have hopes that if standard mixtures, say, one composed of light tannins, and one composed of heavy tannins, are in course of production in a big factory, it may be possible to introduce into these mixtures, proportionately small quantities of a large variety of other barks, that are similar in character to those used in the regular large output from the factory.

These could be collected from yearly coppices. If the Forest Department would then introduce the practice of saving all valuable barks and of putting these under cover in the coupes, until each lot could be offered to the Extract Factory, it might be possible to realise good value for such barks, and thus increase the revenue of the Forest Department.

Conclusion,

The present stage of our researches has made it a difficult matter to compose a report, and I fear that this paper will not be of much value as a record. If, however, what I have written will induce healthy criticism and gain for our Research Factory the invaluable and indispensable help of the Forest Officer, it will have achieved its purpose. Perhaps in a year from now, we shall be able to put on record really valuable concrete results.

I have to express my most sincere thanks to J. A. Pilgrim, Esq., M.I.A.L.T.C., Tannin Expert to the Government of India, with whom I had the pleasure of collaborating for over a year. His accurate analysis particularly, and hearty help in the whole of the work have been of immense value.

I would also thank my assistant Mr. S. P. Chowdrey, F.C.S., whose devoted work and care in experiments have been of the greatest service.

W. A. FRAYMOUTH,

Director, Esociet Tannin Research Factory.

APPENDIX V.

Remarks on Mr. Fraymouth's paper read at the Tanning Conference held at Dehra Dun on 14th August 1917, by the Chemical Adviser, Forest Research Institute.

As Chemical Adviser to the Forest Research Institute, I have something to say to the Introductory. Conference against the new proposals brought forward by Mr. Fraymouth regarding the future of tannin research and the co-operation of the Forest Department in general, as it seems to me that the said proposals involve a complete shifting of the foundations of research in this country, especially of chemical research of tanning materials, from the solid foundations of pure and applied science to what I should call the wasteful and rough empirical processes of the leather manufacturer. It is obvious that no chemical investigation of any tan-material can be regarded as finished, without working out the quality and colour of leather it yields and this proposition needs no emphasis. Mr. Hooper made a catalogue of tannin materials, quoting his own and other people's work without any reference to the colour or quality of leather produced, because he was working on the samples received for the Calcutta Museum and not with immediate reference to the industrial exploitation of these materials. But no work on the less known tan-materials was ever done at this Institute without considering the quality of the leather produced.

For the sake of convenience, I will arrange my remarks under the following heads :—

- (1) The importance of chemical study.
- (2) Local conditions.
- (3) Mr. Fraymouth's researches.

Though we are not in a position to say that our information on the chemistry of tannin is very definite, yet it cannot be denied that as far as it has gone, we have fairly reliable classification of chemical study. of tannins and we can at once predict most of the relevant properties of a new tan-material if we determine the class it belongs to. To ignore the knowledge we thus obtain and to insist upon experiments on a large scale as the only reliable basis of deduction, is as if an astronomer insisted on determining the time of sunrise by daily observations instead of calculating it by known principles which have stood the test of centuries or as if the Agricultural Department insisted on weighing every grain of wheat produced in any particular year to find out the yield for the year. Tannic acid as it occurs in nature is not a single substance, resembling in this respect, "terpenes" in essential oils. Before Wallach perfected his methods of analysis of terpenes and their isolation from each other, our ideas on terpenes were as vague as those on tannin now. The isomers that constitute tannins in nature can only be isolated by research of a high order and not by empirical methods. We know, for example, that the group of tannin contained in mangrove bark which attacks the hide first is not so soft a tanning agent as the tannin that comes out of the bark at a later stage of tanning. We can certainly take advantage of this fact of pure observation in reducing the harsh tannage of mangroves, but there is very little chance of knowing anything more about mangrove tannins by making leathers in factories.

To say that we can decide very little about the quality of tannin by studying its chemical reactions and classification is absurd. Let me take an example to see how we can proceed to select the suitable materials for a particular purpose merely from theoretical considerations. Suppose the problem before us is to find the substitute of *tarvad*. I argue that *tarvad* contains Catechol and gives soft tannage and good body to the leather. I know that the latter property is tannin, and gives soft tannage and good body to the leather. I therefore, turn my attention to all Catecho-tannins; but that most of them give hard tannage. I therefore, turn my attention to the Catechol-tannins that are available such as the wood of *Acacia Catechu* and attention to the Mangrove barks, etc. The practical question is to find out the ingredients to be added to these Mangrove barks, etc. As a working hypothesis, I in order to get soft tannage, such as myrabolans and sumachs, etc. As a working hypothesis, I consider that a mixture of myrabolan and khair or Khair wood and Sumach on a mixture of mangrove bark and myrabolan, are the required substitutes for *Tarwar*. One advantage in using mangrove bark and myrabolan, the latter like gambier will soften the leather and give it excellent body. The slow oxidation of catechin in the process of tanning will give small quantities of *lent* body. The slow oxidation of catechin in the process of tanning will give small quantities of *lent* body. The slow oxidation of catechin in the process of tanning will give small quantities of *lent* body. The slow oxidation of catechin in the process of tanning will give small quantities of *lent* body. I believe in my conclusions given above and in this way theoretical scientific work may guide and help commercial practice.

Mr. Fraymouth's tacit condemnation of the utility of theoretical work which is apparent even with our limited chemical knowledge of the subject seems to me unsound. When studying materials already known like oak barks of the Himalayas, wattle barks of the Nilgiris, it is waste of time to go to leathers for judging them. We will only see if they give their own reactions

already known and if they have the proper percentage of tannin. If we cannot use them on a commercial scale, it would be for reasons other than their quality of producing leather. There is every chance of good tanning materials being thrown out by "leather-tests" not properly carried out. With the same material I would not be able to produce that good leather which an experienced tanner could do without much trouble. The quality of leather finally produced has as much to do with the liming, bating and other preliminary processes it has to undergo, as the tannin used. In fact, a judicious mixture of any tannins will give good results in the hand of a good tanner. It is wholly out of the legitimate sphere of a tannin-chemist to go and meddle with the art of the tanner. For example, Babul bark is considered in certain quarters to give leather which cracks. But it is not on account of the quality of tannin but due to the dry climate or bad liming that it cracks. If we did not know this, we would be liable to condemn Babul bark unjustly.

Local conditions.

The second point which I think deserves a still greater consideration is that no industrial research can be properly carried out without an adequate reference to the "local conditions." These "local conditions" are an important factor in determining the commercial value of a new material brought forward. The "local conditions" can be altered for a short time for the purposes of emergency to meet a particular need, but nothing, not even official intervention can bring about much change in them except by a process of gradual and slow evolution. "Local conditions" include many factors like (1) the climate, (2) the habits of the people, their needs and their means, (3) the availability of the raw materials, (4) the market and its idiosyncracies, as well as its financial conditions, including the law of demand and supply, facilities for transports, etc.

With reference to Indian tan-materials, I can safely say that "local conditions" have determined for many years past "Babul bark" as the tanning material for the United Provinces, the Punjab, and Bengal, "*tarvad*" bark for Central Provinces, Bombay and Madras. And why? Because "Babul bark" in one part and "*tarvad*" in another part of the country are easily obtainable and give good leather at a very low cost. To give an idea of the state of affairs from this view-point, the "Babul tanned" leather of the Punjab sells in normal times at Rs. 55 to Rs. 60 per maund of 82 lbs. (buffalo) and about Rs. 70 per maund (cow). This means that they succeed to sell leather at the rate of annas 11 a lb. buffalo and one rupee a cow. Even in these war times this leather is available at about annas 15 per lb. buffalo and about Rs. 1-2-0 per lb. cow. Till 1915, Babul bark was sold for annas 12 per maund, but the present price is about Rs. 1-8-0 a maund. Forty-five lbs. of green pelt can be thoroughly tanned by 100 lbs. of Babul bark which yields about 22 lbs. of leather in about 90 days. The cost of 45 lbs. of green pelt being Rs. 18 and that 100 lbs. of bark being Rs. 2—it just costs about annas 14 a lb. and this when we take into consideration the cost only of pelt and the tan bark, omitting the cost of preparing the hides for tanning and liming, supervision and interest on the capital, etc. This shows that the Punjab tanner, favoured by local conditions, obtains his bark at a rate much lower than the market rates; otherwise he loses on every pound he sells in the market.

Similar is the case with the "*tarvad*" bark in the south. One-hundred lbs. of "*tarvad*" costing about Rs. 2-8-0 in normal times tans 57 lbs. of pelt giving 28 lbs. of leather in sixty days. (In both cases of "*tarvad*" and Babul, less is the weight of leather if the full days of number is not given to the tanning process, as it will give only 14 lbs. in the case of "*tarvad*", if we take it out after 35 days and similar is the result for Babul bark). The price of 100 lb. of bark being Rs. 3 and that of 57 lbs. of pelt being Rs. 23—we make "*tarvad*" leather at about annas 15 a lb. and the Madras and Bombay tanners have a very limited outlet for cow leather for export in normal times, they only sell sheep and goat leather which is exported for being retanned as semi-chrome to be finally finished as glassy kid, or for morocco. In normal times, the Madras and Bombay tanners sell these sheep and goat skins from Rs. 1-2-0 to Rs. 1-6-0 per lb. And considering that the leather tanned by "*tarvad*" absorbs a very large quantity of oil, they naturally get the benefit of the excess of oil put in. If the quantity of the oil that they sell as leather be omitted they apparently cannot be making much profit unless like their brothers in the Punjab and United Provinces, local conditions favour them.

As I have said the "local conditions" have already fixed these two materials for general tanning industry that there is in this country. One thing is patent that these barks are easy to get and are available in fairly large quantities and have been till now meeting the demand of the tanning industry to a very large extent in normal times, otherwise surely some other tan-materials would have come into use and already replaced Babul and "*tarvad*". Under normal circumstances, there is hardly any other material as good as these two obtainable in similar abundance which can be put on the market at these low rates. A detailed and thorough study of these "local conditions" would surely lead us to the same fact which has been fully acknowledged till now that it is an extremely difficult and slow a process if not practically an impossible one to replace Babul and "*tarvad*". It is for this reason that it has been till now considered more economic to extend the plantations of these common materials rather than think of more inaccessible (and therefore costly) ones. It is for these and other similar reasons that it became necessary to think of other fields of profitable utilisation of the less accessible materials of the Indian forests. The only conclusion that was possible to come to was to make

them into extracts and export them and I must say it holds good even now in normal conditions of things. It is still a doubtful question whether in normal conditions of trade, it will pay us better to export our tanning materials in the form of solid extracts and raw hides or to make the latter into unfinished leather for export as now brought forward by Mr. Fraymouth.

All foreign countries need our tan-materials and raw hides at all times and in any quantities, but they do not require all of our unfinished leather. To take here another analogous example it is as in normal times, it pays us better to export oil seeds rather than oil and oil cake. To hope or to think that after the war we shall be able to stop all trade on the old lines by restricting the export of raw hides, etc., is wholly impractical. In these days, the Forest Department is to help the War Department by all means at its disposal, but in normal times, the Forest Department cannot think of having plantations of tanning materials if they get nothing but a few rupees revenue after the enormous trouble taken in supplying hundreds of maunds of leaf-tans, required as cheap as Re. 1 to Rs. 1-12-0 a maund. If I gather aright, it has not been possible to those of the Babul or to prove that he can produce leather in normal times by any of its mixtures at the rates given above, to say nothing about his proposal of collecting the violet twigs of *Dhawa*, which, I must say have been discovered by him to contain as much as 40 to 45 per cent. of tannin. Under normal conditions, it is but natural that the Forest Department will again run on strictly business lines. It is certain that Babul and "*tarvad*" will not let us make anything cheaper than themselves in India, and even if we could collect leaf-tans cheaper than Babul bark, they are not the ideal tannins as with leaf-tans alone no tanner can produce good leather. The barks are the real basic tanning materials and the leaf and the fruit-tans are mere auxiliaries to give better colour or to mellow down the harsh tannage. If for argument's sake it may be allowed that the leaf-tans are the ideal tan-materials it would still be unwise to use them in this country when better prices can be obtained in other countries for extracts from them. From these considerations, I should think that after the war the only economic procedure for us will be to extend the cultivation of Babul and "*tarvad*" with no special organisation or cost and to export all other tanning materials in the form of extracts or in other concentrated forms.

In my opinion Mr. Fraymouth has not established his case for shifting the fundamental principles of our research work. I must say that all what he has told us about the admixtures is as old as leather tanning. The comparative "cold leaching" of sumach, or leaf-tans is already down in the text books. Great credit is due to him for finding that the violet twigs of *Anogeisus Latifolia* contain as much as 40—45 per cent. of tannin, but this discovery is of no economic importance on account of the difficulties of collection and drying, etc., at reasonable cost. He will have eventually to fall back on ordinary Dhawa leaves as can be made available at average prices which we can possibly allow for them in normal times of fair competition. The mixing of different tanning materials is an art of the tanner and it is universal. In fact when this Institute proposed some years ago to make tan-extracts of suitable mixtures for export, the chief of the Leather Sellers Company, England, Mr. Pullman, gave us to understand that the English tanners do not wish to get any mixed extracts. They are particular to get different materials in the form of pure extracts which they will mix themselves according to their own judgment. The idea was then dropped. And in this connection I wish to say again that these admixtures are made in Europe by tanners largely assisted by chemical analysis, and all this work is done according to the standard methods. Mr. Fraymouth's remarks against the classification of tannins into Catechol and pyragallo tannins, etc., are wholly unwarranted and unsupported by any work of his own or that of any body else. As I have already said, it is the chemical constants of tannin that tell us what kind of leather it will give.

He has not proved, and cannot prove that in normal times it will pay better to export leather than the raw hide and the extracts. He has not yet proved that his mixtures are a commercial success, unless he gets bounties in the shape of concessions from the Forest Department, and the Railways.

The proof of real industrial research lies in the discovery of processes which will pay without being bounty-fed.

I therefore respectfully urge on this Conference that Mr. Fraymouth has made out no case for such radical departure from what is termed by him an old view of things.

13

1917.

PURAN SINGH,

Chemical Adviser.

APPENDIX VI.

(TAKEN AS READ.)

Note by Mr. Puran Singh, Chemical Adviser, Forest Research Institute, Dehra Dun on *Acacias* in the Nilgiris.

About seventy years ago, three species of Australian Wattles, i.e., *Acacia Melanoxyylon*, (the Australian blackwood), *Acacia dealbata* (the silver wattle), and *Acacia decurrens*, (the black wattle) were introduced in the Nilgiris, but up till the present time their barks have not been extensively employed for tanning purposes. This is chiefly due to the fact that the various analyses carried out have shown the tannin content to vary to a marked degree. Another factor which has stood against their introduction on the market is the distance over which they have to be exported to central tanneries.

Various analyses of the barks of the Nilgiri Wattles have been recorded. In some cases they have been found too poor in tannin to be considered as tanning materials of any economic importance and in others the results indicate that some barks are quite as rich in tannin as the average Australian or African Wattles. At the instance of Mr. R. D. Richmond, the District Forest Officer, Nilgiris, authentic specimens of the Nilgiri Wattle barks were examined with a view to arriving at some definite conclusion as to the desirability or other otherwise of extending their cultivation. It is, however, unfortunate that even the present enquiry has given no concordant results. The barks derived from the Government plantations gave a very low percentage of tannin, while the specimens of the barks collected from trees grown in some of the private estates of the Nilgiris show as much tannin as that recorded for the Australian or the African barks. It has not been possible to assign any reason for the great variation of tannin content in these two classes of barks. Possibly it may be due to climatic or silvicultural conditions or to slight botanical variation of the species. If this is so, it might be advisable for the Silviculturist or the Forest Botanist to carry out further enquiries. At the same time, though results obtained from analyses cannot be claimed to prove anything definite as regards the yield from a given variety, they at least show that the same species under different conditions yield varying amounts of tannin.

Wattle barks are valuable tanning materials containing as much as 35-40 per cent. of tannin and it is essential when planting these exotic species in our forests that a careful study of the factors which tend to increase or decrease the tannin content should be made in order to get the best results, and it is of first importance to select the species or varieties yielding the largest per cent. of tannin.

The Wattle bark is extensively used in European tanneries and is a tanning material of great commercial value. Before the war, most of it found its way to Germany where it is said to have been first converted into tan extracts. It is a material rich in tannin but of comparatively deeper colour when compared with many other good tanning materials of similar quality. Its tannin is easily leached out of the bark and only about 3-4 per cent. is left in the spent tan. It can be used with great advantage as an admixture with other materials, is best suited for tanning heavy leathers and in certain cases for the production of light leathers also.

Paessler* points out that the Wattle bark has only about 14 parts of sugars as compared with Oak and Pine barks, which contain as much as 30 and 40 parts of sugar per 100 parts of tannin respectively. The tan-liquors made from the Wattle bark are therefore far less prone to fermentation than those produced from other materials.

Many tan-liquors lose their strength on storage. The following table prepared by Professor Paessler illustrates the fact that the Wattle bark tan-liquors maintain their strength when stored. The figures given in the following table represent the percentage of loss of tannin from liquors of 2° Baume strength, after keeping for sixty days:—†

	Per cent.
Gambier	0.0
Mangrove bark	0.0
Quebracho wood	4.0
Oak bark	7.5
Oakwood extract	12.5
Galls	16.0
Myrabolans	24.0
Valonia	29.0
Divi Divi	29.0
Wattle bark	2.0

The samples of the Nilgiri Wattle barks obtained from time to time through the kind offices of the District Forest Officer, Nilgiris, were examined with the following results. The trees from which the bark was stripped were felled and the bark dried in shade before despatch to Dehra Dun. An average sample of the bark to be examined was powdered and analysed according to the chromed hide powder process of the International Leather Trades Chemists' Association.

*Journal of the Society of Chemical Industry, 1913, page 501.

†Collegium 1904, 277-280-284, 290 and also Journal of the Society of Chemical Industry, 1904, pages 991-92.

Table of analysis of the Wattle barks from the Nilgiris.

Serial No.	Description of the bark.	Age.	Moisture, per cent.	Ash, per cent.	Total soluble solids, per cent.	Non-tannin, per cent.	Tannin, per cent.	Tannin calculated on dry material, per cent.	Tintometer reading on tan liquor calculated to contain 5 per cent. strength in 1 c. m. all.	
									Red.	Yellow.
1	Bark of <i>Acacia dealbata</i> from Governor Shola, VI-L.	51 years.	12.59	3.65	24.08	9.04	15.04	17.21	12	21.5
2	Bark of <i>Acacia dealbata</i> from Sheffield III-L.	6-9	15.21	3.11	12.35	4.60	7.75	9.14	..	..
3	Bark of <i>Acacia dealbata</i> from Bleak House Compartment VII.	25 years.	9.07	2.05	16.69	2.34	14.35	15.78	15.0	27.0
4	Bark of <i>Acacia dealbata</i> from Bandy Shola Compt. V.	15 years.	8.04	2.30	18.13	2.81	15.32	16.66	8.8	23.0
5	Bark of <i>Acacia dealbata</i> from Forest Ranger, Coonoor.	9 years Opples shoots.	7.94	..	23.44	10.50	12.94	14.05	5.4	11.0
6	<i>Acacia melanoxylon</i> from the Forest Ranger, Coonoor.	9 years.	7.87	..	26.56	12.07	14.49	15.72	6.0	12.0
7	<i>Acacia melanoxylon</i> from the Forest Ranger, Coonoor.	20 years.	7.23	..	21.25	10.91	9.36	10.10	5.7	14.0
8	Bark of <i>Acacia melanoxylon</i>	..	12.31	2.18	17.87	6.77	11.10	12.65	..	..
9	<i>Acacia decurrens</i> Baikie IV, 3	6-9 years.	14.4	2.04	24.72	6.96	17.76	20.76	10.0	19.0
10	<i>Acacia decurrens</i> from Range Officer, Ootacamund.	6-9 years.	7.94	..	28.84	11.36	17.48	18.98	10.4	21.5
11	<i>Acacia decurrens</i> from Mr. Parry a Local Planter, Ootacamund. The tree having been raised from the seeds obtained from Natal.	About 10 years.	8.85	2.67	51.24	10.78	39.46	43.29	5.5	7.6
12	<i>Acacia decurrens</i> from trees grown in the This Shola Estate.	8 years.	12.06	3.47	38.16	7.56	30.60	34.80	7.0	14.0
13	<i>Acacia decurrens</i> from a dead tree.	..	14.63	3.71	27.00	2.60	24.40	28.58	15.3	22.5
14	The bark of <i>Acacia decurrens</i> from trees grown in Baikie Block IV, Compt 4.	33 years.	10.12	2.30	30.16	4.51	25.65	28.54	9.0	18.6
15	The bark of <i>Acacia decurrens</i> from trees grown in Baikie Block IV, Compt 4.	33 years.	10.06	2.07	26.72	5.90	20.82	23.15	11.0	21.0
16	The bark of <i>Acacia decurrens</i> from trees grown in Baikie Block IV, Compt 4.	33 years.	10.20	2.10	23.92	4.08	19.84	22.10	23.5	29.0
17	The bark of <i>Acacia decurrens</i> from trees grown in Rob Roy Estate, near Kotagiri.	6-7 years.	11.64	2.79	53.12	8.33	45.50	51.59	5.6	6.0

Acacia dealbata and *Acacia melanoxylon*. It is evident from the results given above that the variation in the tannin yield of the bark of *Acacia dealbata* taken from trees, 5, 9, 15 and 25 years old trees respectively is not high. The tannin content of the bark of *Acacia melanoxylon* is about 15 per cent. These results are similar to those obtained for the Australian and African Silver Wattles. Both these species have already been rejected for industrial exploitation by the African planters.

Acacia decurrens. As regards the bark of *Acacia decurrens*, the variation in the percentage of tannin in different samples is remarkable. The barks obtained from trees grown on private estates, e.g., the This Shola Estates, Mr. Parry's and Rob Roy Estate, show a tannin percentage of 34.43 and

51 respectively.* On the other hand, the maximum percentage of tannin in samples received from the Government plantations is about 29, and the average is about 20.22. As regards the best age for collection, it may be generally said that the young trees yield a richer bark than the old ones. For stripping purposes the tree may be said to be mature for yielding the tan bark at the age of 6-9 years. From the results obtained it is evident that no conclusion can be arrived at as to the respective value of these Wattles for tannin purposes, nor will it be possible to do so until their botanical classification is definitely settled. It is therefore recommended that the question of planting *Acacia decurrens* in India for purposes of utilising its bark for tanning should be deferred until the various species now growing in the Nilgiris have been satisfactorily identified, after which it will be possible to carry out their chemical analysis with a fair hope of arriving at more uniform results.

As desired by Mr. R. D. Richmond, the leaves of *Acacia dealbata* and *Acacia decurrens* were also examined with the following results:—

Serial No.	Description.	Moisture, Per cent.	Ash, Per cent.	Total solubles, Per cent.	Non-tannin, Per cent.	Tannin, Per cent.	The Tannin Content of Wattle leaves from Nilgiris.
1	Dry leaves of <i>Acacia dealbata</i> obtained from Nilgiris, collected in winter.	8.34	3.22	21.36	17.76	3.60	
2	Dry leaves of <i>Acacia decurrens</i> obtained from Nilgiris, collected in winter.	9.15	3.70	15.12	11.98	3.14	

From this tabular statement it is apparent that the above are useless as tanning agents.

In order to see if the bark of *Acacia decurrens*, grown elsewhere in India, is richer than that of the Nilgiris, two samples of the same were obtained from the Ranikhet plantations through the kind offices of the Conservator of Forests, Kumaun Circle. They were examined with the following results:—

Serial No.	Description.	Moisture, Per cent.	Total soluble solids, Per cent.	Non-tannin, Per cent.	Tannin, Per cent.	Total calculated on dry material, Per cent.
1	The bark of young Wattle trees (<i>Acacia decurrens</i>).	10.34	27.76	7.89	19.87	22.16
2	The bark of the old Wattle tree ..	10.65	25.31	7.37	17.94	20.08

These results show that the trees grown at Ranikhet give a bark yielding a similar percentage of tannin to those from the Government plantations in the Nilgiris.

*Mr. Hooper loc. cit. mentions one of the barks from the Private Estates of Nilgiris examined by him as derived from *Acacia pyramantha* and not as from *Acacia decurrens*.

To Under Secretary

2. A copy of the Government of India letter, with a copy of the proceedings of the Tanning conference may be sent to Home (Educational) department for issue of necessary instructions with reference to para.5 (a) of the Govt. of India letter.

G.H.J.

S.R.
7-11-17.

P.O.
7-11-17.

To Secretary

G.H.J.
7-11-17.

Yes, but the main file must not leave Revenue. It may be needed at any time.

A.R.K.
7-11-17.

X.R.

Home (Educ.) no.



Home (Educ.) Dept.

A draft order is submitted for approval.

875
7/11/17

Dr. L. 12/11/17

MY
11/11/17

Op. at sec. 9/11

Rev. no. 2800A/17-4
8.11.17.

17/10

Sept. 11-10 (6)—1-17

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C. No. 2391A From the last 2 divs No. 5787 dated Mar. 10, 1917

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No. 1416, dated 12-11-1917

(c.f.)

A copy of the letter from the Govt of India, No. 5707-162-12, dated the 12th October 1917, with enclosures, is forwarded to the officer in charge of the Dept of Industries who is requested to arrange for the conduct of the experiments suggested in para 5 (a) of the letter.

8k
11.11.17

To The officer in charge
of the Dept. of Education
(with copy of Govt's letter and
copy to the Rev. Dept.)

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1/11

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