BULLETIN OF THE IMPERIAL INSTITUTE

A QUARTERLY RECORD OF PROGRESS IN TROPICAL AGRICULTURE AND INDUSTRIES AND THE COMMERCIAL UTILISATION OF THE NATURAL RESOURCES OF THE COLONIES AND INDIA

EDITED BY THE DIRECTOR AND PREPARED BY THE SCIENTIFIC AND TECHNICAL STAFF OF THE IMPERIAL INSTITUTE AND BY OTHER CONTRIBUTORS

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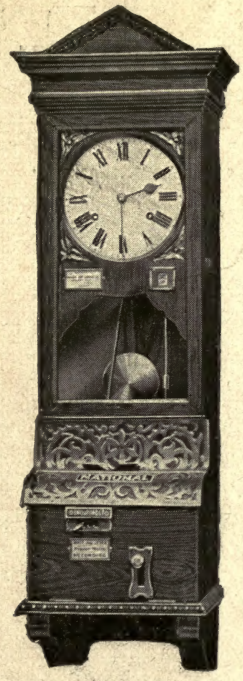

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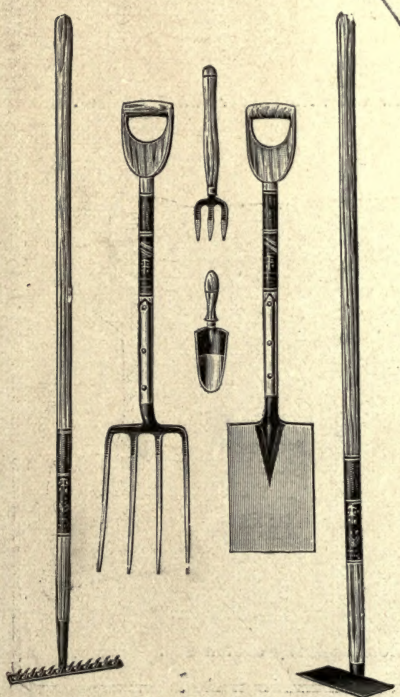

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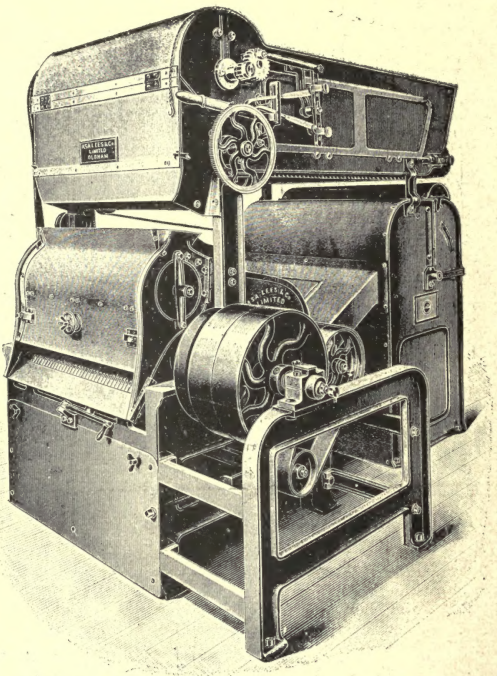

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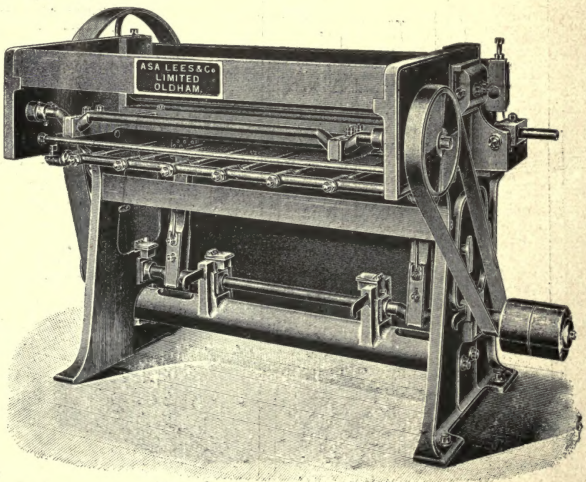

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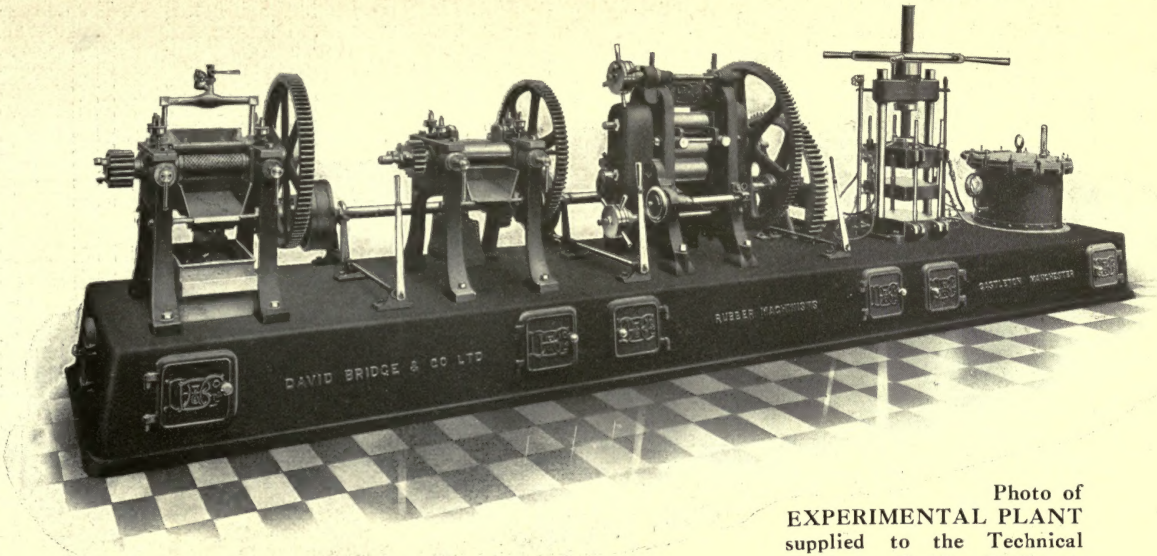

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1913

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VOL. XI NO. 3

[*Face 1st matter*

REPORTS OF RECENT INVESTIGATIONS AT THE IMPERIAL INSTITUTE

The following summaries have been prepared from a selection of the Reports made by the Director of the Imperial Institute to the Colonial, Indian, and other Governments concerned.

THE QUALITY OF PARA RUBBER FROM VARIOUS SOURCES

In the following pages an account is given of the results of the examination at the Imperial Institute of a number of samples of Para rubber from Ceylon, India, Southern Nigeria, British Guiana, and Papua.

Ceylon

In previous numbers of this Bulletin (1911, **9**, 300, 406; 1912, **10**, 496) reference has been made to tapping experiments carried out in Ceylon with the object of ascertaining the most suitable interval between successive tappings. Seven samples of the rubber obtained in the course of these experiments were received at the Imperial Institute for examination. Each sample consisted of a number of biscuits and represented the rubber prepared from a row of trees tapped at intervals of one, two, three, up to seven days respectively.

The samples exhibited good physical properties on the whole, but a few of the biscuits were rather weak. The results of the chemical analyses are shown in the following table:

Percentage Composition of Dry Washed Rubber

	Caoutchouc.	Resin.	Protein.	Ash.
No. 1	95·7	1·7	2·3	0·3
No. 2	95·4	2·5	1·9	0·2
No. 3	96·1	1·7	2·0	0·2
No. 4	96·3	1·8	1·7	0·2
No. 5	96·0	2·0	1·8	0·2
No. 6	96·3	2·0	1·5	0·2
No. 7	96·3	1·8	1·7	0·2

It will be seen that all the samples were of very good quality, so far as composition is concerned, and it is of interest that the rubber obtained by tapping at intervals of three to seven days contained a little more caoutchouc than the rubber obtained by tapping every day or every other day.

For an account of other samples of Para rubber produced in the course of tapping experiments in Ceylon, see this BULLETIN (1912, **10**, 380).

INDIA

Six samples of Para rubber produced in the Mergui District, Burma, were received for examination in July 1912. The samples were as follows :

No. 1. "*Scrap Crêpe.*"—Thick crêpe rubber of dark brown colour, well prepared, and containing only a small quantity of vegetable impurity. The physical properties of the rubber were very good.

No. 2. "*Dark Crêpe.*"—Rather thick crêpe rubber, very similar to the preceding specimen, but a little darker and not quite so clean. The physical properties of the rubber were very good.

No. 3. "*Smoked Crêpe No.* 1."—Thin reddish-brown crêpe rubber, possessing a distinct smoky odour. The rubber was clean and well prepared, and its physical properties were satisfactory.

No. 4. "*Smoked Crêpe No.* 2."—Thin crêpe rubber varying in colour from light to dark brown and having a smoky odour. The rubber was fairly clean, and its physical properties were satisfactory.

No. 5. "*Pale Crêpe.*"—Thin pale crêpe rubber, clean and

well prepared. The rubber exhibited very good physical properties.

No. 6. "*Crêpe.*"—Thin pale crêpe rubber, clean and well prepared, but rather darker than the preceding specimen of "pale crêpe."

The results of chemical analyses and the valuations of the samples are shown in the following table:

	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	No. 6.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Loss on washing (moisture and impurities)	0·8	1·6	0·4	0·4	nil.	0·2
Composition of dry washed rubber:						
Caoutchouc	92·1	92·0	92·8	90·0	94·3	93·6
Resin	2·8	2·5	3·6	3·1	3·2	3·1
Protein	3·3	3·8	3·1	2·9	2·2	3·0
Ash	1·8	1·7	0·5	4·0	0·3	0·3
Value in London, with fine hard Para at 3*s.* 4*d.* per lb.	3*s.* 2*d.*	3*s.* 2*d.*	3*s.* 3*d.*	3*s.* 3*d.*	3*s.* 4*d.*	3*s.* 3½*d.*

It will be seen that the samples showed some variation in composition. In general the percentages of resin and protein were a little higher than is usual in the best plantation Para, and in three cases, viz. Nos. 1, 2, and 4, the amount of ash was excessive. The two best specimens, Nos. 5 and 6, contained 94·3 and 93·6 per cent. of caoutchouc respectively in the dry material, and were of very good quality.

Southern Nigeria

Two samples of Para rubber grown at Sapele, Central Province, Southern Nigeria, were received in May 1912 and January 1913 respectively. Previous samples obtained during tapping experiments at Ebute Metta and at Orugbo were dealt with in this Bulletin (1910, **8**, 342).

No. 1.—This consisted of two rough biscuits of dark brown rubber with a strong smoky odour. The rubber was clean and well prepared, but contained some specks of solid impurity; the physical properties of the rubber were satisfactory.

No. 2.—This sample consisted of a large thin biscuit of brown rubber, which was very well prepared, although a

little rough on the surfaces. The rubber, which had been slightly smoked, exhibited excellent physical properties.

The results of the chemical examination of the two samples were as follows :

	No. 1.	No. 2.
	Per cent.	*Per cent.*
Loss on washing (moisture and impurities)	0·6	0·6
Composition of dry washed rubber :		
Caoutchouc	93·0	93·8
Resin	4·3	3·5
Protein	2·2	2·3
Ash	0·5	0·4

Sample No. 1 was classed as fair average quality by brokers, and was valued at about 4*s.* 10*d.* per lb. in London, with fine hard Para at 4*s.* 10½*d.* per lb., and smoked plantation sheet at 4*s.* 8*d.* to 4*s.* 11*d.* per lb. Sample No. 2 would have a similar value.

The results of the examination show that these rubbers were satisfactory both in composition and physical properties, and that consignments of similar character would realise very good prices in the market.

British Guiana

A sample of Para rubber biscuits and one of scrap rubber were received from British Guiana in February of this year. The rubber was obtained from trees planted at the Government Rubber Station at Issorora in the North-West District of the Colony. The trees were first tapped in July 1912, when they were about four and a half years old, their average girth at 3 ft. from the ground being 18 in.; tapping was continued every second day for six months. The samples of rubber were as follows :

No. 1. *Biscuit Rubber.*—Small thin biscuits, light brown to reddish-brown in colour, clean and in good condition. The rubber was slightly weak, but, considering the age of the trees from which it was obtained, its physical properties must be regarded as quite satisfactory.

No. 2. *Scrap Rubber.*—Cakes of rubber varying in colour from light brown to almost black. Like the preceding specimen, the rubber was slightly weak.

The results of examination of the samples are shown in the following table :

	Biscuit rubber. *Per cent.*	Scrap rubber. *Per cent.*
Loss on washing (moisture and impurities).	1·0	2·8
Composition of dry washed rubber :		
Caoutchouc	95·3	93·7
Resin	2·0	2·5
Protein	2·5	3·2
Ash	0·2	0·6

The biscuit rubber was valued at about 3*s.* per lb. in London and the scrap rubber at about 2*s.* 6*d.* per lb., with fair average-quality plantation sheets and biscuits at 3*s.* 1½*d.* to 3*s.* 2½*d.* per lb., and fine hard Para at 3*s.* 6½*d.* per lb.

The biscuit rubber was very satisfactory in chemical composition, containing over 95 per cent. of caoutchouc in the dry material, and in this respect it was quite equal to plantation Para rubber from the East. The strength of the rubber will no doubt improve as the trees become older, and the product will then be of excellent quality. The scrap rubber was also of good quality. It contained a little more resin, protein, and ash than the biscuit rubber, and consequently the percentage of caoutchouc was lower.

Papua

Up to the present all the rubber exported from Papua has been obtained from *Ficus Rigo* and an unidentified vine, which are indigenous to the island (cf. this Bulletin, 1912, **10**, 386), but *Hevea brasiliensis* and other rubber-yielding trees have been planted, the area under the former on March 31, 1912, being 4,496 acres. Some of the Para rubber trees are now coming into bearing, and tapping has been commenced recently. A sample of the first consignment of Para rubber produced in the Territory was received at the Imperial Institute for examination in November 1912. It was stated to have been obtained from trees grown at Sogeri, 32 miles from Port Moresby, at an elevation of about 1,200 ft., and about 25 miles from the coast.

The rubber was in the form of large thin sheets of pale brown colour; it was clean and very well prepared. The

physical properties of the rubber were excellent. It was analysed with the following results:

	Per cent.
Loss on washing (moisture and impurities)	0·4
Composition of dry washed rubber:	
Caoutchouc	95·7
Resin	2·8
Protein	1·3
Ash	0·2

The sample was valued at 4*s.* per lb. in London with fine hard Para at 3*s.* 11*d.* per lb. and fair average-quality plantation sheets and biscuits at 3*s.* 10¾*d.* to 3*s.* 11¼*d.* per lb.

This rubber from Papua was of excellent quality both as regards chemical composition and physical properties. In these respects it was quite equal to the best plantation rubber produced in the East, and consignments of similar character would always realise the current market price of the highest grades of plantation rubber. The prospects of the cultivation of the Para tree in Papua, therefore, appear to be exceedingly promising.

CEARA RUBBER FROM NORTHERN NIGERIA

The Ceara rubber which is dealt with below was received from Northern Nigeria in January of this year. The following particulars in regard to the rubber were supplied by the Director of Agriculture.

The sample consisted of balls and strips of rubber and represented the produce of nine trees, which were said to be six years old, their average girth being 18 in. The trees were growing at Bida, and their poor growth may probably be accounted for by the poverty of the soil at that place. Tapping took place in the morning between 6.0 a.m. and 7.0 a.m. every alternate day, on the Lewa system as practised in East Africa, the latex being coagulated on the tree with fresh lime juice. The total number of tappings was fourteen, but the yield of rubber diminished very rapidly after the fourth tapping. This experiment was carried out towards the end of the rains, and probably a great deal more rubber could have been obtained if the trees had been tapped

earlier in the season. The trees did not appear to have been seriously damaged by the tapping.

The strips of rubber were light brown, clean, and well prepared, and very satisfactory in physical properties. The balls were darker in colour and not of such good appearance as the strips, owing to the development of mould on the surface.

For the purpose of chemical examination the strips of rubber were taken and were found to have the following composition:

	Per cent.
Loss on washing (moisture and impurities)	8·6
Composition of dry washed rubber:	
Caoutchouc	82·3
Resin	7·6
Protein	8·4
Ash	1·7

The rubber was therefore of very fair quality, comparing favourably in composition with specimens of Ceara rubber prepared in East Africa by the Lewa process. Ceara rubber obtained by this method usually contains a rather high percentage of protein, as the whole of the protein present in the latex is included in the rubber.

Ceara rubber in strips or balls similar to these samples would always be readily saleable. The rubber in strips would be more valuable than that collected in balls, and as the preparation of the strips involves no difficulty the collection of the rubber in this form should be encouraged. It is impossible to give a definite valuation for such a small sample, but rubber in strips similar to the sample would probably be worth about 3*s.* 6*d.* per lb. in London with fine hard Para at 3*s.* 11*d.* per lb., whilst the balls would probably realise a few pence per lb. less, say 3*s.* 3*d.* to 3*s.* 4*d.* per lb.

THE COTTON INDUSTRY OF UGANDA

The development of the cotton industry of Uganda dates from 1904, when the Government imported seed of three varieties of Egyptian cotton. Shortly afterwards the

Uganda Company introduced American Upland, Peruvian, Sea Island, and other cottons. As there was no organisation for dealing with the industry at that time, the seed became mixed, and for several years the lint produced was a mixture of the different varieties which had been introduced, and in which American Upland characteristics largely predominated. The staple was naturally very irregular, and spinners were unable to deal with the product economically. In 1908 an Ordinance was enacted which gave the Government power to make rules for maintaining and improving the quality of the cotton produced in the Protectorate (see this BULLETIN, 1909, **7**, 92). Rules were made which prohibited the sowing of any seed other than that provided by Government. The variety supplied by Government was an American Upland cotton, " Black Rattler," and during 1908 and 1909 all plants exhibiting Egyptian characteristics were uprooted as far as possible in order to keep the newly introduced variety as pure as possible. Although this action resulted in a more uniform type of cotton being produced in the Protectorate, the quality was still capable of improvement, and the production of an acclimatised cotton of good quality has formed an important part of the experimental work carried out under Government supervision during recent years. An account of this work was included in an article by Mr. P. H. Lamb, lately chief Agricultural Officer in Uganda, published in this BULLETIN last year (1912, **8**, 424), to which reference should be made for fuller details.

Since the Government took the work in hand the cotton industry has made rapid progress. In 1903–4 the value of the cotton exported amounted to only £6, in 1906–7 the exports had risen to £11,411, and in 1911–12 to £230,850. Much of the cotton is ginned in the country, five factories being in operation on March 31, 1912, whilst the total number of gins in the country on that date was 74 roller gins, 5 saw gins, and 82 hand gins. The unginned cotton exported from Uganda is ginned at Kisumu, on the East Africa Protectorate side of Victoria Nyanza.

The quantities and values of ginned and unginned cotton exported from Uganda in recent years are shown in the following table :

	1908–9.		1909–10.		1910–11.		1911–12.	
	cwt.	£	cwt.	£	cwt.	£	cwt.	£
Ginned .	10,247	30,003	13,197	27,416	32,694	120,664	59,227	184,639
Unginned .	12,806	11,229	29,922	22,180	50,281	44,748	45,664	46,211

Cotton seed is also exported in considerable quantity, the exports in 1911–12 being 58,549 cwt., valued at £5,909. An oil-extraction plant capable of producing 192 gallons of cotton seed oil and 4 tons of cake per day of 8 hours has been erected.

The estimated area under cotton in the various districts of Uganda in 1911–12 was as follows:

District.	Area. *Acres.*	District.	Area. *Acres.*
Buganda . .	27,380	Bunyoro . .	3,700
Bukedi . .	19,720	Toro . . .	120
Busoga . .	10,000	Ankole . .	100

Transport difficulties offer a serious hindrance to the extension of cotton growing in many parts of the Protectorate, but the completion of the Busoga railway from Jinja to Kakindu should prove of great value to the neighbouring district, whilst a portion of the loan of £500,000 provided by the British Government for the development of the cotton industry is to be expended on the construction of roads in various parts of the Protectorate.

A large number of samples of Uganda cotton have been examined at the Imperial Institute. Samples of "Sunflower," "Allen's Improved," and "Abassi" cotton have already been described in this BULLETIN (1912, **10**, 481), and other samples have been dealt with in *British Cotton Cultivation. Reports on the Quality of Cotton grown in British Possessions* (*Colonial Reports, Miscellaneous Series*, No. 50 [Cd. 3997], 1908, p. 15). In the following pages the results of examination of samples received in recent years are given.

No. 1. *Black Rattler.*—This sample of ginned cotton, grown in the Chiope District, was received in February 1907. It consisted of rather harsh and woolly, fairly lustrous cotton of very even cream colour and free from stains.

The strength of the fibres was normal, and they varied in length from 1·2 to 1·5 in.; their diameter ranged from 0·0005 to 0·0012 in., with an average of 0·0008 in.

This cotton was of excellent quality, and would be readily saleable. The sample was valued at about 8*d.* per lb. with "middling" American at 7·40*d.* per lb.

The following twenty samples of seed-cotton were received in September 1908. They were procured from various districts of the Protectorate, and each sample represents an individual load as brought to the ginneries by the native growers. They consequently convey an accurate idea of the general character of the cotton produced in the country at that time. The seed from which the samples were obtained was the product of the early importations of Egyptian and American Upland varieties, and was specially selected with the object of eradicating the former type owing to its alleged unsuitability to the country. The cotton was therefore produced from acclimatised seed, the youngest of which was seed in its second season, and the oldest in its fifth season.

No. 2. From Bulemezi District.—The yield of lint on ginning was 33 per cent. The lint was soft, lustrous, pale cream in colour, with a slight reddish tinge, and some brown and yellow stains. The seeds of this sample, as well as of samples 3 to 21, were of average size, and generally closely covered with a light brown down. The present sample contained also a small proportion of smooth seeds. Twenty per cent. of the seeds examined were withered, but no insect pests were noticed either in the cotton or in the seed.

The strength of the cotton was normal; the length varied from 1·1 to 1·5 in., and the diameter ranged from 0·0004 to 0·0010 in., with an average of 0·0007 in.

Compared with a standard sample of Upland cotton, this cotton was longer and deeper in colour. In its other characters it resembled the American cotton, and would probably be classed as a fairly high grade of this variety. It was valued at 5·60*d.* per lb., ginned, with "middling" American at 5·17*d.* per lb.

No. 3. From Bulemezi District.—The lint obtained on

ginning this sample was similar to that of No. 2, but the yield was 32 per cent. The seed also resembled that of No. 2, but a slightly larger proportion of smooth seeds was present. Twenty per cent. of those examined were withered.

The cotton was of uneven strength, some portions being very weak. The fibres varied in length from 1·1 to 1·4 in., and their diameter ranged from 0·0005 to 0·0011 in., with an average of 0·00073 in.

The lint in this case was valued at 5·50*d.* per lb.

No. 4. From Bulemezi District.—Both lint and seed were similar to those of No. 2. The yield of lint on ginning was 34 per cent., whilst 36 per cent. of the seeds examined were withered.

The cotton was of normal strength on the whole, but some portions were rather weak. It varied in length from 1·0 to 1·4 in., and the diameter ranged from 0·0004 to 0·0010 in., with an average of 0·00075 in.

The ginned cotton was valued at 5·60*d.* to 5·70*d.* per lb.

No. 5. From Bulemezi District.—The lint in this case also was similar to that of No. 2, but was more even in colour; the yield on ginning was 32 per cent. Twenty-six per cent. of the seeds examined were withered.

The cotton was of normal strength; the length varied from 1·1 to 1·4 in., and the diameter ranged from 0·0004 to 0·0010 in., with an average of 0·0007 in.

This sample was similar to the preceding one, but was rather more even in colour. It was valued at 5·70*d.* to 5·80*d.* per lb. ginned.

No. 6. From Bulemezi District.—This sample yielded on ginning 32 per cent. of soft, lustrous lint, which was pale cream in colour, with occasional brown and yellow stains. The seeds were similar to those of No. 2, but about two-thirds were smooth. Twenty per cent. of those examined were withered.

The strength and length of this cotton were similar to those of No. 5. The diameter ranged from 0·0005 to 0·0010 in., with an average of 0·00072 in.

This cotton was of fair quality, but rather stained. It was valued at 5·50*d.* per lb., ginned.

No. 7. From Gomba District.—This sample yielded on ginning 31 per cent. of lint of similar appearance to that of No. 2. In this case, however, there was a slightly larger proportion of smooth seeds. Thirty per cent. of the seeds examined were withered, but no insect pests were noticed.

This cotton was of uneven strength, some portions being rather weak. The length varied from 1·1 to 1·4 in., and the diameter ranged from 0·0004 to 0·0010 in., with an average of 0·00068 in.

This cotton appeared to have been grown from the same type of seed as No. 2, from Bulemezi District. Although somewhat inferior in strength, it was of similar quality, and was valued at the same price.

No. 8. From Gomba District.—This sample also yielded 31 per cent. of soft lustrous lint on ginning, but the lint was very uneven in colour and contained an unusually large quantity of yellowish-brown stained cotton. About 30 per cent. of the seeds examined were withered, and there were signs of the attack of insect pests.

This cotton was of poor strength; the length of the fibres varied from 1·0 to 1·4 in., and their diameter ranged from 0·0004 to 0·0010 in., with an average of 0·0007 in.

This cotton was of rather poor quality, and much stained. It was valued at 5·30*d.* per lb., ginned. Several small, reddish grubs were noticed in the sample. These were dry and generally mutilated, but they bore a strong resemblance to insects of *Gelechia* sp. (see this BULLETIN, 1913, **11**, 354).

No. 9. From Gomba District.—This yielded 31 per cent. of lint on ginning. The lint was soft, lustrous, pale cream in colour, but much stained. Forty per cent. of the seeds examined were withered; there were signs of the attack of insect pests, but no specimens were noticed.

The strength of the cotton was uneven, some portions being very weak. The length and diameter of the fibres were the same as in No. 8.

This cotton also was of rather poor quality and much stained, and was valued at 5·30*d.* to 5·35*d.* per lb., ginned.

No. 10. From Gomba District.—This yielded on ginning 33 per cent. of soft, lustrous lint of pale cream colour, and

generally free from stains. Forty per cent. of the seeds examined were withered.

The cotton was of normal strength. The length varied from 1·1 to 1·4 in., and the diameter ranged from 0·0005 to 0·0010 in., with an average of 0·00068 in.

This sample was of good quality, clean and lustrous, and was valued at 5·80*d.* per lb., ginned.

No. 11. From Gomba District.—The yield and appearance of the lint of this sample were the same as those of No. 10, except that a quantity of yellowish-brown stains was present. Thirty per cent. of the seeds examined were withered.

The strength of the cotton was uneven, some portions being rather weak. The cotton varied in length from 1·0 to 1·4 in., and in diameter from 0·0005 to 0·0010 in., with an average of 0·0007 in.

This cotton was of fairly good quality, but rather stained. It was valued at 5·60*d.* per lb., ginned.

No. 12. From Bunyoro District.—The lint in this case resembled that of No. 2 in appearance; the yield on ginning was 33·5 per cent. Smooth and "woolly" seeds were present in about equal proportions, whilst 20 per cent. of those examined were withered.

The cotton was of uneven strength, some portions being rather weak. It varied from 1·0 to 1·4 in. in length, and the diameter ranged from 0·0004 to 0·0010 in., with an average of 0·00071 in.

The ginned cotton was valued at 5·60*d.* per lb.

No. 13. From Bunyoro District.—This yielded on ginning 31 per cent. of soft, lustrous lint of even pale cream colour, and almost free from stains. About 20 per cent. of the seeds were smooth; all those examined were healthy, and there were no signs of the attack of insect pests.

The cotton was of normal strength. The length varied from 1·0 to 1·3 in., and the diameter ranged from 0·0005 to to 0·0011 in., with an average of 0·00072 in.

This cotton was of very good quality, and was valued at 5·90*d.* per lb., ginned.

No. 14. From Busiro District.—The lint of this sample was similar to that of No. 2, but was more even in colour;

the yield on ginning was 32 per cent. Smooth and "woolly" seeds were present in about equal proportions. Twenty-four per cent. of those examined were withered.

The cotton was of normal strength on the whole; the length varied from 1·0 to 1·4 in., and the diameter ranged from 0·0004 to 0·0010 in., with an average of 0·00071 in.

This sample was similar to Nos. 2–6, but of better colour, and was valued at 5·90*d.* per lb., ginned.

No. 15. From Busiro District.—This yielded on ginning 32 per cent. of soft, lustrous lint of pale cream colour, with some brown and yellow stains. Thirty-five per cent. of the seeds examined were withered.

The strength of the cotton was rather uneven, some portions being weak. The fibres varied in length from 1·0 to 1·4 in., and in diameter from 0·0004 to 0·0010 in., with an average of 0·00069 in.

This cotton was of fair quality, but somewhat stained. It was valued at 5·40*d.* per lb., ginned.

No. 16. From Busiro District.—The lint of this sample was similar to that of No. 15, but was of rather deep cream colour, with a small quantity of reddish-brown stains; the yield on ginning was 33 per cent. About 30 per cent. of the seeds examined were withered.

The cotton was of normal strength on the whole, but some portions were rather weak. The length varied from 1·0 to 1·4 in., and the diameter ranged from 0·0005 to 0·0010 in., with an average of 0·0007 in.

This sample was of fair quality, but rather poor in colour. It was valued at 5·40*d.* to 5·50*d.* per lb., ginned.

No. 17. From Busiro District.—This seed-cotton yielded on ginning 32 per cent. of soft, lustrous lint of even pale cream colour and generally free from stains. Eighteen per cent. of the seeds examined were withered.

The strength of this cotton was normal, whilst the length and diameter of the fibres were the same as in No. 16.

The cotton was of good quality, clean and lustrous, and was valued at 5·80*d.* per lb., ginned. Some insects of *Oxycarenus* sp. were noticed in the cotton, but they did not appear to have damaged it in any way.

No. 18. From Singo District.—The lint in this case was fairly soft, lustrous, of deep cream colour, with some slight brown stains; the yield on ginning was 32 per cent. About 25 per cent. of smooth seeds were present, whilst 25 per cent. of those examined were withered.

This cotton was of normal strength but uneven in length, the fibres varying from 0·9 to 1·4 in. Their diameter ranged from 0·0005 to 0·0011 in., with an average of 0·00074 in.

This sample was rather stained, but of much better colour than many of the preceding samples. It was valued at 5·70*d.* per lb., ginned.

No. 19. From Singo District.—This sample yielded on ginning 31 per cent. of lint, which was soft, lustrous, and of pale cream colour, with occasional reddish-brown stains. About one-third of the seeds were smooth, whilst 25 per cent. of those examined were withered.

The strength of the cotton was normal on the whole, but some portions were rather weak. The length varied from 1·1 to 1·4 in., and the diameter from 0·0004 to 0·0010 in., with an average of 0·00075 in. This cotton was of fairly good quality, and was valued at 5·60*d.* to 5·70*d.* per lb., ginned.

No. 20. From Mawokota District.—The lint obtained on ginning this sample was soft and lustrous, of even pale cream colour, and generally free from stains; the yield was 33 per cent. Twenty per cent. of the seeds examined were withered.

This cotton was of normal strength, and the fibres varied from 1·0 to 1·4 in. in length and from 0·0005 to 0·0010 in. in diameter, with an average of 0·00073 in.

This sample was clean and lustrous, and of very good quality. It was valued at 5·90*d.* to 6·00*d.* per lb., ginned.

No. 21. From Mawokota District.—This sample yielded 31·5 per cent. of soft, lustrous lint of rather deep cream colour, with a quantity of reddish-brown stains. Forty per cent. of the seeds examined were withered.

The strength of this cotton was generally normal. The length varied from 1·2 to 1·5 in., and the diameter ranged from 0·0005 to 0·0011 in., with an average of 0·00071 in.

This cotton was of fairly good quality, but was rather stained. It was valued at 5·50*d.* per lb., ginned.

All these samples of cotton (Nos. 2–21) were of very promising quality, and would be readily saleable. Generally speaking, they showed a decided improvement on specimens of similar type from Uganda, previously examined at the Imperial Institute.

The cottons were considerably softer, and had a greater length of staple, than a standard sample of American Texas cotton with which they were compared. In all cases the valuations given were higher than that of "middling" American cotton on the same date, viz. 5·17*d.* per lb.; but long-stapled cotton of the type represented by these samples is nominally worth about 1*d.* or 2*d.* per lb. more than "middling" American cotton, so that in most cases the present samples were of lower value than standard samples of the same type.

No. 22. *Black Rattler.*—This sample of seed-cotton, grown at the Buddu cotton-seed farm, was received in January 1909. The yield of lint on ginning was 38 per cent., the yield per 100 seeds being 5·63 grams. The lint was fairly soft, lustrous, of even pale cream colour, and generally free from stains. The seeds were of medium size; two types were present in about equal proportions: (*a*) smooth, dark brown seeds with slight tufts at the pointed ends; (*b*) seeds closely covered with a short light-brown down. Ten per cent. of those examined were withered.

The cotton was of fairly good strength, but some portions were rather weak. The length varied from 0·8 to 1·2 in., with an average of 1·0 in., and the diameter ranged from 0·0005 to 0·0012 in., with an average of 0·00078 in.

Two valuations of this cotton were obtained: (1) possibly 4¾*d.* per lb., ginned, with "middling" American at 5·13*d.* per lb.; (2) about 5½*d.* per lb., ginned, with "middling" American at 5·52*d.* per lb.

If this cotton was grown from true "Black Rattler" seed, it would appear that the seed may have been of inferior quality, since, although the cotton was of very good appearance and free from stains, it was considerably shorter than previous samples of cotton of the same variety, which were found on the average to vary in length

from 1·1 to 1·4 in. The present sample, averaging only 1·0 in. in length, was barely equal in this respect to ordinary "middling" American cotton, and was decidedly inferior to the more valuable varieties of "improved" American, such as are represented by a normal sample of "Black Rattler" cotton. The shortness of staple in the present instance seriously lowered the value.

No. 23. Black Rattler.—A sample of seed-cotton and one of ginned cotton of this variety, which were stated to be the first year's produce of newly imported seed, were received in June 1909. The seed-cotton yielded on ginning 37 per cent. of lint, the yield per 100 seeds being 5·9 grams. The lint was soft, very lustrous, of an even pale cream colour, and entirely free from stains. The seeds were of medium size; about 60 per cent. were closely covered with a very short, light brown down, whilst the remainder were smooth, dark brown in colour, and bore light brown tufts at the pointed ends. The seeds were generally very healthy, only 6 per cent. of those examined being withered.

The cotton was of normal strength on the whole. The length of the fibres varied from 0·9 to 1·2 in., and their diameter ranged from 0·0005 to 0·0010 in., with an average of 0·00073 in.

Although of short staple, this cotton was of very good quality, and would be readily saleable in the English market. It was probably worth about 6½*d.* per lb., ginned, with "middling" American at 6·56*d.* per lb. The average length of "Black Rattler" cotton (1·2 to 1·5 in.) is, however, greater than that of the present sample, and on this account a well-grown sample of the "Black Rattler" variety should have a considerably higher value than ordinary Upland cotton.

This cotton was very similar to No. 22 (*see above*); both samples were of approximately the same value when considered in relation to that of "middling" American.

No. 24. Black Rattler.—Further samples of seed-cotton and ginned cotton from newly imported seed, first year's sowing, were received in July 1909.

These were of very similar quality to the preceding two

samples. The only differences observable were (1) an apparently higher percentage of lint (40 per cent.), and (2) a slightly greater average diameter of fibres (0·0008 in.). The former difference is to be attributed to the presence in this sample of a larger proportion of withered seeds, which are lighter than healthy seeds, whilst the increased average diameter of the fibres is probably to be accounted for by the presence of a small quantity of slightly immature fibres, which are generally of greater diameter than fully mature fibres. There were no signs of the attack of insect pests, but about 40 per cent. of the seeds examined had been attacked probably by a fungoid pest, and would be useless for sowing. In all other respects the cotton resembled No. 23, and would probably have the same market value.

No. 25.—A specimen of cotton, which was stated to be a sample of the new Uganda crop, was received in June 1909. It consisted of clean ginned cotton, soft, lustrous, and of even pale cream colour, with occasional yellow stains. The strength was uneven, some portions of the cotton being very weak. The length of the fibres was 1·0 to 1·3 in., and their diameter ranged from 0·0005 to 0·0010 in., with an average of 0·00074 in.

The cotton was of very good marketable quality, but its slightly stained condition somewhat depreciated the value. It resembled Nos. 22–24 (*see above*) in being of rather shorter staple than some previous samples of the Black Rattler variety grown in the Protectorate. The sample of the new crop was very slightly longer, and perhaps a little more silky than Nos. 22–24, but it was distinctly inferior to them in appearance.

No. 26.—A sample of ginned cotton, stated to be the "best yet grown in the country," was received in November 1909. It consisted of clean, soft, lustrous cotton, of fairly even cream colour, with some slight yellowish-brown stains.

The strength was normal on the whole, but the stained portions were rather weak. The length varied from 1·0 to 1·4 in., and the diameter ranged from 0·0006 to 0·0011 in., with an average of 0·0008 in.

This cotton was valued at about 8·62*d.* per lb., with "middling" American at 7·62*d.* per lb., and although of good length, its value was considerably reduced on account of its somewhat unsatisfactory colour. The slight stains noticed in the sample suggested that the crop had been attacked to some extent by insect pests. The value of the material would have been enhanced if the stained portions had been completely removed before the product was ginned.

No. 27. Kampala Cotton.—This sample of ginned cotton was received in July 1910. It consisted of fairly harsh, lustrous cotton, of cream colour with some brown and pale yellow stains. It was of normal strength on the whole, but some parts were weak. The length of the fibres varied from 0·8 to 1·3 in., but was mostly from 1·0 to 1·2 in. The diameter ranged from 0·0006 to 0·0011 in., with an average of 0·00081 in.

This sample was regarded as being fairly representative of the bulk of the Uganda crop derived from the acclimatised plant. Its quality was very satisfactory, and it was valued at 70 to 80 points (0·7*d.* to 0·8*d.*) on "middling" American, but the value would be still higher if the cotton could be obtained free from stains.

No. 28. Buddu Cotton.—This was received with the preceding sample, and consisted of rather harsh, fairly lustrous cotton of deep cream colour, with some brown and pale yellow stains. The cotton was rather weak, and somewhat irregular in length, varying from 0·7 to 1·4 in., but was mostly from 0·9 to 1·2 in. The diameter ranged from 0·0006 to 0·0011 in., with an average of 0·00083 in.

The value of this cotton was only 10 to 20 points (0·1*d.* to 0·2*d.*) on "middling" American. The fact that it was of poorer quality and lower value than the sample of "Kampala cotton" (No. 27) is of considerable interest, since it appears from the Report of the Uganda Cotton Department for 1909–10 that the seed from which the "Buddu cotton" was grown was the offspring of the imported "Black Rattler" variety. The "Kampala cotton," on the other hand, is believed to have been derived from the acclimatised Uganda cotton, and the results of the

present examination afford further evidence that this cotton is superior to the "Black Rattler" variety.

A series of five samples of cotton (Nos. 29 to 33) was received in October 1910. These consisted of (1) a typical sample of the ordinary seed-cotton of Bukedi; (2) the same as (1), but hand-picked to remove stained and immature cotton, as is done prior to ginning in the case of seed for distribution, and subsequently passed through a cleaning machine; (3) the same as (2), but roller-ginned; (4) a typical sample of seed-cotton from Buddu, where climate and other conditions militate against quality; (5) the same as (4) but roller-ginned. Samples (1) and (2) were forwarded with the object of ascertaining what difference exists in the commercial value of seed-cotton as often presented by the native for sale, and the same article after dirty and stained cotton has been removed by hand-picking. The samples were examined with the following results. At the date of valuation of the samples "middling" American cotton was quoted at 8·05*d.* per lb.

No. 29. Bukedi Ordinary.—This yielded on ginning 33·7 per cent. of lint, the yield per 100 seeds being 4·6 grams. The lint was soft, lustrous, and of pale cream colour, but not very clean and showing some yellow stains. The seeds were fairly small, and mostly covered with a white, pale brown, or greenish down. A few smooth, dark brown seeds were present. Twenty-five per cent. of the seeds examined were withered.

The cotton was of uneven strength, some portions being very weak. The length of the fibres was irregular, varying from 0·8 to 1·7 in., mostly from 1·0 to 1·5 in. Their diameter ranged from 0·00055 to 0·00090 in., with an average of 0·00070 in.

From the irregularity of the staple it appears probable that this cotton was grown from mixed seed. The ginned cotton was valued at about 8*d.* to 8½*d.* per lb.

No. 30. Bukedi. Hand-picked and passed through cleaning machine.—The yield of lint in this case was 34·3 per cent., or 5·16 grams per 100 seeds. The lint was soft, lustrous, of pale cream colour, clean, and free from stains. The seeds were similar to those of No. 28, but only 15 per cent. of those examined were withered.

This cotton was somewhat weak; the dimensions of the fibres were the same as in No. 28.

The hand-picking had greatly improved the appearance of this Bukedi cotton as compared with sample No. 28, since it had removed not only the stained portions of the lint but also some of the immature fibres. The colour of this hand-picked cotton was very good. The ginned cotton was valued at 9·50*d.* per lb.

No. 31. *Bukedi. Hand-picked and roller-ginned.*—This sample was similar to the lint of No. 29 in appearance, but the fibres varied in length from 0·8 to 1·5 in., being mostly from 1·1 to 1·3 in.; in diameter they ranged from 0·0006 to 0·0009 in., with an average of 0·00072 in.

The remarks made on sample No. 29 apply also to this cotton, which was valued at the same price.

No. 32. *Buddu. Passed through cleaning machine.*—This sample yielded 38·3 per cent. of lint, the yield per 100 seeds being 4·84 grams. The lint was fairly soft, lustrous, of cream colour, with some yellow stains. The seeds were small and mostly covered with a white or brown down. Some smooth, dark brown seeds were also present. Thirty-eight per cent. of those examined were withered.

This cotton was also somewhat weak. It varied in length from 0·9 to 1·4 in., but was mostly from 1·1 to 1·3 in. The diameter ranged from 0·00065 to 0·00090 in., with an average of 0·00078 in.

This sample was of fair quality and resembled the Buddu cotton previously examined at the Imperial Institute (No. 28), but it was somewhat softer than the latter. The ginned cotton was valued at 8·50*d.* per lb. The value of the product would have been greater if it had been free from stains and of greater strength.

No. 33. *Buddu cotton. Roller-ginned.*—This sample closely resembled the lint obtained from No. 32, and may be described in the same terms.

In December 1910 several samples (Nos. 34–37) of Improved American Upland seed-cottons, grown experimentally at the Namenage Farm, Busoga District, were received, together with a sample (No. 38) of the variety commonly in cultivation throughout the Protectorate, grown

on the same farm. These were examined with the following results. At the date of the valuation of the samples "good" machine-ginned Broach was valued at $7\frac{7}{16}d.$ and "middling" American at 8·27*d.* per lb.

No. 34. *King.*—This sample yielded on ginning 38·5 per cent. of lint, the yield per 100 seeds being 6·29 grams. The lint was clean, soft, rather lacking in lustre, of white to pale cream colour, and almost free from stains. The seeds were fairly large, and mostly coated with a white or grey velvety down; a few black seeds bearing a white fuzz at one end were also noticed. The seeds were in good condition; only 6 per cent. of those examined were defective, about 3 per cent. being mouldy and 3 per cent. withered.

The cotton was of good strength and varied in length from 0·9 to 1·2 in., but was mostly from 1·0 to 1·1 in. The diameter ranged from 0·0006 to 0·0011 in., with an average of 0·00083 in.

This seed-cotton gave a large yield of lint, which was rather short in staple and would therefore compete with Indian cotton. It was valued at 7·50*d.* per lb., ginned.

No. 35. *Toole.*—The yield of lint in this case was 40·4 per cent., or 6·49 grams per 100 seeds. The lint was clean, fairly soft, rather lacking in lustre, of cream colour, and almost free from stains. The seeds were large, in some cases covered with a whitish down, whilst others were smooth and black, and usually bore a tuft of down at one end. The seeds were in good condition, only 2 per cent. being defective.

The strength of the cotton was good, but the length somewhat irregular, varying from 0·9 to 1·4 in., mostly from 1·1 to 1·2 in. The diameter ranged from 0·0005 to 0·0010 in., with an average of 0·0008 in.

This seed-cotton also gave a large yield of lint, which was somewhat short and irregular in staple, but was otherwise of fairly good quality. The ginned cotton was valued at 7·75*d.* per lb.

No. 36. *Simpkins.*—This sample yielded 38·2 per cent. of lint on ginning, the yield per 100 seeds being 6·24 grams. The lint was clean, fairly soft, rather dull, of cream colour, and almost free from stains. The seeds were large, mostly

covered with a white or greenish down or fuzz; a few black or dark brown seeds, partially coated with down, were also present. The seeds examined were in good condition; only 8 per cent. were defective, about 3 per cent. being mouldy, and 5 per cent. withered.

The cotton was rather weak, and varied in length from 0·8 to 1·2 in., but was mostly from 0·9 to 1·0 in. The diameter ranged from 0·0006 to 0·0010 in., with an average of 0·00081 in.

This seed-cotton gave a fairly large yield of lint, which was somewhat weak and rather short, but otherwise of fairly good quality. It was valued at 7·75*d.* per lb., ginned.

No. 37. *Sunflower* (*acclimatised three years in British East Africa*).—The yield of lint in this sample, viz. 31·8 per cent., or 5·28 grams per 100 seeds, was less than that of the preceding samples. The lint was clean, soft, of good lustre, of white to pale cream colour, and almost free from stains. The seeds were generally of medium size, and mostly coated with a white down or fuzz; a few dark brown seeds partially covered with down were also noticed. The seeds examined were in good condition; only 8 per cent. were defective, 6 per cent. being mouldy, and 2 per cent. withered.

The strength of this cotton was good, but the length irregular, varying from 0·9 to 1·7 in.; mostly from 1·2 to 1·4 in. The diameter ranged from 0·0005 to 0·00085 in., with an average of 0·00069 in.

This cotton was of good quality but irregular length. It was valued at 9·0*d.* per lb., ginned.

No. 38. *Uganda.*—This sample yielded on ginning 36·1 per cent. of lint, or 5·87 grams per 100 seeds. The lint was clean, soft, lustrous, of white to pale cream colour, and free from stains. The seeds were generally fairly large, mostly covered with a white or green fuzz; a few dark brown seeds, sparsely coated with white down, were also noticed. The seeds were in good condition, only 2 per cent. of those examined being withered.

This cotton also was of good strength, but somewhat irregular in length, varying from 1·0 to 1·5 in.; mostly

from 1·1 to 1·3 in. The diameter ranged from 0·0006 to 0·0010 in., with an average of 0·00078 in.

This cotton, which was of American Upland type, was of good strength and colour, and of fairly good length. It was valued at 8·75*d.* per lb., ginned.

The examination of these cottons showed that Nos. 34, 35, and 36 were of rather short staple and somewhat low value, and were consequently inferior to the acclimatised Uganda cotton which was at that time being grown.

The "Sunflower" cotton (No. 37) was of excellent quality, but of rather irregular length. It was recommended that the acclimatisation of this variety should be continued (*cf.* this BULLETIN, 1912, **10**, 429, 481).

The acclimatised Uganda cotton (No. 38) was also of excellent quality, and promises well for the future of the industry.

Of the following six samples of seed-cotton (Nos. 39–44) received in January 1913 the first three were grown at the Government Experimental Plantation, Kadungoro, and the remainder by natives in different districts of the Eastern Province. At the date of the valuation of the samples "middling" American was quoted at 6·85*d.*, and "fully good fair" Abassi at 10·45*d.* per lb.

No. 39.—This sample yielded on ginning 28·4 per cent. of lint, the yield per 100 seeds being 4·16 grams. The lint was clean, soft, fine, lustrous, slightly "leafy," light cream in colour, and showing a few small yellow stains. The seeds were of medium size, and covered with a fairly long white fuzz.

The cotton was of irregular strength, but fair on the whole; some weak immature fibre was present. The length of the fibres varied from 1·2 to 1·9 in., but was mostly from 1·5 to 1·7 in.

This cotton was of excellent quality, except for a little irregularity in strength. It was valued at 8·25*d.* per lb., ginned.

No. 40.—The yield of lint in this case was 29·6 per cent., or 4·52 grams per 100 seeds. The lint was similar to that of No. 39, whilst the seeds were of medium size, and in most cases covered with fairly long white or

brownish fuzz; a few smooth or almost smooth dark brown seeds were also present.

The strength of the cotton was irregular, but fair on the whole, though some weak undeveloped fibre was present. The length was also irregular, varying from 1·0 to 1·8 in.

The ginned cotton was valued at 7·75*d.* per lb., its value being depreciated by its uneven length and strength.

No. 41.—This sample yielded on ginning 29·3 per cent. of lint, the yield per 100 seeds being 4·32 grams. The lint was clean, soft, fine, somewhat curly, of rather good lustre, of cream colour, and practically free from stains. The seeds were of medium size, and mostly covered with rather long white or greenish fuzz, but some almost smooth dark brown seeds were also present which had a small tuft of fuzz at the pointed end.

The strength of the cotton was irregular, and on the whole rather poor. A fair proportion of weak undeveloped fibre was present. The length was also rather irregular, varying from 1·0 to 1·6 in., but was mostly from 1·2 to 1·4 in.

This cotton showed the same defects as the preceding sample, No. 40, and though rather more regular in length it was somewhat weaker. It was valued at 7·40*d.* per lb., ginned.

No. 42. *Cotton grown by natives at Kumi, Eastern Province.*—The yield of lint from this sample was 33·4 per cent., the yield per 100 seeds being 5·09 grams. The lint was clean, fairly soft, fine, lustrous, of cream colour, and free from stains. The seeds were mostly of medium size, and covered with long white fuzz, or medium-length green or brownish fuzz; but about 16 per cent. were clean or almost clean dark brown seeds, with a small tuft of white fuzz at the pointed end.

The strength of the cotton in this case also was irregular, and rather poor on the whole. The length was rather irregular, varying from 0·9 to 1·6 in.; mostly from 1·3 to 1·5 in.

This cotton was uneven in length and strength, like the preceding samples, Nos. 40 and 41, but it was not quite so soft. It was valued at 7·25*d.* per lb., ginned.

No. 43. *Cotton grown by natives at Sambwe, Serere County, Eastern Province.*—This sample yielded 31·9 per cent. of lint on ginning, the yield per 100 seeds being 4·82 grams. The lint was similar in appearance to the preceding sample, No. 42, but a few large yellow stains were present. The seeds were of medium size, and covered with short, medium, or rather long white or greenish fuzz; a few almost clean dark brown seeds were present.

The strength of this cotton was rather irregular, but fairly good on the whole. The length varied from 0·8 to 1·4 in., but was mostly from 1·1 to 1·3 in.

The ginned cotton was valued at 6·15*d.* per lb. The length and strength of this cotton were somewhat irregular, and its value was reduced by the presence of stains.

No. 44. *Cotton grown by natives at Bugondo, Serere County, Eastern Province.*—The yield of lint from this sample was 29·0 per cent., the yield per 100 seeds being 4·27 grams. The lint was very similar to that of No. 41, but of a deeper cream colour. The seeds were of medium size and mostly covered with fairly long white or bright green fuzz; some smooth seeds without fuzz were also present, together with a number of undeveloped seeds.

This cotton was also of irregular strength, and poor on the whole. Some weak undeveloped fibre was present. The length varied from 0·9 to 1·6 in., but was mostly from 1·3 to 1·5 in.

This cotton exhibited similar defects to the preceding sample No. 43, and though rather longer it was somewhat weaker. It was valued at 6·40*d.* per lb., ginned.

These six cottons (Nos. 39–44) were all of good appearance, but they were somewhat irregular in staple. They contained an appreciable quantity of weak, immature fibre, which would create a certain amount of waste in the processes preparatory to spinning. This defect might possibly be remedied by allowing the cotton to ripen more completely before it is picked.

No. 45. *Caravonica Silk Cotton.*—This sample of seed-cotton, received in December 1910, was grown at Koba, Nile Province. The yield of lint, on ginning, was 33·5 per cent., the yield per 100 seeds being 5·98 grams. The lint

was clean, somewhat harsh, lustrous, white, and free from stains. The seeds were large, smooth, and dark brown, mostly bearing a small tuft of white fuzz at the pointed end. Forty-eight per cent. of the seeds examined were defective, 46 per cent. being mouldy and 2 per cent. withered. They would be useless for sowing.

The cotton was of good strength, but somewhat irregular in length, varying from 1·2 to 2·0 in., but mostly from 1·3 to 1·6 in. The diameter ranged from 0·0005 to 0·0009 in., with an average of 0·00072 in.

This material was somewhat harsh for Caravonica silk cotton, but it was of very good quality, and was valued at about 11*d.* per lb., ginned, with "good" moderately rough Peruvian at 10·50*d.* per lb. The cultivation of this or any other tree-cotton in Uganda cannot be recommended on account of the tendency of such plants to harbour insect and fungoid pests and thus endanger the other cotton of the country. Moreover, the commercial experts reported that there is only a limited demand for cotton of this type.

NEW COLONIAL AND OTHER TANNING MATERIALS

In a previous number of this Bulletin (1907, **5**, 343) some account was given of the results of examination of a large number of tanning materials from the Colonies and India which had been investigated at the Imperial Institute. Since that date a number of other reports and articles dealing with important tanning materials have been published in this Bulletin, especially on wattle bark (1908, **6**, 157; 1910, **8**, 245; 1911, **9**, 116), valonea (1912, **10**, 645), Cyprus sumach (*ibid.* p. 45), Chinese gall-nuts (*ibid.* p. 576), and "teri" pods (*Cæsalpinia digyna*) from India (*ibid.* p. 219). In the present summary it is proposed to give further information on some of the products mentioned in the previous articles, references to which are quoted above, and also to publish the results of examination of a number of other materials which are either new in this industrial application or are new in the sense that they are from countries which do not at present export commercial supplies of these materials.

Many of the products referred to are not rich enough in tannin to be worth export in the raw state as tanning materials, but they are still of commercial interest, since they appear to be suitable for local use either for the preparation of leather for export or for the manufacture of tanning extracts which could be exported. The demand for tanning extracts is steadily increasing, especially in the United Kingdom, and there seems to be no reason why a large proportion of the imports of these products, that now reach the United Kingdom from foreign sources, should not be obtained from the Colonies and India.

Some of the materials referred to are obviously of no value as tanning materials, and they are referred to merely because they have been mentioned elsewhere as suitable for use in this way and it seems desirable to put the results of their examination on record so that they may be available for reference.

Black Wattle Bark from the East Africa Protectorate

Reference has already been made in this Bulletin (*loc. cit.*) to the cultivation and production of wattle bark in various British territories, and the results of examination at the Imperial Institute of samples of the bark from South Africa and the East Africa Protectorate have been also published (1908, **6**, 165; 1910, **8**, 245). The planting of black wattle has made considerable progress in the East Africa Protectorate in recent years, and an Ordinance has been enacted for the protection of the industry (this Bulletin, 1912, **10**, 479).

The cultivation of black wattle in the Protectorate is carried on chiefly in the Limoru, Kikuyu, Njoro, Makuru, Londiani, and Lumbwa districts. On March 31, 1911, there were 800 acres planted with trees three years old and over, whilst during the preceding fifteen months about 2,000 acres were planted out, and further extensive areas were being prepared for sowing. Wattle bark first appears in the published export figures for the Protectorate in 1911–12, when 10 tons were exported.

At the present time the chief sources of the wattle bark

used for tanning purposes in Europe are Australia and South Africa. The exports from these countries in recent years are shown in the following table. The figures for the Australian Commonwealth are for "tanning bark," and probably include a certain proportion of mallet bark.

	Union of South Africa.		Commonwealth of Australia.	
	Cwt.	£	*Cwt.*	£
1910 . .	826,875	219,433	295,616	119,254
1911 . .	992,904	289,557	253,556	104,646
1912 . .	1,055,527	283,060	figures not available.	

A number of samples of black wattle bark from the East Africa Protectorate have been received at the Imperial Institute in recent years, and these are dealt with in the following pages:

No. 1.—This sample of black wattle bark, received in December 1910, was obtained from trees planted in November 1903, near Kikuyu. It consisted of quills of bark about 3 ft. long and varying from $\frac{1}{8}$ to $\frac{1}{4}$ in. in thickness. The bark was dark brown externally, the thinner quills being smooth, whilst the thicker ones were wrinkled; internally it was smooth and brown. The bark gave a fibrous fracture, the broken surface being almost white.

The following table shows the results of examination of (1) an average sample, and (2) of some of the thicker pieces of bark in the consignment:

	Average sample from the consignment.	Thick bark only.
	Per cent.	*Per cent.*
Moisture	9·5	12·4
Ash	2·4	2·1
Tannin	35·7	43·1
Extractive matter (non-tannin) . .	9·6	8·6
Colour of a 0·5 per cent. tannin solution in a 1 cm. cell . { *Red*	6·2	4·5
Colour of a 0·5 per cent. tannin solution in a 1 cm. cell . { *Yellow*	6·6	5·5

The bark yielded a rather soft leather of a pale pink colour.

A small lot of this bark was offered for sale in London through brokers, and was finally disposed of at a rate of about £7 10*s.* per ton delivered in London.

The price of chopped Natal wattle bark at the time of

the report ranged from £8 to £8 10*s.* per ton, so that having regard to the fact that this consignment of East African bark was small and consisted of mixed thin and thick bark of varying quality and colour, the price obtained for it must be regarded as very satisfactory.

No. 2.—This sample was obtained at Njoro, and was received in August 1911. It consisted of pieces of bark about 7 in. long and ¼ in. thick. The outer surface of the bark was fairly smooth and dark greyish-brown, whilst the inner surface was smooth and brown. The bark gave a fibrous fracture of pink colour.

This bark was analysed, with the following results:

	Per cent.
Moisture	13·6
Ash	2·4
Tannin	39·2
Extractive matter (non-tannin)	9·6

The bark yielded with split calf-skin a slightly pinkish-brown leather of a fairly soft but firm texture.

This bark was of good quality and was valued as probably worth about £8 per ton in London (December 1911), when Natal wattle bark was selling at £6 5*s.* to £10 per ton, according to quality.

No. 3.—This bark, which was received in October 1911, was stated to have been obtained from a tree 16 in. in girth, growing in a closely-spaced plantation of trees about 5½ years old and averaging 50 ft. in height, and it was desired to ascertain whether the percentage of tannin in the bark of the trees was affected by the conditions under which they were grown.

The sample consisted of quills of bark 2 ft. 6 in. in length, and varying from $\frac{1}{16}$ to ¼ in. in thickness. The outer surface was dark reddish-brown and fairly smooth, whilst the inner was light brown, smooth, and fibrous. The bark showed a pink fibrous fracture.

In order to make a fair comparison between this sample and previous samples of wattle bark from the East Africa Protectorate, it was necessary to ascertain the composition of the thick and thin barks separately. Analyses were therefore made of (1) the original sample of mixed bark;

(2) the thin bark, forming 86 per cent. of the total; and (3) the thick bark, forming 14 per cent. of the total. The results were as follows:

	Whole sample.	Thin bark.	Thick bark.
	Per cent.	*Per cent.*	*Per cent.*
Moisture	10·0	9·8	10·0
Ash	2·6	2·6	2·7
Tannin	30·5	29·4	34·1
Extractive matter (non-tannin)	11·6	12·6	10·6
Colour of a 0·5 per cent. tannin solution in a 1 cm. cell. *Red*	4·7	5·3	4·3
Colour of a 0·5 per cent. tannin solution in a 1 cm. cell. *Yellow*	7·0	9·1	6·0

The bark furnished a pale pinkish leather of firm texture.

The above results illustrate the importance of keeping thick and thin wattle bark separate for export, since the former is almost invariably richer in tannin and of better colour than the thin bark, and realises better prices.

The present sample contained less tannin than any specimen of wattle bark yet received at the Imperial Institute from the East Africa Protectorate. The average amount of tannin in commercial wattle bark is, however, only 32 per cent., so that in this instance the thick bark is a little above the average, whereas the thin bark is below it.

In a letter relating to this sample the Conservator of Forests stated that it was obtained from a single tree in a plantation, the trees of which were raised from seed sown *in situ* 4 ft. by 4 ft. apart in February 1906, so that when the bark was collected in October 1911 the tree was about $5\frac{1}{2}$ years old. The plantation was stated to have been thinned in September 1908, but no information was supplied as to the spacing round this particular tree after thinning. In Natal it is customary to grow wattle trees with a spacing of 12 ft. by 6 ft., or to sow them 6 ft. by 6 ft. and to thin to 12 ft. by 6 ft. in the fifth or sixth year. Under these conditions the bark is often thick enough and rich enough in tannin to be worth harvesting after five years, though usually the trees are allowed to grow for from seven to ten years before being stripped.

It is clear from these results that under the conditions prevailing in the plantation from which this sample of bark

was obtained, wattle trees will not yield bark very rich in tannin in from $3\frac{1}{2}$ to $4\frac{1}{2}$ years, as was the case with the trees furnishing some previous samples examined at the Imperial Institute (Nos. II., III., and IV. in the table on p. 408; see also this BULLETIN, 1910, **8**, 249). There is, however, no reason to suppose that the trees in this plantation will not give bark of normal richness in tannin after the lapse of another year or two.

Five samples of bark obtained from trees growing in close plantations at Njoro were received in August 1912. They were as follows:

No. 4.—Pieces of bark measuring from 3 to 4 in. in length and up to $1\frac{1}{2}$ in. in width. The thickness was generally less than $\frac{1}{8}$ in. The bark was rough and greenish-brown externally, and smooth and pinkish-brown internally. The fracture was fibrous.

No. 5.—Broken pieces of bark, resembling those of the preceding sample No. 4, but smaller in size, rather thicker on the whole, and of a reddish tint externally.

Nos. 6, 7, *and* 8.—Pieces of bark resembling sample No. 4, but rather larger.

Samples 4–8 were examined with the following results:

	No. 4.	No. 5.	No. 6.	No. 7.	No. 8.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Moisture	9·9	10·2	10·9	11·1	11·4
Ash	3·2	3·3	2·7	3·3	3·8
Tannin	36·9	37·2	36·7	35·9	36·3
Extractive matter (non-tannin)	12·6	13·8	12·5	11·8	11·5
Colour of a 0·5 per cent. tannin solution in a 1 cm. cell. *Red*	3·4	4·0	5·0	3·9	5·0
Colour of a 0·5 per cent. tannin solution in a 1 cm. cell. *Yellow*	4·9	6·7	8·0	5·7	10·0

The percentage of tannin in these samples (Nos. 4–8) was slightly below that usually present in wattle barks from the East Africa Protectorate (cf. table on p. 408). This was probably due to the fact that the trees furnishing the samples were only three years old, though it may be added that two previous samples of wattle bark from East Africa examined at the Imperial Institute from trees $3\frac{1}{2}$ years old contained as much as 40 per cent. of tannin (Nos. III. and IV. in table on p. 408). These previous samples were, how-

ever, for the most part from more or less isolated trees, and did not, like the present samples, represent the produce of close plantations.

No. 9.—A sample of bark from a tree five years old grown in the Victoria Nyanza Basin at an altitude of approximately 4,000 ft., was received in February of this year. It consisted of pieces of wattle bark, having the usual appearance of this bark and varying in thickness from $\frac{1}{16}$ to nearly $\frac{1}{4}$ in. (mostly from $\frac{1}{8}$ to $\frac{3}{16}$ in.).

It gave the following results on examination :

	Per cent.
Moisture	10·3
Ash	2·9
Tannin	36·9
Extractive matter (non-tannin)	11·2
Colour of a 0·5 per cent. tannin solution in a 1 cm. cell — *Red*	5·2
Colour of a 0·5 per cent. tannin solution in a 1 cm. cell — *Yellow*	5·5

The bark yielded a fairly pale leather, with the slightly purplish tint usually given by wattle bark.

This bark was of good quality and contained an average amount of tannin. It was submitted for valuation to a London firm dealing in tanning materials and to two similar firms in Hamburg. The London firm reported that the quality and condition of the bark were good, and that if shipped in bags it would be worth £7 10*s.* per ton c.i.f. London (May 1913). One of the German firms reported that the condition and appearance of the bark were excellent, and that if shipments of similar quality could be made they should realise 2*s.* 6*d.* per ton over the ordinary market price. The firm evinced great interest in the bark, and expressed a desire to receive consignments for sale on the Hamburg market. They added that it would be better to cut the bark into pieces about half as large as those in the present sample.

The second Hamburg firm considered that wattle bark as dry as this sample should compete successfully with the bark shipped from Natal, and valued it at about £7 1*s.* 3*d.* per ton c.i.f. Hamburg. They considered that it might even realise a higher price than Natal bark, and suggested that a trial shipment of about 25 tons should be consigned

to them for sale in order to test the market and afford a basis for further trade.

It is clear from the opinions quoted above that consignments of wattle bark of the quality of the present sample would be readily saleable in either London or Hamburg.

As a considerable number of samples of black wattle bark from the East Africa Protectorate have now been examined at the Imperial Institute, the results obtained are summarised in the following table for convenience of comparison :

Number of sample.	Age of tree.	Moisture.	Ash.	Tannin.	Extractive matter (non-tannin).	Value in London.
Samples previously examined at the Imperial Institute.	*Years.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per ton.*
I.	5	12·9	2·4	38·4	12·2	£8 (March 1910)
II.	4½	9·0	2·7	43·6	10·4	£8 (March 1910)
III.	3½	10·6	3·2	39·6	11·2	£8 5*s.* (March 1910)
IV.	3½	9·9	3·0	40·3	10·3	£8 10*s.*–£8 15*s.* (March 1910)
V.	6½	11·9	1·9	35·8	12·2	£8 10*s.* (March 1910)
VI.	10	11·4	1·7	39·7	11·8	£8 10*s.* (July 1910)
Present samples.						
1 (average sample)	7	9·5	2·4	35·7	9·6	Sold in London at the rate of £7 10*s.* per ton [1] (February 1912)
1 (thick bark)	7	12·4	2·1	43·1	8·6	—
2	—	13·6	2·4	39·2	9·6	£8 (December 1911)
3	5½	10·0	2·6	30·5	11·6	—
3 (thin bark)	5½	9·8	2·6	29·4	12·6	—
3 (thick bark)	5½	10·0	2·7	34·1	10·6	—
4	3	9·9	3·2	36·9	12·6	—
5	3	10·2	3·3	37·2	13·8	—
6	3	10·9	2·7	36·7	12·5	—
7	3	11·1	3·3	35·9	11·8	—
8	3	11·4	3·8	36·3	11·5	—
9	5	10·3	2·9	36·9	11·2	£7 10*s.* (May 1913)

[1] *Small consignment only* (see p. 403).

Acacia arabica Pods from the Sudan

The pods of *A. arabica* are used for tanning purposes in the Sudan, where they are known as "Sant" pods. They have also from time to time been imported into the United Kingdom, for use as a tanning material, from West Africa, and are known here as "Gambia" pods. They are also used in India under the name "babul" pods. A sample of the whole pods from the Sudan was examined at the Imperial Institute in 1906, and the results showed that they were a very promising tanning material for use in the

United Kingdom (see this BULLETIN, 1906, **4**, 95). The whole pods, as produced in the Sudan, contain on the average about 30 per cent. of tannin, and would be readily saleable in the United Kingdom as a tanning material. It is, however, possible to considerably increase the amount of tannin by lightly grinding the pods to a granular powder and sifting the product to remove seed and some of the fibrous matter which contains no tannin, and the two following samples of "Sant grains" were prepared in this way by the Sudan Forest Department and submitted to the Imperial Institute for examination.

"*Sant Grains*"

The first sample was received in May 1910, and consisted of a granular material composed mainly of yellowish grains with some fibrous matter.

The second sample was a fine powder, of pale buff colour, with a small proportion of minute brownish-black grains.

The results of analyses of the two samples were as follows:

	No. 1. *Per cent.*	No. 2. *Per cent.*
Moisture	5·9	8·5
Ash	3·7	4·2
Tannin	60·9	54·5
Extractive matter (non-tannin)	21·7	20·9
Colour of a 0·5 per cent. tannin solution in a 1 cm. cell. *Red*	not determined	1·1
Colour of a 0·5 per cent. tannin solution in a 1 cm. cell. *Yellow*	not determined	1·6

The powder yielded a faintly pinkish-white leather of soft but firm texture.

Samples of the material were submitted to a number of firms of tanners and commercial experts, and the more useful reports received were as follows:

(1) A firm of extract manufacturers considered the sample to represent a useful material, but they regarded the powder as an unsuitable form in which to market the pods, and expressed the opinion that the whole pods, compressed into bales, should be shipped from the Sudan.

(2) Another firm of extract manufacturers, after testing the second sample, also stated that there would be little

demand for it in the powdered form, as tanners do not care for finely ground material, but prefer it in the form of an extract (either solid or liquid) soluble in water.

(3) A third firm similarly reported that in the powdered form the material was not suitable for extraction purposes, but they expressed a desire to receive a large sample of the whole pods for trial.

(4) A firm of tanners considered that the powder should be very suitable for the production of light leathers.

These results are somewhat disappointing, since it might have been supposed that a concentrated material of this kind, which is as rich as many of the tanning extracts imported to the United Kingdom, is of very pale colour, and yields leather of good quality, would have been a welcome addition to commercial tanning materials. The general opinion of dealers in tanning materials, and of extract makers, as well as tanners, in the United Kingdom, however, was that the material was not suitable for importation in this form, though almost all the firms consulted thought the whole pods (see below) would find a market here, and one of them valued the whole pods at £8 per ton.

Whole Sant Pods

These were received in December 1912. They consisted of 70 per cent. pod cases and 30 per cent. small, flat, very hard, dark brown seeds. The pod cases freed from the seeds were examined with the following results :

		Per cent.
Moisture		7·8
Ash		4·5
Tannin		38·9[1]
Extractive matter (non-tannin)		15·7
Colour of a 0·5 per cent. tannin solution in a 1 cm. cell	*Red*	1·3
	Yellow	2·6

[1] *Equivalent to* 27·2 *per cent. expressed on the whole pods, including the seeds.*

An infusion of the pods yielded a pinkish-white leather which was fairly soft and of firm texture.

The pods were submitted to a commercial expert, who reported that if they could be shipped in commercial

quantities, and at a reasonable price, they should be readily saleable in the United Kingdom. He considered that it would be easier to find a market for large consignments of hundreds of tons than for small quantities of the pods.

Acacia arabica Pods from Northern Nigeria

A sample of these pods from Kontagora, Northern Nigeria, was received in May 1907.

It consisted of dark brown pods made up usually of three to five segments, each containing one seed. The pods were covered with a fine bloom, which was not easily rubbed off. On breaking the pods transversely a brown, transparent, gum-like material, which was highly astringent, was found between the inner and outer layers of the skin of the pod.

The whole pods, including the seeds, gave the following results on analysis :

	Per cent.
Moisture	11·24
Ash	2·80
Tannin	26·69
Extractive matter (non-tannin)	15·38

The pods tanned calf-skin rapidly, and yielded a pale, fawn-coloured, but rather soft leather.

This sample of *A. arabica* pods contained rather less tannin than those from the Sudan (see p. 410).

As already stated, West African *A. arabica* pods are sometimes imported to the United Kingdom under the name of "Gambia pods."

Pods of *Acacia arabica* var. *Kraussiana* from South Africa

A sample of the pods of this variety of *A. arabica* was received from the Trades Commissioner to the Government of South Africa in December 1911. The pods were thin, blackish-brown, brittle, and were nearly all broken. They were $\frac{3}{8}$ in. in width, and were divided transversely into numerous segments, each of which contained a small, flat, shrivelled seed.

The pods were analysed with the following results:

	Per cent.
Moisture	11·6
Ash	3·7
Tannin	19·6
Extractive matter (non-tannin)	20·8

An infusion of the pods gave a rather stiff greyish-brown leather of firm texture.

These pods contained only 19·6 per cent. of tannin, but the leather they produced, although of inferior colour, was of good quality. If employed in conjunction with some other tanning material of better colour the pods should prove very satisfactory for use in South Africa, but it is improbable that the pods would find a market in Europe.

Talh Bark (Red Variety) from the Sudan

A sample of this bark, the product of *Acacia Seyal*, was received from the Sudan in May 1910. It consisted of small, irregularly-shaped pieces of fibrous bark; the outer surface was smooth and dull green, and the inner very pale cream colour. The fracture was dark brownish-red. The bark gave the following results on analysis:

	Per cent.
Moisture	9·4
Ash	6·7
Tannin	18·1
Extractive matter (non-tannin)	13·1

The bark produced a rather harsh leather of dull, dark reddish-brown colour.

This bark contained a fair quantity of tannin, but yielded leather which was too dark-coloured and red to be satisfactory. The bark might be used locally as a tanning agent in admixture with a better and lighter-coloured material, but it is unsuitable for export to Europe.

Acacia longifolia Bark from Cyprus

A sample of the bark of *A. longifolia*, Willd., was received from Cyprus in May 1909. It consisted of quills of thick bark from 8 to 12 in. long. Externally the bark was dark rusty-brown in colour and much fissured; internally it was dull purplish-brown and fairly smooth. The fracture

was very fibrous. The bark gave the following results on analysis:

	Per cent.
Moisture	10·9
Ash	4·0
Tannin	15·3
Extractive matter (non-tannin)	7·5

The bark produced a rather harsh dull brown leather with a purplish tint. It would be suitable for local use as a tanning agent, especially if used in admixture with a lighter coloured tanning material, but it is too poor in tannin to be worth exporting. The amount of tannin found in this sample from Cyprus is similar to that recorded for *A. longifolia* bark in Australia.

Acacia cyanophylla Bark from Cyprus

Two samples of the bark of *A. cyanophylla*, Lindl., have been received from Cyprus.

No. 1. This sample, received in May 1909, consisted of quills of thick bark about 9 in. long. The exterior was dull brown and smooth; the interior pale to reddish-brown. The fracture of the bark was fibrous.

No. 2. This, received in June 1910, consisted of quills of bark measuring 9 in. in length and $1\frac{1}{4}$ in. in diameter. The quills were light greyish-green and generally smooth externally, and reddish-brown on the inner surface.

The results of analyses of the two samples were as follows:

	No. 1. *Per cent.*	No. 2. *Per cent.*
Moisture	15·5	15·7
Ash	3·5	5·3
Tannin	19·5	16·3
Extractive matter (non-tannin)	12·4	10·0

Sample No. 1 produced a rather harsh, dull brown leather with a purplish tint. Sample No. 2 produced a rather stiff, light brown leather.

The results of the chemical examination indicate that the bark contains too little tannin to be worth exporting, especially as the leather produced does not exhibit any marked feature, such as might specially recommend the bark as a tanning agent. The bark should, however be a

good tanning material for local use in Cyprus, either alone or in conjunction with a milder material producing a lighter-coloured leather.

Sample No. 2 was stated to have been collected from ten-year-old trees, so that by analogy with other species of Acacia there is little hope of bark richer in tannin being obtained from *A. cyanophylla* in Cyprus.

Anogeissus leiocarpa Bark from Southern Nigeria and the Sudan

A sample of the bark and roots of *A. leiocarpa*, Guill. & Perr., was received from Southern Nigeria in June 1911, and one of the powdered bark of this plant from the Sudan in August 1911.

That from Southern Nigeria consisted of (1) roots bearing thin bark, (2) small pieces of wood covered with fairly thick bark, and (3) loose pieces of bark. The thick bark alone was examined in detail. It varied from $\frac{1}{16}$ to $\frac{1}{4}$ in. in thickness, and had a non-fibrous fracture varying in colour from yellow to brown. The inner surface of the bark was smooth and blackish-brown, whilst the outer surface varied from smooth to rough, and was brown with greyish patches.

The sample from the Sudan consisted of a fine powder, of a rather dark brownish-buff colour.

The two samples gave the following results on examination :

	Sample from Southern Nigeria. *Per cent.*	Sample from the Sudan. *Per cent.*
Moisture	10·9	8·5
Ash	12·8	13·8
Tannin	17·1	9·6
Extractive matter (non-tannin)	9·4	10·8
Colour of a 0·5 per cent. tannin solution in a 1 cm. cell — *Red*	10·6	11·7
Colour of a 0·5 per cent. tannin solution in a 1 cm. cell — *Yellow*	29·3	28·6

The Southern Nigeria specimen yielded a yellowish-brown leather of stiff and somewhat harsh texture, whilst the powdered bark from the Sudan yielded a stiff leather of firm texture and greyish-buff colour.

Neither material was rich enough in tannin to be profitably exported, but the bark could be used locally for

tanning purposes, especially in conjunction with a better material, such as *Acacia arabica* pods. It could probably also be used for the manufacture of tanning extracts

Mangrove Barks from Southern Nigeria

Mangroves occur in great abundance on the west coast of Africa, but so far they have not been utilised as a source of bark. Mangrove barks from various parts of West Africa have been examined by different investigators, and all the results go to show that the bark is invariably of poor quality, compared with that obtained in British and Portuguese East Africa, which may contain as much as 45 per cent. of tannin (compare this Bulletin, 1907, **5**, 346).

Series 1

Four samples of mangrove bark were received in December 1910. They were as follows :

No. 1. "Akoriko."—Strips of bark, somewhat curved, about 1 ft. long and 2 in. wide, and from $\frac{1}{8}$ to $\frac{1}{4}$ in. thick. The strips were brown on the exterior surface; the outer bark had been removed, leaving a soft, cork-like covering. The inner surface was smooth, dark brown, and fibrous. The fracture was very fibrous.

No. 2. "Egba."—Small pieces and chips of heavy red bark of varying thickness up to $\frac{1}{2}$ in. Externally the bark was rough and greenish-grey, whilst the inner surface was rough, dark red, and fibrous. The fracture was somewhat soft.

No. 3. "Ogbunda."—Small broken pieces of bark from $\frac{1}{4}$ to $\frac{3}{8}$ in. thick. Externally the bark was fairly smooth, and whitish with brown markings; the inner surface was also fairly smooth, but of reddish-brown colour. The fracture was hard and woody.

No. 4. "Ikate."—Small pieces and chips of bark about $\frac{1}{8}$ in. thick, with some dust. The bark was rough and grey externally, whilst the inner surface was smooth and brown. The fracture was somewhat fibrous on the inner surface of the bark.

These four barks were analysed with the following results :

	No. 1.	No. 2.	No. 3.	No. 4.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Moisture	11·0	11·5	12·6	11·0
Ash	3·2	3·7	2·9	8·4
Tannin	1·9	16·8	12·9	3·8
Extractive matter (non-tannin)	4·9	5·6	6·1	2·6

Bark No. 2 furnished a pale pinkish-brown leather of fairly stiff texture, whilst that produced by No. 3 was pale brown and of fairly stiff texture, but rather more pliable than that from No. 2. The percentage of tannin in Nos. 1 and 4 was too small to render them of value as tanning materials.

Series 2

Five samples of mangrove bark known by the Jakri name "Egbadedu," from different localities in Southern Nigeria, were received in December 1911. They were as follows:

No. 5. From Koko. Obtained from a tree 4 ft. 6 in. in girth.

No. 6. From Nana Creek. The tree from which this sample was obtained was 2 ft. 4 in. in girth.

No. 7. From Escravos river. Girth of tree, 4 ft. 9 in.

No. 8. From Forcados river. Girth of tree, 4 ft.

No. 9. From Ramos river. Girth of tree, 4 ft. 2 in.

The barks were all very similar in appearance and consisted of typical thick mangrove bark with a whitish-brown layer on the outer surface. The inner surface was fibrous and of dark red colour. When cut across, the bark showed a large number of white specks.

The barks were examined with the following results:

	No. 5.	No. 6.	No. 7.	No. 8.	No. 9.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Moisture	14·5	14·4	15·5	13·9	13·4
Ash	3·8	4·4	3·8	4·1	4·4
Tannin	22·0	17·4	27·7	16·8	14·9
Extractive matter (non-tannin)	5·7	7·4	8·7	5·0	6·2
Colour of a 0·5 per cent. tannin solution in a 1 cm. cell. *Red*	21·6	27·6	30·9	33·3	28·8
Yellow	28·4	28·7	36·1	29·8	30·8
Character of the leather produced.	Pale reddish-brown, fairly stiff, of firm texture.	Similar to No. 5, but slightly darker.	Similar to No. 6.	Similar to No. 5, but slightly redder.	Similar to No. 8.

Series 3

Three samples of bark from Degema, Eastern Province, were received in May 1912.

No. 10. Red mangrove bark (*Rhizophora* sp.).—The sample consisted of fragments of thick bark, greyish-brown to brown externally, and brown and rough on the inner surface. The fracture was characteristic of mangrove bark.

The material was damp on arrival at the Imperial Institute, and was air-dried before being analysed. The loss of weight on air-drying was 10·2 per cent.

No. 11. Red mangrove bark (*R. Mangle*).—This sample consisted of irregular fragments of thick bark, greyish-brown in colour and rough externally, but dark brown on the inner surface. The bark showed a characteristic mangrove fracture.

No. 12. White mangrove bark (*Avicennia africana*).—The sample consisted of irregular fragments of moderately thin bark, which was rough and greyish-brown externally and brown on the inner surface. It gave a characteristic mangrove fracture.

The barks were examined with the following results:

	No. 10.	No. 11.	No. 12.
	Per cent.	*Per cent.*	*Per cent.*
Moisture	13·8	16·4	15·8
Ash	6·3	4·8	4·6
Tannin	19·8	17·1	12·5
Extractive matter (non-tannin)	5·2	9·4	9·8
Colour of a 0·5 per cent. tannin solution in a 1 cm. cell. *Red*	25·7	60·3	62·3
Colour of a 0·5 per cent. tannin solution in a 1 cm. cell. *Yellow*	33·7	22·1	31·9
Character of the leather produced.	Rather harsh, of pale brown colour and firm texture.	Similar to No. 10.	Similar to No. 10, but darker in colour.

Some of these samples of mangrove bark from Southern Nigeria, especially Nos. 5 and 7, contained a higher percentage of tannin than is usually present in West African mangrove barks, but none of them was rich enough to be worth exporting to Europe in competition with East African mangrove bark. All except Nos. 1 and 4 would, however, be quite suitable for local use in the Colony, or for the manufacture of mangrove cutch for export.

Mangrove Leaves from the East Africa Protectorate

Two samples of mangrove leaves were received from the East Africa Protectorate in July 1908.

The stems of the East African mangrove trees are now used for "boriti" poles, for which there is a large demand along the East African coast. The bark, which is very rich in tannin, is collected for export; but the leaves are not utilised, and these samples were forwarded for examination in order to ascertain whether they contained enough tannin to make them of commercial value.

No. 1. From a large tree.—This consisted of dry, reddish-brown, coriaceous, oval leaves, from 3 to 4 in. in length and with a maximum width of 2½ in. They had a distinctly saline taste.

No. 2. From a young tree.—Dried, dark reddish-brown leaves of similar appearance and size to the preceding sample.

The samples were examined, with the following results:

	No. 1. *Per cent.*	No. 2. *Per cent.*
Moisture	18·52	18·73
Ash	9·92	9·37
Tannin	9·13	8·78
Extractive matter (non-tannin)	18·80	20·72
Sodium chloride	5·78	6·87
Sodium chloride in total soluble solids	19·60	24·53

An extract of the leaves in each case tanned skin extremely slowly. No. 1 produced a light reddish, harsh leather of poor quality, whilst that produced by No. 2 was similar but of slightly darker shade.

The amount of tannin in these leaves is far too low to render them of value for export. It is, moreover, doubtful whether such material would be suitable for local use, as, on account of the large percentage of salt (sodium chloride) which the leaves contain, they tan very slowly and yield a leather of poor quality.

Mangrove Extract from Fiji

Three samples of mangrove extract from Fiji were received early in 1912, and were examined with the following results:

No. 1.—This consisted of a soft cake of very dark

reddish-brown, friable material, which had a vitreous fracture. The extract was not completely soluble in water.

No. 2.—This was an almost black powder, together with some lumps of friable material. It was not completely soluble in water, and gave a very deep-coloured infusion, indicating that it had probably been overheated during preparation.

No. 3.—This consisted of particles of dark brown friable extract, which was not completely soluble in water.

The samples were examined with the following results, compared with those afforded by a sample of commercial Borneo cutch, previously examined at the Imperial Institute.

	No. 1.	No. 2.	No. 3.	Borneo cutch.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Moisture	26·3	15·8	13·1	15·90
Ash	3·1	7·5	6·4	2·12
Tannin	59·5	55·3	69·4	66·20
Extractive matter (non-tannin)	12·8	22·7	15·3	16·50
Colour of 0·5 per cent. tannin solution in a 1 cm. cell. *Red*	36·1	150·0	25·8	Not determined
Colour of 0·5 per cent. tannin solution in a 1 cm. cell. *Yellow*	28·0	—	28·8	Not determined
Character of leather produced.	Reddish-brown, very stiff, of firm texture.	Similar to No. 1, but very dark in colour.	Reddish-brown, of firm texture.	Pinkish-buff, of good texture.

None of these samples of mangrove cutch from Fiji except perhaps No. 3 would be suitable for tanning leather without decolorisation, but they could be used, like commercial mangrove cutch, for dyeing sails, fishing nets, etc.

Samples 1 and 2 were submitted to commercial experts, who stated that their full value, packed in strong 1 cwt. cases, would be about £14 per ton c.i.f. Liverpool (June 1912). Sample No. 3 was of rather better quality, and should realise a somewhat higher price. The prices ruling for mangrove cutch in 1912 in the United Kingdom ranged from £11 to £14 10*s.* per ton, according to quality.

Brachystegia Barks from Mozambique

Three samples of bark, gathered from three distinct species of Brachystegia at Mocoque, in the Mozambique Company's Territory in Portuguese East Africa, were

received for examination in February 1912. They were as follows:

No. 1.—Small pieces of bark, $\frac{1}{4}$ to $\frac{1}{2}$ in. thick, greyish-brown in colour and varying from smooth to rough externally, and brownish-red and smooth on the inner surface. The fracture was very hard and short.

No. 2.—Small pieces of bark, $\frac{1}{4}$ to $\frac{3}{8}$ in. thick, greyish-brown and rather rough externally, and reddish-brown and smooth on the inner surface. The fracture was very hard and rather fibrous.

No. 3.—Small pieces of bark, $\frac{1}{8}$ to $\frac{1}{4}$ in. thick, greenish-brown and smooth externally, and reddish-brown and smooth on the inner surface. The fracture was hard and rather fibrous.

The results of examination of the barks are given in the following table:

	No. 1.	No. 2.	No. 3.
	Per cent.	*Per cent.*	*Per cent.*
Moisture	10·2	11·0	11·9
Ash	7·0	7·3	6·5
Tannin	18·4	14·1	13·2
Extractive matter (non-tannin)	8·0	7·9	4·1
Colour of a 0·5 per cent. tannin solution in a 1 cm. cell. *Red*	23·1	14·5	12·8
Yellow	21·0	24·1	27·1
Black	3·4	—	—

None of these three barks was sufficiently rich in tannin to be worth exporting to Europe, but they would all be suitable for local use in East Africa. Samples 2 and 3 gave pale-coloured leathers of good texture, whilst No. 1, the richest of the three barks in tannin, yielded a dark-coloured leather, which, however, apart from its colour, appeared to be of good quality. There is a prejudice in Europe against dark-coloured leather, which, therefore, only realises low prices, whilst tanning materials producing such leather are almost unsaleable. Bark No. 1 could, therefore, not be employed for the manufacture of leather or extract intended for export to Europe. Barks Nos. 2 and 3 would probably yield extracts of good quality which would be suitable for export, and this may also be the case with No. 1 if a satisfactory process of decolorisation can be found.

Osyris abyssinica from the Transvaal

Four samples of the dried leaves and twigs of *O. abyssinica*, Hochst. (= *Colpoon compressum*, Berg.) were received from the Transvaal in January 1910. The first two samples described below were collected at Buffelspoort, and the other two near Pretoria. Samples were previously received from South Africa in 1907 under the name of "Cape Sumach" (see this Bulletin, 1906, **4**, 354), but the plant is quite distinct from the true sumach (*Rhus Coriaria*, L.), and possesses different properties.

The samples received in 1910 were as follows:

No. 1.—Dried green leaves and twigs, the latter forming a large proportion of the sample and varying considerably in age, some of them consisting of thin green branches and others of woody branches $\frac{1}{4}$ in. in thickness.

No. 2.—Dried, thin green branches, with a few rather broken, dry green leaves.

No. 3.—Chiefly dried leaves, together with a few thin green stalks carrying leaves.

No. 4.—This sample resembled No. 3, but contained a larger proportion of leaves.

Samples 2, 3, and 4 produced a pale fawn-coloured leather, fairly soft, but rather porous. Sample No. 1 was somewhat abnormal in giving a rather harsh and brittle leather of pale fawn colour.

The following table shows the results of the analyses of the present samples of *Osyris abyssinica*, as well as of previous samples which have been examined at the Imperial Institute:

	Present samples from the Transvaal (1910).				Previous samples from the Transvaal (1907).		Samples from Somaliland (1905 and 1906).	
	No. 1.	No. 2.	No. 3.	No. 4.	Stems.	Leaves.	Leaves and twigs.	Leaves.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Moisture . .	11·7	7·9	10·5	8·2	11·2	11·2	11·0	10·3
Ash . . .	5·8	5·4	4·2	6·9	not determined		7·1	5·4
Tannin . .	13·6	18·8	21·6	24·7	12·9	13·6	23·3	24·8
Extractive matter (non-tannin) .	18·3	24·6	25·3	26·9	14·6	21·4	13·2	21·8

It will be seen that sample No. 1 contained a low percentage of tannin, resembling in this respect the material previously received at the Imperial Institute from the Transvaal. Samples Nos. 2 and 3 were richer in tannin, but contained less than is usually found in *O. abyssinica* (viz. about 23 per cent.) and less than was present in the samples from Somaliland. No. 4 was the best of the four samples, and was as rich in tannin as the Somaliland material.

The samples from the Transvaal differed greatly in the amount of tannin they contained. In the absence of any particulars regarding them, a full explanation of this variation cannot be given; but judging from analyses of the samples received in 1910, the leaves are generally richer in tannin than the stems, and the latter appear to become less rich in tannin with age. The value of this material as a tanning agent is discussed in the previous report (*loc. cit.*) and the remarks made then apply equally to the present specimens. Samples Nos. 2, 3, and 4 were richer in tannin than those previously examined, and would be suitable for local use, but the material possesses no special qualities which would render it suitable for export to Europe.

"Subakh" Bark from the Sudan

A sample of "Subakh" bark derived from *Combretum Hartmannianum*, Schweinf., was received from the Sudan in May 1910. It consisted of small pieces of almost flat bark; the outer surface was reddish-brown and the inner pale yellowish-brown. The bark was coarsely fibrous, and had a pale pinkish-brown fracture. It was analysed with the following results:

	Per cent.
Moisture	7·6
Ash	10·2
Tannin	12·8
Extractive matter (non-tannin)	11·1

The material tanned very slowly and unevenly, giving a light-coloured leather of poor quality.

This bark might be suitable for local use as a tanning

material, especially in conjunction with a better product such as Sant pods, but it is too poor in tannin to be of any value for export purposes.

The Bark of *Aleurites* spp. from Hong Kong

In 1901 von Schröder published a statement (*Deut. Gerb. Zeit.* 1901, **54**, 6) that the bark of *Aleurites cordata* is rich in tannin, whilst more recently a similar assertion has been made regarding the bark of *A. triloba* (*A. moluccana*). Authentic specimens of the barks of these two trees, as well as of *A. Fordii*, were procured from the Superintendent of the Botanical and Forestry Department at Hong Kong in 1909, and these have been examined at the Imperial Institute with the following results:

No. 1. *A. Fordii.*—Long narrow quills of dull grey bark; the outer surface was rather rough, the inner surface pale and woody.

No. 2. *A. cordata* (*A. montana*, Wilson, see p. 445).—Long strips of fibrous bark, the outer surface of which was dark and striated.

No. 3. *A. triloba.*—Large quills of thin bark, about 18 in. long, and covered with a dark, smooth outer layer; the inner surface was red, but the fracture was white and woody.

The following table shows the results of analyses of these barks:

	A. Fordii.	*A. montana.*	*A. triloba.*
	Per cent.	*Per cent.*	*Per cent.*
Moisture	12·89	13·62	13·59
Ash	7·74	4·68	14·41
Tannin	11·90	6·03	5·70
Extractive matter (non-tannin)	8·70		

The bark of *A. Fordii* produced a rather harsh, but fairly pale-coloured leather of medium quality. This material could be used locally as a tanning agent and would yield leather of fair quality, especially if employed in admixture with a mellower and richer tanning material, such as myrabolans.

The results now recorded do not bear out the statements

referred to in the opening paragraph, since neither the bark of *A. montana* nor that of *A. triloba* contains enough tannin to make it suitable for use as a tanning material, whilst the amount of tannin present in the bark of *A. Fordii* is small. Of the three barks, only that of *A. Fordii* could be used for tanning, but even this material contains too little tannin to be worth exporting, and it would only be suitable for local use.

It seems unlikely that the present results differ from those previously recorded owing to differences in the ages of the trees yielding the barks. The three samples of bark forwarded from Hong Kong were apparently obtained from fairly old trees, and as a rule the percentage of tannin in the bark increases with the age of the tree. It is therefore improbable that the deficiency of tannin in the present specimens is due to collection at too early a stage.

If these samples of various Aleurites barks from Hong Kong may be taken as typical and fairly representative of the barks produced by these trees elsewhere, it would appear that the statements made regarding their richness in tannin are inaccurate, possibly owing to the examination of unauthenticated material.

Phyllocladus rhomboidalis Bark from Tasmania

A sample of the bark of *P. rhomboidalis*, Rich., (celery top pine) was received from Tasmania in May 1912. The sample consisted of two pieces of bark measuring respectively 12·5 by 3·5 by 0·4 in. and 12 by 3 by 0·3 in. The outer bark was dark brown, and gave a brittle fracture of dark purplish-red colour; the inner bark, which formed about 67 per cent. of the total, was yellow to orange-brown, with a fibrous fracture.

The results of analyses of the outer and the inner barks were as follows:

		Outer bark. *Per cent.*	Inner bark. *Per cent.*
Moisture		13·6	11·1
Ash		1·2	2·7
Tannin		24·8	16·7
Extractive matter (non-tannin)		6·6	6·8
Colour (approx.) of 0·5 per cent. tannin solution in a 1 cm. cell.	*Red*	23·8	25·0
	Yellow	25·0	25·0

The proportion of tannin, expressed on the whole of the inner and outer bark, was about 20 per cent.

The outer bark gave a pale purplish, soft leather, of firm texture, and the inner bark a pale orange-tinted leather of similar quality.

Both the inner and outer barks represented by this sample contained too low a percentage of tannin to be remuneratively exported to Europe, but they could be used locally in Tasmania for tanning or for the manufacture of extract.

"Kumbuk" Bark from Ceylon

A specimen of "Kumbuk" bark derived from *Terminalia glabra* was received from Ceylon in August 1910. The bark was smooth, thin, and loosely adherent, greyish-brown externally, and showing a tough, fibrous fracture of bluish-pink colour.

In August 1911 a further sample of the bark was received. This consisted of broken pieces of hard, heavy bark, ¼ to 1¼ in. thick, greenish-brown in colour and smooth on the outer surface, and dark brown on the inner surface. The fracture was brittle and showed a pinkish-brown colour.

The two samples were analysed with the following results:

		No. 1. *Per cent.*	No. 2. *Per cent.*
Moisture		11·6	11·1
Ash		9·0	13·1
Tannin		31·6	27·2
Extractive matter (non-tannin)		5·8	6·5
Colour of a 0·5 per cent. tannin solution in a 1 cm. cell.	*Red*	12·3	10·8
	Yellow	26·4	32·8

The bark produced a pale pinkish-brown leather of stiff texture. Trials which have been carried out for the Imperial Institute by a tanning expert have shown, however, that this bark offers certain difficulties in the tanning process which would make it difficult to sell in competition with the large number of rich tanning materials of normal quality now available. An independent trial made by a firm of light leather tanners showed that although the bark could be used commercially for tanning such leather it

yielded a product which was too dark in colour to be acceptable under present conditions.

It does not seem likely that *T. glabra* bark could be profitably exported to the United Kingdom as a tanning material. It could, however, be quite suitably employed in Ceylon in preparing leather either for local use or for export.

Phyllanthus Emblica Leaves from Hong Kong

A sample of the leaves of *P. Emblica*, L., was received from the Superintendent of the Botanical and Forestry Department in Hong Kong in September 1911. The leaves are said to be used in Hong Kong as a black dye-stuff for silk.

The sample consisted of small leaves, about ¾ in. long and ¼ in. broad, varying in colour from pale greyish-green to brown. The leaves were examined at the Imperial Institute both as a tanning material and as a dye-stuff, with the following results:

The leaves were analysed and found to contain:

	Per cent.
Moisture	10·5
Ash	3·4
Tannin	16·8
Extractive matter (non-tannin)	11·9

The colour of a 0·5 per cent. tannin solution in a 1 cm. cell was 4·1 red, 14·9 yellow.

The infusion of the leaves yielded a soft leather of firm texture, and of pale cream colour, with a faint greenish-yellow tinge.

The above results show that the leaves are not rich enough in tannin to be suitable for export to Europe as a tanning material, but that they could be used locally in Hong Kong for tanning purposes, and would produce leather of a good quality.

Experiments carried out at the Imperial Institute showed that, used alone with silk, the leaves gave only a rather dull brownish-yellow tint. When an aluminium mordant was used, aqueous extracts of the leaves gave colours ranging from deep cream to pale yellow, according

to the strength of the extract and the method of treatment employed. By the use of an iron mordant it was found possible to obtain grey and black dyes, as is usually the case with materials containing tannin.

In Watt's *Dictionary of the Economic Products of India* (vol. vi., part i., p. 218 [1892]), the results are recorded of some trials carried out by Wardle, in which the leaves of *P. Emblica* gave light drab or brownish-yellow colours; and, referring to the fruit of the plant, in *Commercial Products of India* (1908, p. 887), Watt states that it gives a blackish-grey dye if used alone, but that it "is generally mixed with salts of iron or the barks of other trees to produce a black." It appears clear from these statements and from the experiments carried out at the Imperial Institute that the leaves of *P. Emblica* cannot be used for dyeing black, except in the presence of iron.

Divi-Divi Pods (*Cæsalpinia coriaria*) from the Gold Coast

A sample of divi-divi pods was received from the Gold Coast in August 1907. Samples from India and Queensland have been previously examined at the Imperial Institute, and the results of analyses of these will be found in this Bulletin (1904, **2**, 93).

The present sample had the usual appearance of divi-divi pods, but the husks were much broken, rather stringy and fibrous in appearance, dull externally and somewhat mouldy internally. A few of the pods had not been separated longitudinally, but were merely broken across, which seems to indicate that they had been collected in an immature condition, when they are difficult to open.

The pods were analysed with the following results:

	Per cent.
Moisture	14·42
Ash	1·22
Tannin	33·10
Extractive matter (non-tannin)	14·63

The material furnished a soft, pale-brown leather of good texture and appearance.

This sample of divi-divi was rather poor in tannin in comparison with the ordinary divi-divi of commerce, which contains from 40 to 45 per cent. of tannin. This fact, and the rather unpleasing appearance of the sample, due to insufficient care having been taken in its preparation, diminished its commercial value. It was valued at £5 per ton as against £9 to £11 per ton obtainable on the same date for West Indian and South American divi-divi.

Divi-divi pods are richest in tannin when just mature, and after collection at this period the pods should be split open longitudinally, the seeds removed, and the husks dried as rapidly as possible in the sun. Slow drying frequently allows fermentation to commence, with the production of red colouring matter which diminishes the value of the material.

ESSENTIAL OILS FROM VARIOUS COUNTRIES

In the following pages an account is given of the results of examination of a number of essential oils from Cyprus, Hong Kong, West Indies, and Zanzibar, which have been received at the Imperial Institute in recent years.

CYPRUS

In addition to the "origanum" and "marjoram" oils from Cyprus to which reference has been made in this Bulletin from time to time, a number of new essential oils have been received from Cyprus during the last few years for examination, and it is of interest to place the results obtained on record, though none of the oils have so far proved to be of much commercial importance. Samples of all the oils are available at the Imperial Institute, where they can be inspected, and small specimens can be supplied to commercial firms interested in these products.

"Juniper" Oil

This product is distilled from the unripe berries of *Juniperus phœnicia*, L., and therefore differs in botanical

origin from the juniper berry oil of commerce distilled from the berries of *J. communis*, L.

The sample was pale yellow in colour, and had a characteristic aromatic odour, differing considerably from that of ordinary juniper oil.

The oil was examined with the following results, which are compared with those of commercial juniper berry oil :

	Present sample.	Juniper berry oil (recorded by Gildemeister).
Specific gravity at $\frac{15°\,C.}{15°\,C.}$	0·8684	0·867 to 0·875
Optical rotation in 100 mm. tube at 20° C.	+ 3° 4′	Generally lævorotatory, up to − 11°.
Saponification value [1] :		
Original oil	9·8	5 to 11
Acetylated oil	16·8	21 to 26
Solubility in alcohol	Not soluble to a clear solution in 10 volumes of either 70 or 80 per cent. alcohol. Gives a slightly opalescent solution with 9 volumes of 90 per cent. alcohol.	Soluble in 8 to 10 volumes of 90 per cent. alcohol.

[1] *Milligrams of potash per gram of oil.*

The oil was submitted to two firms of commercial experts, who agreed in the view that it differed greatly in odour from ordinary juniper berry oil, and that it could not be sold as such.

"Sage" Oil

This oil is distilled from *Salvia cypria*, Unger and Kotschy. The true sage oil of commerce is distilled from *S. officinalis*, L., but oils prepared from other species of *Salvia* are obtainable in commerce though they fetch lower prices than genuine sage oil.

Two samples of the Cyprus oil have been examined.

The first was a pale yellow oil possessing a characteristic odour, somewhat recalling those of camphor and camphor oil. The second was quite similar to the first in appearance and aroma.

These two samples gave the following results on examination ; the characters of genuine sage oil are added for comparison ;

	Cyprus "Sage" oil.		Genuine Sage oil.
	Sample 1.	Sample 2.	
Specific gravity at $\frac{15°\,C.}{15°\,C.}$	0·9263	0·925	0·915 to 0·925
Optical rotation in 100 mm. tube at 20° C.	−6° 31′	−22° 23′	+10° to +25°
Saponification value[1]:			
Original oil	13·9	8	6 to 18
Acetylated oil	38·9	36	Not recorded.
Solubility	In 1 or more volumes of 80 per cent. alchohol.	In 0·8 or more volumes of 80 per cent. alcohol.	In 2 or more volumes of 80 per cent. alcohol.

[1] *Milligrams of potash per gram of oil.*

These results show that the Cyprus oil differs from ordinary sage oil in being lævorotatory, and in being more soluble in alcohol. Further examination showed that it contained a large proportion of cineole (75 per cent. as determined by the resorcinol process) and a small proportion of camphor. Genuine sage oil contains as its chief constituents, thujone, borneol, cineole, and pinene.

Specimens of the Cyprus sage oil were submitted to several firms dealing in essential oils, for opinions as to its commercial value. One or two firms thought it might be sold as a substitute for Spanish sage oil, which was then worth 1*s.* 1*d.* to 1*s.* 4*d.* per lb. (September 1910), but the general view was that the product would not be readily saleable in the United Kingdom unless it was offered at a very low price.

Laurel Leaf Oil

Three specimens of laurel oil distilled in Cyprus from *Laurus nobilis* have been received at the Imperial Institute for examination. The first sample (No. 1) was forwarded early in 1908, the second (No. 2) was received in March 1909, whilst the third (No. 3) was received in July 1909.

It was desired to ascertain whether there would be a market for this oil, of which it was stated considerable quantities could be prepared in Cyprus.

All the samples consisted of clear, yellow oil, possessing the characteristic odour of laurel leaf oil. Sample No. 1 was slightly turbid owing to the presence of moisture.

The oils were examined and furnished the following results, compared with those of commercial laurel leaf oil :

	Sample No. 1.	Sample No. 2.	Sample No. 3.	Commercial laurel leaf oil. (Gildemeister.)
Specific gravity at 15° C.	0·940	0·934	0·9224	0·92 to 0·93
Optical rotation in 100 mm. tube . .	− 5° 21′	−4° 45′	−11° 32′	−15° to −18°
Solubility in alcohol.	Soluble in 1·7 or more volumes of 80 per cent. alcohol.	Soluble in 1½ volumes or more of 80 per cent. alcohol.	Soluble in 1 volume of 80 per cent. and in from 5 to 6 volumes of 70 per cent. alcohol.	Soluble in from 1 to 3 volumes of 80 per cent. alcohol.

Nos. 1 and 2 contained 66 and 71 per cent. of cineole respectively as determined by the resorcinol process.

Samples of these laurel oils from Cyprus have been submitted to experts both in this country and on the Continent.

A London firm reported that there is very little demand for laurel oil in this country, although they believed that it is used to a larger extent in Germany and on the Continent generally. They stated that its principal use, so far as they were concerned, would be as a source of cineole (eucalyptol), and mentioned that they were able to buy eucalyptus oil, containing about 78 to 80 per cent. of cineole, at 1*s.* 2*d.* per lb.

Another British firm to whom the oil was submitted stated that there is only a very small demand for it in this country, while a third London firm reported that this oil was not of any interest to them.

In reporting on sample No. 1 commercial experts stated that the aroma was not inferior to that of the laurel oils usually met with in commerce and valued the sample at about 9*s.* per lb. (May 1908).

Sample No. 2 was submitted to commercial experts in Germany, who reported that its odour was quite equal to that of ordinary laurel oil. They stated that the value of good quality laurel oil was about 8*s.* 3*d.* per lb. (May 1909), but pointed out that the present supply of this oil easily covers the demand, and that any further encouragement of

its preparation on a large scale would lead to a considerable over-production with a consequent rapid fall in prices.

Oil distillers in France and Germany were also consulted regarding the value of sample No. 3. The French firm stated that the oil was of no interest to them, whilst the German firm reported that they distil for themselves all the laurel oil they require. The value of laurel oil in Germany in October 1909 is stated to have been about 10*s.* per lb.

The results of the enquiries made regarding the value of this laurel oil indicate that there would be great difficulty in selling it in this country, and the present demand in Germany appears to be fully met by the existing sources of supply.

"*Mint*" *Oil*

This sample was received in October 1909. It was described as "oil distilled from *Mentha sylvestris*" and consisted of golden-yellow oil, possessing a sharp, spicy taste and a strong odour recalling that of a mixture of peppermint, spearmint, and pennyroyal oils.

It was examined with the following results:

Specific gravity at $\frac{15^\circ\ C.}{15^\circ\ C.}$	0·9687
Optical rotation in 100 mm. tube at 20° C.	+ 31° 58′
Saponification value:	
Original oil	24·9
Acetylated oil	175·5
Solubility in alcohol	In 2½ or more volumes of 70 per cent alcohol.

The oil was submitted to several firms of English and Continental distillers, and dealers in essential oils, who all agreed that it would have no commercial value as a peppermint oil. One firm described it as more like lemon-thyme oil than mint oil, and expressed the opinion that it was distilled from a mixture of plants, probably including pennyroyal.

The distinctive features of this oil are its high specific gravity and its strongly dextrorotatory character. In these respects it differs from most peppermint oils and is more like the pennyroyal oils, but the proportion of alcohols present is higher than in the latter oils and the odour is different.

As this oil does not resemble any of the essential oils of commerce, and presents no peculiarity in odour likely to make it useful, it is improbable that it would find a market.

Myrtle Oil

Two samples of myrtle oil from Cyprus were received in October 1909 and March 1910 respectively. Sample No. 1 was described as "Myrtle oil from *Myrtus communis*." Sample No. 2 was labelled "Myrtle oil extracted from leaves of Myrtle collected at Pyego." The former was pale yellow in colour, and the latter pale yellowish-green; both possessed a marked odour somewhat recalling those of rosemary and eucalyptus oils.

The following table shows the results of examination of these oils compared with those of commercial myrtle oil:

	Sample No. 1.	Sample No. 2.	Oil of *M. communis* according to Gildemeister and Hoffmann.
Specific gravity at $\frac{15^\circ C.}{15^\circ C.}$	0·9166	0·9302	0·890 to 0·915
Optical rotation in 100 mm. tube at 20° C.	+ 8° 14′	+8°	+10° to +30°
Saponification value:			
Original oil	25·1	25·2	not recorded
Acetylated oil	61·5	—	,,
Solubility in alcohol	In 5 or more volumes of 70 per cent. alcohol.	—	—

The oils were submitted to several firms of merchants dealing in essential oils, from whose reports it appears that there is only a very small sale for myrtle oil in the United Kingdom. It is thought that the only possible use for this Cyprus oil would be as a substitute for rosemary or spike oils, but even this is doubtful, as it is lacking in fragrance as compared with these oils. Moreover the price of these oils was then only about 2*s.* per lb. (April 1910). A German firm reported that this myrtle oil resembled samples from Asia Minor which they had examined but for which no market had been found.

The analytical results recorded above show that the Cyprus myrtle oil has a specific gravity and optical rotation similar to those of the myrtle oils prepared in other countries,

but that it most closely resembles the myrtle oils of Corsica, Asia Minor, and Southern France. Like these oils the saponification values of the original oil and the acetylated oil are relatively low.

About twenty years ago myrtle oil was used, especially in France, for the production of "myrtol," the portion of the oil boiling at 160° C. to 180° C., which was used in medicine. The value of "myrtol" was however subsequently shown to be due to cineole, a substance present in much greater quantity in eucalyptus oil. For this reason the use of "myrtol" declined, and the small demand appears now to be amply met by the small quantities of myrtle oil produced in France and Spain.

PEPPERMINT OIL FROM HONG KONG

Two samples of Chinese peppermint oil from Hong Kong were received in December 1909 and July 1911 respectively.

No. 1.—This consisted of dark red oil, which had a strong peppermint odour. The Chinese oil is stated to be usually colourless or only faintly yellow, so that the discoloration of this sample was probably due to the rusting of the tin in which the oil was forwarded.

No. 2.—A dark brown oil, containing a small quantity of reddish matter in suspension and possessing a pleasant peppermint odour.

The results of the chemical examination of the samples are given in the following table:

	No. 1.	No. 2.
Specific gravity at $\frac{15° \text{ C.}}{15° \text{ C.}}$ . . .	0·9235	0·9359
Optical rotation in 100 mm. tube at 20° C.	− 44° 8′	− 41° 15′
Total menthol . . . . *per cent.*	61·84	59·8
Free menthol . . . *per cent.*	47·49	43·3
Menthol (as esters) . . *per cent.*	14·35	16·5
Both oils dissolve to a clear solution in 2½ volumes of 70 per cent. alcohol.		

The intense dark red colour of the oil would prove an objection to its ready sale, and a portion of sample No. 1 was therefore re-distilled in steam. As thus obtained the oil was almost colourless and possessed a pleasant peppermint odour. The results of the examination of the re-dis-

tilled oil, which are given in the following table, show that its physical and chemical characters were only slightly affected by the re-distillation:

Specific gravity at $\frac{15^\circ\text{ C.}}{15^\circ\text{ C.}}$	0·918
Optical rotation in 100 mm. tube at 20° C.	− 44° 40′
Solubility:	Soluble in 2½ volumes of 70 per cent. alcohol.
Total menthol *per cent.*	64·24
Free menthol *per cent.*	50·69
Menthol (as esters) *per cent.*	13·55

Since the dark red colour of the oil as received was certain to be unacceptable to consumers of peppermint oil in the United Kingdom, it was thought desirable to submit only the re-distilled oil for valuation. The latter was valued at 5*s.* 6*d.* to 6*s.* per lb. in London, with Japanese dementholised oil quoted at 5*s.* 2*d.* to 5*s.* 3*d.* per lb. (September 1910).

This Chinese peppermint oil somewhat resembles in composition the dementholised peppermint oil imported to this country from Japan, as the following comparison shows, but it will be noted that the Chinese is much richer in menthol than even the best specimens of Japanese dementholised oil.

	Present samples.		Dementholised Japanese peppermint oil.
	No. 1.	No. 2.	
Specific gravity at $\frac{15^\circ\text{ C.}}{15^\circ\text{ C.}}$	0·9235	0·9359	0·895 to 0·905
Optical rotation	− 44° 8′	− 41° 15′	− 20° to − 35°
Total menthol *per cent.*	61·84	59·8	43 to 50
Free menthol *per cent.*	47·49	43·3	34 to 44
Menthol (as esters) *per cent.*	14·35	16·5	6 to 11

The value of peppermint oil of a particular class is mainly dependent on the quantity of menthol present in the free state and as "esters." In this respect this Chinese oil is distinctly superior to Japanese dementholised oil, and when it became better known would probably realise higher prices than the latter.

The Superintendent of the Botanical and Forestry Department, Hong Kong, stated in the letter accompanying sample No. 1 that the wholesale price of the oil in Hong Kong is $8.40 (about 14*s.* 9*d.*) per lb., but that the price fluctuates from time to time, whilst sample No. 2 was stated to be worth $9 per lb. in Hong Kong. In view of the valuation of the London dealers quoted above, it does not appear possible that the oil can be exported profitably to this country.

"Ngai Yau" Oil from Hong Kong

This oil, which was labelled "Ngai Yau," was stated to be probably derived from *Artemisia vulgaris*, L., and was said to be distilled in the Kwangsi Province. It was a very dark brown oil, with a sweetish odour, which was slightly camphoraceous but not very penetrating.

The oil was submitted to examination, with the following results:

Specific gravity at 15° C.	0·9390
Optical rotation	The oil was too dark to allow of this determination.
Saponification value	103·3
„ „ after acetylation	205·87
Solubility in alcohol	The oil gave a clear solution in 1 volume of 90 per cent. alcohol. The addition of further alcohol rendered the solution very turbid.

This oil is stated to be worth $7.20 per lb. in Hong Kong.

A note on the examination by Messrs. Schimmel & Co. of *A. vulgaris* oil from India is given at p. 527.

Lime Leaf Oil from Montserrat

This sample, described as "lime leaf oil," prepared at the Botanic Station, Montserrat, was received in February 1910. It consisted of pale yellow oil, having an odour recalling that of lime oil and "petit grain" oil.

It was examined with the following results :

Specific gravity at $\frac{15^\circ\ C.}{15^\circ\ C.}$	0·8772
Optical rotation in 100 mm. tube	+ 38° 17′
Saponification value	27·6
Aldehydes (by sodium bisulphite method) *per cent.*	43
Solubility in alcohol	Not soluble to a clear solution in even 10 volumes of 70 or 80 per cent. alcohol; gave a clear solution with 90 per cent. alcohol up to the addition of 9 volumes when a slight opalescence was produced.

The sample was submitted to a firm of oil distillers, who reported that it was difficult to assign a value to the oil on the results of the analysis alone ; they did not consider that it would be of value in perfumery, especially as the odour was not altogether pleasant. In their opinion the oil is only of scientific interest. This oil was first examined by Dr. Francis Watts in 1886 (*Trans. Chem. Soc.* 1886, **49**, 316).

"Petit Grain" Oil from Jamaica

This sample, which was received in August 1909, was stated to be distilled in Jamaica from bitter orange leaves. It consisted of a clear, very pale yellow oil, having an odour slightly different from and less pleasant than that of the "petit grain" oil of commerce. The difference in odour was probably due to the presence of more "free alcohols" than is usually present in "petit grain" oil.

The oil was examined with the following results, which are compared with the figures for commercial oil :

	Present sample.	Commercial "petit grain" oil from leaves, twigs, and immature fruits.	Commercial "petit grain" oil from leaves only.
Specific gravity at 15° C.	0·8884	0·887 to 0·900	0·891 to 0·893
Optical rotation in 100 mm. tube	− 6° 45′	−1° 22′ to + 3° 43′	−5° 12′ to −6° 15′
Esters calculated as linalyl acetate *per cent.*	30·6	38 to 85	51·5 to 69·6
Solubility in 80 per cent. alcohol	Soluble in one or more volumes.	Soluble in 2 volumes.	Soluble in 1 to 1·1 volume.

The oil was somewhat abnormal in composition for a "petit grain" oil. It was found to contain 31·6 per cent. of "free alcohols" and 55·65 per cent. of total alcohols (combined and free).

The sample was too small to permit of commercial valuation.

Pimento Leaf Oil from Jamaica

A sample of this oil, which was obtained from the leaves of *Pimenta officinalis*, Lindl., was received from Jamaica in August 1909. It consisted of clear, light brown oil, with a distinct odour of eugenol and a burning taste.

The oil was examined with the following results, compared with pimento berry oil of commerce.

	Present sample.	Commercial pimento oil (from berries).
Specific gravity at 15° C.	1·026	1·024 to 1·050
Optical rotation in 100 mm. tube	− 5° 30′	slightly lævo-rotatory.
Phenols (chiefly eugenol), *per cent.*	68·6	65
Solubility in alcohol	Soluble in 1·6 vols. of 70 per cent. alcohol.	Gave a clear solution in 2 vols. of 70 per cent. alcohol.

Pimento leaf oil is not a regular article of commerce, and there is very little information on record regarding it. The above figures, however, show that the present sample is about as rich in eugenol as the pimento berry oil of commerce, and it should therefore be readily saleable for the manufacture of eugenol.

The sample was too small for commercial valuation.

Clove Leaf Oil from Zanzibar

This sample was received at the Imperial Institute in April 1909. It consisted of dark brown oil, which possessed the characteristic odour and taste of cloves.

It was examined with the following results:

Specific gravity at 15° C.	1·0652
Optical rotation	The oil was too dark to admit of the determination of this constant.
Eugenol *per cent.*	85·7
Solubility	The oil was soluble in 1·1 or more volumes of 70 per cent. alcohol.

The sample of oil was not large enough to permit of commercial valuation. The value, however, of clove oil containing 82 to 85 per cent. of eugenol was at the time of the report about 3*s.* 1*d.* per lb. (June 1909), and this clove leaf oil would probably realise a similar price.

The results obtained in the examination of this Zanzibar oil are quite similar to those afforded by a sample of clove leaf oil from Seychelles examined in 1907 (see this BULLETIN, 1908, **6**, 111).

"GORLI" SEED FROM SIERRA LEONE

Two samples of seeds of the "Gorli" plant were received from Sierra Leone in 1908. Herbarium specimens of the plant were subsequently received, and these were identified at the Royal Botanic Gardens, Kew, as *Oncoba echinata*, Oliver. The plant is stated to grow fairly abundantly in the Yorney district and at Gbatema in Sierra Leone, but only in the few remaining patches of high forest, where it would be difficult, if not impossible, to collect large quantities of the seed.

The seeds were of rather irregular shape, from $\frac{1}{4}$ to $\frac{3}{8}$ in. long and $\frac{1}{8}$ to $\frac{3}{16}$ in. wide at the broadest part. The average weight of a single seed was 0·046 gram. The seeds possessed a stiff, brown seed-coat. Internally they were white, waxy in appearance, and soft, but they did not yield visible oil when squeezed with a knife. They possessed a bland, oleaginous taste, but when chewed left a faint peculiar after-taste. The second sample of seeds had a somewhat mouldy odour.

The seeds on analysis gave the following percentage results:

	No. 1.	No. 2.
Moisture	5·8	5·8
Fat	46·6	46·6
Crude proteins	17·5	18·1
Consisting of:		
True proteins	11·3	10·2
Other nitrogenous substances	6·2	7·9
Starch, etc. (*by difference*)	11·8	12·1
Crude fibre	15·6	14·7
Ash	2·7	2·7

The fat was hard, white, and crystalline, and possessed a peculiar characteristic odour. The results of its examination were as follows :

		Fat from sample No. 1.	Fat from sample No. 2.
Specific gravity at 15·5° C.		0·898	0·896
Acid value		4·5	22·4
Saponification value		192·4	193·9
Iodine value	*per cent.*	99·7	96·8
Titer test		57·8° C.	57·8° C.
Hehner value		96·5	96·5
Reichert-Meissl value		*nil*	*nil*
Unsaponifiable matter	*per cent.*	1·6	1·3

The fat had not a definite melting point, but gradually liquefied above 35° C., and was completely melted at 45° C.

The higher acid value of the fat from sample No. 2 and the slight variations of the other constants from those of No. 1 were probably due to the fact that the seeds of No. 2 were somewhat mouldy.

The fat yielded a hard soap of satisfactory appearance but possessing the persistent odour of the fat itself.

The fat obtained from these seeds has been further examined by Dr. Ernest Goulding and Mr. Noel C. Akers, of the Scientific and Technical Department, Imperial Institute, and the results have been recently communicated to the Chemical Society of London (*Proc. Chem. Soc.* 1913, **29**, 197).

The fatty acids obtained by hydrolysing the fat had an iodine value 105·1, and specific rotation $[\alpha]_D^{18°} + 52·5°$, and consisted of a mixture of a crystalline solid and a liquid. The former, after purification, was obtained in the form of thin, lustrous plates, and was identified as chaulmoogric acid, a substance first obtained by Power and Gornall (*Journ. Chem. Soc.* 1904, **85**, 846) from the Indian product "chaulmoogra oil."

The liquid portion of the fatty acids, although saturated with chaulmoogric acid, gave an iodine value 122, showing that the liquid acids are highly unsaturated; it darkened rapidly on exposure to the air.

The mixed fatty acids consisted approximately of chaulmoogric acid, 87·5 per cent., and liquid acids, 12·5 per cent.

The seeds of the Gorli plant could probably be employed as a source of fat, which might be of use for soap or candle manufacture, but no definite opinion can be expressed on this point in the absence of technical trials. The fat would not be suitable for edible use on account of the large proportion of chaulmoogric acid it contains, fats containing this acid having recently been proved to possess toxic properties (see this BULLETIN, 1911, **9**, 406).

SPECIAL ARTICLES

THE "WOOD-OIL" TREES OF CHINA AND JAPAN

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ALEURITES, a small genus of about six species belonging to the Euphorbiaceæ, all trees and natives of extreme eastern Asia and Malaysia, is of considerable economic importance, owing to the fact that the seeds of all the species are rich in useful fixed oils. The products of these trees have, in a limited way, been known for a very long time, but in the near future they are destined to occupy a much more important place in Western arts and commerce than heretofore. In particular does this apply to the so-called "wood-oils" of China and Japan. During the past decade there has been an increasing demand for these oils in the markets of Europe and North America. The exports from China have increased enormously, and prices have risen considerably. In a densely populated country like China, where the food of the people is all supplied from within, and where every inland district is compelled, owing to difficulties of intercommunication, to support its own inhabitants, every available square yard of land is tilled for the production of foodstuffs and other crops indispensable to the life of the people. Plants yielding economic products useful in the arts and in general commerce can of necessity be allowed to occupy only such land

as it is impossible to cultivate otherwise. These facts serve to demonstrate that until vast changes take place in China in the conditions of the life of the people and of intercommunication, there must be an obvious limit to the supply of such products for export purposes. If, therefore, the increasing demand for wood-oils in Western markets is to be adequately met, it is imperative that the source of supply be extended. Within the British Empire can be found vast tracts of country little suited to general agriculture or to the cultivation of more exacting economic plants, yet admirably adapted for the culture of Chinese Wood-oil trees. In warm-temperate, rocky parts of Australia, South Africa, the East Africa Protectorate, India, and elsewhere, the attention of agricultural departments might advantageously be directed towards these trees.

Their cultural requirements are of the simplest. The growth is rapid, and the trees commence to bear fruit in four or five years after the seed is sown. The trees are of relatively low stature, with wide-spreading heads, and are apparently indifferent to the nature of the soil. They are exceedingly ornamental when in flower, and they fruit very freely. These qualities, together with an assured market for the oil in increasing quantities, should be sufficient inducement to warrant their experimental culture being undertaken in suitable parts of the British Empire.

The Department of Agriculture of the United States has been experimenting with the most important of these Wood-oil trees (*Aleurites Fordii*) since 1905, and from a *Circular* on the subject (*Circ.* No. 108, *Bur. Pl. Indust., U.S. Dept. Agric.*, April 1913) it is evident that a very considerable measure of success has been attained. It has been shown that this tree can be successfully grown in parts of the United States; also that it fruits freely, and that there is no reason to believe that the oil obtained is of other than equal value with that produced in China. Wood-oil trees have fruited well in South Carolina, Alabama, Louisiana, Mississippi, Georgia, Texas, California, and Florida. In the last-named State, one tree, raised from seed sent from Hankow, China, in 1905, bore 410 fruits in 1911 and 852

fruits in 1912, approximately one and two bushels respectively. It has not been injured by a temperature of 14° F.[1] "The tree has stood a temperature as low as 4° F. at Clemson College, South Carolina, without injury, except the loss of a few lateral branches, and is slow to start into growth even when subjected to a temperature of 80° F. It is therefore not so liable to be injured when this temperature is immediately followed by a drop to 18° F." The same *Circular* states further that the imports of this oil into the United States in 1911 amounted to five million gallons, to produce which 40,000 acres of trees would be required, planted 20 ft. by 20 ft., that is, 108 trees to the acre. It concludes by stating that the Department of Agriculture will have, in 1914, a limited number of one-year-old trees for distribution to *bona-fide* experimenters. "Experiments with single trees have been made, and what is now desired is the creation of acre plantations in the hands of private individuals."

It is the purpose of this article to give an account of the Wood-oil trees of the Far East, more especially of the particular species which yields fully nine-tenths of the oil used in and exported from that region.

In China, two distinct species of Aleurites (*A. montana* Wils., and *A. Fordii* Hemsl.), each occupying for the most part distinct geographical areas, yield the wood-oils of commerce. In southern Japan a third species (*A. cordata* R. Br.), occurs, but the oil does not figure as an article of export to western countries. These three species from very early times have been almost hopelessly confused. The confusion began with Lamarck (*Encycl. Méth. Bot.* ii. 329 (1786)), who described the flowers, leaves, and shoots of *A. cordata* and the fruit of *A. montana* under the name of *Dryandra oleifera*. In 1824, Adrien de Jussieu (*Euphorb. Gen. Tent.* 38, t. 11, fig. 35), described and figured the flowers of *A. cordata* and the fruit of *A. Fordii* under the name of *Elæococca verrucosa*. Since the above dates, many names have been applied to these

[1] In that part of China where this tree luxuriates, the temperature seldom falls below 25° F., and the tree is not in any sense of the term hardy in cool-temperate regions.

Chinese and Japanese trees, and various botanists, Adrien de Jussieu himself, for example, considered that two species were involved, but not until 1906, when Hemsley (in *Hooker's Icon.* xxix, tt. 2801, 2802) established *A. Fordii*, was this clearly defined. Unfortunately, owing doubtless to lack of sufficient material, Hemsley failed to distinguish the Japanese and southern Chinese trees as distinct species, and, therefore, while correcting Adrien de Jussieu's mistake, he unwittingly perpetuated that of Lamarck.

As will be shown later (pp. 445, 456), these three species possess very distinctive characteristics, especially in the fruit, yet in the absence of complete material it is easy to confuse them. The oil from the seeds of any of the three species has been indiscriminately known to foreigners trading with China as "wood-oil" from the earliest times, and the explanation of this is not far to seek. The first sea-trade between Europe and China commenced in A.D. 1516, when Captain Raphael Pestrello, a Portuguese, visited Canton. In 1517, a small Portuguese fleet, under the command of Ferdinand Andrade, anchored near Maçao. The commander was well received by the Chinese, and allowed to proceed with two ships to Canton, where he obtained permission to trade. Other expeditions followed, and in 1537 the Portuguese had established three trading stations in the gulf of the Canton river. Of these, Maçao, on account of its favourable location, was the most important, and the others were in time abandoned. For more than three centuries the trade between the Occident and China was carried on principally with Maçao, Canton, and the near-by ports in south-east China. The names assigned to various native products by foreign traders in these early days were afterwards applied to the same or similar products emanating from northern, central, and western China. Hence the name wood-oil ("mu-yu"), strictly applied by the Chinese to the oil expressed from the seeds of *A. montana*[1] in south-eastern China, was in time extended by foreigners to include a similar product obtained from the Yangtze Valley and derived from

[1] The ripe fruit of this tree is hard and woody, and probably this is the origin of the name "Wood-oil tree" ("Mu-yu shu").

A. Fordii, which the Chinese themselves designate tung-oil[1] ("tung-yu").

"*Mu-yu shu.*"—As indicated earlier in this article (p. 443) the first mention of the Mu-yu shu (literally, Wood-oil tree), *A. montana* Wils., occurs in Lamarck's *Encycl. Méth. Bot.*, where, under the name of *Dryandra oleifera*, the fruit of this tree is described, in conjunction with the flowers and foliage of *Aleurites cordata* R. Br.. The major part of the description refers to this latter tree, and therefore the specific name cannot stand, yet Lamarck's general remarks leave no doubt but that he had the Chinese rather than the Japanese tree in mind. He states that it is called "Mou-yeou" by the Chinese and that it was cultivated in the Jardin du Roi à l'Isle de France. The Jesuit missionary, Loureiro, a Portuguese, established himself at Canton in 1779, and for three years investigated the flora of that region. He secured specimens of the Mu-yu shu, and in his *Fl. Cochinch.* 587 (1790) describes it as *Vernicia montana*, and his specific name, being the oldest valid name, must stand. Subsequent authors gave other names to this tree, and several of them, notably Mueller Arg. (in De Candolle's *Prodr.* xv. pt. 2, 724 (1866)), continued the confusion begun by Lamarck (*loc. cit.*).

As a cultivated tree, *Aleurites montana* occurs in the sub-tropical parts of south-eastern China from the province of Fokien southward to Tonking, and is also undoubtedly a native of these regions. I have seen herbarium specimens of this tree from Fokien and from the island of Hainan, but have only seen living trees on the island of Hong Kong, and therefore am not in a position to give intimate details concerning its cultivation. It, without question, requires a sub-tropical climate and a more abundant rainfall than its more northern relative, *A. Fordii*. In the central parts of the Fokien province, both Mu-yu and Tung-yu trees occur, according to Dunn (*Report on the Bot. and For. Dept. Hong Kong*, 1905, 117), and are known colloquially as "Hwa-tung"

[1] The name "Tung" is applied in China to several widely distinct trees having large, heart-shaped leaves, among them Paulownia, of which four or five species occur. In Japan "Giri" ("Kiri") is the name of *Paulownia tomentosa* Steudel, and it is worthy of note that one of the colloquial names for *Aleurites cordata* R.Br., is "Abura-giri"—"Oil-giri."

and "Guong-tung" respectively. "The Hwa-tung," to quote Dunn, "is the most valued because all the flowers of the majority of the trees produce fruits from which the oil is made, while in the second kind a few flowers only in each cluster are perfect, quite 80 per cent. being male flowers." This statement is not borne out by specimens before me, including some collected in Fokien by Dunn. The inflorescences might almost be classed into male and female, but there is nothing to indicate whether or not they came from the same or different trees. From the herbarium material, one might reasonably assume that the tree was nearly diœcious, yet in all probability it is monœcious, as in other species of the family, but with a strong tendency to have the male and female flowers collected into different inflorescences on the same tree.

The Mu-yu tree in size, habit, foliage, and general appearance (but not in its flowers and fruit) closely resembles the Tung-yu tree (*A. Fordii* Hemsl.). The flowers are borne in a terminal corymb or a raceme on shoots of the current season's growth after the leaves have fully expanded. The "male" inflorescence is many-flowered, much-branched, corymbose, 15–20 cm. long and 20–30 cm. (1 cm.=0·3937 in.) broad. The "female" inflorescence is relatively few-flowered, racemose, and 8–12 cm. long. The fruit (Plate XIII., Fig. 1) is markedly distinct, being egg-shaped, 5–6 cm. long, 4–4·5 cm. wide, pointed at the summit and flattened at the base, with three longitudinal and many transverse, much-raised ridges; the interior part of the fruit (mesocarp) is thick and woody and encloses (usually) three compressed, broadly obovoid seeds, each about 3 cm. long by 2·5 cm. broad, and warty on the outside. When ripe the fruit opens from the base upward into three parts and the seeds can then be readily extracted. Since the fruit is comparatively thick and quite woody, it is not easily retted by fermentation, as is the case in that of the Tung-yu tree.

As will be shown later, the exports of oil from this tree are small, and it is quite impossible to cite chemical analyses that apply solely to the mu-yu, the product of *A. montana*. In all probability mu-yu has been investigated

by chemists, but owing to the botanical confusion that has existed down to the present it has not been clearly distinguished from the tung-yu or from the Japanese wood-oil. It is therefore very desirable that both the kernels which yield this mu-yu and the commercial product itself be examined by chemists, and its constants, etc., definitely established. In order to avoid any possible error, a sample of the fruit should be obtained and the seeds extracted in the laboratory.

Tung-yu shu. — The first reference in European literature to the Tung-yu shu (literally Tung-oil tree), *A. Fordii* Hemsl., occurs in Adrien de Jussieu's *Euphorb. Gen. Tent.* p. 38, t. 11, fig. 35 (1824), where, under the name of *Elæococca verrucosa*, the fruit and seed are figured, together with the flowers of the Japanese *Aleurites cordata* R. Br.. This confusion remained until Hemsley (in *Hooker's Icon.* xxix. tt. 2801, 2802 (1906)), established the Tung-yu shu as a distinct species under the name of *A. Fordii.* This species is the most hardy member of its family. It is much more widely distributed in China than the allied species *A. montana*, and furnishes fully nine-tenths of the wood-oil used in and exported from China. The Tung-yu shu is unquestionably the tree whose culture should be experimentally undertaken in the parts of the British Empire already indicated. In procuring seeds for this purpose, it must be borne in mind that, like all seeds rich in oils or fats, they soon lose their power of germination if exposed to sunlight and air. The ripe seeds keep quite well in the fruit husks, and it is advisable to obtain them for planting in this form. If the ripe fruits are dried in the sun for two or three days and then packed in sacks or barrels, the seeds will travel well and retain their germinating power for three or four months. If the seeds are removed from the fruit they must be packed in thin layers, in boxes of soil. The soil used should contain sufficient moisture to cause the particles of earth to cohere when firmly squeezed in the hand, but not enough to prevent them falling asunder into a powder when the mass is dropped from a height of 2 ft. or so to the bottom of a box or on a hard floor. Any attempt to transport the shelled seeds loose in boxes or

bags, over distances long enough to occupy a month or more in transit, especially through the tropics, will end in failure.

The Tung-oil tree occurs in all the warm-temperate parts of China, but more especially those within the watershed of the Yangtze River. It also occurs in the provinces of Fokien and Yunnan. Its centre of distribution is undoubtedly north-west Hunan and Kweichou, and the region contiguous to the Yangtze River, in western Hupeh and Szechuan, from the city of Ichang westward to that of Chungking: thereabouts, up to 800 metres altitude (1 metre = 3·27 ft.), a traveller is never out of sight of groves of this tree, and in April, when in flower, it is a most striking feature in the landscape. The tree appears to have no strong predilection in the matter of soil, and grows equally well on conglomerate, hard limestone, sandstone, or sandy clay. It is essentially a hill-side tree, thriving in the most rocky situations and in the poorest of soils where there is a minimum rainfall of 70 cm.; it will also withstand drought and a few degrees of frost. At Ichang, where this tree luxuriates, the climate is one of extremes. The summer is tropical, the temperature in June, July, and August ranging between 90° and 110° F. in the shade. The winter is cold, snow often lying on the ground for days, but the temperature seldom falls as low as 28° F. In the mountains, at 800 metres altitude, the summer is somewhat cooler and the temperature may fall to 24° F. and occasionally even as low as 20° F. The annual rainfall at Ichang, according to the Maritime Customs' statistics, averages about 75 cm., most of which is precipitated in the months of April, July, and August.

A quick-growing, short-lived tree, *A. Fordii* seldom exceeds 10 metres in height, and averages less. It has a much-branched, flat-topped or rounded head, 5 to 10 metres or more through, and is highly ornamental either in flower or foliage (Plates IX. and X.). The bark is smooth and pale grey: the wood white, soft, and of no value save as fuel. The flowers are produced in April before the leaves unfold, and are borne in numerous, terminal and axillary, few-flowered cymose corymbs, which

PLATE IX.

Aleurites Fordii, 2 metres tall. Banks of Yangtze River, April 6, 1908.

collectively form, at the end of every shoot, a loose, rounded truss of flowers. These flowers are 2·5–4 cm. across, white, stained with pink, and have yellow markings, more especially near the base; the central, terminal flower of each cyme is female, the others are usually male. The leaves are deciduous, and when full grown, dark, shining green, broadly ovate, long-pointed, and heart-shaped at base; the blade is 10 to 20 cm., or more, long and broad; the leaf stalks 15 cm. or more long; on young trees and on very vigorous, usually sterile shoots, the leaves are three-lobed. The fruit (Plate XII., Fig. 2; Plate XIII., Fig. 2) is apple-like, green passing to dull brown when ripe, flattened round or somewhat turbinate, 4 to 5 cm. long and broad, with a short point at the summit, somewhat narrowed to the foot-stalk, and perfectly smooth on the outside. The fibrous "flesh" is 3–4 mm. thick, and encloses three to five, rarely more, compressed, broadly obovoid seeds, each 2–2·5 cm. long and broad, and very slightly ridged and warty on the outside (Plate XII., Fig. 2). Both fruit and seed are poisonous to man, causing severe vomiting and purging.

The fruit ripens in September and October, and breaks naturally from the base upward into three parts when ripe and dry, but it is invariably gathered before this stage, and collected into heaps which are covered with straw and grass. Fermentation sets in and quickly disposes of the thin "flesh" of the fruit, after which the seeds are easily removed. The low stature of the trees simplifies the gathering of the fruits, which is accomplished by knocking them off with poles. The yield per tree varies from one to five or more bushels, according to size. As mentioned earlier, there are no systematically cultivated orchards of this tree in China. It is planted on rocky hill-sides, waste places and road-sides, being allowed to occupy only sites where farming is impossible. In such places, the trees may be few and scattered, or they may form dense groves (Plate XI.), but any one attempting the cultivation of these trees as a business is recommended to plant them not less than 20 ft. apart each way.

Extraction and Uses of Wood-oils in China

The process adopted by the Chinese for extracting the oil is very simple. The seeds are first crushed in a circular trough beneath a heavy stone wheel worked by horse- or ox-power. The comminuted mass is then partially roasted in a shallow pan, after which it is placed in a wooden vat, fitted with a wicker bottom, and thoroughly steamed over a cauldron of boiling water. Next, with the aid of an iron ring and straw, it is made into circular cakes about 45 cm. in diameter and 10 cm. thick. These cakes are arranged edgeways in a large wooden press (Plate XII., Fig. 1) which accommodates about a dozen, and when full, pressure is exerted by driving in one wedge after another, thereby crushing out the brown, somewhat watery and heavy-smelling oil, which falls into a vat below. The yield is about 40 per cent. by weight of the kernels; the refuse cakes are used on the fields as manure. This tung-oil is packed in wooden tubs or bamboo baskets, and is ready for export. In Hupeh I have frequently seen the fruit of the "Lacquer-varnish tree" (*Rhus verniciflua*, Stokes) (this Bulletin, viii. 32, (1910)) mixed and ground up together with the tung-oil seeds. The oil expressed from the mixture of the two is used as an illuminant, but is very dirty, producing much smoke and very little light. The oil from the fruit of the Lacquer-varnish tree is made into candles and used by the Chinese peasants in mountainous districts. Of late years, since the increased demand for tung-oil as an article of export, bean-oil, obtained from the Soy Bean, has become a recognised adulterant, and sesamum-oil is also used. As the demand increases other oils will doubtless be thus illegitimately employed, including that obtained from the fruit of the Lacquer-varnish tree.

Uses.—In China the uses of mu-yu and tung-yu are manifold. They are the chief paint-oils of the country, and are largely employed as varnish, as waterproofing material, as ingredients in concrete, as medicine, etc. The Chinese do not paint their boats, they oil them, and the myriads of such craft plying on the Yangtze and other rivers of

Aleurites Fordii. A full-grown tree of average size. 8 metres tall; head 6 metres across.

China, and up and down the coasts of that country, are all coated, and the upper-works kept waterproof, with these oils. For how many hundreds of years the Chinese have known and employed these wood-oils it is impossible to compute. Marco Polo[1] says "They take some lime and chopped hemp, and these they knead together with a certain *wood-oil*; and when the three are thoroughly amalgamated they hold like any glue, and with this mixture they do pay their ships." What the famous Venetian observed in the latter end of the thirteenth century obtains to-day. The boats in China are still caulked with the above material, and probably have been since before the dawn of the Christian era.

The tung-yu is much more plentiful and is consequently more widely used in China than the mu-yu; it is also the oil of which I have intimate knowledge, and the remarks which follow apply strictly to this oil. The crude tung-yu, after being boiled for an hour, becomes a greyish-white, syrupy oil ("pei-yu" or white oil) and is used for mixing with paints or lacquer-varnish, and as a varnish for boats, furniture, and general woodwork. The method of applying it as a varnish is very simple. The surface of the wood is smoothed with a plane or some other sharp-edged tool, and the pei-yu is rubbed on with a piece of rag, a dry and preferably a sunny day being chosen for the purpose. Two or three separate coatings are applied, each being allowed to dry before another is put on. The drying process only occupies a few hours. When finished, such varnished woodwork glistens in the sun like a mirror. Pei-yu is added to lacquer-varnish for the double purpose of lightening the colour and causing it to dry more quickly. Four to eight ounces of pei-yu added to 16 oz. of crude lacquer-varnish, which is black, will produce a brown varnish, which dries rapidly even in moderately dry, hot weather. The more pei-yu added the paler the varnish, and the more quickly it dries. This mixture is commonly employed on the upper works of foreign ships engaged in the coast trade of China. The colour is much more serviceable than that of lacquer-varnish alone; moreover,

[1] *The Book of Ser Marco Polo, the Venetian*, 2nd. ed., ii. 232 (1875), by Col. Yule.

the latter is irritant and poisonous, and will only dry outside in cloudy weather, when the atmosphere is surcharged with moisture. Pei-yu is also one of the constituents of red and of yellow lacquer-varnish. A chocolate-coloured pei-yu is obtained by allowing the oil to mature in old lacquer-varnish tubs.

Crude tung-yu, boiled for two hours with the addition of certain mineral substances, produces a yellowish-grey, viscid varnish known as "kuang-yu." I am not sure of the nature of the mineral substances. One, called "tu-tzu," consists of nodules of earth, grey coloured outside and dark brown within; the other, known as "to-shên," is powdered quartz, impregnated with a substance resembling iron pyrites. To 100 catties (1 catty equals $1\frac{1}{3}$ lb.) of crude tung-yu is added half a catty of tu-tzu and 8 catties of to-shên. Kuang-yu is applied by a brush to silk gauzes and pongees to make them waterproof. It dries very quickly on exposure to the air, and is kept carefully covered with paper to prevent drying before application.

As an illuminant tung-yu is of little value, being exceedingly dirty, and is only used by the peasants in the more remote parts of central China. The lamp-black produced by burning the oil, or the fruit, is a most important ingredient in the manufacture of Chinese ink.

Exports of Wood-oils

The only statistics available on the trade of China are those published by the Maritime Customs, and these only cover the returns for the few treaty ports, and even of these have no concern with the vast volume of trade passing through the Native Customs. The Maritime Customs trade returns are very condensed, and various oils are frequently grouped under one heading, and it is only in the returns of one or two ports that wood-oils appear as a separate item. Hankow is the great trade entrepôt of central China, and monopolises the export of many products, including that of tung-oil. The export from Hankow of this oil in 1900 was 330,228 piculs,[1] valued

[1] By the Trade Regulations annexed to the British Treaty of 1858, the "picul of 100 catties is held to be equal to $133\frac{1}{3}$ lb. avoird.," giving a catty of $1\frac{1}{3}$ lb. avoird., and a tael of $1\frac{1}{3}$ oz. avoird., equal to 583·3 grains.

PLATE XI.

Grove of trees of *Aleurites Fordii*, 5 to 6 metres tall. Banks of Yangtze River, January 5, 1909.

at 2,559,344 Haikwan taels[1]; and in 1910, 756,958 piculs, worth 6,449,421 Haikwan taels.

This product, apart from adulteration with other oils (see p. 450), is all obtained from *Aleurites Fordii.*

Wood-oils figure as an article of export from Wuchow, a treaty port west of Canton, on the West river. The export in 1900 was 24,469 piculs, valued at 146,813 Haikwan taels; and in 1910, 52,106 piculs, value not returned.

This product, wholly or in part, not reckoning adulterants as mentioned above, is presumably obtained from *A. montana* (Mu-yu shu). However, it is very probable that a certain amount of tung-oil is also concerned in this export. On this point information is lacking.

From Kongmoon, a port in the Canton delta, a small export of wood-oil is made, and this product is without doubt obtained from *A. montana.*

From none of the other coast or riverine treaty ports[2] do wood-oils figure as an export in the Maritime Customs Trade Returns. Dunn (*Report Bot. For. Dept. Hong Kong*, 1905) states that wood-oil is abundantly produced in the province of Fokien, and is one of the chief products brought down the Min River from the western part of the province. After mentioning that he found two species of Wood-oil trees (*A. montana* and *A. Fordii*) growing together near Yenping, and giving a brief account of these trees and the method of obtaining the oil, Dunn concludes by stating that "it does not appear to have been suspected that wood-oil was a mixture of the products of two species." These observations have local value and significance only. Wood-oils do not figure as an article of export in the Maritime Customs Trade Returns for Foochow, Amoy, or Santuao, the only treaty ports of the province of Fokien. An enormous quantity of these wood-oils is used in China, and it figures as a native import of considerable importance in the trade returns above cited for several

[1] Haikwan, or "Customs" tael, is the currency in which duties are levied by the Chinese Maritime Customs, but it is purely a money of account, and not an existing currency. It is the equivalent of 584·85 grains of pure silver, and its sterling value is dependent on the market price of silver.

[2] Shanghai returns are of no value in this trade, since wood-oil is simply a re-export from Shanghai, having been brought down from Hankow.

treaty ports on the coast. From all sources of information available, it is evident that more than nine-tenths of the wood-oil of commerce is exported from Hankow, and that this oil is obtained from but one species of Aleurites, namely, *A. Fordii*, the Tung-yu shu of the Chinese.

Composition of Tung-oil

Although tung-oil has been used for many centuries in China, its introduction into European and American commerce is comparatively recent. When introduced into these countries the peculiar properties of the oil at first prevented its adoption by manufacturers of paints and varnishes, but means of utilising the oil for many purposes have now been discovered, and it is at the present time in good demand at a price higher than that paid for linseed oil.

Tung-oil, as it appears in European commerce, is a yellowish-brown or brown viscous oil, with a peculiar, characteristic smell. The constants of the oil have been until recently a matter of some doubt, investigators in the past having quoted very variable figures. These differences were probably due to such causes as (1) the examination of adulterated samples, (2) differences in the methods of preparing the oil, (3) alteration of the oil during storage, and (4) confusion between Japanese and Chinese wood-oils. The recent researches of Kreikenbaum (*Jour. Ind. Eng. Chem.* ii. 205 (1910)), Chapman (*Analyst*, xxxvii. 543 (1912)), Hoepfner and Burmeister (*Chem. Zeit.* xxxvii. 18, 39 (1913)), and others have, however, afforded accurate information as to the constants of tung-oil as it appears in commerce. The following figures were obtained by Chapman (*loc. cit.*) from the examination of seventeen samples of oil from Hankow, to which are added, for purposes of comparison, the results obtained with oil extracted from kernels of *A. Fordii* at the Imperial Institute (this Bulletin, v. 134 (1907)); these kernels contained 58·3 per cent. of oil.

		Maximum.	Minimum.	Mean.	Oil of *A. Fordii*.
Specific gravity at $\frac{15^\circ\ C.}{15^\circ\ C.}$		0·9440	0·9406	0·9425	0·940
Saponification value		196·6	192·0	194·2	191·8
Iodine value	*per cent.*	176·2	166·4	170·6	166·7
Refractive index at 20° C.		1·5207	1·5150	1·5179	—
Viscosity by Redwood viscosimeter at 15·5° C.	*seconds*	2,178	1,605	1,850	—

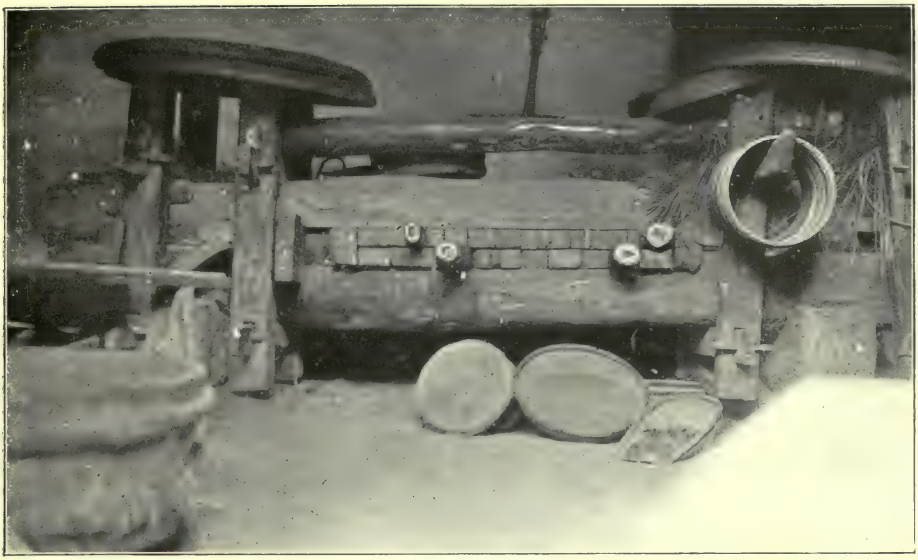


FIG. 1.—Wedge press used for extracting wood-oil. Basket of seeds and oil-cake in foreground.

FIG. 2.—Fruit and seeds of *Aleurites Fordii*. Natural size.

The above figures show that tung-oil is characterised by (1) a specific gravity higher than that of almost any vegetable oil, except castor and tallow-seed oils, (2) a refractive index considerably higher than that of any known vegetable oil, and (3) a high viscosity. The most characteristic property of the oil is its conversion into a firm, gelatinous mass when heated to a temperature of 250° C. or over, for a short time; this change appears to be due to polymerisation and not to the absorption of oxygen. The polymerised oil does not melt on further heating, and is insoluble in the usual solvents for oils, such as ether, etc. This property of forming a gelatinous mass on heating is the basis of a number of tests, in which the oil is heated under stated conditions for a certain time. Under these conditions genuine tung-oil should yield a firm jelly, which will crumble readily in the fingers, and is not sticky. Samples adulterated with other oils yield, on the contrary, a soft, sticky jelly, or even remain liquid, if large quantities of adulterants have been added.

Chinese wood-oils are said to consist chiefly of glycerides of oleic and elæomargaric acid (Lewkowitsch, *Chemical Technology and Analysis of Oils, Fats, and Waxes*, ii. 62 (1909)), and in tung-oil the power of polymerising may be due to the presence of the latter constituent, the properties of which have not been investigated very completely up to the present time.

Uses of Tung-oil in Europe and America

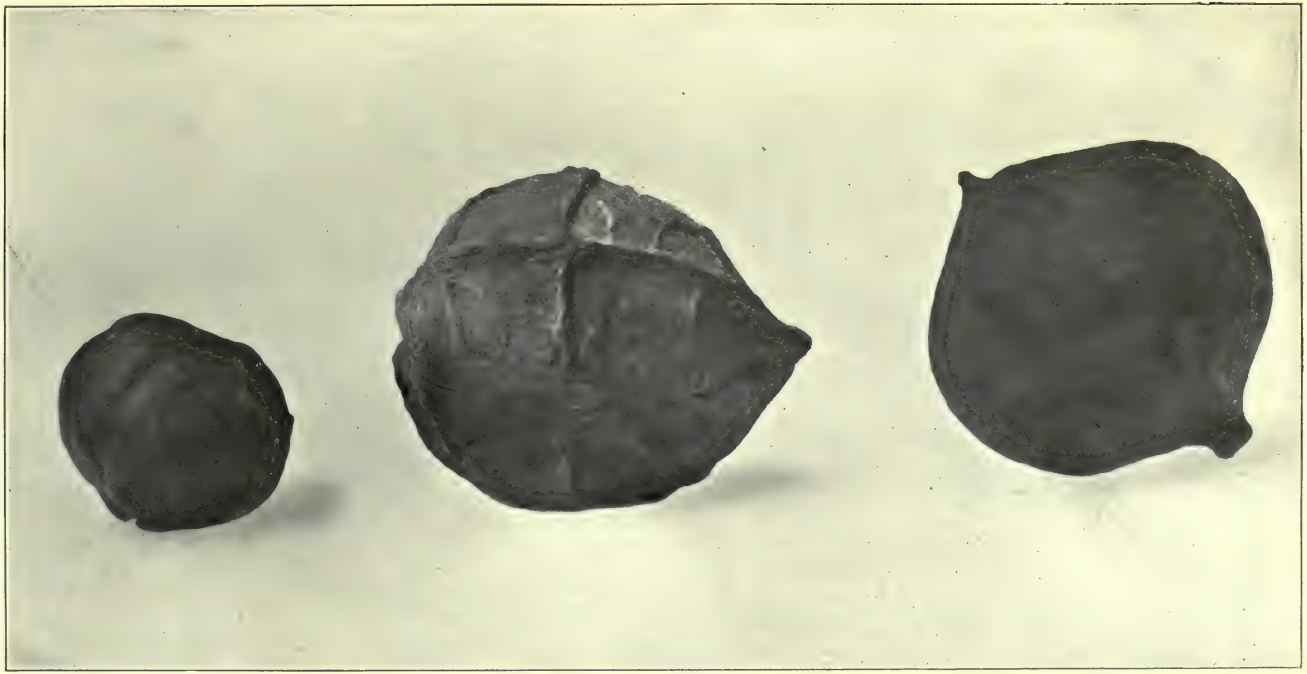
Although tung-oil possesses a drying power even higher than that of linseed oil it does not yield a clear, bright, transparent film like that afforded by linseed oil, the film produced by raw tung-oil being opaque, and having a matt and sometimes wrinkled surface. This fact, and its polymerisation on heating, render the raw oil unsuited for use in paints and varnishes, and appear to have prevented its adoption when first introduced into Europe and America. There can be no doubt, however, that these difficulties have been overcome, as large quantities of tung-oil are now used by paint and varnish makers, especially in the United States, although manufacturers

are distinctly reticent as to their methods of using the oil. According to Bottler (*Varnish-Making*, English translation by Sabin, 1912, 49), the raw tung-oil is heated for two hours at 170° C., and then allowed to stand and clear. The cleared oil is next heated to 180° C. for one hour, when it thickens somewhat; it is then allowed to cool to 130° C., and 2 per cent. of litharge is added. After this treatment the oil can be thinned with oil of turpentine or other solvent, and used as required for paints or varnishes. Although the gelatinous, polymerised oil is insoluble in the usual solvents, such as oil of turpentine, it can be melted by adding an equal amount of poppy-seed oil or walnut oil and heating: the resulting soft mass is soluble in solvents, and can be used for varnish making. (*Handbuch der Lack und Firnis-Industrie*, Seeligmann und Zieke, p. 319 (1910)).

The principal uses of tung-oil are in the paint and varnish industry; the oil is also used for the preparation of paint "driers," consisting of compounds of the fatty acids of the oil with such metals as lead or manganese. These compounds are known as "tungate" driers. A number of processes have been devised and patents taken out for the utilisation of the oil in the manufacture of linoleum, rubber substitutes, waterproof paper, etc., but it is not possible to state to what extent the oil is used for such purposes at the present time.

The Japanese "Wood-oil" Tree

Heretofore, as the synonomy cited in an appendix to this article (p. 460) shows, the Japanese Wood-oil tree (*A. cordata* R. Br.) has been confused with the two Chinese species. In order to clear up this confusion some account of the Japanese tree appears necessary. I have not seen this tree in a living state, and my knowledge of it is derived from herbarium specimens and various literature. The first mention of this tree in European literature occurs in Kaempfer's *Amœnitat. Exotic.* fasc. v. 789 (1712), under the Japanese name of "Abrasin." Thunberg (*Fl. Jap.* 267, t. 27 (1784)), named the tree *Dryandra cordata*, and gives a very good figure of the flowers and leaves. Under



Fruits of (1) *Aleurites montana* Wils., (2) *A. Fordii* Hemsl., (3) *A. cordata* R. Br. Natural size.

this name Banks (*Icon. Kaempfer*, t. 23 (1791)), published Kaempfer's original drawing of the young fruit and leafy shoots. Both Kaempfer and Thunberg mention that the seeds yield a useful oil. Thunberg states that it occurs wild in central Japan. Franchet and Savatier (*Enum. Pl. Jap.* i. 425 (1875)), apply the name *Elæococca cordata* to this tree, and give numerous localities from central to southern Japan. Lastly in this connection, Shirasawa (*Icon. Ess. For. Jap.* i. t. 56 (1900)), figures both flowers and fruit, and states that the tree is cultivated in the warmer parts of Japan. From the above, not to mention other authorities, it may be fairly assumed that this tree is both wild and cultivated in Japan, and very probably it also occurs in the Liu-kiu Islands.

In general appearance, size, habit, and foliage the Japanese species is similar to *A. montana* Wils., of sub-tropical, south-eastern China, and, like that species, produces its flowers at the end of the current season's growth, after the leaves are fully expanded. The flowers are borne in branched, erect, cymose panicles, and there is a decided tendency towards separate male and female inflorescences, but these are produced on shoots growing close together on the same branch. The flowers are rather smaller than in *A. montana*, and the leaves on the flowering branches are often three-lobed. The fruit of *A. cordata* is somewhat turbinate and trigonous (Plate XIII., Fig. 3), about 2·5 cm. long, wider than long, flattened and often depressed at the summit, slightly tapering to the pedicel, with three slight longitudinal and several irregularly transverse ridges (verrucose). The "fleshy" part of the fruit is thin, soft, and fibrous, and encloses three to five seeds, which are smooth, compressed, subglobose, 1·5 cm. long and broad. The fruit of this Japanese species is therefore much smaller, more fragile, and is very distinct from that of the two Chinese species (Plate XIII.), and indeed equally so from any other known member of the family.

According to Rein (*The Indust. of Jap.* p. 156 (1889)), the oil expressed from the seeds of *A. cordata* is used in Japan chiefly as an illuminant. This authority states that the tree is of medium size, with wide-spreading crown, and that

it is usually planted in soil that is unfitted for farming. It has four Japanese names, viz. "Dokuye," "Yama-giri," "Abura-giri," "Abura-no-ki," the last name signifying "Oil-tree." The Japanese botanists, Hayata (in *Jour. Coll. Sci. Tokyo*, xx. art. 3, 55 (1904)), and Matsumura (*Ind. Pl. Jap.* ii. 300 (1912)), give only "Abura-giri" as the Japanese name for this tree, and Hayata cites several localities for the tree in the island of Hondo.

Since in the past botanists have confused the Wood-oil tree of Japan with those of China, the chemist may be excused for having done the same with the oil itself. This confusion (in part at least) explains the discrepancies in the results of different observers' analyses of the wood-oils of the Far East. In order to ensure accuracy in the matter of identification, I prefer to quote here only the recent figures obtained from samples secured direct from Japan by Chapman (in *Analyst*, xxxvii. 551 (1912)). This investigator erroneously identifies the source of Japanese wood-oil as *Paulownia imperialis*, which is unfortunate, and could have been easily avoided by submitting a sample of the "nuts" to some botanical institution for determination before publishing the paper. After the article appeared, Prof. W. R. Dunstan obtained some of the "nuts" from Mr. Chapman and forwarded them to me for identification, and in consequence I am able to state positively that they are the seeds of *A. cordata* R. Br.

Chapman (*loc. cit.*) states that, "through the courtesy of the British Consul-General in Kobe, he obtained three samples of Japanese wood-oil which on examination gave the following results:

Sample.	Iodine value.	Specific gravity $\frac{15^\circ C.}{15^\circ C.}$	Saponification value.	Refractive index at 20° C.	Time of efflux at 15·5° C. seconds.	Polymerisation. Two hours at 250° C.
No. 1 .	158·0	0·9377	195·2	1·5083	1,230	Soft.
No. 2 .	149·0	0·9400	193·4	1·5052	1,620	Soft.
No. 3 .	151·8	0·9349	196·3	1·5034	—	Very soft.

'No. 1' was produced in Wakasa, whilst 'No. 2' came from Idzumo. As to the district from which 'No. 3' was derived, I am not quite sure."

A sample of nuts was also obtained, and from this "a quantity of oil was prepared by extraction with light petroleum and gave on analysis the following results :

Specific gravity $\frac{15^\circ C.}{15^\circ C.}$	0·9351
Iodine value	153·5
Saponification value	193·5
Refractive index at 20° C.	1·5050
Bromine thermal value (rise in degrees Centigrade)	24·5

When heated for two hours at a temperature of 250° C. this sample had not solidified, but was still a viscous oil. On reference to the above numbers it will be seen that with the possible exception of 'No. 2' the specific gravities are very appreciably below those of the Chinese oil, which confirms the statements of Lewkowitsch and other observers. The same applies to the iodine values and refractive indices. Even greater than these differences, however, are the differences in polymerising properties, the Japanese oil remaining quite liquid under conditions such as suffice to convert the Chinese oil into a very hard jelly, which crumbles when rubbed between the fingers and becomes a dry powder."

Conclusions

In any attempt to establish new industries, and particularly those of an agricultural character, the question of labour and its cost is of primary importance. This problem can only be dealt with by those possessing intimate knowledge of local conditions. In China, labour is notoriously cheap, although, as elsewhere in the world, there is now a decided upward tendency. It cannot be said that the maximum export of wood-oils from China has yet been reached, but the economic conditions briefly alluded to early in this article show that in the nature of things there must be a limit to the output of these products, which is independent of the ordinary laws applicable to and governing supply and demand in occidental countries. Since the demand for these oils will undoubtedly increase, it would appear essential that the source of supply be extended.

The utilisation of waste products in arts and commerce

has made enormous strides during the past quarter of a century. The science of agriculture has much concern with instructing the world how best to utilise the waste lands of the earth. The object of this article is to give the facts concerning Chinese wood-oils and the trees yielding them. It is for the various departments of agriculture in the warm-temperate and sub-tropical parts of the world to weigh with professional acumen the *pros* and *cons* as to the advisability or otherwise of attempting in the countries, whose people it is their business to educate in matters agricultural, the experimental culture of the trees yielding Chinese wood-oils.

The photographs illustrating this article were taken in China by the author for the Arnold Arboretum, and are reproduced by courtesy of Prof. C. S. Sargent, Director of that Institution.

APPENDIX

REVISION OF SYNONYMY WITH PRINCIPAL REFERENCES

Aleurites montana Wilson, n. comb.

Dryandra oleifera Lamarck, *Encycl. Méth. Bot.* ii. 329 (quoad fruct.) (1786).

Vernicia montana Loureiro, *Fl. Cochinch.* 587 (1790).

D. Vernicia Correa in *Ann. Mus. Hist. Nat. Paris*, viii. 69, t. 32, fig. 1 (1806).

Elæococcus Vernicia Adrien de Jussieu apud Sprengel, *Syst. Veg.*iii. 884 (1826); Steudel, *Nomencl. Bot.* ed. 2, 1, 545 (1840).

Aleurites Vernicia Hasskarl in *Flora*, xxv. pt. ii. *Beibl.* 40 (1842).

A. cordata Mueller Arg. in De Candolle, *Prodr.* xv. pt. ii. 724 (pro parte) (1866); Bretschneider, *Early Res. Fl. China*, 172 (1881); Hemsley in *Jour. Linn. Soc.* xxvi. 433 (pro parte) (1894), in *Kew Bull. Misc. Inform.* 1906, 120 (exclud. speciminibus Japon.); Dunn, *Rep. Bot. For. Dept. Hongk.* 1905.

South-eastern China: province of Fokien southward to Tongking.

It is highly probable that *A. verniciflua* Baillon, (*Hist. Pl.* v. 116, fig. 170, 171 (1874)), belongs here, but the seed only is figured, and this might well represent that of *A. Fordii* Hemsley.

A. Fordii Hemsley in *Hooker's Icon.* xxix. tt. 2801, 2802 (1906), in *Kew Bull. Misc. Inform.* 1906, 120; *Bull. Imp. Inst.* v. 134 (1907); Fairchild in *U.S. Dept. Agric. Circ.* No. 108, with figs. (1913).

Elæococca verrucosa Adrien de Jussieu, *Euphorb. Gen. Tent.* 38, t. 11, fig. 35 (quoad fruct. et semen) (1824).

Dryandra oleifera Wallich, *Cat.* No. 7958 (nomen nudum) (1828) non Lamarck.

Aleurites cordata Hooker f., *Fl. Brit. Ind.* v. 384 (1887) (non R. Brown); Hemsley in *Jour. Linn. Soc.* xxvi. 433 (exclud. synon. et speciminibus e Hainan, e Hongkong partim) (1894); Diels in *Bot. Jahrb.* xxix. 430 (1900); A. Henry in *Chemist and Druggist*, May 31, 1902; Hosie, *Rep. Prov. Ssuch'uan*, 34 (China No. 5), 1904; Pampanini in *Nuov. Giorn. Bot. Ital.* n. ser. xvii. 410 (1910)

China: central provinces from coast to near the borders of Eastern Thibet; also in the south-western province of Yunnan.

A. cordata R. Brown apud Steudel, *Nomencl. Bot.* 286 (1821); Mueller Arg. in De Candolle, *Prodr.* xv. pt. ii. 724 (quoad specimina Japon.) (1866); Shirasawa, *Icon. Ess. For. Jap.* i. t. 56 (1900); Hayata in *Jour. Coll. Sci. Tokyo*, xx. art. 3, 55 (*Rev. Euphorb. Jap.*) (quoad plantam Japon.) (1904); Hemsley in *Kew Bull. Misc. Inform.* 1906, 120 (quoad specimina Japon.); Matsumura, *Ind. Pl. Jap.* ii. 300 (exclud. synon. *Vernicia montana*) (1912).

Dryandra cordata Thunberg *Fl. Jap.* 267, t. 27 (1784); Banks, *Icon. Kaempfer*, t. 23 (1791).

D. oleifera Lamarck, *Encycl. Méth. Bot.* ii. 329 (exclud. fruct.) (1786).

Elæococca verrucosa Adrien de Jussieu, *Euphorb. Gen. Tent.* 38, t. 11, fig. 35 (excl. fruct. et semin) (1824); Siebold and Zuccarini in *Abh. Akad. Münch.* iv. pt. ii. 145 (*Fl. Jap. Fam. Nat.* i. 37) (1843).

E. cordata Blume, *Bijdr.* xii. 618 (1825); Miquel in *Ann. Mus. Lugd.-Bat.* iii. 127 (*Prol. Fl. Jap.* 291) (1867); Franchet and Savatier, *Enum. Pl. Jap.* i. 425 (1875).

Elæococcus verrucosus Adrien de Jussieu apud Sprengel, *Syst. Veg.* iii. 884 (1826); Steudel, *Nomencl. Bot.* ed. 2, i. 545 (1840).

Aleurites japonica Blume ex Miquel in *Ann. Mus. Lugd.-Bat.* iv. 120 (quasi synon.) (1868).

Paulownia imperialis Chapman in *Analyst*, xxxvii. 551 (1912) non Siebold and Zuccarini.

Southern Japan: Hondo, various localities *ex* Hayata, Franchet and Savatier; also cultivated.

THE ORGANISATION OF EXPERIMENTAL WORK IN AGRICULTURE IN THE GERMAN COLONIES

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The economic prosperity of the German colonies is based primarily on agricultural production. Although here and there valuable mineral discoveries, such as the diamonds and copper of South West Africa and the phosphate deposits of the Pacific Colonies, have become of great economic importance to these particular colonies, such occurrences are exceptional. Similar gratifying incidents may perhaps be repeated in these or other places, but agriculture will always remain the backbone of the prosperity of the German colonies.

When the present condition and future prospects of agriculture in these colonies is considered somewhat more closely, very different pictures present themselves, since the three factors—climate, soil, and man—which lie at the base of all agricultural production, differ greatly in the various countries. The three German colonies in tropical Africa—German East Africa, Kamerun, and Togoland—reveal, in respect of climate, soil, and inhabitants, considerable differences. German East Africa and Togoland are dominated by the savannah climate, which prevails over large tracts of tropical Africa, a climate which prescribes certain natural rules for plant cultivation and which especially sets certain definite limits to plantation culture under European management. Aided by the climate, man in earlier times considerably diminished the enormous covering of forest, which extended over the country, and in some cases quite obliterated it, and this has naturally proceeded furthest in the areas that were first settled. This deforestation must have seriously affected the chemical and physical properties of the soil, and only on the mountains or in specially favoured parts of the lowlands have the forests remained undisturbed, and here the soil is of greater fertility and higher water content.

Kamerun, owing to its position on the Gulf of Guinea, is, on the other hand, exceptionally favoured by nature in respect of climate. Not merely the broad belt of primeval forest, which is among the most rainy parts of the globe, but also the grass-land lying behind, have a very favourable rainfall. The Kamerun forest zone with its superior soil, partly of volcanic origin and partly lateritic loam in nature, offers a wide scope for the cultivation of plants of economic importance in European plantations. Cocoa, tobacco, and Para rubber, for example, can be established in such parts, whilst in East Africa coffee cultivation must be restricted to the more rainy, wooded regions in some of the mountainous districts. Sisal hemp, Ceara rubber, and more recently, cotton have found a suitable home in the steppes of East Africa. In Togoland, where, in the forest region near the boundary of the Gold Coast Colony, cocoa cultivation is extending more and more among the natives, it should be possible to cultivate on the plains less exigeant plants, as in the savannah districts of East Africa. The extension of plantations in this colony is hindered by the occasional poverty of the soil and especially by the character of the natives, whilst in the more thickly populated parts the more valuable stretches of level soil are required for raising native food-stuffs.

In these German colonies, as in all other parts where land is being opened up for agriculture, the conditions of settlement of the natives, the density of the population, the general standard of civilisation, whether the people are in settled communities or nomadic, the capacity of the natives for any particular kind of activity, all play an important rôle. And in proportion as the people incline towards agriculture, so attention must be paid to the inclinations and needs of the separate races, and lastly to the extent, organisation, and methods of native agriculture. All these matters, in association with climate and soil, form the basis for future native economic development under the guidance of the colonising nation.

The German colonial government has laid it down as a principle that native agriculture in the tropical colonies

should be allowed to develop freely side by side with plantations under European control, wherever this does not interfere with higher interests. Local conditions will decide how far in each particular region this or that method of organising agriculture is to be preferred. But wherever climate, soil, and condition of settlement do not admit of plantation culture, and a native population capable of production is present, the government will, as a matter of course, encourage native agriculture as much as possible, and by this means create an improved economic position. This holds good for Togoland, for great parts of German East Africa, and for the Kamerun grass lands.

In the Pacific colonies of New Guinea and Samoa, where the conditions are specially favourable to extensive plantation culture, it is also important that native agriculture should not be overlooked. The link between cultivation on a large scale by white men and on a small scale by natives is formed by the coconut palm, which dominates the whole agricultural life in these colonies.

In German South West Africa the conditions are otherwise. This country is, by reason of its nature and its sparse population, a colony of settlement *par excellence.* Here it is possible for the white man himself to till the land and to engage in stock-farming. Here he can rear up a family, which can become established and remain there for generations.

Stock-farming still provides on every hand in the German colonies great problems, on the solution of which the future position of agriculture in the tropical African possessions depends in a high degree. These problems will be far more difficult to solve than those relating to the cultivation of the land. Stock-raising and stock-keeping are still frequently impossible in large regions of East Africa, Kamerun, and Togoland, owing to the endemic existence of the "Surra" disease and its carrier, the "tsetse" fly. One of the most important tasks of medicine and veterinary science will be to find an effective remedy for "Surra" and the sting of the dangerous "tsetse" fly, a problem whose solution would be of enormous consequence to agriculture in the whole of tropical Africa. But even in

those parts of these colonies where "Surra" and the "tsetse" fly do not occur, and where stock-raising by the natives has been able to develop undisturbed, there is need almost everywhere of a fundamental reformation of the methods of breeding, and the introduction of better breeds of cattle.

As the following summary shows, experimental work was commenced as far back as the occupation of the colonies. At that time Germany entered upon the path which at the commencement was trodden also in the British, Dutch, and French colonies, and which was naturally followed in the newly opened tropical lands. That is to say, Germany began with the establishment of experimental gardens for raising imported economic plants, such as coffee, cocoa, rubber, etc., in the interest of plantation culture, and for the advancement of gardening and fruit production. A change, or rather a completion of this system came about when the European settlers took up agriculture on their own account. It was then found that the experimental work of the botanical gardens was no longer adequate to the new requirements. For this purpose experimental work must be carried on on a purely agricultural basis. In addition there came still another demand, viz. the improvement of native agriculture. For this work specially organised institutes and agricultural staffs were needed. The measures taken in Togoland in 1900 for the introduction and extension of cotton cultivation became the standard for agricultural experimental work in the three tropical African colonies.

There was then nowhere in tropical Africa any model or pattern for the rational practice of cotton cultivation. The natural conditions of Egypt and the United States were entirely different, and in new countries new ways and means must be sought.

In Kamerun the cultivation of the oil-palm and the systematic exploitation of the enormous stocks of wild oil-palm and rubber were also taken up, whilst the introduction of cocoa cultivation and the production of other materials for export by the natives started new tasks. In almost all the colonies cattle-raising ultimately demanded more specialised experimental work.

From these preliminary remarks it will be apparent that agricultural experimental work in the German colonies has been and still is confronted with many and serious tasks.

I now proceed to give some examples of what has been done in the way of agricultural experiments in the different colonies.

(1) German East Africa

The Biological-Agricultural Institute at Amani, in the Usambara Mountains, was founded in 1902. Since then it has developed into a well-equipped, scientific institute, and in 1909, when the Imperial Government at Daressalam created a Department of Agriculture, it became the centre for the organisation of the agricultural staff, which has to discharge all official duties connected with the development of agriculture in the protectorate.

Experimental work is carried on by the stations mentioned below, whilst the purely scientific researches are conducted by the Biological-Agricultural Institute at Amani.

Three special scientific officers have been appointed by the Government to deal with work relating to manures (*see below*), for soil investigations, for practical stock-farming researches in the districts suitable for this industry, and finally for the study of cotton pests and diseases. In administrative districts, where agricultural products are raised in large quantities for export, and where the natural conditions and existing circumstances of settlement and trade make it possible, agricultural assistants are maintained. These act as district agriculturists, and at the same time as travelling instructors to the natives. Their number will soon be increased. At the present time eight agriculturists have been appointed to the following districts: Bagamoyo, Daressalam, Kilwa, Lindi, Kissaki, Morogoro, Rufidji, and Tabora. In the three last-named districts these officers also act as assistants in the local cotton stations (*see below*).

The protectorate is provided with five effective agricultural experiment stations and one experimental fruit

farm. In 1913 the white agricultural staff of the colony consisted of 15 first grade, 10 second grade, and 5 third grade officers.

(1) *Biological-Agricultural Institute, Amani. Situated in the Usambara mountains in the Tanga district.*—This is an institute for research in natural science, and possesses botanical, chemical, and zoological laboratories. Experimental gardens and plantations exist at Amani and at Sigital. The scheme of work comprises the introduction and cultivation of tropical economic plants, scientific research and experiment in the interest of the planting industry in German East Africa, the study of plant pests and diseases, manurial experiments, soil analyses, technical research on the more valuable indigenous products, and the holding of courses of instruction for planters.

The scientific staff consists of a director, two chemists, two botanists, and a zoologist. In addition a head gardener and several other gardeners are employed.

(2) *Kibongoto Agricultural Experiment Station at Kilimandjaro, Moschi district.*—This experiment station, which was founded in 1911, serves primarily the special needs of European planters in the Kilimandjaro and Meru mountains. It carries on all branches of agriculture (tillage operations, plantation culture, management of pastures, and breeding of cattle), variety and cultivation experiments with cotton, Turkish tobacco, coffee, cereals, leguminous crops and other vegetables, the raising of local races of cotton and the most important kinds of grain, experiments with fodder plants for the improvement of pastures and the hay crop, and with green manures. Of the special work particular mention may be made of the experiments on the cultivation, curing, and fermentation of Turkish tobacco, problems not easily solved, though exceedingly important.

The work in cattle-breeding concerns itself in the first place with the indigenous races of cattle and with experiments on Franconian cattle imported from Germany, whilst arrangements are also made for experiments with small stock, in particular with the breeding of pigs and wool-bearing sheep.

The European staff consists of a manager, who is an

agricultural expert, a trained scientific assistant, and a Turkish tobacco planter.

In the last three years three special experiment stations for cotton cultivation ("cotton stations") have been established for the advancement of cotton cultivation in the protectorate. Their programme of work embraces: (1) Comparative cultivation experiments with different species and varieties of cotton, with a view to finding out which of the better known kinds are most suitable for local conditions. (2) Breeding experiments for the production of more valuable varieties and local races from specially suitable kinds of cotton, by means of continued individual selection, and the increase of the best sorts by mass selection for the production of seed. (3) Rotation experiments with various other crops. (4) Experiments on the proper working of the soil and on green manuring. (5) Observations and experiments concerning cotton diseases and pests. In addition the chief officials of these stations have to assist with advice the European cotton planters in their respective districts, whilst the assistants act as travelling instructors to the natives.

(3) *Mpanganya Cotton Station on the Rufidji river, Mohorro district.*—Founded in 1904 as a cotton school of the Kolonial-Wirtschaftliches Komitee. In 1910 it was taken over by the Imperial Government, and whilst continuing the school work for the natives, it was laid out as a special experiment station for cotton cultivation and selection.

The European staff consists of an agricultural expert as manager, and an agricultural assistant.

(4) and (5) *Myombo Cotton Station, near Kilossa, Morogoro district, and Mabama Cotton Station, near Tabora.*—These stations, which were founded respectively in 1911 and 1912, provide no school instruction, but in all other respects do the same kind of work as the Mpanganya Cotton Station.

The establishment of two additional cotton stations, in the Lindi and Muansa districts, is planned for 1913.

Finally, of the newer establishments, mention may be made of the *Morogoro Station for Fruit Culture*, which was founded in 1910. The work here comprises the cultivation of tropical fruit trees and the distribution

of young plants to Europeans and natives. The only European member of the staff is the manager.

(2) Kamerun

Until 1911 the Experimental Institute for Agriculture in Victoria served as the centre for the whole of the experimental work in the colony. In that year the Imperial Government at Buea created a Department of Agriculture, which has since then dealt with all questions relating to organisation, while the technical and scientific investigations are undertaken by the Experimental Institute. At first the agricultural work was devoted mainly to aiding the planting industry in the Kamerun mountains, but as the colony became opened up fresh problems naturally presented themselves. The large stocks of rubber (*Funtumia elastica* and Landolphia vines) constitute not the least of the natural wealth of the colony. The reckless exploitation of the rubber forests carried on some time ago led to the establishment of a special rubber inspectorate (*see below*). A similar organisation, the oil-palm inspectorate, is about to be instituted. The chief duty of the latter will be to lay the groundwork of a system for the proper exploitation of the large, and hitherto unused, stocks of wild oil-palms, and to instruct the natives in a rational system of oil-palm culture.

Various arrangements exist for the development of native cultivation. Some years ago special small experimental gardens were created in the larger administrative stations of the interior. These deal with the cultivation by natives of products suitable for export. In each case a farmer or gardener has been appointed to take charge of the station. More recently larger, more specialised organisations, a cocoa inspectorate, and an experiment station for native cultivation, have been established. The former is concerned with the introduction of native cocoa cultivation in those districts where European cocoa plantations do not exist, and where they are unlikely to be established. The object of the experiment station for native cultivation in Nomajos, Jaunde district, which is not yet complete, is to encourage the cultivation of such crops as ground nuts, plantain and manioc, with a view to their export.

As cotton has been cultivated by the natives in the Kamerun grass lands from ancient times, and the conditions are favourable for its extension over large areas, as in Bamum and Adamaua, two agricultural experiment stations, devoted primarily to cotton cultivation, have been founded in recent years at Kuti and Pittoa. The programme of work at these stations (*see below*) also embraces other branches of agriculture, including stock-raising.

Besides the five stock-breeding stations mentioned below, the oldest of which has been in existence for 15 years, a new and larger experiment station for cattle-breeding will be established at Bamenda in 1913. In those districts of the grass land where cattle are abundant, a uniform, systematic improvement of the native cattle is needed, as well as the instruction of the natives in rational methods of cattle-breeding and management.

Another urgent need is that horse-breeding, which has been established in Adamaua for a long time, should be brought up to a higher grade, both in quality and in quantity. For this purpose a governmental stud farm is being established at Golombe in Adamaua.

In 1913 the agricultural staff consisted of 14 first grade, 7 second grade, and 28 third grade officers.

(1) *Experimental Institute for Agriculture at Victoria.*—A Botanic Garden was founded in 1891, and botanical and chemical laboratories were added in 1905, thus constituting the present Institute. The work carried on includes the raising of tropical economic plants, the distribution of seed and plant material, experiments on plantation culture, especially as regards cocoa, rubber, and the oil-palm, manuring experiments, and scientific and technical research.

Since 1910 an agricultural school has been attached to the Institute, in which young natives are trained as plantation managers.

The scientific staff consists of a director, chemist, and botanist, whilst a garden inspector and several gardeners are employed in the Botanic Garden.

(2) *Cattle Farm and Dairy at Buea, Buea district, in the Kamerun mountains.*—Founded in 1898. Carries on the pure breeding of Allgau cattle and distributes pure-bred

bulls and cows for breeding purposes to other official centres and to private individuals. It supplies Buea and district with dairy produce and also carries on pig-breeding.

(3) *Buea Sub-Farm.*—The work of this farm, which was founded in 1901, includes cross-breeding experiments with Allgau bulls and indigenous cows, the production of draught cattle for the Government service in Buea and Victoria, the supply of Buea, Soppo, and Victoria with cattle, and the cultivation of maize and potatoes.

(4) and (5) *Cattle-Breeding Stations at Dschang and Djuttitsa, Dschang district.*—These stations, which were founded in 1909, carry on cross-breeding experiments with Allgau bulls and Kamerun humped cows at Dschang, and pure-breeding of the local humped cattle at Djuttitsa. Fodder for the herds of cattle is cultivated at both places. In Dschang the agricultural officers also supervise the local breeding of cattle and their improvement in the district, among other ways, by supplying Adamaua bulls to the natives for breeding purposes.

(6) *Dschang School of Agriculture.*—This school was founded in 1909. Here young natives are instructed in the use of the plough and in other rational methods of agriculture.

Stations 4, 5, and 6 are under one manager; an agricultural assistant and a subordinate staff of Europeans are also employed.

(7) *Jaunde Cattle-breeding Station, Jaunde district.*—This was founded in 1911. The cross-breeding of Allgau bulls and Kamerun humped cows is carried on, with the object of obtaining draught cattle for the district and supplying meat and dairy produce to the Europeans.

(8) *Kuti Agricultural Experiment Station, near Fumban, Bamum district.*—This station, which was founded in 1912, serves primarily for the advancement of cotton cultivation in the district, and the programme of work in this direction is the same as that at the cotton stations in German East Africa (see p. 468). The work also includes comparative cultivation experiments with indigenous cereals, pulses, and root-crops, as well as fodder plants; experiments on

the introduction of cultivation by the plough; manuring and rotation experiments; cattle-keeping and cattle-breeding; and the training of native travelling instructors.

The European staff consists of an agriculturist as manager, and an agricultural assistant.

(9) *Pittoa Agricultural Experiment Station, near Garua, Adamaua.*—This station was also founded in 1912 and has the same objects, programme of work, and personnel as that at Kuti.

(10) *Rubber Inspectorate*, with stations for rubber cultivation at Sangmelima, Ebolowa district; Akonolinga, Jaunde district; Dume, Dume district; Djahposten, Lomie district. Founded 1907–09.

The work carried on comprises the distribution of Funtumia and Hevea plants to the natives; the superintendence of new plantations; the regeneration of the stocks of wild rubber which have become exhausted by careless exploitation, and the instruction of the natives in the tapping of rubber trees, and in the preparation and preservation of rubber.

Each station is in charge of an assistant officer who is subordinate to the Inspector of the rubber district.

In order to deal adequately with the agricultural questions which arise locally in the various districts, most administrative stations possess, apart from the established experimental gardens mentioned above, agricultural officers whose duty it is to superintend local experimental fields and gardens. Such officers are employed at the following stations, among others: Duala, Edea, Bare, Yoko, and Bamenda. The chief aim of the experimental gardens at these stations is to develop the cultivation of export products, whilst experiments with foreign economic plants yielding produce suitable for export are also conducted.

(3) German South West Africa

The peculiar conditions of this country have made it necessary to specialise to a high degree, both in the experimental work and the agricultural staff. Stock-raising occupies first place in the agriculture of the country, and as a matter of course the government devotes special

care to the advancement of the different branches of animal-breeding. The following survey of the existing institutions in German South West Africa hardly needs any further explanation.

The cultivation of the soil was at one time in the background in the development of agriculture in the country, but it has recently come more and more to the front. This is borne out by the fact that of three experiment stations created in recent years, one is for general tillage and one specially for tobacco cultivation.

The Imperial Government at Windhuk has appointed four agricultural experts, one for the study of each of the following subjects: (i.) cattle-breeding, (ii.) sheep-breeding, (iii.) agriculture, (iv.) fruit and vine culture.

The expert in sheep-breeding is also the manager of the Karakul sheep-breeding farm at Fürstenwalde (*see below*), whilst the agriculturist manages the Neudamm experimental farm (*see below*).

(1) *Experimental Farm for Tillage in Neudamm, near Windhuk.*—Founded in 1911. The work comprises comparative cultivation experiments with corn and fodder plants, as well as experiments in "dry-farming."

(2) *Experiment Station for Tobacco Cultivation at Okahandja.*—Founded 1912. This station is devoted entirely to the advancement of tobacco cultivation in the country. Comparative cultivation experiments with various kinds of tobacco are carried on, as well as experiments on the preparation of tobacco.

The European staff comprises an agricultural expert and an agricultural assistant.

(3) *Imperial Stud Farm at Nauchas.*—Founded 1898. This stud farm is the centre for the breeding of horses in the colony. Breeding experiments with imported thoroughbreds are carried on, for the purpose of obtaining farm stallions and the production of a uniform type of horse, whilst the organisation and supervision of the stallion service in the country is also dealt with. The European staff comprises a manager, a stud attendant, and other minor officials.

(4) *Farm for the breeding of Karakul Sheep, Fürstenwalde,*

near Windhuk.—Founded in 1909 with animals imported from Bokhara. Pure-breeding and cross-breeding of the sheep are carried on here.

(5) *Otjituezu Experimental Farm for the breeding of Ostriches, on the White Nossob in the Windhuk district.*—Founded in 1911. The work comprises the pure breeding of imported brood birds and experiments with indigenous wild ostriches. The European staff consists of a manager and an assistant.

The older experimental gardens of the country, in part established in 1897–99, serve particularly for fruit and vegetable culture. Experimental gardens of this kind are situated at Windhuk, Grootfontein, Bethanien, Gobabis, and Klein-Windhuk.

(4) Togoland

It has already been mentioned in the introduction that there is no important European planting industry in this colony. On the other hand, the, for the most part, thickly settled land possesses an active, intelligent population with an inclination towards agricultural work. The agricultural methods of the negro, especially in the south, are however on a low level, so that a continuous and well-regulated system of instruction for the natives is needed, in order to make production more effective both for local consumption and for export. To deal with this work the agricultural staff includes travelling instructors (district agriculturists) in all districts of South Togoland, whilst a school for young natives is maintained at the Agricultural Institute, Nuatjä. Cotton cultivation is promoted by means of three cotton stations.

In 1913 the European agricultural staff consisted of 3 first grade, 5 second grade, and 7 third grade officers.

Since 1911 the Governor of the Colony has had available an Agricultural Adviser, for the consideration of all matters relating to agriculture, whilst a second agricultural expert is employed for work relating to plant-breeding and manures.

Five agricultural assistants (district agriculturists) are stationed in the districts of Lome-land, Anecho, Misahöhe,

Atakpame, and Sokode. Those in the three last-named districts supervise cultivation experiments at the cotton stations (*see below*), the supreme direction of which is in the hands of the Agricultural Adviser. The assistants, as already mentioned, act also as travelling instructors to the natives, dealing chiefly with the cultivation of cotton, cocoa, and the oil-palm.

(1) *Nuatjä Institute for Agriculture, Atakpame district.*—Founded in 1912 by the Atakpame station; in 1903 it was handed over to the Kolonial-Wirtschaftliches Komitee as a cotton school for the natives. In 1907 the Imperial Government took it over and it was enlarged as a general agricultural school for natives. In 1912, whilst retaining the school work, it was raised to the status of an Institute for Native Agriculture. Young natives from different parts of the country are given practical and theoretical instruction in rational methods of cultivation and in cattle-keeping. The work includes cultivation experiments with cereal, leguminous, and root crops, manurial experiments, and cattle-, pig-, and goat-breeding.

The European staff consists of a manager, an agricultural assistant, and subordinate officers.

(2) *Nuatjä Cotton Station.*—Founded in 1911 in connection with the farm school at that time existing at Nuatjä. The programme of work comprises comparative experiments with various species and varieties of cotton, as well as the cultivation of selected varieties for seed (cf. the programmes of the cotton stations in German East Africa). The station possesses its own ginnery.

The work of the cotton station is conducted by the staff of the Institute for Native Agriculture.

(3) *Tschatschamanade Cotton Station on the Kamaa river, Sokode district.*—This station, also founded in 1911, carries on similar work to that done at the Nuatjä Cotton Station. The European staff consists of an agricultural assistant acting under the Agricultural Adviser (see p. 474).

(4) *Tove Cotton Station, near Palime, Misahöhe district.*—Founded in 1912. In addition there is a station for the production of cotton-seed at Kpandu. The programme of work and the scale of staff are the same as at Nuatjä.

(5) German New Guinea

The economic development of this colony has hitherto been carried on more one-sidedly than in the German tropical African possessions. Agricultural production is essentially confined to the large planting undertakings in the coastal districts and on some of the islands. As a result, until quite recently experimental work has been only moderately developed and was centred at the Botanic Gardens at Rabaul. These have existed since 1906, and serve as a centre for raising tropical economic plants. In recent years the need for a special organisation, which would be of service to the planting industry and promote the development of native agriculture, has made itself felt. Facilities for scientific research, similar to those afforded by the laboratories at Amani and Victoria (*see above*), are also needed, as well as special experimental plantations for the scientific and practical study of the varieties and races of the coconut palm, particularly as regards their yielding capacity. In order to open up the interior of Kaiser Wilhelmsland, which is richly endowed by nature, an agricultural experiment station ought to be established on the Sepik river. Finally, a special animal-breeding station is necessary, as the country, in spite of its favourable conditions for cattle-breeding, has not been made known in this capacity hitherto, owing to its isolated and unsettled state. The Government has recently perfected a scheme for experimental work and for the organisation of an agricultural department, which has been approved by Parliament, and which will be realised in 1913 and 1914. This scheme embraces the following projects :

(i) An experiment station for the study of the varieties and races of the coconut palm and its diseases and pests, and for experiments in the best methods of preparing copra.

(ii) An agricultural experiment station in Kaiser Wilhelmsland for experiments with rubber, cocoa, rice, sugar-cane, tobacco, and Manila hemp.

(iii) Extension of the Botanic Gardens by the establishment of branch stations.

(iv) An agricultural laboratory at Rabaul for chemical research on local products, soils, etc., and for researches on plant diseases, insect pests, etc.

(v) An animal-breeding station for experiments with various kinds of cattle, pigs, goats, and poultry, for horse-breeding, the cultivation of fodder plants, experiments on the establishment of artificial pastures, and the advancement of cattle-breeding among the natives.

(vi) The appointment of four district agriculturists for the improvement of native agriculture.

On the completion of this scheme in 1914 the agricultural staff of the colony will consist of 5 first grade and 7 second grade officers; the subordinate-staff will be composed of Malays and Chinese.

(6) Samoa

In this colony an Agricultural Expert has been employed since the beginning of 1912, and an experimental plantation is being formed. Diseases and pests of the coconut-palm and of cocoa make their appearance on the island in some years, and as these need special attention, a specially trained scientific officer(phytopathologist)is stationed there.

General Remarks

Extensive and systematic manurial experiments, to determine the nutritive requirements of the most important cultivated plants, have been carried on since 1911 on both the experimental stations and private estates in the tropical colonies of Africa and the South Seas. This experimental work is carried on under the control and at the expense of the Imperial Government, and has been sanctioned for a number of years. The work requires a special staff of agricultural experts and assistants, who are not included in the permanent staff, and in the present survey this personnel is not considered.

As the foregoing review shows, experimental work in almost every branch of colonial agriculture is extending more and more in the German colonies. It is of particular service to the settler, farmer, and planter in the

performance of their most difficult work; it endeavours to show how they can procure as high a return as possible for their farming operations, and it attempts to raise the agricultural output of the natives to a higher level, thereby increasing the whole agricultural prosperity of the colonies. Our experimental work serves ultimately the self-evident demand for a sound national trade policy, especially by encouraging in our colonies the production of those raw materials which Germany must still draw from foreign lands for the sustenance of its people and industries.

An inexperienced colonising people undoubtedly meets great difficulties at the beginning, when its own knowledge of tropical lands is small. Germany has adopted two methods to overcome these difficulties: the first is to learn from the older, more experienced colonial nations, and to bear in mind the experience that has been gained during the lapse of years in foreign dominions. For this purpose experts of the German colonial service have carried out studies in various parts of the world, and, as we gratefully recognise, have received much courteous assistance from foreign governments and private persons, so that they have in each case returned richly informed.

The second method is to transfer to colonial agriculture as far as possible the long-approved system of German agriculture, which rests on a strong scientific foundation, built on the results of exact investigation and methods. In this, however, one has to guard against indiscriminate transfer to the Equatorial regions of practice peculiar to European conditions. The rational methods of German agriculture, perfected by the long and assiduous work of generations, have to be very largely transformed into new methods and systems for employment in the tropics. By this means the German colonial government has kept pace with the present-day organisation of agricultural experimental work in the colonies.

Although only at the commencement of our work, we hope that we are at least proceeding on the right lines.

GENERAL NOTICES RESPECTING ECONOMIC PRODUCTS AND THEIR DEVELOPMENT

THE OCCURRENCE, DISTRIBUTION, AND USES OF MERCURY

Mercury or quicksilver ores have been found in all formations from the Archean to the Quaternary in rocks of such widely varying character as sandstones, shales, limestones, quartzites, crystalline schists and basic eruptive rocks. Large deposits are rarely found in eruptive rocks, but they frequently occur near such formations and also in the locality of hot springs.

Mercury deposits, when first opened up, often yield ore carrying as much as 25 per cent. of the metal, but usually the grade soon falls off and the large deposits now being worked rarely yield ore carrying over 3 per cent. of the metal. The most important ore-mineral of mercury is the sulphide, cinnabar, but native mercury and meta-cinnabarite also occur. Tiemannite (HgSe), calomel (Hg_2Cl_2) and native amalgam with silver are rare.

Cinnabar (HgS) is a bright red sulphide of mercury. It usually occurs in a massive or granular condition, but crystals belonging to the trigonal system are sometimes found. It has a bright scarlet streak and a sub-conchoidal fracture. The hardness varies from 2 to 2·5, and the specific gravity is about 8·1. The mineral is readily recognised by the fact that when heated in an open tube it yields a sublimate of mercury and fumes of sulphur dioxide.

Distribution of Mercury Ores

Europe

Austria-Hungary.—A large proportion of the world's output of mercury is obtained from the State mines at Idria in Carniola, which have been worked since the tenth century, and where deposits of cinnabar occur in rocks belonging to the Alpine Trias series. There are few true veins, the ore occurring chiefly as impregnations in the country rock, associated with quartz, calcite and dolomite.

The cinnabar is found also in pockets and lenticular masses in slates, especially where the latter are contorted and carry organic matter. Native mercury is of fairly frequent occurrence, associated with pyrite.

The ore is worked at six levels, and it is estimated that the reserves will be sufficient to last seventy years at the present rate of working.

Germany.—Only a small amount of mercury ore is now produced in Germany, but at one time important deposits were worked at Obermoschel and Landsberg. The ore is chiefly cinnabar associated with galena, iron and manganese ores, and copper pyrites. Tetrahedrite containing silver and mercury occurs in a group of veins which extend from Rossbach to Roth, and cinnabar occurs in the copper lode at the Neuermath mine in Nanzenbach. Mercury ores also occur in the eastern portion of the Saarbrück coal basin.

Italy.—About one-fifth of the world's production of mercury is obtained from the mines of the Monte Amiata district of Tuscany, which have been worked since 1846. Monte Amiata is an eruptive mass of trachyte, which has been intruded through strata of Eocene age, and the cinnabar is found near the zone of contact of the eruptive rocks with the stratified deposits. These deposits have been classified by Spirek into four types. The first is the Siele Solforate type, in which the mercury-yielding limestone is surrounded in both the hanging and foot walls by an impermeable bituminous clay ("gallestro"). It is with this mode of occurrence that the richest quicksilver deposits are usually associated in this area. The second, or Montebuono type, has a foot wall of "gallestro," but in the hanging wall the limestone is often overlain by a sandstone into which the cinnabar has penetrated. Both the limestone and sandstone are mined for their cinnabar, but yield relatively poor ore. The third type is the Cornacchino, which occurs in the Lias limestone, and has a hanging wall of slate and a foot wall of cherty material (phthanite). The fourth or Abbadia San Salvatore type occurs in the Eocene and Lias limestones which are overlain by trachytes.

The deposits are very extensive, but are much faulted.

The most important mines are those of Siele, Cornacchino, and Montebuono. At the two latter mines ore yielding 0·2 and 0·3 per cent. of mercury is worked at a profit. A full account of the Monte Amiata deposits is given in the *Mining Magazine of New York* (1906, **13**, 277). A general description of the method of smelting employed in this district is given on page 492.

Russia.—At one time Russia made a substantial contribution to the world's output of mercury, but during the past decade the production has steadily declined. In 1905 it amounted to 300 tons of metallic mercury, but fell to 4 tons in 1910, and about 25 tons was obtained in 1911. At the present time it is stated that the only mercury deposits being worked in Russia are those of Nikitovsky in the Ekaterinoslav district of Southern Russia. At these mines the cinnabar occurs crystalline in sandstone of Carboniferous age, and also in the quartzites which underlie the sandstone. The associated minerals are antimony sulphide and sulphur. The ore carries 0·4 to 1·1 per cent. of mercury. In the Urals several deposits of mercury ore have been located, the most important being that of Olene Travyansky. A deposit which may prove to be of some importance has been discovered recently on the Ayatsky estate in Ekaterinberg. On the surface numerous pebbles containing up to 10 per cent. of mercury were found, and at a depth of 5 ft. a vein of cinnabar 3 in. wide was found. A cross-cut disclosed another vein 21 in. wide, the cinnabar being irregularly distributed throughout the mass.

Servia.—The most important mercury ore deposits in the Balkan peninsula occur at Avala, situated about 15 miles south of Belgrade. The ore is cinnabar, and occurs associated with calomel and native mercury in barite-quartz veins which traverse a Cretaceous limestone.

Spain.—About one-third of the world's supply of metallic mercury is produced in Spain, most of the ore being obtained from the famous mines of Almaden in Cuidad Real province. There are also several smaller mines in Oviedo. At the Almaden mines the rocks consist of

upturned slates of Devonian and Silurian age, together with intercalated quartzites. The cinnabar is rarely found in the slates, but occurs in three beds in the quartzite, each about 25 ft. thick and separated from one another by a few feet of soft slate. These beds unite at a depth of about 800 ft. from the surface. The ore is stated to carry on the average about 8 per cent. of mercury. The chief mine in Asturias province is El Porvenir, where cinnabar occurs in rocks of Carboniferous age, accompanied by realgar, orpiment, and metallic arsenic. This ore is said to carry about 0·3 per cent. of mercury.

Asia

Asia Minor.—Several years ago ancient workings were located at Koniah, and these have since been profitably worked. The cinnabar occurs in small veins and nodules at the contact of a crystalline limestone and a talcose schist. The ore mined contains from 1·5 to 2·5 per cent. of mercury. Cinnabar is here also found associated with stibnite, the ore carrying about 8 per cent. of mercury. The plant installed includes a Spirek shaft furnace and a Czermak-Spirek roasting furnace having a capacity of 15 tons and 8 tons per day respectively.

Important deposits are also being worked at Kara Bourna, about 18 miles from Smyrna, where cinnabar occurs impregnating a siliceous rock. The ore averages 0·75 per cent. of mercury, and it is stated that ore containing as little as 0·25 per cent. can be worked at a profit. A plant similar to that at Koniah is in operation.

Borneo.—Native mercury and its ores have been found in many parts of Borneo, and occasionally small quantities of the metal have been exported. Native mercury has been found near Marup at Sadong in Sarawak. Deposits of ore occur in the upper basin of the Sarawak River in the Samarahan district, and small quantities of cinnabar have been obtained from the rich drifts which flank the Tejora and Gading hills.

Cinnabar has been found in many places in West Borneo, but the results of prospecting carried out some years ago indicated that the deposits would not repay

working. At Nanga Betung, cinnabar occurs associated with iron pyrites, and also in drifts with antimony sulphide.

In South Borneo, mercury ores occur associated with gold, copper, and tin ores in the drift deposits of Lower Katingan and Kataringin. In the Bawang Mountains cinnabar has been found disseminated in phyllite at Sungei Sekire. A full account of the occurrences of mercury ore in Borneo is given in *Borneo, Its Geology and Mineral Resources*, by T. Posewitz (London: E. Stanford, 1892).

China.—Mercury is much used in China as the source of the pigment vermillion and for gilding. Ores of mercury are reported to occur in many parts of China, but at the present time the only mines known to be of any importance are those of Yuan Shan Chiang, which are situated in the south-east part of Kweichow Province. The cinnabar occurs as impregnations and bunches in nearly horizontal beds of magnesian limestone. The ore mined contains an average of 2·8 per cent. of mercury, and is smelted in two 12-ton furnaces.

India.—Cinnabar has been reported to occur in India, but the reports appear not to have been substantiated. India imports about 160 tons of mercury annually.

Japan.—Deposits of mercury ore occur in several localities in Japan, but no production of the metal was recorded until 1908. In that year mercury to the value of £144 was obtained from the Suigin mine at Suii, in Shikokw, where cinnabar occurs in the form of small veins along a fault-plane in Mesozoic limestone.

Africa

Algeria.—For some years past small quantities of mercury have been exported from Algeria, most of the ore coming from the localities of Taghit and Ras-el-Ma. The cinnabar occurs at Taghit associated with zinc blende, calamine, siderite, and galena, and is stated to carry, on an average, 1·2 to 1·5 per cent. of mercury, and 5 to 15 per cent. of zinc. Works for treating the ore were built in 1903, and now include a Spirek shaft furnace having a capacity of 6 tons per day, and Czermak-Spirek roasting and calcining furnaces of similar capacity. A full account

of these deposits and others in Algeria will be found in *Les Richesses Minérales de l'Afrique*, by L. de Launay (Paris: J. Béranger, 1903).

Union of South Africa.—Although large quantities of mercury are consumed in the gold industry, and ores of mercury have been found in several localities, no appreciable quantity has yet been produced in South Africa.

In the Transvaal cinnabar has been found in quartzites and altered slates in the Kaap Valley. It also occurs in a quartzose sandstone in the Lebombo Mountains to the east of De Kaap, and associated with galena and zinc blende at the Erasmus mine in the Marico district.

It is stated that mercury deposits situated near Hector Spruit on the Delagoa Bay line have been worked to a small extent (*Mineral Industry*, 1907, **16**, 818).

Cinnabar has been reported to occur at Mosita, about 50 miles south of Mafeking, and native mercury associated with gold in the Prince Albert district of Cape Province.

Australian Commonwealth

New South Wales.—Cinnabar has long been known to occur in this State, and smelting of the ore was carried out on a limited scale at Cudgegong as far back as 1869. The production has, however, been small, and a bonus of £500 offered by the New South Wales Government for the first 50,000 lb. of mercury produced from ore raised in the State is still unclaimed.

Cinnabar was located many years ago in a lode at Spring Creek, situated about 3 miles south-east of Bingera. The ore occurs disseminated through a dyke of decomposed serpentine rock, but the yield of mercury, as shown by samples of ore from the shafts sunk, did not justify further development.

In 1895 cinnabar was found at Yulgilbar, about 7 miles from Lionsville, on the Clarence River. The country rock consists of a hornblende granite, into which a dyke of quartz diorite has been intruded. The cinnabar is found near the junction of these rocks, and occurs associated with quartz and calcite. A considerable amount of development work has been done on this deposit, and it

is stated that there is a good supply of ore carrying 0·5 to 1·0 per cent. of mercury. At a depth of 70 ft. carbonate of copper is found with the cinnabar. In 1902 an attempt was made to work these deposits, and a 50-ton shaft furnace was erected.

A considerable amount of prospecting work has been done during recent years on a deposit situated at Pulganbar on Gordonbrook in the Copmanhurst division. During 1911 about 300 tons of low-grade and 50 tons of rich ore were raised and smelted in a small furnace. A larger plant is now being installed for treating the ore.

A full account of the above occurrences, together with eighteen other localities in which mercury ore has been found, is given in the *Mineral Resources of New South Wales*, by E. F. Pittman (Sydney: W. A. Gullick, 1901).

Queensland.—Mercury ore was raised and smelted many years ago in this State, but during recent years little work seems to have been done in this direction. Between 1874 and 1891 about 41 tons of metallic mercury was produced from the Kilkivan mines and utilised in the Gympie district.

It is stated that eight lodes were located in the Kilkivan district, in the valley of Wilde Bay Creek, distributed over a length of about 10 miles. One of the largest lodes is the "Queensland," which is 7 ft. wide in places, and yielded a dressed ore containing 4 per cent. of mercury. About 70 tons of the ore was smelted with rough appliances, and yielded about 2·7 tons of mercury. The lodes are said to occur in granites and schists which are associated with breccias and tuffs. A small parcel of ore was produced in 1908, and it is reported that prospecting has been in progress during the past year. A full account of these deposits will be found in "Alluvial Cinnabar Deposits near Kilkivan" (*Publication* 79, 1892, *Geol. Surv., Dept. Mines, Queensland*).

In the Little River district of North Queensland mercury ores associated with copper ores have been found in veins in andesite. The cinnabar is found best developed in the cavities and joints of the calcite veins where these traverse the kaolinised rock. About 1 ton

of picked ore, containing 5 to 6 per cent. of mercury, was sent to London for treatment, but was reported on unfavourably. The workings have disclosed a mercury lode which averages 18 in. in width at the surface, but decreases to about 6 in. at lower levels. A recent description of these deposits will be found in *Publication* No. 222, 1910, *Geol. Surv., Dept. Mines, Queensland*, and this BULLETIN, 1912, **10**, 138.

Cinnabar has also been found in the following localities in Queensland: Mount Perry, Montalbion, Mungana, Gilberton, Nebo, and Montsildale.

South Australia.—Mercury ore was reported to occur at Myponga, about 8 miles from Willunga, in a formation consisting of clay slates, mica schists, phyllites, and quartzites. A certain amount of prospecting work was done, including the sinking of a 50 ft. shaft and two tunnels 120 and 250 ft. in length, but failed to locate mercury ore in payable quantities.

Victoria.—Mercury ores have been found in this State at Silver Creek on the Jameson River in Wonnangalla, where both the native metal and cinnabar occur in chloritic slates. The deposit was worked for a short time, but proved unprofitable owing to the small yield obtained. The last production recorded was in 1899, when metal to the value of £20 was produced. Fragments of cinnabar have also been found in the vicinity of a quartz reef near Balumwaal in Central Gippsland (*Economic Minerals of Victoria*, by A. E. Kitson. Melbourne: Victoria Department of Mines, 1906).

New Zealand

From time to time attempts have been made to work the deposits of mercury ore which exist in several localities in New Zealand, and small outputs of the metal have been recorded. One of the most recently exploited deposits is the Ascot mine, situated about 1 mile north of Karangahake. The cinnabar, which is stated to occur in horizontal seams in a flinty rock, is smelted in a Novak shaft furnace. In 1911 two tons of mercury, valued at £400, was produced. In the Hokianga division in 1866 mercury was observed

at the Ohaeawai Hot Springs, and in 1895 a company was formed to work the deposits. The ore, which occurs as irregular impregnations in carbonaceous sands and clays, is associated with sulphur, bituminous matter, marcasite, chalcedony, and antimonite. A large amount of development work was done on the deposit, and a reduction plant erected; but the operations stopped in 1897 owing to litigation between the owners. Trouble was experienced in mining the ore owing to the hot spring waters and the sulphurous gases evolved from them. In smelting, the presence of the hydrocarbons caused difficulty owing to the fact that they prevented the aggregation of the mercury. It is stated that the ore contained from 0·5 to 5·0 per cent. of mercury, the average grade being 1·5 per cent. The yield of mercury on smelting amounted to about 70 per cent. of the total amount present in the ore. A full account of the attempt to work these deposits is given in *Trans. New Zealand Inst. Min. Eng.* (1898, **2**, 48).

Cinnabar has also been found in five other localities close to the Ohaeawai Hot Springs; information concerning these is given in a recent report, "The Geology of the Whangaroa Subdivision" (*Bulletin* 8, 1909, *Geol. Surv., New Zealand*).

In 1899 a cinnabar lode was found between Waipori and Waitahuna, in Otago. Some rich ore was obtained at a shallow depth, but an adit failed to locate any considerable amount of ore, and the mine closed down in 1903. A cinnabar lode at Kaweranga Creek in the Thames division was worked to some extent some years ago.

New Caledonia

Deposits of mercury ore carrying from 1·75 to 2·75 per cent. of the metal occur at Bourail, Canala, Konaona and Piwaka, but are not at present worked.

America

Brazil.—In Minas Geraes a deposit of mercury ore has been worked to some extent near Tripuhy station.

Canada.—At the present time no mercury is produced

in Canada; but in the past small quantities have been obtained, the maximum production being in 1895, when 2·4 tons was produced. No production has been recorded since 1897, when the output was 375 lb. The deposits worked were those of Kamloops Lake, British Columbia, where cinnabar occurs in calcite and quartz veins which traverse a grey felspathic and dolomitic rock. The veins can be traced through a section 45 miles long and 1 mile wide running north and south of Kamloops Lake. It is stated that large supplies of ore containing 0·5 to 1·0 per cent. of mercury are available. The failure of the undertaking is stated to be due to the unsuitability of the furnaces employed, and also to the fact that a large amount of development work was done on unpromising locations. A full account of these deposits is given in *Ann. Rep., Geol. Surv. Branch, Dept. Mines, Canada* (1898, **11**, 108 S, 1900, **13**, 87 S). Native mercury has recently been found near Field, in the gravels of Kicking-Horse Valley, British Columbia; but attempts to locate the source of the metal were unsuccessful. Cinnabar, however, was located in a massive limestone on the north side of the valley between Emerald Creek and Amiskwi River. In the Lower Kicking-Horse Canyon cinnabar has been found in a calcite vein near Glenogle Station.

Cinnabar is known to occur on certain islands in Barclay Sound, on the west of Vancouver Island. Average samples of the ore showed 0·5 per cent. of mercury. Important deposits of mercury ore have been reported recently from Groundhog, east of Cochrane, in northern Ontario.

The occurrence of mercury ore at the Nipissing mine in the Cobalt district has already been recorded in this BULLETIN (1911, **9**, 427). The ore is said to carry 4 to 5 lb. of mercury per ton.

Colombia.—Cinnabar occurs in quantity in a mica-slate in the Quindico Mountains between Ibagué and Cartago.

Dutch Guiana.—Mercury ore has been reported recently in the Maroni district as a vein of cinnabar averaging 20 ft. in thickness. The deposit is said to be of considerable extent and to yield rich ore in workable quantity. The

area is receiving the attention of certain Dutch and American mining engineers.

Mexico.—A considerable output of metallic mercury is obtained annually from Mexico. The richest mine so far exploited is stated to be that of Guadalupana in San Luis Potosi. The ore is cinnabar and occurs, associated with calcite and gypsum, in much-folded marl-stones. As there is no water near the mine, the ore is conveyed 11 miles to the smelting works. There are no sulphides other than that of mercury in the ore, which is said to carry 10 per cent. of the metal.

At various times attempts have been made to work the Chiquilistlan deposits of Jalisco. Here cinnabar occurs, associated with copper ores and limonite, in the fissures which traverse a hard grey Cretaceous limestone. Other mines that have produced payable ore are situated at Guadalcazar and Huitzuco in the State of Guerrero.

Peru.—There is a small annual output of mercury from Peru, obtained from the Departments of Huanuco and Huancavelica. The mines in the latter locality have been worked since the sixteenth century, the cinnabar belt running N.E. and S.W. for a distance of about 60 kilometres. The chief mines are those of Santa Barbara, situated about 2·7 kilometres from Huancavelica, on the eastern slope of the Western Cordillera of the Andes. The ore mined is said to carry about 2 per cent. of mercury. The production of metallic mercury in Peru for 1910 was valued at £94.

United States.—For several years past there has been an annual production of over 700 tons of mercury in the United States, about 83 per cent. of this being obtained from California, the remainder coming from Texas, Nevada, and Oregon.

The most important Californian deposits are those of New Idria, in San Benito Co., which yielded half the total output of the United States in 1910. The ore bodies are found in metamorphosed rocks of the Lower Cretaceous series, near the contact of these with the unaltered sediments of the Upper Cretaceous series. The ore occurs as irregularly distributed shoots in hard shale and

sandstone. The ore is smelted at the mine, a Hüttner-Scott type of furnace being employed for fine ore and two Newcome furnaces for coarse ore. The furnace operations are assisted by the high content of pyrite in the ore, which also decreases the fuel costs.

The second largest producing deposits in California are those of New Almaden and Guadalupe in Santa Clara Co. The original workings at the Guadalupe mines were situated in the valley close to the Capitancillos Creek, but these had to be abandoned owing to water in the mine. The present workings are in the hillside and are reached by an adit 2,000 ft. in length. The cinnabar, which occurs in a serpentine near its contact with an intrusive rhyolite, is crushed and separated by sifting into grades above and below 1½ in. For the distillation of the mercury oil fuel is used, the consumption being about one barrel per 10 tons of ore smelted. The yield of mercury from the mines in Santa Clara Co. averages 0·4 per cent. on the ore smelted.

Smaller mercury deposits occur and are worked in several other counties in California.

The average recovery of mercury from mines in this State was 0·5 per cent. of the ore treated in 1910.

Mercury ores have been found in many localities in Texas, but at the present time nearly the whole output is obtained from the Terlingua district in Brewster Co. Here cinnabar occurs in Cretaceous limestones and shales into which Tertiary igneous rocks have been intruded. In the past considerable difficulty has occurred owing to a scarcity of fuel and water. In 1910 the yield of mercury for the whole of Texas averaged 1·7 per cent. of the ore smelted.

Some of the richest mercury ore treated in the United States is obtained in Nevada, but the output is small. The average recovery in 1910 was 7·5 per cent. on the ore smelted. Retort furnaces were formerly used, but recently these had to be abandoned owing to injurious effects on the health of the workmen. The most important deposits are situated in Nye and Humboldt Counties.

Extraction of the Metal

Mercury is obtained from its ores by a process of distillation which can be easily effected, as the metal boils at a temperature of 357° C. This also renders the separation of the metal from the gangue a comparatively easy matter, but it is necessary to have very efficient means of condensing the vapour, which is poisonous.

As the grade of the mercury ore worked is low, often being about 1 per cent. or less, it is essential to obtain as much of the metal as possible if the work is to prove remunerative. It is stated that lack of effective condensation has led to the abandonment of several promising deposits (see under Canada, p. 488).

Two methods have been generally employed for the smelting of mercury ores. In the one case the ore is heated with lime or iron in the absence of air, and in the other it is heated alone in a current of air. The first method necessitates the use of retorts, and owing to its high cost has been almost entirely abandoned, except for very rich ores. It has also the disadvantage of causing serious injury to the health of the workmen who have to empty the retorts. The second is the one now generally adopted, as it permits of poor ores being treated at a profit. The general practice is to separate the ore into coarse and fine grades and to smelt the coarse ore in a shaft furnace and the fine ore in a reverberatory type of furnace. Numerous varieties of these two classes of furnace are in use, and good descriptions and plans are given in *Mineral Industry* (1901, **10**, 559; 1902, **11**, 548).

In general the shaft furnace may be described as a rectangular, double-walled, firebrick furnace, having an outer covering of cast iron and a base of the same material. The shaft is roughly 22 ft. high and about 7·5 ft. in diameter at its widest part. Ore and fuel are charged into the top intermittently, and the air necessary for the combustion is supplied through holes in the base. Means are provided at the base for the withdrawal of the spent ore. Furnaces of this type include the Novak and Czermak-Spirek.

The second or fine-ore type of furnace, of which there

are many modifications, may be briefly described as one in which the ore passes by gravitation down a series of sloping shelves which are heated by means of an external fire. Typical furnaces of this class are the Czermak-Spirek continuous roasting furnace, the Hüttner-Scott, and the Livermore.

Smelting.—The smelting of the ore, as carried out in the Monte Amiata district of Italy, may be briefly described, as it is typical of modern practice. The ore as it comes from the mine contains 0·2 per cent. or more of mercury, and is graded according to size—(1) below 40 mm., and (2) 40 mm. to 200 mm. The first grade is roasted in an automatic reverberatory furnace, and the second grade in a shaft furnace. Wood fuel, chiefly beech, oak, and chestnut, is employed. For small quantities of ore containing over 20 per cent. of mercury a small automatic reverberatory furnace is used, having a daily capacity of 2 to 6 tons. The products of the roasting are chiefly mercury vapour and sulphurous acid, together with any other volatile products present in the ore. The temperature in the roasting zone in the furnace reaches about 700° C., and the gases leaving the furnace have a temperature below 200° C. In order effectively to collect the mercury, the gases are next passed through condensers consisting of cast iron, clay, or wooden pipes, which are elliptical in cross section, and are cooled by water externally. Those portions of the condensers where the temperature is below 100° C., and where the condensation of acid vapours takes place, are lined with cement to prevent corrosion. The speed of the gases through the condensers is maintained at a constant rate of about 0·5 metres per minute by means of a Roots blower, and by this means effective condensation is assured. More than 6 per cent. of the mercury originally present in the ore is retained in the "stupp" or soot which collects on the walls of the condensers. About 90 per cent. of this mercury, which is in the form of minute globules, is recovered by mechanical agitation of the stupp with 17 to 30 per cent. of its weight of slaked lime. The residue is then returned to a small roasting furnace to recover the remaining metal.

A complete account of the metallurgy of mercury is given in "La Metallurgia del Mercurio," by V. Spirek, *Trans. Internat. Congress of Applied Chemistry, Rome* (1906, **2**, 340). The following is an estimate by V. Spirek of the cost in Europe of the plant necessary to treat 13,500 tons of ore per annum, to yield 160 tons of metallic mercury:

	Daily output.	Cost. £
1 continuous roasting furnace and condenser	16 tons	1,508
1 medium " " "	8 "	873
1 small " " "	2 "	198
1 double shaft furnace	18 "	317
1 single " "		159
Muffle furnace	1 ton	357
Drying furnace		238
Central condensing chamber		397
Machinery		317
Buildings		1,587
		5,951

The cost of treatment in the Monte Amiata district is said to average 36·56*d.* per ton of ore, distributed as follows:

	Pence.
Furnace workers	6·55
Sifting of ore	3·23
Drying of ore and cost of transport	5·70
Supervision and packing	5·98
Fuel	12·25
Repairs, etc.	2·85
	36·56

The cost of mining in the Monte Amiata district is said to vary from 14*s.* to 23*s.* per ton of ore.

Properties and Uses of Mercury

Metallic mercury is a silver-white substance, liquid at temperatures above – 38° C. and boiling at 357° C. It has a specific gravity 13·6, and readily forms amalgams with gold, silver, bismuth, tin, lead, and zinc, at ordinary temperatures, and with many other metals on heating.

Mercury finds a wide application in the arts and manufactures. Probably the largest use at the present time is its employment in the gold industry for amalgamation purposes. Since the introduction of the cyanide process the consumption of mercury, in proportion to the gold recovered, has considerably diminished. At the present

time the average consumption of mercury per ton of gold ore treated varies from 0·2 to 0·3 oz. At first sight this would not appear to indicate a large demand, but when it is remembered that in the Transvaal alone during 1911 24,000,000 tons of gold ore were crushed, the magnitude of the demand for this purpose becomes obvious.

The metal is also used in the manufacture of mercury fulminate, the active ingredient in igniting and detonating mixtures for explosives. The value of mercury fulminate in this connection depends upon its great sensitiveness to friction and percussion. For most purposes mercury fulminate is too rapid in its action to be used alone, and it is therefore mixed with varying amounts of potassium chlorate and other substances. In detonators for industrial purposes gun-cotton is sometimes also added. The "service composition" for percussion caps of cordite small arms ammunition is stated to have the following percentage composition: mercury fulminate, 19·05; potassium chlorate, 33·33; antimony sulphide, 42·86; sulphur, 2·38; finely powdered gunpowder, 2·38.

Mercury is also used to make the pigment vermillion, a sulphide of mercury. The raw cinnabar is stated to be unsuitable for this purpose, as the impurities present affect the colour.

In medicine and surgery several salts of mercury find application. Amongst these may be mentioned the nitrate, chlorides, and iodide. Mercuric chloride (corrosive sublimate) is also employed in very dilute solutions as a fungicide.

A certain quantity of metallic mercury is employed in the manufacture of scientific instruments, and it is also used in the Chinese method of gilding. A small quantity is also consumed in the manufacture of the mercury-vapour electric lamp. Nitrate of mercury is stated to be sometimes employed in the manufacture of felt hats. An amalgam of mercury and tin is sometimes employed for "silvering" mirrors.

Statistics of Production and Trade

The following table shows the output of mercury in the chief producing countries:

	Metric tons. 1910.	*Metric tons.* 1911.	*Metric tons.* 1912.[2]
Austria-Hungary	603	685	675
Italy	893	815	823
Spain	1,000	1,055	1,035
China[1]	49	—	—
Mexico	200	95	112
United States	701	723	857

[1] *Exports only.* [2] *Estimated production.*

The following figures indicate the import and export trade in mercury in some of the chief countries where that metal is used. In converting the published figures into metric tons a flask has been taken as equal to 75 lb.:

	1910.		1911.	
	Import. *Metric tons.*	Export. *Metric tons.*	Import. *Metric tons.*	Export. *Metric tons.*
United Kingdom	1,520	843	1,587	1,071
France	146	—	196	—
Germany	836	31	919	36
India	160	2	106	2
Union of South Africa	129	—	108	—
Australian Commonwealth	57	—	41·5	—
Canada	129	—	59	—
United States	0·3	65	—	—

Commercial Value.—Mercury is sold and shipped in iron bottles (flasks) each containing about 75 to 76 lb. During recent years the average price has shown a slight upward tendency. The following table shows the prices in London during recent years:

	Highest. £ s.	Lowest. £ s.
1908	8 10	7 12
1909	9 17	7 19
1910	9 15	7 9
1911	10 0	7 0

The present price (August 1913) is £7 5*s.* per flask.

Specimens of mercury ore from the following localities are shown in the public exhibition galleries of the Imperial Institute:

New South Wales	Cudgegong near Rylstone; Yulgilbar, Clarence River District.
Queensland	Kilkivan.
Union of South Africa	Hector Spruit, Swaziland.
Canada	Kamloops, British Columbia; Barclay Sound, British Columbia.

THE COALS OF CANADA

During recent years extensive investigations have been made of the coal resources of Canada, and a considerable amount of literature has been published on this subject by the Department of Mines. The most important of these publications is *An Investigation of the Coals of Canada*, by J. B. Porter, R. J. Durley, and others, which embodies the results of work carried out at the McGill University, Montreal, under the authority of the Dominion Government. In view of the great importance of Canadian coal resources, an attempt has been made in the present article to summarise the information now available. At the end of the article is given a bibliography comprising the more important publications dealing with the coal resources of Canada.

The coal fields of Canada may be grouped in the four great divisions which, with their estimated contents of workable coal, are given below:

(1) *The Atlantic Provinces.*—Nova Scotia and New Brunswick:

Bituminous coal	3,500,000,000 tons

(2) *The Central Plains and the Eastern Rocky Mountains.*—Manitoba, Saskatchewan, Alberta, British Columbia:

Anthracite	400,000,000 tons
Bituminous coal	30,000,000,000 ,,
Sub-bituminous coal and lignite . .	100,000,000,000 ,,

(3) *The Pacific Coast and the Western Mountains.*—British Columbia and the Yukon:

Anthracite	61,000,000 tons
Bituminous coal	40,000,000,000 ,,
Lignite	500,000,000 ,,

(4) *The Arctic-Mackenzie Basin*:

Lignite	490,000,000 tons

There are also certain small fields in Ontario containing some millions of tons of lignitic peat, and others of doubtful extent and value in the far north.

Owing to shipping facilities and proximity to markets the Nova Scotian coal fields have hitherto been the most

productive. The Western fields, however, are rapidly developing, and will doubtless continue to do so as railway extensions open up new districts. The relative importance at the present time of the different areas is shown by the following table, giving the output by provinces for the last three years.

Province.	1910.		1911.		1912.	
	Production. Short tons.[1]	Value. $	Production. Short tons.[1]	Value. $	Production. Short tons.[1]	Value. $
Nova Scotia . .	6,431,142	12,919,705	7,004,420	14,071,379	7,791,440	17,391,608
British Columbia	3,330,745	10,408,580	2,542,532	7,945,413	3,220,899	10,065,311
Alberta . . .	2,894,469	7,065,736	1,511,036	3,979,264	3,446,349	8,471,126
Saskatchewan .	181,156	293,923	206,779	347,248	196,325	327,054
New Brunswick	55,455	110,910	55,781	111,562	42,780	85,560
Yukon Territory	16,185	110,925	2,840	12,780	2,160	8,640
Total . . .	12,909,152	30,909,779	11,323,388	26,467,646	14,699,953	36,349,299

[1] 2,000 *lb.*

In the following pages the coal fields of Canada are considered province by province, beginning with Nova Scotia and proceeding westward.

Nova Scotia

The coal-bearing measures of this province belong to the Carboniferous system, and are practically confined to the sub-division known as the Productive Coal Measures. All the coal is bituminous in quality. There are five distinct coal fields, known as the Sydney, Inverness, Richmond, Pictou, and Cumberland fields.

Sydney Coal Field.—The Sydney field is situated in the north-east corner of Cape Breton county, with the deep-water harbour of Sydney as its central point; it also takes in a small portion of Victoria county. It covers about 200 square miles of land, with important extensions beneath the ocean. The coal measures are largely composed of shales and sandstones, the solidity and coherence of which favour submarine exploration. The seams occur in a series of basins which are partially submerged; they dip seawards at angles of 5° to 12°, and are but little affected by faults and disturbances. The aggregate thickness of coal, in workable seams from 3 to 9 ft. thick, is 40 or 50 ft. The coal is well adapted for general purposes,

while some seams are specially suitable for the manufacture of gas. As compared with the Pictou coal it is characterised, on the whole, by a greater proportion of combustible matter and a smaller proportion of ash; but, on the other hand, it usually contains a greater amount of sulphur, only a part of which can be removed by washing. The following table shows the suitability of some of the Sydney coals for gas manufacture.

Mines.	Gas, cubic feet, per ton.	Candle-power of gas.	Coke produced, per ton.
Little Glace Bay	9,268	15	40 bushels
,, ,, ,, ...	9,700	14·75	39 ,,
International	10,000	16	1,470 lb.
Sydney Mines	8,200	8	1,295 ,,
Gowrie Mines	9,000	15	1,230 ,,
Caledonia Mines	8,900	14·25	36 bushels
Reserve Mines	9,950	13·17	1,500 lb.

Inverness Coal Field.—In the Inverness field the coal measures comprise a series of narrow areas on a line extending from Judique to Margaree, along the western shore of Cape Breton Island. They appear as remnants of the rim of a basin, the greater part of which has been eroded. At Port Hood one seam, 6 to 8 ft. thick, is being worked, and another 6-ft. seam is reported to occur. Some ten miles farther north, near Mabou, a section is said to show six seams ranging from 3 to 15 ft. in thickness. Twelve miles farther north, at Port Ban, another narrow fringe of coal-bearing measures comes in, and continues with a few interruptions as far as Chetikamp, a distance of over 50 miles if measured along the coast. In several places there are good seams of coal which have been worked at various times, and one of which is being worked at present. Near Broad Cove, Inverness, for instance, seams of 3 ft., 5 ft., 7 ft., and 3 ft. 6 in. occur, dipping seaward at from 10° to 20°. At Chimney Corner the seams measure 3 ft., 5 ft., and 3 ft. 6 in.

Richmond Coal Field.—In Richmond county, in the south-western part of Cape Breton Island, a small development of coal measures occurs between the Strait of Canso and Inhabitants river. Coal seams of workable size are visible on the shore of Cariboo cove, at Sea-coal bay,

where they dip at 75° to the south-west. The principal seam is 11 ft. thick, inclusive of several bands of shale. The others are 4 ft. and 5½ ft. thick, the latter including a 15 in. band of fire-clay. At a point on Little river, about 3 miles north of the Cariboo cove outcrops, a 3-ft. and a 4-ft. seam have been proved. This area is very much disturbed, and dips of 85° occur.

Pictou Coal Field.—The Pictou field is situated in the centre of Pictou county, south of the town of New Glasgow. It extends 12 miles in an east and west direction, with a maximum breadth of 3 miles. It may be divided into three districts or sections, viz.: the Westville section on the west, the Stellarton or Albion section in the centre, and the Vale section on the east. The Westville division is separated from the adjacent one to the east by the McCulloch fault, the throw of which has been estimated at 2,600 ft. Four seams have been recognised: the Main or Acadia seam, 17 ft.; Second seam, 12 ft.; Third seam, 6 ft.; Fourth seam, 8 ft. The average strike is north-west and south-east, and the dip 16° to the north-east. The Stellarton or Albion section is remarkable for the great size of some of its seams. They are, in descending order, the Main seam, 38 ft.; Deep seam, 22 to 40½ ft.; Third seam, 12 ft.; Purvis seam, 3 ft.; Fleming seam, 5·6 ft.; McGregor seam, 15 ft.; Stellarton oil-coal, 5 ft. The general strike of the outcrops is more nearly east and west than in the preceding division, and the dip varies from 15° to 30° to the north. In the Vale division the coal measures take the form of a syncline. The known seams are: the George McKay 4-ft. seam, good coal 2 ft.; the Six-foot seam; the McBean seam, 8 ft.; and a small seam of 2 ft.

Cumberland Coal Field.—In Cumberland county there are two considerable areas of Productive Coal Measures, separated by a tract of newer rocks. One of these, the Springhill area, is situated near the middle of the county; it measures about 7 miles north and south by about 3 miles east and west, and the formation extends farther westward beneath the younger rocks. There are at least five workable seams in this field, ranging in thickness from 4 to 13 ft. The dip is steep, averaging from

25° to 30°, and reaching 75° in places. The other important section of the coal field is the Joggins area. Here the coal measures are exposed on the shores of Chignecto bay, an arm of the bay of Fundy, and stretch eastward for some 18 miles, with an outcrop about 2 miles wide and a dip to the south. The Productive Coal Measures are about 2,540 ft. thick and contain a great number of coal seams, most of which are very thin. Small seams also occur in the underlying Millstone Grit series. A third small area of coal measures lies to the north of the Springhill field, near Salt Springs station on the Intercolonial Railway.

Coals of Nova Scotia

	Fixed carbon.	Volatile matter	Ash.	Sulphur.	Moisture.	Calorific value.[1]
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Small calories.*
Sydney coal field.						
Gowrie seam, North Atlantic Collieries, Port Morien	53·0	34·7	12·3	6·4	2·8	7010
Hub seam, Dominion No. 7 Colliery, Glace Bay	57·6	36·5	5·9	2·4	2·6	7700
do. do. do. washed coal	59·1	38·2	2·7	2·0	—	7950
Harbour seam, Dominion No. 9 Colliery, Glace Bay	55·5	38·6	5·9	3·7	1·6	7780
Phalen seam, Dominion No. 5 Colliery, Glace Bay	59·5	35·0	5·5	1·8	1·9	7800
do. Dominion No. 1 Colliery, do.	59·8	34·3	5·9	1·9	2·1	7780
Emery seam, Dominion No. 10 Colliery, Glace Bay	53·8	35·1	11·1	2·5	2·0	7290
do. do. do. washed coal	57·3	36·9	5·8	2·1	—	7710
Lingan seam, Dominion No. 12 Colliery, Glace Bay	57·9	37·3	4·8	1·8	3·6	7660
Sydney Mines, No. 1 Colliery	55·4	37·4	7·2	2·9	2·7	7650
do. do. washed coal	56·3	40·2	3·5	1·9	—	8050
do. No. 3 Colliery	54·3	39·0	6·7	2·5	4·0	7600
Inverness coal field.						
Inverness Colliery	49·6	40·0	10·4	6·0	7·5	6750
do. washed coal	51·0	42·5	6·5	5·0	—	7110
Port Hood Colliery	48·3	37·1	14·6	7·9	3·2	6540
do. washed coal	51·2	37·9	10·9	6·7	—	6970
Pictou coal field.						
Six-foot seam, Vale Colliery, Thorburn	50·6	32·1	17·3	1·0	2·1	6680
do. do. washed coal	54·2	33·2	12·6	1·0	—	7090
Foord seam, Allan Shaft Colliery, Stellarton	55·4	33·3	11·3	0·6	1·7	7350
Third seam, Albion Colliery, Stellarton	55·5	29·8	14·7	1·4	2·0	6990
do. do. do. washed coal	56·9	30·8	12·3	1·0	—	7250
Cage Pit seam, Albion Colliery, Stellarton	58·1	31·4	10·5	0·9	1·9	7320
Main Seam, Acadia Colliery, Westville	64·8	26·0	9·2	0·9	1·6	7700
do. Drummond Colliery, Westville	60·8	24·7	14·5	2·5	1·1	7200
do. do. do. washed coal	63·4	25·3	11·3	1·3	—	7530
Springhill coal field, Cumberland county.						
No. 1 Colliery, Springhill	63·3	33·3	3·4	1·0	2·2	7880
No. 2 Colliery, do.	58·5	32·3	9·2	1·6	2·0	7430
do. do. washed coal	59·8	33·1	7·1	1·4	—	7700
No. 3 Colliery do.	55·0	33·5	11·5	1·8	2·3	7220
do. do. washed coal	57·0	34·7	8·3	1·5	—	7540
Joggins-Chignecto coal field, Cumberland County.						
Chignecto Colliery	45·7	41·0	13·3	6·4	3·2	6750
do. washed coal	49·6	41·3	9·1	6·2	—	7160
Minudie Colliery	48·8	35·7	15·5	6·7	2·8	6570
do. washed coal	51·7	37·3	11·0	6·3	—	7000
Joggins Colliery	41·8	36·6	18·6	5·4	0·6	6440
do. washed coal	51·6	38·1	10·3	4·8	—	7080

[1] *In this and the following tables the calorific values are from determinations made with the Köhler bomb calorimeter on coal dried at* 105° *C. They are given in gramme-degree Centigrade units (small calories) per gramme of coal burnt. All the samples represent the normal output of producing mines.*

New Brunswick

The Productive Coal Measures which occur in Nova Scotia appear to be absent from New Brunswick, where the coal seams are found in the slightly older Millstone Grit series.

In the Grand Lake area, Queen's county, the coal measures are nearly horizontal. Two coal seams occur, separated by a parting of varying thickness. The upper seam is about 20 in. thick, and the lower 10 in. They coalesce in certain places, and form a seam 30 in. thick. The coal occurs quite near the surface, the deepest shafts not exceeding 40 ft. in depth. There are numerous small mines in the field. The coal is mined either by stripping the overburden, or by driving levels from the bottom of a shaft. When the levels reach a length of 400 or 500 ft. the practice is to move the whole plant, and sink a new shaft some 1,000 ft. from the old one in order to minimise underground haulage.

Mining on a small scale has been carried on near Beersville, in Kent county, on a seam about 20 in. thick. At Dunsinane, on the Intercolonial Railway about 30 miles south-west of Moncton, several drifts have been made in a seam 18 to 20 in. thick.

Coals of New Brunswick

	Fixed carbon.	Volatile matter.	Ash.	Sulphur.	Moisture.	Calorific value.
Grand Lake coal field	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Small calories.*
King's Mine, Minto . . .	53·4	32·2	14·4	5·8	0·9	7160
do. do. washed coal	56·6	34·0	9·4	4·9	—	7680

Ontario

In the northern part of Ontario beds of low-grade lignite occur in clays and shales of Glacial age. These stratified deposits appear to have been formed during an interglacial period, and to have suffered severe erosion on the return of the ice. They are particularly well developed in the Moose River basin, and although they are too

remote to be of any present economic value they constitute fuel assets which may become important in the future.

Manitoba and Saskatchewan

No coals of Carboniferous age are known in the western half of Canada. There the coal-bearing beds belong chiefly to the Cretaceous system and to the Laramie formation, which may be regarded as its upward continuation. Jurassic and Tertiary coals occur in a few localities. Cretaceous beds first appear a little to the west of Winnipeg, whence they extend without interruption to the Rocky Mountains; but coal occurrences are few and of comparatively little importance until Alberta is reached.

The most easterly of these coal-bearing areas is that of Turtle Mountain, in Manitoba. This is situated near the intersection of the 100th meridian with the International Boundary, the southern half of the area being in North Dakota. Turtle Mountain is composed of sandy beds belonging to the Laramie formation. Seams of lignite occur at various points, and have been worked for local use. The lignite disintegrates on drying, and will not stand long transportation.

Laramie beds cover some 4,000 square miles in the southern part of Saskatchewan, and cross the International Boundary into North Dakota. Lignite seams are numerous, but, owing to the character of the country, and to the thick covering of superficial deposits, their study is difficult, and very little is known of the possibilities of the area beyond the Souris river district. Here, in the neighbourhood of Estevan, the seams are exposed in the river banks. They occur at three horizons. In the upper one the main seam is 4 ft. thick, locally thickening to 8 ft., but the lignite is of rather inferior quality. The middle horizon is characterised by a very variable seam, ranging from 2 to 6 ft. in thickness, sometimes split into three seams. In some places this is separated from the coal of the upper horizon by 40 to 60 ft. of indurated clay and sand; at others, the two seams come together. The lower horizon, about 50 ft. below the middle one, contains several seams which in

places come together, and form a seam 8 ft. thick. This lignite is of better quality than that of the overlying seams, but contains much water and disintegrates after a comparatively short exposure to the air.

Two seams of low-grade lignite, 3 ft. and 5 ft. thick, are exposed on Big Muddy creek near the International Boundary. An 18 ft. seam occurs on the Poplar river. At Wood Mountain seams of 6 ft. and 5 ft. have been opened. Lignite is also exposed at Willowbunch, and further west a 4 ft. seam is recorded in the Cypress hills.

Lignites of Saskatchewan

	Fixed carbon.	Volatile matter.	Ash.	Sulphur.	Moisture.	Calorific value.
Souris River coal field.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Small calories.*
Western Dominions Collieries, Taylorton . .	42·9	49·0	8·1	0·6	18·0[1]	5940
Eureka Coal and Brick Co., Estevan . .	43·2	40·0	16·8	0·5	18·2[2]	5360

[1] *Before air-drying*, 28·6. [2] *Before air-drying*, 30·9.

Alberta

The principal coal-bearing horizons in Alberta are, in descending order, the Edmonton, Belly River, and Kootanie formations, all of which belong to the Cretaceous system. The overlying Paskapoo series (Tertiary) contains a few seams of lignite, which are worked for local use, but these are of comparatively little importance.

Edmonton Formation.—The Edmonton series forms a gentle trough, the axis of which runs roughly parallel with the Rocky Mountains, and covers an area of some 35,000 square miles. The upper part generally contains lignite in seams up to 25 ft. thick.

At Edmonton a seam varying from $3\frac{1}{2}$ to 6 ft. is extensively worked, mainly for domestic purposes. The seam is practically level. At Strathcona two seams, 5 and 6 ft. thick, are worked. Near Morinville there is a thickness of 12 ft. of lignite, with a parting from 6 in. to 2 ft. thick in the middle. A 5-ft. seam is worked at Diamond City.

Numerous outcrops of lignite have been recorded, as on the Bow river, on Red Deer river at several points, at Buffalo lake, on Battle river, on the Athabaska, Pembina, Brazeau, and Saskatchewan, and east of the Porcupine hills.

Belly River Formation.—The Belly River coal formation is separated from the Edmonton coals by a vertical thickness of 1,000 ft. of shales. Its outcrop covers 18,000 or 20,000 square miles in southern Alberta and in Saskatchewan, to the east of the Edmonton series. The fuel is lignite, but of better quality than that of the Estevan district.

At Taber, 75 miles west of Medicine Hat, a horizontal seam containing 41 or 42 in. of clean coal is mined at a depth of 100 ft. The seam worked at Lethbridge gives 4 ft. of coal, with a parting 2 to 6 in. thick in the upper part. At Lundbreck, 75 miles west of Lethbridge, the beds are rather disturbed. At one mine a seam 9 ft. thick, dipping at 60° to 80°, is being worked. Several outcrops are known in the neighbourhood of Medicine Hat, and also on the Belly, Bow, and Red Deer rivers, and near Irvine station. In the foothills this formation reappears from under the younger rocks, and workable seams occur south of Morley station, on the Jumping-pond and Elbow rivers, and on Sheep creek. Farther north, in the Peace river country, there are two areas of these beds, but the seams are mostly thin except across the boundary in British Columbia.

Kootanie Formation.—The Kootanie coal formation, at the base of the Cretaceous system, is only known to reach the surface in the disturbed region of the Rocky Mountains, and the foothills to the east of them. Here it occurs in a series of troughs and fault blocks separated by outcrops of older rocks. It contains seams varying in quality from coking and non-coking bituminous coals to anthracites with 85 per cent. or more of fixed carbon. The amount of volatile matter appears to depend on the degree of disturbance the beds have undergone.

The Blairmore-Frank coal field is situated in the south-western part of Alberta, on the Crowsnest branch of the

Canadian Pacific Railway. It includes several troughs of coal-bearing rocks, separated by north and south faults, and by ridges of older rocks. In a section measured in the northern part of the field the coal measures have a thickness of 742 ft., and contain seven seams over 8 ft., six seams between 5 and 8 ft., and eight seams under 5 ft. Another section in the southern part of the field shows nine seams from 8 to 16 ft. thick in 480 ft. of measures. The coal, as a rule, is a good coking coal, though rather high in ash. Several collieries are operating within 5 miles of Frank. At the Maple Leaf and Leitch collieries the seam worked is 7 ft. thick. At the Hillcrest mine a seam from 12 to 20 ft. thick, dipping at 30° to the west, is worked. At the Lille colliery two seams are worked, 4½ and 8 ft. thick, dipping at 35°; at this colliery there is a washing plant, and fifty coke ovens of the Bernard type. The Canadian American Coal Company work a colliery at Frank on the slope of Turtle Mountain; the seam ranges from 10 to 20 ft. in thickness, and is almost vertical. At the Denison mine, near Coleman, the seam known as No. 2 yields 12 to 14 ft. of good steam coal, and is separated by 150 ft. of strata from No. 4 seam, 6 to 8 ft. thick. The coal from this seam is used for the manufacture of coke, for which purpose 176 beehive ovens have been built.

The Canmore and Cascade Mountain coal areas are near Banff on the main line of the Canadian Pacific Railway. The coal measures form a narrow band in which the dips are to the south-west at from 30° to 50°. At Canmore, 14 miles south-east of Banff, five seams are worked, having the following thicknesses: No. 2 seam, 6 ft.; No. 3 seam, 5 ft.; No. 6 seam, 5 ft.; No. 1 seam, 4 ft. 6 in.; No. 4 seam, 4 ft. At the Bankhead mine, 3 miles north of Banff, eleven seams are cut by a tunnel driven into the west slope of the valley of the Cascade river. The coal of the lowest seams is very near anthracite in composition and physical character, while in the upper seams the fixed carbon gradually diminishes and the volatile matter increases. The coal requires sizing and screening, and the dust is made into briquettes with coal tar pitch as a binder. Anthracitic coal

was formerly mined at Anthracite, 3 miles south-east of Bankhead.

Coal seams also occur in the Kootanie beds of the Livingstone, Moose Mountain, Palliser, Costigan, Sheep Creek, and Bighorn areas.

Coals and Lignites of Alberta

	Fixed carbon.	Volatile matter	Ash.	Sulphur.	Moisture.	Calorific value.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Small calories.*
Edmonton coal field.						
Strathcona Coal Co., Strathcona	47·6	41·0	11·4	0·4	18·2	5960
Parkdale Coal Co., Edmonton	51·3	37·8	10·9	0·4	18·9	6060
Standard Coal Co., do.	49·9	42·0	8·1	0·4	19·8	6310
Belly River coal field.						
Canada West Coal Co., Taber	49·9	36·0	14·1	1·4	11·7	6130
Galt Colliery, Lethbridge	51·5	37·5	11·0	0·8	7·9	6510
Lund-Breckenridge Coal Co., Lundbreck	40·2	30·1	29·7	1·2	3·8	5450
Blairmore-Frank coal field.						
Leitch Colliery, Passburg	55·1	27·0	17·9	0·6	1·0	6800
Hillcrest Colliery, Hillcrest	55·4	29·3	15·3	0·6	1·3	6920
do. do. washed coal	60·4	29·8	9·8	0·5	—	7450
No. 1 seam, Bellevue Colliery	56·9	27·6	15·5	0·8	0.2	6880
do. do. washed coal	58·9	28·4	12·7	0·5	—	7210
No. 1 seam, Lille Colliery	58·6	25·0	16·4	0·5	0·8	6930
No. 2 seam, Denison Colliery, Coleman	55·1	25·1	19·8	0·4	0·7	6510
do. do. do. washed coal	62·0	26·4	11·6	0·4	—	7320
No. 4 seam do. do.	59·9	23·9	16·2	0·6	0·6	6960
Cascade coal field.						
No. 1, or Old Mine, Canmore	70·5	17·2	12·3	0·8	0·9	7340
do. do. washed coal	77·9	16·2	5·9	0·7	—	8000
Bankhead Colliery, pea coal	76·0	11·8	12·2	0·6	0·5	7400
do. buckwheat No. 1	71·5	12·6	15·9	0·6	0·5	7040
do. mixture of pea and buckwheat No. 1	73·3	12·6	14·1	0·6	—	7270
do. coal dust briquettes	68·6	17·1	14·3	0·6	0·9	7280

British Columbia

The coal fields of British Columbia fall into three groups, viz., the Rocky Mountain fields in the east, a central group including the Princeton, Nicola, and Telkwa Valley fields, and the Vancouver and Queen Charlotte Islands fields in the west.

The Crowsnest Pass coal field is situated immediately to the west of the summit of the Rocky Mountains, in Crowsnest Pass, a small portion crossing the watershed into the province of Alberta. The Crowsnest branch of the Canadian Pacific Railway crosses the northern part of the field and skirts its western edge for a distance of 25 miles, and the district is also served by the Great Northern Railway. The

field has the form of a flat-bottomed basin of Cretaceous rocks resting on limestones of Devono-Carboniferous age. The Crowsnest Coal Measures, which belong to the Kootanie series, have a thickness of 1,850 ft. near Morrissey, and contain 198 ft. of coal, of which at least one-half is workable. The opening of this coal field has been of the greatest importance to the smelters of southern British Columbia, and has reduced the cost of fuel to about one-half. At Coal Creek, 5 miles from Fernie, the seams are worked by tunnels driven on either side of the valley. Besides being used on the railways and for domestic purposes in British Columbia, Alberta, and Washington, the coal is largely converted into coke for metallurgical use. For this purpose 454 beehive coke ovens are at work, with a capacity of 643 tons per day. At the Michel colliery, 24 miles north of Fernie, the coke oven plant consists of 486 beehive ovens, with a capacity of 688 tons of coke per day. The Hosmer mines, 8 miles north of Fernie, are worked by tunnels which cut thirteen seams, from 4 to 30 ft. thick. The coke oven plant can produce 300 tons per day. The Corbin Colliery, near the centre of the field, works one seam which is 40 ft. thick in places and dips at 70° to the east.

Immediately to the north of the Crowsnest Pass basin, but separated from it by a belt of the underlying limestones, there is another trough of coal-bearing Cretaceous rocks. This extends northward along the Elk river for some 50 miles, to the Kananaskis Pass. At one point twelve seams were observed, from 8 in. to 35 ft. in thickness, and a railway running northward from Michel would enable large deposits of coal to be exploited. An average of eight analyses of coal samples from Aldridge creek, a tributary of Elk river, shows 67·3 per cent. fixed carbon, 25·6 per cent. volatile combustible matter, and 7·2 per cent. ash.

The Princeton coal field is situated at the junction of the Tulameen and Similkameen rivers in southern British Columbia. Seams of high-grade lignite occur in sandstones and shales of Tertiary age. A bore hole at Princeton showed an 18-ft. seam 49 ft. below the surface, and seams

outcrop at various places on the banks of the rivers. A sample from the large seam at Princeton gave on analysis 41·67 per cent. fixed carbon, 37·58 per cent. volatile combustible matter, 4·58 per cent. ash, and 16·17 per cent. moisture.

There are a number of promising outcrops of bituminous coal in the hills on the southern bank of the Tulameen river between Granite creek and Otter Flat, about 12 miles west of Princeton. One of the seams produced excellent coke when tested in Belgian ovens. Samples from one of these seams gave the following range of results on analysis: Fixed carbon 54·0 to 51·9; volatile matter 33·7 to 32·1; ash 12·3 to 16·0; moisture 2·3 to 3·2 per cent.

The Nicola Valley coal field lies to the south of Nicola lake in the Kamloops district. The seams occur among greyish sandstones and shales of Tertiary age. Mines have been opened on various seams near Coutlee. The Diamond Vale seam, at the top of the series, is 4 ft. 6 in. thick, with a parting of about 12 in. The Rat Hole seam is 6 ft. thick, the Gem seam 3 ft., the Major seam 17 ft. 6 in., the Ells seam 9 ft., and the Jewel seam is in two benches of 9 ft. and 5 ft. 6 in., with a parting of 2 ft. 6 in.

The Telkwa Valley Coal Field.—Further north, in the Skeena river country, the Telkwa Valley coal field will probably soon become important on the construction of the projected line of the Grand Trunk Pacific Railway. The rocks of this district are, in ascending order, (1) the crystalline rocks of the Coast range, (2) a great thickness of volcanic rocks, (3) the coal-bearing beds, chiefly shales, (4) a series of newer eruptive rocks. There is some evidence that the coal-bearing series is of Lower Cretaceous age. Owing to the soft and easily eroded nature of these beds, and the considerable folding and faulting they have undergone, their outcrop is confined to a few isolated patches. In places four seams have been uncovered, from 4 to 7 ft. in thickness, contained in a few hundred feet of measures. The character of the coal varies from bituminous to semi-anthracitic, analyses showing the following range of composition: Fixed carbon 56·90 to 82·70; volatile combustible matter 30·45 to 10·80; ash 5·90 to 9·20; moisture 0·58 to 6·60 per cent.

Vancouver Island.—Here coal-bearing Cretaceous beds outcrop in a long, narrow strip occupying most of the southern half of the east coast. On the west they abut against the old crystalline rocks, and on the east they dip beneath the Strait of Georgia. A break some 12 miles long at Nanoose Bay divides the strip into two portions, the Nanaimo field in the south and the Comox field in the north. A third area is the Suquash field near Alert Bay, 125 miles north of Comox.

Near Nanaimo the seams worked are the Douglas, 7 to 10 ft., the Newcastle, 2½ to 8 ft., and the Wellington seam, 4 to 14 ft. thick. The general dip is about 10°.

In the Comox field four mines are situated near the town of Cumberland, 13 miles from the shipping wharves at Union Bay. The seams vary from 3 to 8 ft. in thickness. A coal-washing plant is installed, and also a battery of 100 beehive coke ovens.

The Suquash field is not at present producing, but borings have proved a very constant 5-ft. seam at 172 ft. from the surface, with two other seams at about 900 ft. A shaft has been sunk to the first seam and a slope driven under the sea following the dip.

Queen Charlotte Islands.—The most important coal-bearing area known in these islands is found in a development of Cretaceous rocks on Graham Island, the most northerly of the group. Here coal outcrops occur at several places between Skidegate channel and Yakoun lake. At Camp Wilson the seam measures 17 ft. 6 in., with a parting of 6 in. to 1 ft. of sandstone, and dips at 75° to the north-east. Nine miles to the south, at Camp Robertson, there appear to be two seams, the upper containing 6 ft. 3 in. of coal and the lower about 8 ft., with shale partings in each case. The outcrop at Camp Anthracite appears to be on the same line of strike as the Camp Robertson seam, at about 1 mile to the south-east of it. The shale and coal are much broken, and the latter is of poor quality. The coals of Graham Island vary much in character, the fixed carbon ranging from 46·01 to 80·07 per cent.; but the percentage of ash is high, as in most of the Pacific coast coals.

Coals and Lignites of British Columbia

	Fixed carbon.	Volatile matter	Ash.	Sulphur.	Moisture.	Calorific value.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Small Calories.*
Crowsnest coal field.						
No. 3 Mine, Michel Colliery	62·7	24·8	12·5	0·5	0·4	7370
do. do. washed coal	68·6	25·2	6·2	0·5	—	7950
No. 7 Mine, do.	65·5	22·6	11·9	0·4	0·7	7420
No. 8 Mine, do.	65·7	24·1	10·2	0·6	1·1	7490
No. 2 seam south, Hosmer Mines	63·4	21·3	15·3	0·3	0·9	7060
No. 6 seam south, do.	62·0	25·6	12·4	0·6	1·1	7270
No. 8 seam south, do.	64·5	28·0	7·5	0·6	1·3	7770
No. 2 Mine, Coal Creek Colliery, Fernie	64·7	26·3	9·0	0·5	1·3	7680
No. 5 Mine, do. do.	65·2	24·0	10·8	0·5	0·5	7490
Nicola Valley coal field						
Jewel seam, Middlesboro Colliery, Coutlee	46·4	39·1	14·5	0·9	3·9	6490
Rat Hole seam, do. do.	48·1	39·0	12·9	0·7	2·3	6760
Mixture of the last two, washed coal	50·2	39·8	10·0	0·9	—	7010
Nanaimo coal field, Vancouver Island						
Wellington seam, Extension Mine	49·8	40·1	10·1	0·4	1·1	7310
Upper seam, No. 1 Mine, Nanaimo	48·5	41·2	10·3	0·9	1·6	7130
Lower seam, do. do.	46·6	41·5	11·9	1·3	1·9	6930
Comox coal field, Vancouver Island.						
Lower seam, No. 4 Mine, Cumberland	56·5	31·6	11·9	1·0	—	7150
do. No. 7 Mine, do.	60·1	28·0	11·9	0·9	—	7210
Mixture of the last two, washed coal	60·3	30·8	8·9	0·8	—	7550
Suquash coal field, Vancouver Island.						
Suquash Mine, Alert Bay,	42·7	34·3	23·0	1·0	7·0	6170[1]
do. do. washed coal	48·2	36·7	15·1	0·9	5·3	6420[1]

[1] *Determinations made with Parr calorimeter. These two samples were taken during development work and showed signs of surface weathering.*

Yukon Territory

Coal and lignite occur extensively in Yukon Territory. Three of the most important localities are the Whitehorse, Tantalus, and Rock Creek coal areas. In the first two the coal measures occur mainly in the Tantalus Conglomerate and to a less extent in the upper part of the underlying Laberge series, and are of Jura-Cretaceous age. In the more northerly Rock Creek area the coals are all lignites, and occur in beds of Tertiary age.

The Whitehorse coal area is situated about 12 miles to the south-west of Dugdale, a siding on the White Pass and Yukon Railway. Three seams outcrop at the head of Coal creek, measuring 9 ft. 8 in., 10 ft. 4 in., and 2 ft. 6 in. in thickness. The coal is anthracitic. A sample from the first seam, taken at 60 ft. from the outcrop, gave the following percentage results on analysis: Fixed carbon 69·86, volatile combustible matter 6·01, water 2·15, ash 21·98.

Tantalus is situated on the Lewes river, 105 miles from Whitehorse, in a direction slightly west of north. The

coal area extends along the Lewes and Nordenskiöld rivers, with a detached portion farther south known as the Braeburn-Kynocks coal area. The latter lies due west of the northern end of Lake Laberge. The upper coal horizon occurs near the top of the Tantalus Conglomerate, and includes the seams at the Tantalus mine and at Tantalus butte. These seams contain plant remains of Kootanie type. At the Five Fingers mine and in the Braeburn-Kynocks area the seams occur in the lower coal horizon, the upper part of the Laberge series. The coals range from high-grade lignites to coking bituminous coals; they are used principally by the river steamboats, but they yield a good coke in the laboratory and will probably be used for smelting when the copper deposits of Whitehorse and the minerals of other parts of the Yukon become further developed. At the Tantalus mine the upper seam is 3 ft., the middle 6 ft. 6 in., and the lower 7 ft. 6 in. thick. Thin shale partings occur, and the percentage of ash is high. The quality of the output could be improved by sorting, but the cost of labour is prohibitive. At Tantalus butte, on the opposite bank of the river, the best seam contains 5 ft. of good coal, which gave the following percentage results on analysis: Fixed carbon 53·51, volatile combustible matter 32·28, water 9·48, ash 4·73. The Five Fingers mine is on the right bank of the Lewes river, about 16 miles below Tantalus. The seams vary in thickness and dip at 16° to the east. One seam gives 22 in. of coal of the following percentage composition: Fixed carbon 45·16, volatile combustible matter 40·46, water 5·95, ash 8·43. In the Braeburn-Kynocks area several seams of high-grade lignite occur. A surface-sample from an 8-ft. seam contained: Fixed carbon 42·56, volatile combustible matter 34·28, water 12·02, ash 11·14 per cent.

The lignite-bearing Tertiary beds of the Rock Creek area form a strip some 70 miles long between the Ogilvie range and the Klondike and Yukon rivers. At the southern end of the area coal seams outcrop on Coal creek, a tributary of Rock creek, which flows into the Klondike some 12 miles from Dawson. Two seams, 3 ft. and 2 ft. 3 in. thick, were at one time mined for use in Dawson. The

upper seam has the following percentage composition: Fixed carbon 40·88, volatile combustible matter 34·96, water 18·31, ash 5·85. A second Coal creek flows into the Yukon river 50 miles below Dawson. Several seams, from 4 to 20 ft. in thickness, are mined at a point 12 miles from the mouth of the creek, and it is proposed to erect a plant near the mine to supply electrical power to Dawson. At Cliff creek, which enters the Yukon 55 miles below Dawson, a seam was formerly mined which contained 11 ft. of lignite with several clay partings. Lignite from the upper part of the seam gave the following results on analysis: Fixed carbon 45·77, volatile combustible matter 42·02, water 8·57, ash 3·62 per cent. Other coal outcrops in this area are known at Twelvemile creek, Fifteenmile creek, and elsewhere.

Coals of the Yukon Territory

	Fixed carbon.	Volatile matter.	Ash.	Sulphur.	Moisture.	Calorific value.
Tantalus coal field.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Small calories.*
Upper seam, Tantalus Mine . . .	58·0	25·0	17·0	0·5	—	6700
Do., do., washed coal	59·9	26·3	13·8	0·5	—	7110
Middle seam, Tantalus Mine . .	54·1	26·7	19·2	0·5	—	6310
Do., do., washed coal	60·3	25·7	14·0	0·4	—	7070
Lower seam, Tantalus Mine . . .	56·0	27·8	16·2	0·5	—	6790
Do., do., washed coal	59·2	28·1	12·7	0·5	—	7210

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GENERAL NOTES

Cotton Protection Ordinance in Nyasaland.—Great efforts are being made in Nyasaland to protect the agricultural industries from the introduction of plant pests from other countries, and an account of the rules made under the Plants Protection Ordinance was given in this BULLETIN (1913, **11**, 334). There is also a separate Cotton Ordinance, enacted in 1910 (cf. this BULLETIN, 1910, **8**, 431), and a set of rules made under this was published in the *Nyasaland Gazette* of January 31, 1913. These rules are designed to aid in combating pests by enforcing the burning of old bushes, and by bringing the seed sown under control, to maintain the quality and characteristics of Nyasaland cotton, and thus enhance the good reputation which the product has already acquired in the market.

They are to the following effect: All cotton bushes are to be uprooted and burnt before the last day of October following the date of planting, except in the Lower Shire, Ruo, and West Shire Districts, where they must be burnt before the last day of December. If this is not done the landowner and the persons who planted the bushes are liable to penalties, and the bushes may be uprooted and burnt at their expense. All cotton grown by natives upon Crown lands from seed issued by the Government is to be ginned in the Protectorate, and the Government has a right to the seed obtained from it on ginning. Such seed may only be sold or disposed of, if the Government does not need it. No cotton seed is to be issued to natives until it has been approved by the Director of Agriculture. Only persons authorised by the Governor are to distribute seed to natives for cultivation on Crown lands, and only persons who have obtained licences are allowed to purchase cotton grown by natives from seed distributed for cultivation on Crown lands. These licences are obtainable from the district residents for a fee, and are only valid till the following 31st of March, and for the place stated in the licence. Cotton markets are to be established by Government in native cotton-growing districts, and certain market-tolls are to be paid by the purchasers. The licensees are to make monthly returns showing the weight and price of the native-grown cotton from Crown lands that they have purchased, and are to allow the cotton to be inspected and to give information about its origin when required.

Cotton Growing in French Colonies.—The efforts which have been made during recent years to develop a cotton growing industry in the French Colonies have been referred to in several previous issues of this BULLETIN (1904, **2**, 122; 1908, **6**, 288; 1910, **8**, 61; 1912, **10**, 657). At the annual meeting of

the Colonial Cotton Association in March 1913, a report was made of the progress effected during 1912, and this has been published in the *Bulletin de l'Association Cotonnière Coloniale* (1913, **11**, No. 56).

An endeavour is being made to determine the possibilities of cotton production in the Morocco Protectorate, with the hope of enabling an industry to be established which would be of direct benefit to the natives.

The climatic conditions in Algeria in 1912 were unfavourable. In the East, protracted droughts occurred, whilst on the Oran side of the country the ripening of the cotton was affected by insufficient heat in the summer, and by the intervention of rain just at the time of gathering the crop.

In Tunis, efforts to produce a sufficient quantity of selected seed for distribution to growers were continued, and in spite of unfavourable weather, about 5,500 lb. of seed were obtained and placed at the disposal of the planters for the following season.

In Dahomey, experiments are being made to ascertain the yields obtainable from cotton grown on different kinds of soil, and to determine the behaviour of different varieties from the point of view of their suitability for cultivation and the value of their produce. It is anticipated that the projected extension of the railway systems in West Africa will give a considerable impetus to cotton production in Dahomey, especially in the densely populated regions of Jugu and Paraku.

Steady progress is being made in the French Sudan, and it is anticipated that the output in 1912–13 will reach 100 tons. The difficulty of transport is a great obstacle to the industry, but it is expected that when the railway has been constructed from Thies to Kayes the economic conditions of the country will undergo a complete transformation. Trials have been made in Senegal and the French Sudan in growing cotton under irrigation, and have met with considerable success.

The Governor of the Ivory Coast is convinced that cotton will become one of the most important resources of the natives of that country and will lead to a considerable increase in the export trade. A ginning factory has been erected at Bwake, and a study has been made of the local varieties of cotton.

The Association has also installed ginning machinery in New Caledonia and the New Hebrides. The cotton which is being produced is of very satisfactory quality, and spinners have expressed their readiness to purchase it at a price approximating to that of "good fair" rough Peruvian.

The total quantity of cotton produced in 1912, under

the auspices of the Colonial Cotton Association, amounted to 608·5 metric tons as compared with 460·8 metric tons in 1911. The amounts furnished by the different Colonies were as follows:

	1911. *Metric tons.*	1912. *Metric tons.*
Senegal	15	20
Upper Senegal and Niger region	60	100
Dahomey	135	125
New Caledonia	76	165
Madagascar	2·8	3·5
Tahiti	7	15
Algeria	165	180
	460·8	608·5

Balanites spp. from Portuguese East Africa.—In a recent number of this BULLETIN (1912, **10**, 548) an account was given of the fruits and oil of a new species of Balanites found in the Lebombo Mountains and on the banks of the Umbeluzi river in Portuguese East Africa. Herbarium specimens of the tree yielding these fruits have been examined at the Royal Botanic Gardens, Kew, and a description of the tree, under the name *Balanites Maughamii*, Sprague, appears in *Kew Bulletin* (1913, p. 131), together with that of a second new species, *B. Dawei*, Sprague, also from Portuguese East Africa. In addition to the localities mentioned above, *B. Maughamii* has been found in the Madenda Forest, where it is known by the native name "Manduro." Specimens have also been collected from near the Rovuma river. The tree reaches a height of 50 ft., and possesses an irregularly shaped bole up to $1\frac{2}{3}$ ft. in diameter. The short, flower-bearing shoots are spineless, or almost so, but long, barren shoots, bearing forked spines up to $2\frac{3}{4}$ in. in length, also occur. The latter character serves to distinguish the tree from all other species of Balanites, except *B. Wilsoniana*, which possesses, however, much larger, ellipsoidal fruits, $4\frac{1}{2}$ in. long and 3 in. in diameter, as compared with $1\frac{1}{2}$ to $1\frac{3}{4}$ in. long, and 1 in. or rather more in diameter, in the case of *B. Maughamii*. *B. Dawei* also possesses two kinds of shoots, but spines are absent; the fruit of this species is sub-cylindrical in shape, and $2\frac{1}{2}$ to 3 in. long. As was pointed out in this BULLETIN (*loc. cit.*), the difficulty and expense of removing the sugary pulp from the fruit, cracking the shells, and removing the kernels, would prevent the industrial utilisation of the fruits of *B. Maughamii*, and the same remarks no doubt apply also to those of *B. Dawei*.

Mineral Survey of Mozambique.—In 1911 a mineral survey of the territory of the Mozambique Company in Portuguese East Africa was established in connection with the Imperial Institute. The principal purpose of the Survey is to make

a comprehensive general exploration and examination of the mineral resources of the territory, in order to facilitate the detailed exploration of promising areas by private enterprise, with a view to the commercial development of such areas. The work of the Survey is naturally only in the initial stage, and it is not yet possible to make a complete report on the mineral resources of the country. The main features of the work accomplished in the first two seasons has, however, been made known by the publication of a Mineral Survey map, accompanied by a brief explanatory account of the country so far examined, together with a series of photographs and a small-scale map of the whole of the Mozambique Company's territory. The Mineral Survey map is on a scale of about 14 miles to the inch, and embraces a strip of country along the western boundary between the Morungueze river and Macequece. The chief geological features are indicated, as well as the localities where gold, coal, tin, graphite, and monazite have been observed. It is pointed out, however, that the indications as to the occurrence of particular minerals given on the map are not to be taken as meaning that these minerals occur in payable quality or quantity; their occurrence is only recorded as a guide for detailed exploration. Gold has been found to be widely distributed in small quantities in many of the streams, the best prospects being obtained along the Little Musapa river, a tributary of the Lucite river. Coal was found in the Mamoice district, but boring is necessary to determine whether payable coal occurs. Monazite occurs in small quantities in some of the stream beds, but tin ore has not been found so far in any quantity. Highly graphitic schist was found in the Mpunga and Mutanda districts, but no solid veins of graphite have yet been met with.

Copies of the Mineral Survey Map can be obtained without charge on application to the offices of the Mozambique Company at Thames House, Queen Street Place, London, E.C.

Oil Possibilities in South Australia.—It has been repeatedly rumoured that there are indications of the occurrence of petroleum deposits in Kangaroo Island and the western coast of Eyre's Peninsula in South Australia. These rumours have been based on the discovery from time to time of lumps of asphalt on the beaches in this region. The persistence of these rumours, and the recent developments in the uses of petroleum, have roused considerable public interest in South Australia, and the Government Geologist has recently visited the region for the purpose of making a rapid geological examination of those portions of it where discoveries of asphalt have been made.

The results of his investigation have been published as *Bulletin* No. 2, 1913, *Geol. Surv., South Australia.* He reports

that in both districts there is a fundamental and folded complex of ancient rocks, over a large part of which there is spread a thin mantle of sediments, probably of recent age. The sediments lie in approximately horizontal beds, and consist chiefly of loosely aggregated calcareous sand, with some marly beds. An examination of numerous sections showed that there are no continuous argillaceous beds.

No trace of any rock impregnated with bitumen was found, and in no case has any of the reported discoveries of veins of asphalt *in situ* been confirmed by a competent authority. "Fœtid limestones" occur on the shore of Murray's Lagoon, but their odour was found to be due to sulphuretted hydrogen, and they contained no trace of petroleum or petroleum derivatives. Moreover, the geological structure is not favourable for the accumulation of oil.

The Government Geologist is of opinion that the substance coorongite (elaterite or mineral caoutchouc), which has been found in appreciable quantities on the western shore of Murray's Lagoon in Kangaroo Island, is indigenous to the Island, but that it is not a petroleum product. Similar material is found on the mainland at localities where prospecting operations for oil have had negative results.

As regards the blocks of black bitumen or asphalt found on the beaches, there appears to be no doubt that these are petroleum products; but with reference to their place of origin the Government Geologist agrees with his predecessor that they are erratics, and that they have been drifted on to the beaches by ocean currents from some unknown source. Such occurrences have been reported from other parts of the south coast, and one has been found as far west as Bunbury in Western Australia. On some portions of the coast blocks of "kerosene shale" have been found, identical in appearance with that occurring in New South Wales. It is supposed that these also have been drifted on to the coast by ocean currents, after having been dropped in the sea by passing steamers.

The Government Geologist concludes that the various discoveries hitherto made are of no economic significance, and that they give no indication of the existence of oil-bearing deposits on either Kangaroo Island or Eyre's Peninsula.

Mineral Production of Quebec.—According to the *Report on Mining Operations in the Province of Quebec during the year* 1911, the total value of the mineral output for that year was $8,679,786, an increase of $1,356,505 as compared with the output of the previous year. The output during the period from 1899, when it had a value of only $2,083,272, to 1911, shows an almost unbroken record of yearly increases,

which gives indication that the mining industry is built on a well-established basis, and gives promise of a steady future increase.

The chief item in the output was asbestos, the shipments of which reached a total of 102,224 tons, valued at $3,026,306, compared with 80,605 tons, valued at $2,667,829, in 1910. Though the shipments for 1911 were higher than those for 1910, the total quantity of rock mined was less, being 1,759,064 tons in 1911, as compared with 2,035,705 in 1910, the excess in shipments having been drawn from stock in hand. The centres of asbestos mining are Thetford mines, Black Lake, Danville, and East Broughton, all in the Eastern Townships. The growth of the asbestos output in Quebec may be judged from the fact that it was only 21,408 tons, valued at $719,416 in 1900, since when there has been a continuous increase.

A further increase took place in the output of pyritous copper ore, the amount shipped being 38,554 tons, valued at $240,097, the highest recorded since 1899. Almost the whole of this output is derived from the Eustis mine at Eustis and the McDonald mine at Weedon (see this BULLETIN, 1913, **11**, 365).

Among other minerals there were increases in the output of gold and silver, mica, phosphate, graphite (see p. 536), titaniferous ores, magnesite, granite, limestone, and sand. There were decreases in the output of iron ores and ochres, chromite, slates, cement materials, marble, and quartz.

The Report on mining operations for 1911 includes four special features, viz.: (1) a report on Montreal Quarries; (2) a preliminary report on some titaniferous iron ore deposits on the north shore of the river and gulf of St. Lawrence; (3) a report on the magnetic sands of the north shore of the gulf of St. Lawrence; (4) a report on the geology and mineral resources of the Keekeek and Kewagama Lakes region.

Dredging in the Sudan.—An interesting series of photographs illustrating the dredging plant employed by the Sudan Irrigation Service in dredging and confining the Upper Nile has been received at the Imperial Institute from the Secretary of the Central Economic Board, Khartoum. The plant has been designed by Mr. A. W. Robinson, M.I.C.E., of Montreal, to meet the special requirements of the region, and forms the first experimental unit of the Sudan dredging fleet. It consists of a six cubic yard grab dredge, manufactured by Messrs. Simon and Company, of Renfrew; a seven cubic yard dipper dredge, by the Atlantic Equipment Company, of New York; a 24-in. hydraulic dredge, by Messrs. Lobnitz and Company, of Renfrew; one tow-boat, by Messrs. James Rees and Sons, of Pittsburg, for coal transport; and six

coal barges. The first two dredges are used for the removal of sudd and similar material; and the other for mud and silt. The fleet is the property of the Egyptian Government and was erected in Khartoum by the Sudan Government Steamers Department.

Since the commencement of dredging operations in 1909 much useful work has been accomplished in deepening the Bahr-el-Zeraf to allow free navigation throughout the year; in excavating a channel which gives that river perennial communication with the Bahr-el-Gebel; and in modelling and re-banking both these rivers.

Photographs of this equipment which were taken by Mr. Robinson are now exhibited in the Sudan Court of the Exhibition Galleries of the Imperial Institute, and comprise the following views:

Dipper Dredge.—1. "View showing the dredge excavating a new channel through the papyrus swamp and depositing the spoil in a continuous bank. The average output is about 200 cubic yards per dredging hour."

2. "View showing the loaded bucket, dipper arm and end of boom, ready for swinging and dumping the spoil."

3. "View showing a very full bucket in position for pulling the trigger and dumping the spoil."

4. "View showing a new channel, 25 yards wide and 12 ft. deep, excavated through the swamp from the Bahr-el-Gebel to the Bahr-el-Zeraf—the spoil being deposited so as to form two continuous banks."

Hydraulic Dredge.—5. "Front view showing the dredge, floating pipe, and terminal pontoon in working position."

6. "Rear view showing the dredge excavating from the bed of Bahr-el-Zeraf and depositing the spoil on the banks."

7. "View of the specially designed pontoon, showing how the spoil is passed to the suspended discharge pipe through the floating pipe."

8. "View showing the end of the suspended discharge pipe, with spoil emerging. The output of solid material when working in soft mud has reached 1,000 cubic yards per dredging hour."

Grab Dredge.—9. "View showing the dredge widening the channel of the Bahr-el-Gebel by excavating the papyrus with a specially designed bucket."

10. "View showing the specially designed bucket excavating papyrus and vegetation."

11. "View showing the bucket open, as dropped on to the papyrus, and ready for closing and lifting."

Tow-boat.—12. "View showing the tow-boat 'Egypt' transporting a load of 2,000 tons of coal and other cargo from Khartoum to the swamp region for the dredging fleet."

RECENT PROGRESS IN AGRICULTURE AND THE DEVELOPMENT OF NATURAL RESOURCES

In this section of the BULLETIN *a summary is given of the contents of the more important papers and reports published during the preceding quarter, in so far as these relate to tropical agriculture and the utilisation of the natural resources of the Colonies, India, and the Tropics generally.*

AGRICULTURE

Soils.—The nitrogenous constituents of soils and their bearing on soil fertility is the subject of *Bulletin* No. 87, 1912, *Bur. Soils, U.S. Dept. Agric.* Previous investigations have shown that numerous nitrogenous organic compounds occur in soils, and the work now recorded concerns their effect on wheat seedlings. It is shown that nucleic acid, hypoxanthine, xanthine, guanine, creatinine, histidine, arginine, and choline are beneficial to plant growth and that the addition of any one of these substances to culture solutions containing only phosphoric acid and potash, greatly increases growth. It is suggested that these compounds are used directly in building up proteins, as no evidence of the formation of ammonia, nitrates, or nitrites was found ; they also appear to be able to replace nitrate as a nitrogenous plant food.

Certain nitrogenous compounds were found to have a harmful effect on plant growth. Amongst these guanidine is of interest as it produces effects similar to those caused by certain plant diseases, such as bleached spots on the leaves, which finally spread and give rise to wilting. These effects are accentuated by the presence of nitrates. In an appendix a useful table is given showing the recorded effects of numerous organic compounds on plants and their mode of occurrence in nature.

The changes which occur in certain of the organic constituents when soils are steam-heated are discussed in *Bulletin* No. 89, 1912, *Bur. Soils, U.S. Dept. Agric.* A number of samples of two types of loam were heated for three hours by steam at 30 lb. pressure at a temperature of 135° C. They were then treated with a 2 per cent. solution of caustic potash for seven hours, and the solution thus obtained was examined by methods detailed in the paper. The general effect of the heating was to increase the acidity of the soil and the proportion of soluble constituents. It also caused the formation of certain decomposition products of nucleic acid and protein material, such as xanthine, hypoxanthine, guanine, cytosine, and arginine, which are beneficial to plant growth (*see above*). In some of the samples, the harmful dihydroxystearic acid was present after heating, although it could not be detected before this treatment. It is thus evident that steam-heating produces

compounds both beneficial and harmful to plant growth, and the good effects of heating can only be seen when the harmful products have been reduced in quantity or eliminated. In the case of dihydroxystearic acid this result can be attained in several ways, such as by adding lime nitrates, etc., to the soil. Cultural experiments showed that a heated soil gave a poorer crop than one untreated, unless some such method of treatment was adopted. An interesting point in connection with this investigation was the recognition, for the first time, of guanine as a soil constituent.

The nature of the carbonaceous material found in soils is dealt with in *Bulletin* No. 90, 1912, *Bur. Soils, U.S. Dept. Agric.* The carbonaceous matter was separated from large samples of a number of soils and was found to consist of one or more of the following products: coal, lignite, charcoal, or plant and insect remains. The charcoal-like particles are probably not due entirely to the action of fires, as they were found in some cases at depths of 15 to 50 ft. The influence of these various forms of carbonaceous matter on the accuracy of the methods usually employed for the determination of organic matter in soils is also discussed.

An account of the soils occurring in the neighbourhood of Kopjes, Orange Free State, is given in *Agric. Journ. Union of S. Africa* (1913, **5**, 545). The object of the investigation was to ascertain the nature and extent of the alkali salts ("brack") present in the soil in the neighbourhood of the proposed irrigation works, so as to form some idea of the effect that irrigation will have on the fertility of the soil. Nine boreholes were sunk and samples of soil, taken at depths of 1, 2, 3, and 4 ft., were chemically examined. The salts present in largest quantity were found to be sodium sulphate and chloride, whilst the more dangerous sodium carbonate was absent in many cases. The results of the investigation indicate that it will be necessary to drain part of the area examined in order to avoid an increase in the quantity of salts present in the top soil and the consequent loss of fertility. Most of the soils contain satisfactory quantities of nitrogen, lime, and potash, but are deficient in phosphoric acid. The physical condition of many of the soils is stated to be far from satisfactory, many of them caking badly on drying.

Manures.—By a resolution of the German Imperial Parliament, adopted in 1911, part of the funds voted for the furtherance of the German potash industry are to be devoted to manurial experiments in German Colonies. A preliminary report on the experiments carried out in German East Africa during 1911–12 is given in *Düngungversuche in den Deutschen Kolonien* (German Imperial Colonial Office, Berlin, 1913). It is pointed out that the soils

as a whole are not very rich in plant food and cannot be cultivated profitably for a long period without the addition of manure. The results of experiments on rubber, coffee, cocoa, coconuts, Sisal hemp, cotton, maize, cereals, and vegetables are recorded, but owing to the short period which the records cover, the results are not regarded as conclusive.

Foodstuffs

Wheat.—The *Agric. Journ. Union of South Africa* (1913, **5**, 565) contains an account of variety trials with wheat grown as a winter crop under irrigation. Of the varieties tried "Egyptian Red" gave the best yields, its average for six years being 1864 lb. per acre. Although more rust-resistant than most varieties, this wheat yields grain of very poor quality. The third wheat in point of yield, an early, beardless, white, Australian kind, produced the best flour. This wheat, as well as "Glujas Early" and "Potchefstroom White," are recommended for the production of meal for household purposes in South Africa.

It was found that wheat grown on land which had borne legumes in the previous season produced a larger yield than when it followed maize, tobacco, sunflowers, or linseed.

Further details regarding "Marquis" and "Prelude" wheats are contained in the *Rep. Exper. Farms, Ottawa*, 1911–1912, p. 117. The previous records for "Marquis" were surpassed last season at Rosthern, where 70 bushels per acre were harvested. During trials extending over four years at Brandon, "Marquis" yielded 10 per cent. more crop than "Red Fife," and at Indian Head, 50 per cent. more. "Early Red Fife" resembles "Marquis" in many respects, and has an equally good record, but is more subject to rust. "Prelude," a very early variety, at Indian Head last year required 113 days to mature, as compared with 131 days in the case of "Marquis," and 138 days in the case of "Red Fife." "Prelude" was cut on August 10, and yielded 38 bushels per acre. During the two years in which it has been grown at Ottawa, it has ripened in 92 and 82 days respectively, and yielded on an average 31¼ bushels per acre.

Oils and Oil Seeds

Coconuts.—The exports of coconut products from Ceylon in 1912 were smaller than in 1911 and 1910 (*Trop. Agriculturist*, 1913, **40**, 186). This may be accounted for partly by increased local consumption and partly by reduced crop as a result of drought, but the many young plantations coming into bearing should compensate for this. It is considered that the smaller exports are also in part due to the unpro-

ductiveness of the older plantations, and the necessity for improved cultivation is strongly urged. In connection with this question it is interesting to note that exhaustive experiments on the cultivation and manuring of coconuts have been commenced at Peradeniya (*Bulletin* No. 2, *Ceylon Dept. Agric.* 1912). Among the questions which are being investigated are (1) whether old trees (about fifty years) respond to cultivation and manuring; (2) the best form of cultivation; (3) the effect of different manures; (4) the effect of green manures and mulching. Records of the cost of cultivation and manuring and of the value of the crops produced, etc., are also being kept.

The area under coconuts in British Guiana is increasing (*Rept. Dept. Sci. and Agric. Brit. Guiana*, 1911–12, p. 7), there being 12,236 acres under this crop at the end of 1911. The spacing of the trees is good on some of the newer plantations. Diseases are prevalent on the neglected plantations and many trees die from want of drainage. Legislation will be necessary unless planters pay more attention to cultivation and the control of pests and diseases. Trees grown from Tobago nuts are not so promising as those from local nuts, which are presumably better suited to the local soil and climate.

About 200 acres of land are under coconuts in Antigua, but the plantations are comparatively recent and only sufficiently advanced to show that the cultivation is likely to be fairly successful (*Rept. Bot. Stations and Expt. Plots Antigua*, 1911–12, p. 27). Further areas are to be planted, and a trial is also to be made in Barbuda.

Ground Nuts.—The output of ground nuts in the Kano district of Northern Nigeria has increased considerably. According to Lamb (*Nigerian Customs and Trade Journ.* 1913, **3**, 317), the sandy plains of Bida and Kano form an ideal soil for the cultivation of ground nuts, and yields of over 1 ton per acre of freshly harvested nuts have been obtained. This corresponds to at least 1,400 lb. of dried kernels, which sell at Kano for $\frac{5}{8}d.$ per lb., thus realising about £3 13*s.* per acre. This is considered a good return by the producers, and an increased output is anticipated in the present season. If prices were somewhat higher and facilities for marketing the nuts better, larger quantities would be produced in the Nupe district. The establishment of depots for buying the nuts is suggested, while it is stated that the erection of machinery for decorticating nuts would be advantageous in certain districts and should also prove remunerative. The trading firms refuse to buy the unshelled nuts, and the labour of shelling by hand is very considerable; one woman can only deal with about 7 lb. of unshelled nuts per hour, i.e., assuming that the nuts consist of 66 per cent. of dry

kernels and 34 per cent. of shells, 320 hours would be required to shell 1 ton of nuts.

The unshelled nuts can be obtained from the natives at a much lower price than the kernels, and, in spite of the greater cost of transport, it is considered that the export of unshelled nuts is worth consideration. A superior variety producing large nuts is grown near Pategi; a sample of this variety was examined recently at the Imperial Institute and was valued at £19 per ton.

Linseed.—Since the successful experiments carried out at the Kakamega Roman Catholic Mission, British East Africa, linseed cultivation has been taken up rapidly by the natives and promises to become thoroughly established throughout a large part of the Nyanza Province (*Rept. Dept. Agric. Brit. East Africa*, 1911–12, p. 100).

Oil Palm.—Although the quantities of palm oil exported from the ports of Lagos and Opobo are approximately equal, Opobo has for many years past exported very much smaller quantities of palm kernels than Lagos; thus, in 1911 17,552 tons of palm oil and 82,292 tons of kernels were exported from Lagos, while 17,604 tons of palm oil and only 18,645 tons of kernels were exported from Opobo (*Lagos Customs and Trade Journ.* 1913, **3**, 105). It is difficult to ascertain the reasons for such a remarkable difference, but it appears to be due to a variety of causes, among which may be mentioned the smaller home consumption of oil by natives in the Eastern Province, and also the fact that there are very few trading stations in the Opobo district, and consequently less inducement for the natives to produce commodities to exchange for cloth, etc., while the inclusion in the Lagos exports of quantities of kernels brought down from Ibadan and other stations by railway is also a factor. It is considered, however, that much greater quantities of kernels might be produced in those districts of the Eastern Province lying between the Niger and Cross rivers, and that a railway would do much to encourage this. Attempts are being made to introduce better methods of cracking palm nuts.

According to Bret (*Journ. d'Agric. Trop.*, 1913, **13**, 139), it is difficult to obtain regular supplies of palm fruits from existing oil palm areas in quantities sufficient to satisfy the needs of modern installations requiring such large quantities as 50 tons of palm fruits per day, on account of the fact that many of the trees are old and unproductive, and because their height renders the harvesting of the fruits difficult. The author considers that large installations will find it necessary to clear the areas considerably, and eventually to make use of the younger trees as they become available. Such methods of clearing have been

adopted near Bingerville, Ivory Coast, while young palm trees are being planted out at distances of about 30 ft. by 17 ft., and interplanted with cocoa. Young palms can be planted out up to the age of three or four years if this is done at the beginning of the wet season.

Large tracts of land covered with oil palms exist in Portuguese Guinea (*Board of Tr. Journ.*, 1913, **81**, 428), but are mostly unexplored or imperfectly explored at present Land can be granted on feu ("aforamento") by public auction in areas up to 25,000 hectares (61,750 acres), but applicants must be naturalised Portuguese citizens or have resided in Portuguese territory for over six months.

Sesamum Seed.—In experiments in the East Africa Protectorate a crop of 350 lb. per acre was obtained at a cost of Rs. 9·5. When the seed is sown in May heavier crops are obtained than when sown, according to native practice, in October (*Rept. Dept. Agric. Brit. East Africa*, 1911–12, p. 101). The industry has assumed large proportions and continues to extend among native cultivators. Sesamum is recommended as a catch crop on large plantations.

Soy Beans.—Further trials have been made during 1912 with soy beans in Egypt (*Agric. Journ. of Egypt*, 1913, **2**, 91). The seeds were sown on heavy black loam land on May 13, the land being watered a few days previous to sowing. The young plants were watered three weeks after sowing the seed, but did not receive water again until fifty-five days later. The crop showed no signs of suffering from lack of water. A part of the crop was cut on August 1 and used for fodder, the yield being nearly 6 tons per acre. It was found that cattle, sheep, and goats ate the fodder, but that donkeys and mules would not do so. The remainder of the crop was harvested on August 31, the following yields of dry seed in lb. per acre being obtained from the different varieties: Manchurian, 1,257; Medium Yellow, 1,596; Eltum, 1,061; Morse, 1,486. These results are better than those obtained in 1911, and may be due to the fact that the seed was sown six weeks earlier, or because the land had borne a crop of peas during the previous winter.

The cultivation of soy beans and the conditions of the industry in China are discussed in the *Bulletin de la Société Belge d'Études Coloniales* (1913 **20**, 367).

Miscellaneous.—Trees of *Calophyllum Inophyllum*, L., in German East Africa have fruited well, but there does not seem to be much demand for the seed in Germany (*Der Pflanzer*, 1912, **8**, 529).

The seeds of *Euphorbia gregaria*, Marloth, from German South West Africa, have been found to contain about 42 per cent. of oil (*Arbeit. Pharm. Inst. Berlin*, 1912, **9**, 227). No

information is given as to the possibility of obtaining commercial supplies of the seed.

Candle nut trees (*Aleurites triloba*) are plentiful in Hawaii (*Journ. Soc. Chem. Ind.* 1913, **32**, 496), there being some 15,000 acres covered with this tree, which, if the nuts were systematically harvested, should yield 2,375,000 gallons of oil annually.

Trees of *Rhus succedanea*, L., the seeds of which yield Japan wax, grown in German East Africa, produced seeds which would fetch fairly good prices in Germany (*Der Pflanzer*, 1912, **8**, 529).

Attempts have been made to grow candelilla plants at Amani, in German East Africa, but the climate appears to be too moist for them (*ibid.* p. 249).

Essential Oils

Oil of Artemisia vulgaris, L.—Messrs. Schimmel and Co. (*Schimmel's Report*, April 1913, p. 28) have examined a sample of oil distilled in Bengal from *A. vulgaris, L.*, which they received under the name of "Indian Wormwood Oil." The oil was yellow in colour, with a greenish fluorescence, and possessed a sage-like odour. It was found to have the following physical constants: Specific gravity at 15° C., 0·9219; optical rotation in 100 mm. tube, − 8° 52′; refraction at 20°, n_D 1·46201. *a*-Thujone was identified in the oil, and borneol also is believed to be present (see also p. 436).

Borneo Camphor Oil.—A detailed examination of a sample of the oil of *Dryobalanops aromatica*, Gärtn. (Borneo camphor), from Singapore has been carried out by Messrs. Schimmel and Co. (*Report*, April 1913, p. 32). The oil had specific gravity at 15°, 0·918, optical rotation in 100 mm. tube, + 11° 5′, and was found to consist of 35 per cent. of terpenes (*d*-*a*-pinene, *β*-pinene, camphene, and dipentene), 10 per cent. of alcohols (borneol and *a*-terpineol), 20 per cent. of sesquiterpenes, and 35 per cent. of resin.

Oil of "Wild" Cardamoms.—Messrs. Schimmel and Co. (*Report*, April 1913, p. 111) have distilled some "wild" cardamoms, originally derived from Indo-China, of which the parent plant was identified as *Amomum globosum*, Lour. A yield of 4 per cent. of oil of an odour recalling that of camphor oil was obtained. The constants of the oil are given, and are stated to be somewhat similar to those of the oil of "Ceylon cardamom seeds," although the two oils differ considerably in odour. A considerable proportion of camphor is believed to be present in the oil, but, owing to lack of material, this could not be definitely determined.

Rubber

Hevea brasiliensis.—In the *Agric. Bull. Fed. Malay States* (1913, **1**, 323) F. G. Spring gives some preliminary notes on tapping experiments at Kuala Lumpur. Six systems of tapping were tested:

(1) Quarter (half herring-bone), two cuts 18 in. apart, daily tapping. (2) Adjacent quarters (full herring-bone), two cuts 18 in. apart on each quarter, tapped on alternate days. (3) Single V, 36 in. from base of tree, tapped daily. (4) Double V, cuts 18 in. apart, tapped on alternate days. (5) Opposite quarters, one cut of 36 in. on each quarter. (6) Opposite quarters, two cuts 18 in. apart, tapped on alternate days.

In each plot tapping areas were so marked that the circumference of each tree is completely tapped in four years. The number of trees in each plot is sixty-five, and the distance of planting 16 ft. by 16 ft. A table of yields is given for the two years during which the experiments have been in progress. The results go to show that the V system of tapping gives the greatest yield of rubber, als that daily tapping gives a greater yield of rubber than tapping on alternate days for the same amount of bark removed.

The Spotting of Plantation Para Rubber is discussed by K. Bancroft in *Bulletin* No. 16, 1913, *Dept. Agric. Fed. Malay States*. According to the author neither smoked sheet-rubber nor crêpe artificially dried develops spots, but un-smoked sheet is liable to do so, and steamed crêpe is very susceptible to spotting. Spots appear during the process of drying, and may become visible at the end of a week or even earlier. The discoloration increases until the rubber is quite dry, when its development is arrested. In some cases the colour may fade, in others the colour remains even after eight or nine months. Microscopic examination of the residues of the spots after dissolving away the caoutchouc by means of benzene or xylene show structures resembling the hyphæ of fungi.

By transferring spotted rubber to cane juice agar the author isolated a fungus closely resembling in character *Monascus heterosporus*, Schröter. Its causal relation to the production of colour (pink) was established by inoculating fresh rubber with the fungus, and producing the pink colour; control samples of rubber not infected developed no coloration. Further, the author re-isolated the fungus with all its original characteristics from the artificially infected rubber. By the same method a new species of *Spondylocladium*—*S. maculans*—was isolated from a yellowish-red crêpe rubber.

In another experiment thin slices of a red-coloured rubber were transferred to cut surfaces of sterilised

potatoes. In about five or six days three of the surfaces showed a pink colour, and on examination a fungus was found of the form-genus, *Mycogone*.

From a dark blue spotting of crêpe rubber the author also isolated, by means of cane juice agar, a fungus indistinguishable from the "Diplodia" form of *Thyridaria tarda*, the fungus which causes the "die-back" disease of the stem of the Para rubber tree. Species of *Penicillium* and *Aspergillus* were also found.

A micro-organism having all the characteristics of *Bacillus prodigiosus* was isolated from some red discolorations by means of nutrient bouillon and agar-agar. In other samples of spotted rubber a species of *Sterigmatocystis* and a red yeast (unidentified) were also found.

All these organisms occur widely distributed. The Diplodia-form occurs in the Federated Malay States on any recently dead vegetable matter. The author isolated *Monascus heterosporus* and *Spondylocladium maculans* from poles of uncured jungle wood used for hanging rubber in the drying-houses. *Sterigmatocystis* and *Bacillus prodigiosus* are ubiquitous.

As preventive measures the author recommends acceleration of the drying process. The beneficial effect of smoking is attributed partly to the antiseptic properties of the smoke and partly to its hastening the drying of rubber. The use of chemicals is not recommended owing to their deleterious effect on rubber (cf. this BULLETIN, 1913, **11**, 348). Periodic fumigation of the drying-house with sulphur dioxide or spraying with formalin is recommended wherever possible. Spotted rubber should be isolated. The tables and racks of the drying-room should be kept scrupulously clean, and green wood should not be used in their construction. Latex which produces discoloured scrap should be treated with formalin before coagulation. According to the author the discoloration may sometimes be removed by rewashing and crêping the dry rubber.

Hevea Latex.—*The India Rubber Journal* (1913, **45**, 941) contains an article by G. S. Whitby entitled "Some preliminary observations regarding the causes of natural changes in the latex of *H. brasiliensis*." When Hevea latex issues from the tree it is faintly alkaline, but within a short time it becomes faintly acid. If the latex is allowed to stand the acidity increases, and within a few hours the liquid becomes converted into a solid mass. Later putrefaction occurs, and the surface becomes yellow and slimy. Hevea latex always gives the guaiacum and pyrogallol reactions for peroxidases, but in no case was the author able to detect the presence of oxygenase. Latices which darkened rapidly gave a much more marked peroxidase reaction than normal latex. Latex from the higher parts

of the trunk showed a much greater tendency to darken than latex from the lower part of the trunk. Specimens of latex drawn from a tree at points separated by only a vertical distance of 7 in. showed a distinct difference in the tendency to darken. The oxidase, however, is not responsible for the natural coagulation of latex, as this occurs as readily in the absence as in the presence of air. Natural coagulation also occurs too rapidly to be the result of bacterial action. The author also thinks that the natural coagulation is not merely the result of the acid which develops in the latex, because the two phenomena do not occur *pari passu*. For instance, the formation of acid takes place much more rapidly in diluted latex than in undiluted latex, and diluted latex may develop sufficient acid without coagulation taking place (see, however, this BULLETIN, 1913, **11**, 347). The author regards the coagulation of Hevea latex as essentially a physical change, conditioned in the case of natural coagulation by preliminary chemical change brought about by an enzyme, probably a protease. Heating to a temperature which destroys the enzyme prevents coagulation for a time. The darkening of latex is hastened by the addition of phenolic bodies, and the author concludes that the darkening of latex is due to changes produced in phenolic substances present therein (cf. this BULLETIN, 1913, **11**, 348).

Bacterial Disease of Hevea Brasiliensis.—In the *Agric. Bull. Fed. Malay States* (1913, **1**, 268) E. Bateson describes the discovery in the wood of a dead Hevea tree of bacteria which may have been the cause of the death of the tree. Attempts to infect seedlings with the bacterium failed, but the author thinks it advisable to warn planters of this possible bacterial disease of Hevea.

Euphorbia Tirucalli.—In the *Agric. Journ. of the Union of South Africa* (1913, **5**, 706) H. Noyes describes the collection of latex from *Euphorbia Tirucalli* in Natal. This tree is described as a "hard-timbered, rough-barked, leafless tree of umbrageous habit, attaining in good soil and under favourable conditions a height of 25 to 35 ft., and a diameter of 1 to 2 ft. In lieu of leaves it bears at the extremities of the branches bunches of thin leathery fingers, which when broken yield a watery latex." Its natural habitat is in the hot valleys of Natal, between latitudes 25° and 32° S. A well-grown tree, if properly worked, yields latex to the value of *2s. 6d.* per annum. The tree grows vigorously in any soil, provided the altitude is not excessive. It reproduces itself freely, and can be grown from seedlings or stumps. It is best tapped on the half herring-bone system on one quarter of the circumference, in the same manner as Hevea trees. With healthy and well-grown trees tapping

may be carried out twice weekly. The latex is coagulated, after standing twenty-four hours or more, by means of a solution of tannin, or a mixture of tannin and hydrochloric acid, and the coagulum is dried until it contains 25 per cent. of moisture. The dry coagulum contains on the average 13·5 per cent. of caoutchouc, but, according to the author, there is a considerable and increasing demand for the crude coagulum.

Fibres

An account of the fibre industries of the East Africa Protectorate is given in the *Ann. Rep. Dept. Agric., British East Africa*, 1911–12. The prospects of the Sisal hemp industry are satisfactory, and a rapid extension of the area under cultivation in the highlands is anticipated. In the Gazi section, 800 acres have been planted, and of these 75 acres are ready for cutting. The leaves produced by the plants in this district vary from 3 ft. 6 in. to 5 ft. 6 in. in length, and although thinner than those grown in the highlands, they give a large yield of fibre which is of good strength and colour. Extracting machinery is being installed, and the area under the crop is being extended. The preparation of Sansevieria fibre from the indigenous plants is being continued in the neighbourhood of Voi, and the heavy rains which have been experienced are expected to stimulate the production of new leaves in the areas which have already been cut, and thus enable the output of fibre to be increased. Attention is being directed to the floss or silk-cotton, known as "Sufi," which is furnished by a large tree (probably *Bombax* sp.), common at several places along the coast-belt.

Flax.—An association, known as "The British Flax and Hemp Growers' Society," has been formed recently, and was referred to in *The Times* of June 17, 1913. The principal objects of this society are to make experiments on a commercial scale, to distribute information, and to collect and collate trustworthy particulars on the cultivation of flax and hemp, the retting of the stalks, and the preparation of the fibres in Great Britain. The experimental work outlined for the season of 1913 includes the cultivation of the flax plant for both seed and fibre, and the cultivation and extraction of hemp. The work in connection with the cultivation of the flax plant for the production of linseed has been delegated to the South-Eastern Agricultural College, Wye, and arrangements have been made for the establishment of two-acre plots in seven or eight districts in various parts of England and Wales, including localities in Surrey, Shropshire, Yorkshire, and Carnarvonshire. Trials are being made with different varieties of seed, and manurial experiments are being undertaken. An endeavour is being made to obtain a pure strain of the plant for

production of both seed and fibre. The society has arranged for the cultivation of 120 acres of flax at Selby, Yorkshire, and the Leeds University is being invited to conduct the experiments in retting the stalks and preparing the fibre. Selby was chosen as one of the first districts for the revival of the industry, as flax-growing was carried on there largely in the past. Flax is also being cultivated near Yeovil, where 40 to 50 acres have been planted. Retting experiments are to be carried out there by a committee of growers, local representatives of the society, and nominees of Bristol University. This attempt to revive the cultivation of flax and linseed in Great Britain is due to the desire of farmers to take advantage of the introduction of such crops into rotation systems, and to the hope that it may lead to increased employment of labour.

Reference has already been made in this BULLETIN (1903, **1**, 188; 1912, **10**, 498) to the experiments on flax cultivation which have been conducted by the Department of Agriculture and Technical Instruction for Ireland. The work has been continued, and an account of the experiments carried out during 1911 is presented in the *Journ. Dept. Agric. and Techn. Instr., Ireland* (1913, **13**, 515). The results of manurial trials have confirmed the earlier work, and in the light of experience so far obtained flax-growers are recommended to apply 5 cwt. of kainit or 1¼ cwt. of muriate of potash per acre, either at the time of sowing or during the previous winter. Experiments carried out with different kinds of seed have led to the conclusion that the choice of the variety to be sown (whether Dutch or Riga) must be determined by the quality of the seed itself rather than by the class of soil for which it is intended. Farmers are therefore advised to consult the leaflet on flax-seed issued annually by the Department, which gives information as to the harvest conditions prevailing in the two seed-producing countries during the preceding year, and indicates the quality of the seed procurable from each. Trials on both a large and a small scale have been made with a view to ascertaining whether seed obtained from a crop in the comparatively green condition in which it is considered ready for harvesting for fibre is less suitable for sowing than that obtained from a crop which has been allowed to mature completely before being pulled. Very little difference could be detected between the results yielded by the two kinds of seed, and it is thus evident that the seed from flax, pulled at the usual time, is quite suitable for sowing.

Cotton

East Africa Protectorate.—It is stated in the *Ann. Rep. Dept. Agric., British East Africa*, 1911–12, that experiments which were made in Gosha on the Juba river during the

year under report gave encouraging results. The varieties tested were Abassi, Mitafifi, and Yannovitch, and of these the first appeared the most promising. An extension of cotton growing by Europeans has taken place on the banks of the Tana river, and in one or two other districts, but attempts to expand the native cotton industry have not generally met with very great success.

India.—In an article entitled "The Problem of the Improvement of the Indigenous Cottons of the United Provinces" (*Agric. Journ. India*, 1913, **8**, 47), an interesting account is given of efforts to improve the cotton of these regions by direct selection and by breeding. In the Aligarh district a type has been isolated which gives a ginning yield of nearly 40 per cent., as compared with 33 per cent. furnished by the ordinary "desi" cotton, and a yield per acre about 30 per cent. greater than that of the latter. The fibre is not much better than that of the "desi" kind, but the greater productiveness of the new type, and the greater profit obtainable from it, are expected to lead to an increase of the area planted. During 1912–13 1,500 acres were sown with this type, and it is anticipated that in 1913–14 it will be grown on about 20,000 acres. Another type which has been selected does not give the high ginning output of that just mentioned, but yields a lint of improved quality; it is expected that about 450 acres will be planted with this cotton in 1913–14. Two other types described are early maturing varieties, and one of them bears naked seed which enhances the value of the crop for the production of cotton-seed cake. An account is given of hybridisation experiments carried out with the object of obtaining a cotton combining good quality with a high ginning yield. Numerous forms have been isolated, and these are being tested on a seed-farm recently established near Aligarh.

The native cottons of Burma are of very inferior quality, and all attempts to grow better varieties have been frustrated owing to the damage inflicted by insect pests. The various insects have therefore been studied, and are described together with the measures best adapted to control their depredations in *Bulletin* No. 8 (1912), *Dept. Agric., Burma.*

West Indies.—An account of the progress of the cotton industry of St. Vincent is given in the *Rep. Agric. Dept., St. Vincent*, 1911–12. During the year under review the area planted was the greatest yet recorded, and amounted to 5,068 acres of Sea Island, and 1,037 acres of Marie Galante. The increase was due to more extensive planting by the peasantry. Owing to a very unfavourable season, however, the yield per acre amounted on the average to only 96 lb. of lint per acre, as compared with an average

of 150 lb. for the six preceding years. The average price obtained for the Sea Island cotton was 19*d.* per lb., as against 18*d.* per lb. in 1910–11, and that for the Marie Galante variety was 10*d.* per lb., as compared with 9*d.* in 1910–11. Work on the selection and disinfection of seed has been continued, and the results are recorded. The local Sea Island variety has become thoroughly acclimatised, and is much more resistant to disease than newly imported kinds.

The cotton industry of Antigua increased rapidly from 1903 to 1907, but declined greatly during 1908 and 1909. Since this time, however, a steady improvement has taken place, and it is stated in the *Rep. Bot. Station and Expt. Plots, Antigua*, 1911–12, that in a few years the industry will probably be on a much firmer basis than it ever was previously. The area under cultivation during 1911–12 amounted to 495 acres, and yielded 70,209 lb. of lint, equivalent to an output of 142 lb. per acre. In Barbuda 130 acres were planted, and furnished 14,280 lb. of lint, or about 110 lb. per acre, this small yield being due to the extremely dry weather which prevailed. Experimental work on the selection and hybridisation of cotton has been continued, and the greater part of the cotton now produced in Antigua is grown from seed selected by the Department of Agriculture. This probably accounts to some extent for the increased yields now obtained.

FORESTRY AND FOREST PRODUCTS

Indian Timbers.—The following Indian timbers are described in the order named in *Forest Bulletin* (1913, Nos. 16–21), a bulletin being devoted to each species: Gumhar (*Gmelina arborea*, Roxb.), bija sal or vengai (*Pterocarpus Marsupium*, Roxb.), sain or saj (*Terminalia tomentosa*, W. & A.), benteak or nana wood (*Lagerstræmia lanceolata*, Wall.), sandan (*Ougeinia dalbergioides*, Benth.), and dhaura or bakli (*Anogeissus latifolia*, Wall.). Information as to the distribution and habitat of the trees is given, together with notes as to the properties and uses of the timbers and minor products, the reproduction and rate of growth of the species, the method of extraction, and, when available, statistics as to out-turn and cost.

A small longitudinal section of the timber mounted on cardboard accompanies the description of each species.

Bamboos in Burma.—The forest reserves in the Pegu Forest Division are situated on both sides of the upper portions of the Pegu river and Pazundaung creek, which meet near Syriam, and enter the Rangoon river there (*Indian Forester*, 1913, **39**, 176). These forests contain a great variety of bamboos, some species of which cover extensive areas. The most common are the kyathaung

(*Bambusa polymorpha*) and the tinwa (*Cephalostachyum pergracile*), which occur in deciduous forests on well-drained, loamy soils usually associated with teak (*Tectona grandis*) and pyinkado (*Xylia dolabriformis*).

An enormous number of bamboos is cut yearly in the Pegu Division, the natives being allowed to cut as many as they please provided they take out the required licences. The working season is chiefly during the rains from July to November, but is suspended according to rules during the fire season. The industry is chiefly in the hands of bamboo traders, who extract the bamboos from the forests, and raft them down to large villages and towns, where they are sold. The principal species exploited are the kyathaung and the tinwa. The cost of the licence to the trader is Rs.3-2-0 per thousand bamboos. The cutting is done by men who usually work in gangs of from five to ten, and during the cutting season live in camps (*sakans*) of bamboo huts (*tays*) built by the side of the river. Bamboo clumps with straight culms, growing on fairly level ground not far from the river, are selected for cutting. From these are cut straight, healthy, mature culms that average in length about 20 ft. when trimmed at both ends. The culms are cut at various heights above the ground, the cutting being performed by means of sharp knives (*dahs*). On an average a man can cut sixty kyathaung and 100 tinwa bamboos in a day. At about a foot from one end of the bamboo, generally the thicker end, two notches are cut side by side about an inch long and an inch apart to form the drag hole or "napah." The culms are fastened together in fives by means of a slender strip of bamboo, which is passed through the "napahs" of the five culms. They are then made up into bundles comprising twenty kyathaung or twenty-five tinwa bamboos, fastened at one end only by means of thin strips of bamboo or cane. Two such bundles are lashed together, and are hauled down to the water by a pair of buffaloes harnessed to a rough yoke of wood. Sixteen bundles are placed side by side in the water, and are fastened together by means of three strong poles placed cross-wise on the upper side of the bundles. On the top of the poles fourteen similar bundles are placed, and securely lashed together. These thirty bundles, containing from 600 to 750 bamboos, form one section of a bamboo raft, which may comprise from five to ten such sections joined end to end. Generally about four men accompany a raft of 6,000 bamboos. Where the water is shallow the raft is propelled by poling, but where there is a sufficiently strong current it is allowed to drift down stream, being guided by means of long bamboo oars. Lighter rafts have to be constructed during the dry season, when the water is shallow; these consist of two to three layers of single bamboos, fastened together

as above described. By the time the bamboos are landed at Pegu the cost to the trader amounts to Rs.54 per 1,000 kyathaung, and Rs.38 per 1,000 tinwa bamboos. The selling prices at Pegu for these species are Rs.60 and Rs.43 per 1,000 respectively. Landed at Rangoon, the cost for bamboos brought down either the Pegu river or Pazundaung creek would be about Rs.60 and Rs.45 per 1,000 for kyathaung and tinwa respectively.

It is suggested that, owing to the quantity of material available for the manufacture of bamboo pulp, a mill situated at Syriam would prove a commercial success, and the clearing of the bamboo which would be effected thereby would prove beneficial to the more remunerative crops of teak and pyinkado, which are at present choked owing to the dense growth of bamboo.

ECONOMIC MINERALS

Graphite.—A description of the graphite mines of the Province of Quebec is given in the *Report on Mining Operations in the Province of Quebec for the year* 1910. The graphite is mined in the Buckingham district, where it occurs in the flaky or crystalline condition disseminated in gneisses.

At the Buckingham Graphite Co.'s mine the graphite is disseminated through a sillimanite gneiss, in a belt or zone the width of which varies considerably and reaches 10 ft. in places. The strike is south, and the dip 60° to the east. At the workings in the immediate vicinity of the mill, a tunnel has been driven in the side of a low hill from a distance of 300 ft., and two shafts have been sunk from the surface to the tunnel. The milling plant has a daily capacity of 60 tons of ore, yielding between 3 and 4 tons of finished products. The process of concentration is dry throughout. The ore is dried in a stone kiln by means of wood fuel. It is then passed through a Blake crusher, screens, and a second crusher, after which it is concentrated by passing through a series of rolls, screens, and bolts. The flake graphite then undergoes polishing in buhrstone mills. Three qualities of graphite are produced, of which the best contains 96 per cent. of pure graphite.

At the Bell Graphite Co.'s mine the graphitic gneiss occurs in two bands. One of these has been opened up; it strikes south 7° west, has a dip of about 70°, and has been traced for a distance of 2,000 ft. It varies in width up to 15 ft., has a foot wall of quartz rock, and a hanging wall of rusty gneiss. A drift has been driven into it a distance of 185 ft., and at 150 ft. a shaft has been sunk from the surface, 68 ft. above the drift. About 3,000 tons of ore, carrying an average of 8 per cent. of graphite, has been mined from the tunnel.

A considerable amount of development has taken place

at other mines, and now that the concentration difficulties have been overcome, the mining of these disseminated occurrences is a source of profit, and the graphite industry appears to be on a satisfactory basis.

According to the same *Report* for 1911, the shipments of graphite during that year were 753,405 lb., valued at $33,613, which is more than double the output in 1910, and the highest recorded up to that date. The graphite marketed during 1911 was sold at an average price of 4·46 cents per lb. By way of comparison it is stated that the best quality of flake graphite in large quantities was quoted at 10 cents per lb., whereas graphite dust sold as low as 1¼ cents per lb.

Magnesite.—According to the *Report on Mining Operations in the Province of Quebec during the year* 1911, a deposit of magnesite was discovered some years ago on lot 18, range xi, of Grenville Township, Argenteuil county. The locality is situated about 12 miles from the Canadian Pacific Railway, the nearest station being Calumet. The mineral at the surface contained from 10 to 19 per cent. of calcium carbonate, but quarrying has proved that below the surface the mineral is of better quality. The property was actively developed during 1911, and 100,000 tons of merchantable magnesite was blocked out. A grinding plant has been installed on the property; also a calcining kiln, with a capacity of 12 to 15 tons of the finished product per 24 hours. There is said to be an active demand for the product.

Steatite.—In a *Note on Steatite Deposits, Idar State* (*Records Geol. Surv. India*, 1912, **42**, 52), C. S. Middlemiss describes occurrences of steatite discovered during the field-season 1911–12. A large deposit occurs in the hilly area between the Bhil villages of Dev Mori and Kundol. The outcrop is situated in lat. 23° 39′ to lat. 23° 40′, long. 73° 28′. The bed runs N. and S. along the course of two streams, one of which flows N. and the other S., and traverses the intervening col. On either side are parallel ridges of quartzite. At one place the length of the outcrop can be traced for over a mile, showing a width of over 200 ft. and a practically vertical dip. The steatite appears to be fairly uniform in composition. It is finely schistose and of a greyish colour. It is of moderate quality, but not suitable for the finer trade requirements. Assuming a length of a mile, a width of 200 ft., and a depth of 20 ft., there appears to be over two million tons within easy reach of surface quarrying operations.

Tin Ore.—In *The Geology and Mining Industry of the Kinta District, Perak, Federated Malay States*, 1913, J. B. Scrivenor has given an account of the tin-ore deposits of the Kinta district, which lies in the upper part of the Kinta river valley. A large part of the district is occupied by granite,

which forms hills on either side of the valley. One side of the valley is flanked by limestone hills, and limestone forms also the floor of the valley. Lying on the limestone of the valley floor, and younger than the limestone, are clays, shales, and quartzites of Gondwana age; and some of these Gondwana clays are genuine boulder clays of glacial origin. Above these Gondwana strata there are some deposits of recent age, including alluvial beds and beds of lignite.

Along both sides of the valley the junction of the limestone and overlying Gondwana rocks with the granite is a fault junction, and the limestone hills which flank one side of the valley are mostly, if not wholly, fault blocks against which the younger Gondwana beds have been faulted. These structural features are of post-Gondwana age. They originated during the intrusion of the granite, which probably took place during Mesozoic times. During this intrusion, the Gondwana and other sediments were laterally compressed, and bent into a low anticlinal arch. This arch ultimately collapsed, and the strata broke up into blocks which subsided with a differential movement as large masses of strata fell into the granite magma. During the closing phase of the intrusive action, and as the granite mass was solidifying, stanniferous vapours were given off, and from these, tinstone and other minerals were deposited in the rocks. All this took place at considerable depth; but the superincumbent rocks have since been removed by denudation, which has brought out the structural features and laid bare the stanniferous rocks.

Tin ore occurs in all the formations of the Kinta district. In the granites, limestones, and Gondwana beds the ore occurs as primary veins, pipes, and impregnations, which owe their formation to pneumatolysis, *i.e.* to direct deposition from the vapours given off from the Mesozoic granite during the later phases of intrusive activity.

A large amount of the tin ore is, however, detrital, and represents the more stable of the rock constituents, including tinstone, which have resisted the agents of weathering and denudation, and have been distributed over the surface of the district. Such are the recent deposits, in which is found alluvial tin ore that has been derived from the various formations in which primary tin ore occurs. The ore also occurs in caves and solution pipes in the limestone.

One of the most interesting of the occurrences of tin ore is that where it occurs as a detrital constituent of the Gondwana clays and boulder clays, in which the hydraulic mines of the Gopeng, the Kinta tin, and the new Gopeng companies are worked. These Gondwana rocks carry primary tin ore which has been deposited in them directly by the agency of the Mesozoic granite, but the clays and boulder clays also contain large boulders of alluvial origin.

These latter clearly cannot have been derived from the Mesozoic granite, and the Government Geologist is of opinion that the tin ore has been derived from some mass of granite of Palæozoic age, the site of which is not yet known.

The primary pipes of tin ore that traverse the limestone, as at Ayer, Dangsang, and Lahat, have a gangue which is chiefly calcite; the other minerals occurring in the pipes are quartz, pyrite, chalcopyrite, bornite, arsenopyrite, and antimonite. Arsenopyrite is abundant, fluorite and tremolite are common, but tourmaline is rare in the limestone deposits. In the case of the Lahat pipe, the ore-contents of the pipe have been largely oxidised, and the calcitic matrix extensively dissolved by percolating water.

Other minerals which occur associated with cassiterite in the tin ores of the Kinta district are corundum, galena, cerussite, native copper, scheelite, wolframite, strüverite, monazite, xenotime, topaz, and siderite.

Titaniferous Iron Ores.—It is a well-known fact that there are in many parts of the world large deposits of iron ore which, owing to the high percentage of titanium they contain, are of little value in competition with ordinary non-titaniferous iron ore. The smelting of titaniferous ores is accompanied by much difficulty and expense with existing types of furnaces, and as a rule such ores are not saleable if they contain an appreciable percentage of titanium. According to the *Second Annual Report of the Director of the United States Bureau of Mines for the year ended June* 30, 1912, an investigation is being carried out on a small scale to test the possibility of utilising such titaniferous ores. Two deposits that have been examined, viz. at Sanford Hill in the Adirondack Mountains, N.Y., and at Iron Mountain, Wyo., are very large, and have not been utilised on account of their high percentage of titanium. The nature of the ores in these deposits has been studied, and they appear to consist of titaniferous magnetite in which, as is usually the case with this mineral, magnetite is intimately intergrown with ilmenite. Attempts have been made to reduce the amount of titanium by magnetic separation, and it was found that part of the ilmenite can be eliminated in this way; but it was found to be difficult, where not impossible, to obtain concentrates containing less than 6 per cent. of titanium.

It is inferred, therefore, that the utilisation of such iron ores is not feasible unless furnace practice can be so modified as to make practicable the smelting of concentrates that carry from 6 to 7 per cent. of titanium; or unless such concentrates are mixed with three or four parts of non-titaniferous ores, an alternative which is rendered practicable by the small amount of phosphorus and sulphur present in the concentrates.

F. L. Hess, writing on titanium in *Mineral Resources of*

the United States, 1911, *Part I., Metals*, states that most of the ferrotitanium now manufactured seems to be obtained from titaniferous magnetite or from ilmenite. Better results can be obtained in making ferrotitanium with rutile than with ilmenite, as the relative percentages of iron and titanium are more readily controlled, but the cheapness of ilmenite and titaniferous magnetite gives them a great market advantage over rutile. For making titanium carbide, however, ilmenite cannot be used, and there appears to be some demand for rutile for the manufacture of this substance, which is used in the form of electrodes for arc lamps. There appears to have been no rutile mined in the United States during 1911. A little was supplied for export from the Roseland mines in Virginia, but this was taken from accumulated stock. For an account of the distribution and uses of titanium ores see this BULLETIN (1911, **9**, 134).

NOTICES OF RECENT LITERATURE

THE NATION AND THE EMPIRE: Being a Collection of Speeches and Addresses: with an Introduction by Lord Milner, G.C.B. Pp. xlviii + 515, Med. 8vo. (London: Constable & Co., 1913.) Price 10*s.* 6*d.* net; post free, United Kingdom 10*s.* 11*d.*, abroad 11*s.* 4*d.*

The speeches of Lord Milner have a distinctive literary value and character not commonly found in the printed speeches of orators. But, as he says of himself, he is no orator: he is a man of action, an administrator, possessed with the Imperial idea and inspired by it. In a fine passage he reveals himself, thus: "If it is sometimes wearisome and distasteful to have to talk about the Empire, there is nothing so bracing, so inspiriting, as to try to live for it" (p. 330). His attitude towards Imperial Unity is clearly marked. "My ideal," he says (p. 163), "is to see the greatest number of people living healthy and independent lives by means of productive work in our own country. . . . I am not an individualist, and I am not a cosmopolitan. The conception which haunts me is the conception of the people of these islands as a great family, bound by indissoluble ties to kindred families in other parts of the world, and, within its own borders, striving after all that makes for productive power, for social harmony, and, as a result of these, and as the necessary complement and shield of these, for its strength as a nation among the nations of the earth." His view of the British Empire and its future is thus outlined: "When we, who call ourselves Imperialists, talk of the British Empire, we think of a group of states, independent of one another in their local affairs, but bound together for the defence of their common interests, and the development of a common civilisation, and so bound,

not in an alliance—for alliances can be made and unmade, and are never more than nominally lasting—but in a permanent organic union. Of such a union, we fully admit, the dominions of our sovereign, as they exist to-day, are only the raw material. Our ideal is still distant, but we are firmly convinced that it is not visionary nor unattainable" (pp. 90–91). Indeed, he is in favour of constructive statesmanship and the recognition of co-partnership interests in the consolidation of the British Empire and its Dependencies. His speeches are of special interest in connection with the problems of South Africa. In a significant passage, he says: "But though they [*i.e.* the self-governing Dominions] took part in the war, their participation in South African affairs ended with its conclusion. It was regarded as a matter of course that the United Kingdom alone should deal with the situation in South Africa as the war left it. In my opinion [*i.e.* in 1908], the policy to be adopted after the war should have been, like the war itself, the business of the whole Empire, and not of the United Kingdom only. If Canada, Australia, New Zealand had had a voice in it, if the organisation of the Empire had been sufficiently advanced to make that course practicable, I think we should see a more satisfactory state of affairs in South Africa than we do to-day" (pp. 311, 312).

The volume is dedicated to Mr. Charles W. Boyd, who selected, arranged, and annotated the speeches contained in it. The task has been admirably fulfilled. Arranged in the order of delivery—dating from March 1897 to December 1912—and covering the broad material issues or Imperial developments now so freely discussed in the Houses of Parliament and in the Press, the speeches and addresses, of necessity, contain occasional recapitulations—expansion of arguments rather than repetition of common phrasing—but throughout these there runs a singleness of purpose that gives unity to the volume as a whole.

One of the most far-reaching and important acts of Lord Milner has not generally received the recognition it deserves. The establishment of an efficient Department of Agriculture for the Transvaal, modelled on the lines of the Department of the United States, involved a heavy expenditure and was at the time the subject of much adverse criticism. The Department has proved to be of the highest value, and now forms the nucleus of the Agricultural Department of the Union.

Proceedings of the Optical Convention. Vol. II. Pp. viii + 359, 4to. (London: University of London Press, 1912.) Price 10*s.*; post free, United Kingdom 10*s.* 5*d.*, abroad 11*s.*

This volume contains the proceedings of the second Optical Convention, held at South Kensington in June

1912. In his presidential address Professor S. P. Thompson gives a short history of the development of optics, and concludes with a strong plea for the provision of adequate educational facilities in this country for those who wish to study optics for its own sake. He deprecates the present practice of treating optics merely as a part of physics. He calls attention to the fact that though there are professors of electrical engineering and metallurgy in British Universities, there is no professor of optics. At the same time he is not anxious to put the larger study of optics under University control. He emphasises the need for the establishment of an Optical Institute, where the study of theoretical and practical optics will go hand in hand, and where the mathematician will grind his own lenses. Professor Thompson claims that the work of such an institute should be free from what he calls "the examination blight," and "the baneful influence of a University."

The thirty-six papers by eminent specialists that make up the volume deal with varied subjects, and cover a large part of the field of modern optics. The book is well printed and illustrated, and is a valuable addition to optical literature.

Poisons de Flèches et Poisons d'Épreuve. By Ém. Perrot and Ém. Vogt. Pp. xii + 368, Royal 8vo. (Paris: Vigot Frères, 1913.) Price 15 francs; post free, United Kingdom 12*s.* 5*d.*, abroad 12*s.* 9*d.*

Prof. Gley, in a preface to this book, points out that the possibility of investigating arrow- and ordeal-poisons is rapidly disappearing, since the use of these materials by natives is diminishing as a natural result of the spread of civilisation. It is therefore particularly useful that this volume should be published now, not only because it gives a complete account of our present knowledge of these recondite subjects, but because it calls attention to numerous points on which information is incomplete. It may be hoped that one result of this will be that interest may be aroused in these subjects and new collectors and observers secured in those countries in which natives still make use of poisoned arrows and in which trial by the ordeal of poison has not been entirely suppressed. It is scarcely likely that such researches will at the present day afford results of practical value, but it must not be forgotten that several drugs now in use in European medicine owe their introduction into civilised medical practice to the investigation by chemists and physiologists of arrow- or ordeal-poisons used by natives. Among these may be mentioned strophanthus, curare, and Calabar bean.

Prof. Perrot and Dr. Vogt have ransacked ancient and modern literature for references to, and descriptions of,

poisons of these types, their method of preparation, and their composition and properties; and the information thus obtained is critically reviewed and stated in such a way as to make a peculiarly interesting book. The poisons dealt with are of varied types, including extracts of poisonous plants, snake venom, products of putrefaction, and preparations which are virtually primitive attempts at cultures of the tetanus and other disease-producing bacilli. It is curious to note that, no matter whether primitive man of early Europe or primitive man in Africa or Asia of the present day is considered, he seems always to have used for his arrows the most potently toxic material available. In the deserts, where vegetation of any kind is rare, the materials used were the irritant latices of Euphorbias and similar xerophilous plants.

The book is arranged geographically, and the poisons in use or formerly used in the various countries of Europe, Africa, Asia, Oceania, and America are considered in turn. Under "Nigeria," for example, there is a résumé of the papers published by Fröhlich, Mines, La Chard, Parson, Charteris, Laidlaw, and Bolton on the arrow- and spear-poisons used by the Munchis, Ceros, Binis, and other Nigerian peoples, followed by a similar chapter summarising what is known regarding the use of Calabar bean as an ordeal poison in that region.

The amount of literary research involved in the production of this work is enormous, but in spite of the authors' evident care to note everything of value, the book is not as complete as is desirable on the chemical side. Thus there is no reference to Salway's recent work on the chemistry of the Calabar bean, which certainly should not be overlooked by any one interested in this subject. Similarly, the account of the Asiatic aconites does not include all the most recent work on this subject. Further, the summary of the chemical work on the alkaloids of these plants is inaccurate in at least one point, and is, moreover, incomplete.

At the end of the section relating to each continent a map is printed showing the kinds of poisons used in each of the principal areas. There are also a number of illustrations of poisoned weapons and seven excellent plates showing types of arrows used in various parts of Africa (3 plates), Asia and Oceania (2 plates), America (2 plates), and an eighth reproduced from a photograph of a museum group of Perak natives preparing arrow poison. There are three indexes—(1) of native and scientific names of plants and animals used in preparing poisons, (2) of authors whose works are quoted in the text, and (3) of names of native peoples mentioned in the book.

There can be no question that the authors have rendered a signal service to science in compiling this book,

and they may rest assured it will long remain a most valuable source of information on a subject concerning which it has hitherto been extremely difficult to obtain accurate information.

AN INTRODUCTION TO THE CHEMISTRY OF PLANT PRODUCTS. By P. Haas and T. G. Hill. Pp. xii + 401, Med. 8vo. (London: Longmans, Green & Co., 1913.) Price *7s. 6d.*; post free, United Kingdom *7s. 11d.*, abroad *8s. 3d.*

The authors explain in the preface to this volume that it is an attempt to provide botanical students, who already have some knowledge of chemistry, with an introductory account of the chemistry and biological significance of some of the more important substances occurring in plants. During the last few years a great deal of work has been done in the direction of ascertaining the nature and relationships of the compounds which are formed or decomposed in the course of vegetable metabolism, and it is important that the results of this work should be gathered together in such a form that they may be added to the current body of data available for assimilation by students. The accomplishment of such a task requires careful discrimination between fully established facts on the one hand and merely nebulous matter on the other; the former may give the student a clear, though possibly an incomplete picture of what is happening; the latter can only confuse him. In this volume the authors have included some material that is hardly ready for assimilation by students, and they have devoted much space to such matters as descriptions of methods of estimating, isolating, and examining various products, for which the student might have been referred to text-books on chemistry.

The book also needs careful revision on a number of small points. Slightly different names are frequently applied to the same material, *e.g.* "palm-kernel oil" on pp. 29 and 33 and "palm-nut oil" on pp. 32 and 34, "orcin" and "orcinol" on p. 56, "methyl pentoses" on p. 57 and "methylpentose" in the index. On p. 256 it is stated that the Labiatæ are quite free from alkaloids, whilst on the next page, stachydrine, an alkaloid from a plant belonging to this natural order, is referred to.

The authors say in their preface that "although the point of view is in the main purely chemical and botanical, the economic aspect has not been lost sight of." In spite of this there are only incidental references to resins, gum-resins, essential oils, rubber and gutta-percha, all of which are of great interest from the botanical, chemical, and economic points of view. The economic information given is not always quite accurate; for example, the statement on p. 4 that "varnish consists of a mixture of boiled oil with gum resins and oil of turpentine."

In spite of these defects the book is quite a useful publication, since it brings together a great deal of scattered information on a subject which is receiving an increasing amount of attention from scientific workers. It is issued at a reasonable price and is very well produced.

Beurre de Vache et Graisse de Coco. By J. Lahache and F. Marre. Pp. 364, Crown 8vo. (Paris: A. Maloine, 1913.)

This work deals principally with the methods of examination of butter and of butter substitutes manufactured from coconut oil, and also with the important question of the detection of coconut oil in admixture with genuine butter. The book is, therefore, primarily of interest to the analyst. The manufacture and purification of coconut oil for edible use is briefly described, and the legal restrictions imposed in different countries on the manufacture and sale of vegetable butters are discussed.

A rather curious mistake occurs on p. 12 (footnote), where "Ghee" is included in a list of vegetable fats used by natives as food, whereas it is well known to be clarified butter fat. In the same paragraph "Galam," "Shea," "Bambouc," and "Karité" fats are mentioned as if they referred to distinct products, although they are merely local names for the fat obtained from shea nut kernels (*Butyrospermum Parkii*).

The Cane Sugar Factory. A Catechism of Cane Sugar Manufacture for the Use of Beginners. By Frederic I. Scard, F.I.C. Pp. iv + 118, Small 8vo. (London: The West India Committee, 1913.) Price 1*s.* net.; post free, United Kingdom 1*s.* 3*d.*, abroad 1*s.* 4*d.*

This work contains 273 questions, each followed by a short answer. They are arranged under the headings of milling, clarification, filtration, concentration, crystallisation, centrifugalling, steam supply, scientific control, and distilling. The answers are in some cases so brief and incomplete as to be unintelligible to those who have no previous knowledge of the subject, and render reference to other works indispensable. A large part of the book is occupied by a series of useful tables of weights, measures, temperatures, specific gravities, etc., and by a glossary of technical terms used in cane-sugar factories. Emphasis is laid on the importance of keeping careful records of results, and a specimen factory record form is appended.

Outlines of Stationery Testing. By H. A. Bromley. Pp. 74, Crown 8vo. (London: C. Griffin & Co., Ltd., 1913.) Price 2*s.* 6*d.* net.; post free, United Kingdom 2*s.* 9*d.*, abroad 2*s.* 10*d.*

By far the larger portion of this work is devoted to the examination of paper, physically, microscopically, and chemically, the microscopical section containing six plates

illustrating the various fibres commonly occurring in paper. The remainder of the book deals with the examination of other articles employed in the ordinary course of office routine, including, among others, inks, string, paste, and sealing-wax. In view of the comprehensive character of the work only the more important and recognised methods of examination of each material are given. The absence of unnecessary details and technical terms should enable this volume to fulfil its purpose as a useful and practical guide to stationery testing for persons of limited analytical experience.

THE SHEEP AND ITS SKIN. By Alfred Seymour Jones. Pp. viii + 396, Demy 8vo. (London: The Leather Trades Review, 1913.) Price 12*s.* 6*d.* net; post free, United Kingdom 12*s.* 10*d.*, abroad 13*s.*

This book deals with the history, breeds, and diseases of sheep, and also with the utilisation of the skins. In the introductory chapters the evolution and history of the sheep, sheep-rearing, and the more important breeds of sheep, are dealt with briefly. The important questions of the diseases of sheep are next discussed, a whole chapter being devoted to "fluke" or "liver rot," so prevalent at times in this and other sheep-rearing countries. The greater part of this chapter consists of a reprint of Prof. Thomas's paper on the liver-fluke, reproduced by permission of the Royal Agricultural Society.

The remainder of the book deals with the utilisation of sheepskins, and includes a large amount of useful information on fell-mongering, the preservation of skins and pelts, and the preparation of pelts for tanning. The appendix consists of an article by J. T. Wood on the bacteriology of the leather industry. A useful feature is the list of works and articles dealing with the subject. The book is intended to be of use to those engaged in the leather and allied trades, and is written, therefore, in a more or less popular style, devoid of abstruse scientific or technical terms. One ventures to suggest, however, that some of the numerous historical references (*e.g.* that commencing on p. 29) might have been omitted or considerably shortened with advantage. Such a statement as the following (p. 95), "The general molecular forces have been nucleating until the whole mass finally becomes crystalline, a change which is further fixed by the hydrolytic processes of liming," is scarcely calculated to help the reader towards a lucid conception of the causes of "colt" or "deadfat" in sheepskins.

Numerous illustrations are given, many of which are whole-page plates, an unusual feature being their inclusion in the numbering of pages throughout, tending to give a somewhat fictitious idea of the size of the book. The

illustrations are on the whole good, but occasionally so bad as to be quite useless, as in the case of the illustrations of the sheep maggot and fly on p. 150. Both printing and paper are inferior for a book of this character and price. Among misprints one might call attention to "shatole" for skatole (p. 116), and "recinolein" for ricinolein (p. 214).

MISSIONS DANS LE KATANGA. I. Le Commerce au Katanga: Influences Belges et Etrangères. By G. de Leener. Pp. xviii + 143. II. L'Agriculture au Katanga: Possibilités et Réalités. By A. Hock. Pp. 305, Crown 8vo. (Bruxelles: Misch & Thron, 1911 and 1912.) Price per vol., 3 francs 50 centimes; post free, United Kingdom vol. i. 3*s.* 1*d.*, vol. ii. 3*s.* 2*d.*; abroad vol. i. 3*s.* 2*d.*, vol. ii. 3*s.* 4*d.*

These two books form respectively volumes 16 and 18 in the group of "actualités sociales" published by the Solvay Institute of Sociology in Brussels. In 1909–10 the Colonial Studies group of that institute chose as its principal subject for discussion the penetration by the Belgians of the portion of the Belgian Congo known as Katanga. The outcome of that discussion, M. Waxweiler explains in a foreword to the first of these two volumes, was the discovery that authoritative information was lacking, and as a result a special mission to Katanga was organised, the funds being provided by M. Ernest Solvay. The two volumes now under notice contain the results of this mission. M. de Leener describes the actual commercial condition of Katanga, and points out that its various enterprises are mainly in the hands of foreigners, chiefly of British nationality. There are two principal reasons for this, viz. the geographical situation of the territory—it is virtually a hinterland of Rhodesia—and the fact that the British, with their great colonising experience, have developed a mentality which discounts risks, whereas the Belgians, not having had such experience, are as yet disinclined to take the serious risks involved in settling in a new country in which industries and commercial enterprises have still to be created.

In the second volume M. Hock discusses in detail the situation, climate, soils, possible crops, agricultural labour, methods of agriculture, possibilities of cattle-raising, and many other subjects bearing on the future agricultural development of Katanga, especially as a field for planters and small farmers of Belgian nationality.

Both volumes are liberally provided with pictures of typical scenes in Katanga and in various British South African territories, the latter apparently being given with a view to creating in Belgium the desire to reproduce such scenes in Katanga. These books are particularly interesting to British readers, since they give the results of a careful study of the methods which have, on the whole,

proved successful in British colonisation. For such studies we have still to rely almost wholly on foreign sources.

A Commercial Geography of the World. By O. J. R. Howarth, M.A. Pp. 236, with 33 diagrams, Crown 8vo. (Oxford: at the Clarendon Press, 1913.) Price 2*s.* 6*d.*; post free, United Kingdom 2*s.* 10*d.*, abroad 2*s.* 11*d.*

This is one of the series of Oxford Geographies, edited by Prof. Herbertson. The mode of treatment adopted is briefly as follows. The influence of climate and relief on commerce and industry is first considered, and the chief products of cold, temperate, and hot lands are enumerated, with brief descriptions of the more important materials. The fisheries and zoological regions of the world are then dealt with, and this is followed by a chapter on the distribution of minerals and the influence of this distribution on the establishment of great industries. The next three chapters deal with the special subjects of (1) transport, (2) trading centres and migration, and (3) the grain trade, with the closely associated subjects of irrigation, crop failure, and famines. In the last eight chapters the actual commercial and industrial condition of the principal regions of the world are considered under the heads of their political divisions.

The arrangement and matter are admirably suited for giving the reader a broad view of the important facts with which commercial geography is concerned.

There are one or two small matters which will need attention when the book comes to be revised for a second edition. The paragraph headed "quinine" on p. 70, for example, does not make it clear that the South American production of cinchona bark is no longer of great importance, and that the world's supply of this drug is principally derived from Java. The statistician, moreover, will be surprised to find that, according to the table on p. 222, the imports and exports of the United States are respectively twice and three and a half times as great as those of the United Kingdom. The explanation of this error appears to be that the figures for the United States purport to be given in £ sterling, but are really given in dollars.

Petroleum. By Sir Boverton Redwood, Bart. 3rd Edition. 3 Vols. Pp. xxxii + 367 + 417 + 383, 8vo. (London: C. Griffin & Co., Ltd., 1913.) Price £2 10*s.* net.

The present edition of this familiar and standard treatise on petroleum has been prepared with the co-operation of W. H. and L. V. Dalton, A. W. Eastlake, J. Wishart, R. Redwood, V. B. Lewes, A. Cooper-Key, and others. Former editions were in two volumes. Since the issue of the second edition (pp. xxxii + 1064) in 1906 (see this

BULLETIN, 1906, **4**, 368) extensive developments have taken place in the production and utilisation of petroleum, and this fact finds expression in the new edition of Sir Boverton Redwood's treatise, which, as readers of former editions know, is very comprehensive in scope.

Vol. 1 gives a historical account of the petroleum industry, and deals with the geological and geographical distribution, the physical and chemical properties, the origin and production of petroleum and natural gas. In vol. 2 the subjects dealt with are the refining of petroleum; the shale-oil and allied industries; the transport, storage, and distribution of petroleum; the testing of crude petroleum, petroleum and shale-oil products, ozokerite and asphalt; the uses of petroleum and its products. Vol. 3 gives an account of regulations relating to the testing, storage, transport, and use of petroleum and its products, and has various appendices dealing with statistics, marine transport, import duties, and bibliography.

The treatise is richly supplied with maps, plates, and illustrations, and these have shared in the revision and addition which has affected most parts of the work. The continued co-operation of many specialists in the work of revision is a pleasing feature, which adds greatly to the value of the work, and gives the reader confidence.

The bibliography, which is a valuable section, has grown from 5,904 items and 113 pages in the second edition to 8,804 items and 163 pages in the present edition. The index has been considerably diminished in bulk, but greatly improved in quality. The masses of figures without descriptive references, which marred the old index, have given place to a classified and more convenient arrangement.

The author and his co-workers are to be congratulated on the results of their work of revision, but there is still room for improvement. It seems hardly necessary to put on record some of the occurrences and rumours of occurrences of petroleum that are given in this treatise. The historical, geographical, and geological sections of vol. 1 need serious revision. Much that is unimportant might be omitted from these sections, and a more systematic treatment of these portions of the volume would still further enhance the value of an already valuable treatise on petroleum.

THE MINING WORLD INDEX OF CURRENT LITERATURE. Vol. ii., 2nd half-year, 1912. By G. E. Sisley. Pp. xxiv + 234, Med. 8vo. (Chicago: The Mining World Company, 1913.) Price $1.50; post free, United Kingdom 6*s.* 7*d.*, abroad 6*s.* 10*d.*

This is an international bibliography of mining, compiled and revised semi-annually from the weekly index

of the world's current literature published by the *Mining and Engineering World*. The subjects dealt with include metals and metallic ores, non-metals, mines and mining, mills and milling, metallurgy and chemistry, power and machinery. Readers of the *Mining and Engineering World* already realise the value of the bibliography which the journal publishes periodically, and they will no doubt appreciate the issue, in this handy form, of a work of reference which should prove very useful.

THE AMERICAN FERTILIZER HANDBOOK, 1913. Pp. 354, 4to. (Philadelphia, U.S.A.: Ware Bros. Company, 1913.) Price $1 post free.

This handbook contains lists of manure manufacturers, of cottonseed-oil mills, and of makers of machinery, chemicals, and other products used in the preparation of artificial manures. The lists refer to the United States only for the most part, but a few names are included for Canada, the West Indies, and Hawaii.

In addition a number of special articles on the manufacture of certain kinds of manures are published, as well as a great deal of statistical, commercial, and technical information of interest to those who either manufacture or use artificial manures.

THE TROPICAL AGRICULTURIST: Journal of the Ceylon Agricultural Society. Published monthly. Crown 4to. (Colombo: Messrs. H. W. Cave & Co.; London: Messrs. Maclaren & Sons, Ltd.) Annual subscription, Ceylon Rs. 8 (10*s.* 8*d.*), abroad £1 post free.

This well-known publication, which was founded in 1881 by Mr. John Ferguson, C.M.G., and which has been the official magazine of the Ceylon Agricultural Society since 1905, has recently been acquired by the society. Five numbers (March to July 1913) have so far been published under this new arrangement. In addition to recording the work of the society, the *Journal* contains original articles mostly on subjects of special interest to Ceylon, whilst the inclusion of numerous extracts from other publications enables the reader to keep well informed on all matters relating to tropical agriculture. Amongst recent original articles mention may be made of that on paddy cultivation in Ceylon during the nineteenth century, in the March number; and those on tobacco culture in the Northern Province, Ceylon, and the rubber industry in Java, in the June number.

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