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THE IMPERIAL INSTITUTE

THE Imperial Institute at South Kensington was founded as the National Memorial of the Jubilee of Queen Victoria, by whom it was opened in May 1893.

The principal object of the Institute is to promote the utilisation of the commercial and industrial resources of the Empire by arranging comprehensive exhibitions of natural products, especially of India and the Colonies, and providing for their investigation and for the collection and dissemination of scientific, technical, and commercial information relating to them.

The work formerly carried on by the Imperial Institute for the supply of general commercial, statistical, and tariff intelligence is now conducted by the Commercial Intelligence Branch of the Board of Trade. (See statement as to the work of the Commercial Intelligence Branch published in the *Board of Trade Journal.*)

The Imperial Institute works in co-operation with this Branch, which is now located in the City (73, Basinghall Street, E.C.), and with the Emigrants' Information Office in Westminster.

Indian and Colonial Economic Collections.—The Collections of economic products, illustrative of the commercial resources of India and the Colonies, are arranged on a geographical system in the galleries of the Institute. Thirty-eight Colonies and Dependencies are represented.

The Collections are open free to the public daily, except on Sundays, from 10 a.m. to 5 p.m. in summer, and from 10 a.m. to 4 p.m. in winter.

A Superintendent of the Indian Section is appointed by the India Office, and the operations of the Indian Section are supervised, in consultation with the Director of the Institute, by a committee appointed by the India Office.

Information concerning India and the Colonies, their commercial products, industries, trade, prospects for emigration, etc.

may be obtained on application in the first instance at the Central Stand in the Galleries, at the General Enquiry Office, or enquiries may be addressed in writing to the Director of the Imperial Institute, South Kensington, S.W.

Central Stand for Publications and Enquiries.—A stand has been opened in the centre of the main gallery to facilitate the supply of general information and the distribution of literature. Pamphlets, circulars, handbooks, etc., containing information relating to the commerce, agriculture, mining, and other industries of the principal British Colonies, and also to emigration, may be obtained gratuitously. Certain publications are for sale. (See lists on cover.) The publications of the Emigrants' Information Office, established by the Colonial Office, may also be obtained. The principal Indian and Colonial newspapers may be seen on application.

An officer of the Institute is in attendance at this stand, which is in telephonic communication with the general offices in the main building.

The Scientific and Technical Department.—The laboratories of this Department, which occupy the second floor of the Imperial Institute, were established chiefly with the aid of grants from the Royal Commission of the 1851 Exhibition, in order to provide for the investigation of new or little-known natural products from India and the Colonies and of known products from new sources, with a view to their utilisation in commerce, and also to provide trustworthy scientific and technical advice on matters connected with the trade and industries of India and the Colonies.

The work of the Department is chiefly initiated by the Governments of India and by Departments of the Home and the Colonial Governments. Arrangements have been also made by the Foreign Office, whereby British Consuls may transmit to the Departments for investigation, such natural products of the countries in which they are appointed to reside as are likely to be of use to British manufacturers and merchants.

Materials are first investigated in the laboratories of the Department, and are afterwards submitted to technical trials by experts attached to the Department, and finally are commercially valued.

Except under special circumstances investigations are not undertaken for private individuals.

Library and Reading-Rooms.—The library and reading-rooms of the Imperial Institute contain a large collection of Indian and Colonial works of reference, and are regularly supplied with the more important official publications of India and the Colonies, and with many of the principal newspapers and periodicals of the United Kingdom, India and the Colonies.

The library and reading-rooms are on the principal floor, and admittance to them is obtained through the entrance at the west (Queen's Gate) end of the building. These rooms are available for the use of Life Fellows of the Imperial Institute, and of other persons properly introduced.

Colonial Conference Rooms.—Three large rooms, specially decorated and furnished, are reserved on the principal floor for use by representatives of the Colonies for meetings and receptions.

The Cowasjee Jehanghier Hall.—The rooms in connection with this Hall are in the occupation of the Indian Section of the Imperial Institute, whilst the Imperial Institute, the India Office, and the London University have the right of using the Hall or lectures, meetings, etc.

SOCIETIES OCCUPYING ROOMS IN THE IMPERIAL INSTITUTE.

(*a*) **British Women's Emigration Association.** — The British Women's Emigration Association has been assigned an office on the first floor, which is open daily from 10 a.m. to 4 p.m., and advice and information respecting emigration and prospects for women in the Colonies may be obtained there free of charge. This Association works in co-operation with the Emigrants' Information Office in Westminster.

(*b*) **Colonial Nursing Association.**—This Association has been assigned an office on the first floor of the Imperial Institute (Room 5). Its principal object is the selection of trained hospital and private nurses for service in the Crown Colonies and other British Dependencies.

(*c*) **African Society.**—This Society, which is concerned with the discussion and publication of all matters connected with British African Possessions, has been assigned an office on the Mezzanine floor, and holds meetings at the Imperial Institute for the discussion of African questions. The *Journal of the African Society* is published quarterly.

IMPERIAL INSTITUTE, SOUTH KENSINGTON

1906

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Mineral Surveys.

Mineral Surveys of Ceylon, Southern Nigeria, Northern Nigeria and British Central Africa are being made under the supervision of the Director of the Imperial Institute by the following officers; the chemical investigation and valuation of the minerals collected by the Surveyors being conducted at the Imperial Institute.

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BULLETIN

OF THE

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INDIAN AND COLONIAL COLLECTIONS.

QUEENSLAND COURT.

TIMBERS.

Queensland has long been known to possess in its forests large numbers of trees, many producing timbers suited for a great variety of purposes, local or otherwise. The Colonial Botanist, Mr. F. Manson Bailey, has collected samples of a great number of the timbers, and they have been exhibited, amongst other places, at the various Colonial Exhibitions held in London. For several years duplicate specimens have been made, one set being retained in the Colony and the second sent for exhibition in the Queensland Court of the Imperial Institute, which now possesses over 600 polished specimens of Queensland woods. Descriptions of the trees, notes on their distribution, and the qualities and uses of their timbers, are conveniently brought together in the pamphlet entitled *Queensland Timbers*, by Mr. Bailey, copies of the third edition of which, published in 1899, are available for free distribution at the Central Stand in the Exhibition Galleries of the Institute. In this handbook a number is assigned to each timber, and the specimens in the Court are numbered correspondingly, and arranged in numerical sequence and are readily accessible for examination. In 1895 sample logs of seven of the more important hardwoods of the State were submitted to mechanical tests by Prof. Unwin, F.R.S., one of the expert referees attached to the Scientific and Technical Department of the Imperial Institute. The results obtained are summarised in the volume of *Technical Reports and Scientific Papers*, published in 1903, pp. 287-288. During the last forty years timber, both raw and manufactured, has been exported from Queensland, mainly to the other States of the Commonwealth, and Queensland timbers have been but little, if at all, known outside Australian markets. Although the trade has been almost confined to Australia, the timber exported has frequently reached a high value; thus, whilst only £2,400 in 1860, the exports had risen to £30,000 in 1869. During the period 1870 to 1877 the figures fluctuated between £20,000 and £37,000; in 1878 they reached £56,000, and rose to £74,000 in the subsequent year. The following sixteen years show on the whole a steady decrease in the value of timber exported, which in 1895 was little more than £100 in advance of 1860. This year proved the turning-point, and, since then, excepting only in 1899, each year has shown a marked advance on its predecessor as regards the value of woods exported. The figures, in round numbers, from 1899 onwards, well indicate the recent progress:—1899, £6,700; 1900, £18,100; 1901, £19,500; 1902, £22,700; 1903, £44,700; 1904, £83,900.

An event of great importance in bringing Queensland timbers more prominently into notice and developing an export trade beyond the limits of Australia took place in 1903, when the attention of the Minister of Agriculture was drawn to the fact that sleepers from another State of the Commonwealth were being used in South Africa, and, as the result of the action of the Government, a trial was secured for Queensland sleepers. A subsequent order was obtained from one of the Indian railways, and a new phase appears to have been entered upon in the utilisation of the forest wealth of the country.

In order to bring together in convenient form the principal data regarding the more important woods, there has recently been issued under the authority of the Minister of Agriculture a copiously-illustrated volume (reviewed on p. 74) by Mr. P.

MacMahon, Director of the Royal Botanic Gardens, Brisbane, entitled *The Merchantable Timbers of Queensland*, and written with special reference to their uses for railway sleepers, railway carriage and wagon building, and engineering works, from which the following information has been largely summarised.

Queensland, it is pointed out, possesses about 40,000,000 acres or some 62,500 square miles of forests producing merchantable timbers, lying between the eastern seaboard and the Great Dividing Range which traverses the country from north to south at a nearly uniform distance of 200 miles from the coast. The rivers rising on the eastern side of the Dividing Range flow to the coast through this timber belt, and afford a natural means of transport, supplemented by the series of railways which strike in at right angles to the coast-line. To the west of the Great Dividing Range there are, speaking broadly, two zones, the first less densely wooded than that of the eastern side, but containing much Cypress Pine (*Callitris robusta*), some Ironbark (*Eucalyptus siderophloia*), various species of *Eucalyptus*, *Bauhinia*, *Acacia*, etc. Beyond this is the large central area with extensive and often treeless plains bearing salt-bushes, and, to a less extent, the vegetation of the intermediate zone. From amongst the 600 or more timbers found in the State, Mr. MacMahon recommends twenty-four for export purposes, and groups them under the following heads :—

(1) Hardwoods now being exported for sleepers to South Africa and India.

(2) Other hardwoods, which can be recommended for sleepers.

(3) Timbers now in use in the construction of railway carriages and wagons by the Queensland Railway Department.

(4) Other timbers either actually used by the Government or which can be recommended from experience.

Specimens of all of these twenty-four timbers are exhibited in the Queensland Court.

HARDWOODS EXPORTED FOR SLEEPERS.

QUEENSLAND IRONBARK (*Eucalyptus siderophloia*, Benth.).—This tree attains 100 feet in height, and sometimes, although rarely, 5 feet in diameter. The grain of the timber is plain and straight as a rule, but sometimes interlocked and wavy. It is difficult to split, and in seasoning resists warping, twisting and shrinking. The wood is grey to dark brown in colour, extremely hard, but planes well with good tools. For sleepers it is practically indestructible, but is rather too expensive. Other purposes for which it has been extensively used are for bridges, in tunnelling, mining, etc.

QUEENSLAND TALLOW WOOD (*Eucalyptus microcorys*, F. v. M.).—A tall evergreen tree, attaining 100 to 120 feet in height, and 6 or even 8 feet in diameter; it grows rapidly, and is very valuable for reafforestation purposes. The wood owes its popular name to its greasy feel when freshly cut. It is the least liable of all the hardwoods to shrink, twist, warp or split in seasoning, and is easy to work when fresh. The weight per cubic foot is from 65 to 75 lb. The grain is extremely close, often wavy and sometimes mottled. Its uses, in addition to sleepers, include bridge-decking, general building purposes, wood blocks, parquet flooring, etc. The cost in Brisbane is about 6*s*. per 100 superficial feet in the log, or 13*s*. to 15*s*. when sawn.

QUEENSLAND SPOTTED GUM (*Eucalyptus maculata*, Hook fil.).—This tree thrives on stony ridges and rocky hillsides, and in soil where little else will grow. In size it ranges from 100 to 150 feet in height, and usually from 3 to 4 feet in diameter. The timber is coarse in grain and very wavy, extremely tough and pliable, presents no special difficulties in drying, and appears to be very resistant to white ant attacks. The under-framing of carriages and wagons, and wagon sheathing, are uses to which it is put, in addition to being employed for sleepers. Price in Brisbane, 5*s*. per 100 superficial feet in the log, and 13*s*. to 16*s*. when sawn.

QUEENSLAND GREY GUM (*Eucalyptus saligna*, Sm.).—In opposition to the last, this tree grows in deep soil flats and well-sheltered valleys, attaining 100 to 130 feet in height, and a diameter of 5 to 7 feet. The timber varies considerably in grain, is easy to work, and is put to a great variety of uses, including sleepers, house building, wagon work, paving-blocks, felloes, shipwrights' work, etc. It is often of a bright mahogany colour, the weight per cubic foot ranges from 56 to 78 lb., and the cost price in Brisbane is about 13*s.* to 16*s.* per 100 superficial feet, sawn.

QUEENSLAND RED STRINGY-BARK (*Eucalyptus resinifera*, Sm.).—A tree 60 to 150 feet in height, with a diameter from 3 to 6 feet, found on deep soil in forest land. The timber, which is nearly the colour of red cedar, is very durable under varying conditions of damp and dryness, and resists ship worms to a considerable degree. The weight per cubic foot varies from 60 to 72 lb. It is largely employed for piles, bridge-decking, paving-blocks, fences, etc., in addition to sleepers. The price per 100 superficial feet in the log is about 4*s.*, and 12*s.* to 14*s.* when sawn.

QUEENSLAND BLACKBUTT (*Eucalyptus pilularis*, Sm.).—Situations exposed to moist winds possessed of good well-drained soil appear most congenial to this tree, which attains a height of 150 and sometimes even 300 feet. The normal diameter ranges from 3 to 4 feet, although trees of 6 to 7 feet are frequent. A cubic foot of the timber varies from 58 to 66 lb. in weight. In strength, toughness and elasticity this wood closely approximates to ironbark, and it is regarded as a first-class engineering timber. With ordinary care it seasons well. Enormous supplies of this tree are stated to occur in the coastal forests of southern Queensland, and, being a very quick grower, it is of value for reafforestation. Paving-blocks, telegraph-poles, ships' decks and general construction are amongst the chief uses to which it is put. In the log it costs about 5*s.* per 100 superficial feet, and sawn, 12*s.* to 14*s.*

QUEENSLAND MESSMATE (*Eucalyptus Stuartiana*, F. v. M.).—The principal home for this tree is the south-eastern portion of Queensland, 50 to 80 miles north of Brisbane, and about 20 miles from the coast. In height it ranges from 160 to 180 feet, with a diameter of about 6 feet. Exceedingly durable, it is very useful for underground and general engineering work, and for house construction has the merit of being difficult to burn. The weight per cubic foot varies from 65 to 75 lb. In Brisbane it costs about 6*s.* per 100 superficial feet in the log, and 13*s.* to 15*s.* when sawn.

QUEENSLAND TURPENTINE (*Syncarpia laurifolia*, Ten.).—This tree usually attains 100 to 150 feet in height, and 4 to 5 feet in diameter. The timber is particularly remarkable for its resistance to teredo attacks. Like messmate timber, it does not readily burn. It is considered one of the best timbers in Queensland for paving-blocks. Weight per cubic foot about 63 lb. Price in Brisbane, 6*s.* per 100 superficial feet in the log, and 13*s.* to 15*s.* when sawn.

OTHER TIMBERS RECOMMENDED FOR SLEEPERS.

QUEENSLAND BLUE GUM (*Eucalyptus tereticornis*, Sm.).—This species is widely distributed in the State, and usually reaches a height of about 100 feet, with a diameter of 2 to 3 feet. The interlocked grain renders the wood difficult to work when dry. Owing to substitution of other less valuable varieties, which are difficult to distinguish from it, the Railway Department has not encouraged its use in the past, but with strict supervision it is considered likely to be more extensively employed. The wood is red in colour, and weighs about 52 lb. per cubic foot. The price is about 5*s.* per 100 superficial feet in the log, and 13*s.* when sawn.

QUEENSLAND WHITE STRINGY-BARK (*Eucalyptus acmenioides*, Schau.).—This timber has not as yet been extensively used owing to the variety of other woods available. It closely resembles tallow wood in general characters. The southern forests contain large numbers of trees ranging from 50 to 100 feet in height, and 2 to 3 feet in diameter. A cubic foot weighs about 68 lb. The price for building purposes is about 4*s.* 6*d.* per 100 superficial feet in the log, and 12*s.* to 15*s.* when sawn.

QUEENSLAND BLOODWOOD (*Eucalyptus corymbosa*, Sm.).—A common tree in Queensland, reaching 50 to 100 feet in height, and 2 to 4 feet in diameter. The timber is not so strong as several of those considered, but is extremely durable and resistant to white ants owing to the presence of veins of resin, which in no way detract from its usefulness. Many of the wooden residences in Queensland are built on piles of this wood, which is exclusively employed when procurable. The weight of a cubic foot is about 65 lb. In value it is worth about 5*s*. per 100 superficial feet in the log, and 13*s*. sawn.

TIMBERS USED FOR CARRIAGE AND WAGON BUILDING.

Several of the hardwoods previously described are employed as has already been noted. Amongst these, the chief are tallow wood, spotted gum, blue gum, and ironbark. In addition the following ten timbers are utilised :—

QUEENSLAND MORETON BAY PINE (*Araucaria Cunninghamii*, Ait.).—This tree of the *Coniferæ* occurs in quantity in the coastal forest belt, attaining 160 to 200 feet in height, and 3 to 6 feet in diameter. The weight of the timber varies considerably, a cubic foot of seasoned wood being about 30 to 33 lb., whilst the commercial article usually weighs about 45 lb., and other tested specimens have been as heavy as 53 to 54 lb. per cubic foot. The timber is close grained, free from knots, splits readily and presents no difficulties in seasoning or working. It is a soft wood and is put to a multiplicity of ordinary uses, being, for instance, considered superior to all woods for butter-boxes. The Brisbane price is 5*s*. to 6*s*. per 100 superficial feet in the log, and 13*s*. if sawn.

QUEENSLAND BUNYA PINE (*Araucaria Bidwillii*, Hook.).—A large tree, 150 feet in height, and 2 to 5 feet in diameter, found in fairly large quantities on the eastern mountains of Southern Queensland. The wood when polished is very beautiful, sometimes having a figure extremely like bird's-eye maple. It is stronger than the allied wood described above, and, like it, can be used for all kinds of cabinet work, joinery, panelling, etc., offering no special difficulties in seasoning and working. Logs cost about 5*s*. per 100 superficial feet, sawn timber 12*s*. to 14*s*.

QUEENSLAND KAURI PINE (*Agathis robusta*, C. Moore).—The eastern portion of Queensland between 18° and 26° latitude south is the home of this tree, where it thrives on dry sandy soil, in regions of high rainfall. The usual height ranges from 100 to 130 feet, and the diameter from 3 to 6 feet. The characters of the fine timber of this tree are well known. Unfortunately it is now becoming somewhat scarce. The price is about 18*s.* per 100 superficial feet. A large specimen is exhibited in the Court.

QUEENSLAND CEDAR (*Cedrela Toona*, Roxb.).—In rich alluvial soil near the banks of creeks, this tree ranges from 150 to 180 feet in height, and 3 to 6 feet in diameter. The timber weighs about 32 lb. per cubic foot. The rich red colour of the wood is well seen in the large specimen in the Court, and many samples have a very handsome grain. The wood seasons and works up well with little waste, and is put to a great variety of uses. Insects do not attack it as a rule. It is most extensively used by the Brisbane Tramways Company for interior fittings. In the log it costs about 20*s.* per 100 superficial feet, and when sawn about 40*s.*

QUEENSLAND BEECH (*Gmelina Leichhardtii*, F. v. M.).—A tree about 80 to 100 feet in height, and 2 to 5 feet in diameter. The timber, which, when seasoned, weighs about 36 lb. per cubic foot, is most remarkable for retaining its form and volume unaffected by weather, and can thus be used in exposed situations, *e.g.* verandah flooring. The wood is of a light buff colour and not ornamental. The recent price has been about 8*s.* 6*d.* per 100 superficial feet in the log, and 20*s.* if sawn.

QUEENSLAND YELLOW WOOD (*Flindersia Oxleyana*, F. v. M.).—The timber of this tree closely resembles the preceding, but is much more ornamental, and so useful that it fully occupies the place of English or American ash. In height the tree ranges from 60 to 100 feet, with a diameter of 2 to 3 feet. A Departmental Board of the Commonwealth military forces has recently decided that it is the most suitable wood for ammunition-boxes. It costs about 8*s.* per 100 superficial feet in the log, and 18*s.* when sawn.

QUEENSLAND SILKY OAK (*Grevillea robusta*, A. Cunn.).—This is a very ornamental tree which thrives on high upland country, and is well known in other parts of the world than Australia, *e.g.* on Ceylon up-country tea estates, for its rapid growth from seed. Its average height is 70 to 80 feet, with a diameter of 2 to 3 feet. The seasoned timber weighs about 38 lb. per cubic foot. It possesses the characteristic grain found in many woods from trees of the *Proteaceæ.* It seasons and works up well, and as a timber for all kinds of interior decorative work is difficult to surpass. To show the figure to perfection it should be cut on the quarter. In the log it costs about 12*s.* per 100 superficial feet, and when sawn about 18*s.* Large specimen planks are exhibited in the Court.

QUEENSLAND CROW'S ASH (*Flindersia australis*, R. Br.).—A tree of from 90 to 120 feet in height, attaining a diameter of from 3 to 4 feet. In general appearance the grain somewhat resembles oak. The timber is difficult to work; 6*s.* to 8*s.* is the general price per 100 superficial feet in the log, and 14*s.* to 18*s.* when sawn.

QUEENSLAND CROWSFOOT ELM (*Tarrietia argyrodendron*, Benth.).—The timber from this moderate-sized tree varies from rich dark brown to light ash in colour. It seasons remarkably well, is very durable for all kinds of inside work, and is largely employed in the finishing of railway carriages.

QUEENSLAND JOHNSTONE RIVER HARDWOOD (*Backhousia Bancroftii*, Bail.).—Occurring near the Johnstone River in Northern Queensland, this tree yields a dark brown to grey timber which is easy to work, and is employed much as that immediately above. In the log it costs about 5*s.* per 100 superficial feet.

OTHER RECOMMENDED QUEENSLAND TIMBERS.

QUEENSLAND CYPRESS PINE (*Callitris robusta*, R. Br.).—This coniferous tree occurs in sandy soil, and ranges from the sea-coast far into the interior, attaining under favourable circumstances a height of from 60 to 70 feet, and 18 inches to 2 feet in diameter. The timber is very resistant to teredo attack, far exceeding in this respect jarrah or karri. It is very easy to work, and is of especial value for interior house fittings, wainscoting and art furniture. The price ranges from 18*s.* to 25*s.* per 100 superficial feet, sawn.

QUEENSLAND BLACK BEAN TREE (*Castanospermum australe*, A. Cunn.).—One of the most beautiful Australian trees, reaching 90 feet in height and 2 to 3 feet in diameter. The seasoned wood weighs about 40 lb. per cubic foot. In appearance it resembles the richest walnut. It seasons well, is easy to work, and, although not suited to outside work, is a very desirable wood for interior decoration and art furniture. The price is about 35*s.* per 100 superficial feet.

QUEENSLAND PENDA (*Xanthostemon oppositifolius*, Bail.).—The timber of this tree is not extensively used; it is extremely hard and heavy and of great strength. It is mainly employed at present for all kinds of agricultural work and also for sleepers.

LIBRARY.—RECENT ADDITIONS.

Books and Publications, exclusive of Government Publications, presented by Publishers and others to the Library of the Imperial Institute since December 18th, 1905.

Hazell's Annual for 1906 . . .	Edited by W. Palmer B.A. (*Messrs. Hazell, Watson & Viney, Ltd.*)
Mission Émile Laurent (1903–1904). Énumeration des Plantes récoltées par Émile Laurent pendant sa dernière Mission au Congo. Fasc. 1 et 2	By É. de Wildeman. (*Author.*)
A Tropical Dependency. An Outline of the Ancient History of the Western Soudan, with an account of the Modern Settlement of Northern Nigeria	By Flora L. Shaw (Lady Lugard). (*Messrs. J. Nisbet & Co.*)
Report of the Perth Chamber of Commerce, 1904–1905	(*The Secretary.*)
The Paper Mills Directory of England, Scotland, and Ireland, and Year Book of the Paper-making Trade for 1906	(*The Editor.*)

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SCIENTIFIC AND TECHNICAL DEPARTMENT.

REPORTS ON RECENT INVESTIGATIONS.

TIMBERS FROM THE BRITISH EAST AFRICA PROTECTORATE.

THESE samples of timbers were sent to the Imperial Institute by Mr. E. S. Grogan, and have been examined, with a view to their commercial utilisation, at the request of the Colonial Office. The following information was supplied with the samples :—

"These samples of wood were collected in the Mau Forest, situated west of the Eldama Ravine Station. The three samples of white wood are from a Podocarpus, presumably the *Podocarpus falcata* (R. Br.). The three samples of red wood are from a juniper, presumably *Juniperus procera* (Hochst).

"These two timbers form probably 95 per cent. of the contents of the forest in the Eldama Ravine; the other 5 per cent. consists of hardwoods. They practically do not appear below an altitude of 7,000 feet, and the proportion of these woods to hardwoods increases with the altitude. They are distributed through all the high altitude forest areas of British East Africa which I have seen, but their proportion to other harder woods appears to be generally only about 10 to 25 per cent.

"I attribute the peculiarity of the Eldama Forest to its sheltered position, lying, as it does, between the Kamasia, the Elgago and Londiani Mountains, and to the exceptionally heavy rainfall which it enjoys. On the 8,000 feet contour and in the pocket of this forest area the trees grow to great perfection, and the general average of timber contents appears to be not less than 20 standards to the acre; in some portions it rises to 50 standards. The Podocarpus and the juniper are about equally distributed. The following facts about each kind may be of use.

"*Podocarpus.*

"These trees are almost uniformly perfect. They taper very slightly, and show long symmetrical straight trunks measuring 20 to 120 feet to the first branch; the diameters at 6 feet from the ground run from 1 foot 6 inches to 3 feet 6 inches. The wood seems to be extraordinarily free from knots. There is reason to believe that it shows no resistance to the attacks of white ants, and its durability under exposure is probably not greater than the mean of the various pines.

"*Juniperus.*

"These trees are not so uniformly perfect as the Podocarpus, but in the interior of the forest they were generally sufficiently perfect to excite the admiration of the two Canadian lumbermen who were working with me, and who stated that they are immeasurably superior in this respect to the American junipers. In some of the outlying and more exposed parts of the forest they are somewhat marred by the development of 'buttresses' and the undoubted presence of spikes and 'wind-shakes.' Their height to the first branch runs from 20 feet to 80 feet, and their diameter 6 feet from the ground from 1 foot 6 inches to 7 feet.

"They taper much more than the Podocarpus.

"The colour of the wood ranges from light red to a very deep blood red, but it fades considerably on exposure to the open air. The cedar scent is very striking when the wood is freshly cut.

"Its resistance to decay appears to be very remarkable, and in this respect it is fully equal to the timber of *Juniperus Virginiana.* We cut into a number of old windfalls, some of which showed evidence of having been down for fully fifty years, and, despite the dampness and confined atmosphere of the forest, the heart was in every case quite sound. It appears to resist decay to the last fibre.

"A small log was brought out of the forest and left by the roadside near the Ravine Station for six months, in a locality where white ants were very numerous. They had built mounds along both sides of the log, and had cut grooves along the sapwood below the bark, but in no part had they touched the red wood. The scent, however, of this log had remained very strong."

Examination of the Timbers.

The samples of timbers were too small to permit of the determination of their mechanical constants, but were large enough to enable trials of their working qualities to be made. They were therefore sent to Mr. Herbert Stone, who very kindly undertook this work, and who has supplied to the Imperial Institute the following report on the working qualities of the two timbers :—

"*Podocarpus Timber.*

"The yellow wood is a good example of the class of timber afforded by the various species of the genus Podocarpus to which the common Outeniqua and upright yellow woods of Cape Colony and Natal belong. It is so similar to these woods that its qualities may be expressed in almost identical terms, that is to say, it is a straight-grained, easily-worked wood suitable for house building, and such purposes as those to which deal is put. It should be of great value in the locality in which it grows and wherever the freight enables it to compete with deal. It is unlikely that it will pay to export to Europe, as the freight alone will cost about *7d.* per cubic foot, so that, after paying all charges, there would be nothing left for the exporter. The converse would be the case in the South African market, where timber is scarce, and deal is imported from Europe in large quantities. There this yellow wood would have the advantage of the shorter voyage, and, being of much larger scantling and similar to the already known Colonial yellow woods, it would in many cases be preferred to deal. It planes, saws and works without trouble, and is a capital carpenter's wood, though not suitable for turnery. It polishes well without much trouble, but not being in any way ornamental it will be little employed for highly-finished articles.

"Weight of sample No. 1, 35½ lb.; sample No. 2, 36 lb. per cubic foot. It breaks with a fracture, indicating brittleness.

"*Juniperus or Pencil Cedar.*

"The three specimens of pencil cedar are worthy of remark.

"There appear to be two varieties, whose chief differences are in the width of the white sapwood. No. 1 has a thick sapwood some 1½ inches wide. The wood is of excellent colour, straight in the grain, and in every respect similar to the Florida pencil cedar, from which it is indistinguishable. I do not think that any one in the trade could distinguish this wood from the commercial pencil cedar.

"It turns and polishes equally well and works in all respects the same. This wood has an important future before it, and, inasmuch as the great bulk of Florida pencil cedar now coming to market is of small dimensions and in far too many cases defective, such immense logs as this specimen was evidently cut from will be eagerly sought after. I venture to say that if proper precautions are taken to avoid sending imperfect logs, or logs of indifferent colour, this wood will rapidly displace that coming from America. Weight per cubic foot, $37\frac{1}{2}$ lb.

"Specimen No. 2 has a thin sapwood not exceeding $\frac{1}{2}$ inch. It is not of equal quality to No. 1, being of indifferent colour, *i.e.* it is too light-coloured in parts. While no doubt useful for many purposes to which pencil cedar is put, it will scarcely meet the exacting requirements of the pencil and penholder makers. I strongly recommend that this quality be not exported, otherwise the whole of the wood from the locality may be doubted; nevertheless its value for many purposes in the locality will be very great.

"No. 2 appears to me to be upland-grown wood, and Nos. 1 and 3 from lowland and swampy districts. Weight of No. 2 per cubic foot, $41\frac{1}{2}$ lb.

"Specimen No. 3 is of similar quality to No. 1. Weight per cubic foot, 39 lb.

"All the specimens were sound, sweet-scented and very dry. They all turn, plane and polish excellently, these being the chief needful qualities of pencil cedar."

In addition to examining the working qualities of the timbers, Mr. Stone submitted samples of the pencil cedar to various firms in this country who use timber of this type, and, as a result, considerable interest in it has been created, and several firms of importers have entered into negotiations with those interested in the exploitation of this pencil cedar in the East Africa Protectorate for supplies of the timbers. Samples of both the Podocarpus and pencil cedar woods can be seen at the Imperial Institute by those interested in woods of these types.

"DIKA NUTS" FROM SOUTHERN NIGERIA.

SAMPLES of unshelled "dika nuts," of the so-called "dika" or "Gaboon chocolate," and of the sun-dried kernels of the nuts, were forwarded to the Imperial Institute for examination by H.M. Commissioner for Southern Nigeria.

DESCRIPTION OF SAMPLES.

"Dika" or "Gaboon Chocolate."

The sample consisted of a single round cake about 6 inches in diameter. It was of a dirty brown colour externally and was brownish-white internally. It was friable and possessed a mouldy odour, which was masked to some extent by the aroma of the pepper which had been incorporated with the material in preparing the cake.

This sample was compared with a specimen of "dika chocolate" supplied by the Director of the Royal Gardens, Kew. The Kew sample is similar to that now sent from Southern Nigeria, but is somewhat harder, and internally is much darker in colour. It possesses also a curious aromatic odour quite distinct from that of the new specimen from Southern Nigeria. The Kew sample appears to have been cut from a circular cake about 6 inches in diameter. This so-called "dika chocolate" consists of the ground fresh kernels of the nuts, from which a portion of the fat has been removed, worked up into cakes with pepper and salt. The "chocolate" is a staple article of food among West African natives.

Undecorticated "Dika Nuts."

The supply of undecorticated nuts weighed about 50 lb. On examination it was found that only about 5 per cent. of the nuts were sound. This material was therefore unsuitable for detailed investigation.

Sun-dried Kernels.

About 3 lb. of this material were received. The kernels were prepared by cracking the nuts and drying the kernels in the sun. On cracking the nut the kernel splits into two halves, and this sample consisted almost entirely of such split kernels. The material was in good condition when received, and a portion of the sample which has been retained for reference shows no sign of decomposition after preservation for over a year, the white surfaces of the split kernels being still unattacked by fungi. It is evident, therefore, that the sun-dried kernels, when carefully prepared, may be kept for some considerable time without undergoing decomposition.

Results of Examination.

Portions of the sample of "dika nuts" and of the kernels were submitted to an expert, and the following observations on these materials have been kindly supplied by him to the Imperial Institute:—

"The 'dika nuts' were examined immediately on arrival. The kernels in these were, however, found in so advanced a state of mouldiness that it was considered useless to extract any fat from them. The sound nuts yielded 20 per cent. of kernels. The sun-dried kernels were in a comparatively fresh condition; they contained 54·3 per cent. of fat. This fat, on examination, gave results indicating that it consisted principally of glyceryl esters of fatty acids less complex than stearic acid, the preponderating constituent being apparently lauric acid."

A more detailed account of the chemistry of the fat contained in "dika nuts" is given in a recent paper by Dr. J. Lewkowitsch, who worked with material supplied by the Imperial Institute (*Analyst*, January 1906).

Commercial Valuation.

The foregoing results indicate that the "dika fat" expressed from the sun-dried kernels would be suitable either for soap or candle manufacture, and for these purposes it would be worth from £25 to £27 per ton, and the "dika kernels" probably from £10 to £12 per ton. It would not be advisable to ship the unshelled "dika nuts" from Southern Nigeria to this country, since the cost of transport would thereby be materially increased, and the cost of decortication in this country would be high, so that it is unlikely that the unshelled nuts could be sold here at a remunerative price.

It is clear, therefore, that the "dika nuts," if they can be obtained in large quantities in Southern Nigeria, and can be collected and shelled at small cost, should be a valuable product for export.

It will, as already indicated, be necessary to shell the nuts before export. On this point H.M. Commissioner for Southern Nigeria states, in forwarding the samples, that the hand-kernel extracting machines at present sent out to Southern Nigeria by merchants, to be employed in extracting palm kernels are too heavy to be worked by women and boys, and for that reason are not much used. Several firms of engineers and merchants are at present engaged in attempting to solve the problem of devising a simpler nut-cracking machine suitable for use in West Africa, but so far no machine, other than those placed on the market by Miller Brothers of Liverpool, and by a German firm, which are already known throughout West Africa, is available for this purpose. The first of these has been tried at the Imperial Institute with "dika nuts," and, when used with care, appears to be suitable for extracting the kernels. If one of these two machines cannot be used, it will apparently be necessary to have recourse to cracking the nuts by hand until a lighter machine becomes available. In exporting the kernels it will be necessary to dry them in the sun before shipment, in order to avoid fermentation during transit.

The foregoing considerations have reference only to the export of the "dika kernels" to be used in this country for the extraction of fat for industrial purposes, such as the manufacture of candles or soap. The expert is, however, of opinion that the "dika fat" might, if obtained fresh, be used for the preparation of edible fats, such as butter or lard substitutes, in which case it would bring higher prices. For this purpose it is essential that the fat should be free from any trace of rancidity, and consequently it would be necessary to extract it from the kernels while these are still comparatively fresh. This could best be done in Southern Nigeria. It is stated that several firms of West African merchants have already considered the possibility of erecting oil-pressing machinery in Southern Nigeria, and that up to the present the cost of fuel and the scarcity of labour have been regarded as serious if not insuperable obstacles in the way of such an enterprise. In these circumstances it scarcely appears likely that the extraction of fat from the "dika nut" can be undertaken in Southern Nigeria at present. Failing this, it might be found possible to export the sun-dried kernels in a state in which they would still yield their fat in a fairly fresh condition. The possibility of this could only be definitely ascertained by sending to this country a small consignment of the kernels, and having the fat expressed from these and tried technically for the manufacture of edible fats.

COTTON FROM BRITISH NORTH BORNEO.

IN connection with the general inquiry which is being carried on at the Imperial Institute with reference to the extension of cotton cultivation in British territory, a letter was addressed to the Acting Governor of British North Borneo asking for particulars with regard to the prospects of cotton cultivation in that Colony, and also for representative samples of the products.

In reply, information was received to the effect that hitherto the cultivation had only been carried on experimentally, but that efforts were being made to induce the natives to take up the industry systematically. Subsequently samples of ginned cotton and of cotton bolls were forwarded to the Imperial Institute for examination. It was stated that these products had been grown in the Government Garden at Fort Birch, the present interior terminus of the railway.

The samples have been examined in the Scientific and Technical Department, and the results of the investigation are given below.

The cotton was of a fairly even cream colour with occasional yellow stains; it was rather coarse and harsh to the touch, curly, and 1·3–1·7 inches long but contained a small proportion of shorter fibres. The strength of the cotton was fairly good but some portions were weak owing to the presence of immature fibres.

The bolls were small, three-valved, and many of them were withered, owing probably to the attack of some insect pest.

The seeds were of the "kidney" variety, the clusters being small and each containing from four to eight seeds, which varied from light to dark brown in colour. The cotton could be easily detached from the seed. The unginned cotton yielded approximately 27·5 per cent. of "lint."

The commercial experts reported that the ginned cotton was very clean, but of short, rough staple, and worth $5\frac{1}{4}d.$ per lb., "Middling American" cotton being quoted at $5.38d.$ per lb. on the same date.

There can be no doubt that this cotton is capable of considerable improvement, and with careful cultivation would yield a staple of very good quality. The principal defects observed in the present sample were irregularities in length and strength, which were due partly to the presence of immature fibres and partly to injury caused to the crop by some insect pest.

AGAVE AND *FURCRÆA* FIBRES FROM MADRAS.

THESE samples of fibre were forwarded to the Imperial Institute by the Agri-Horticultural Society, Teynampett, Madras. It was stated that the plants had been grown at Madras, Bangalore, and Chickmagalur in the Kadur district, that is, at sea-level, and at 3,000 and 4,000 feet above the sea-level respectively.

The samples have been submitted to chemical and mechanical tests in the Scientific and Technical Department of the Imperial Institute, and have been referred to commercial experts for valuation. A description of the fibres and an account of the results of the investigation are given below.

SAMPLE NO. 1 (*Agave Vera-Cruz*).—This sample of *Agave Vera-Cruz* fibre from Chickmagalur, Kadur, was of a dirty white colour, and had not been well cleaned and prepared, but still retained some adherent green matter. The material was rather weak and irregular in strength, and varied in length from 3 to 4 feet.

The results of the chemical examination of this sample are as follows :—

Moisture, per cent.	9·1
Ash, per cent.	2·5
α-Hydrolysis, loss per cent.	19·8
β-Hydrolysis, „ „ „	21·4
Acid purification, loss per cent.	5·7
Mercerisation, loss per cent.	12·2
Nitration, gain per cent.	39·1
Cellulose, per cent.	71·4

From a comparison of these results with those obtained with other Indian specimens of *Agave* fibres which have been examined in the Scientific and Technical Department of the Imperial Institute (see table on p. 28), it is evident that the present sample suffers considerable loss when boiled with dilute alkali (α- and β-hydrolysis). It is probable, however, that this loss is largely due to the extraction by the alkali of gummy matter which was not removed during the preparation of the material, since the greater part of the loss takes place during the first five minutes' boiling (α-hydrolysis), and the additional loss after an hour's boiling is comparatively small. It is probable that, if well prepared, the fibre would be of a good, durable quality. The proportion of cellulose in the fibre is somewhat low, but this, again, is no doubt due to the presence of the impurities already mentioned.

The commercial experts reported that the fibre was worth about £24 to £25 per ton, but that, if well prepared and thoroughly cleaned, it would probably be worth from £26 to £28 per ton in the London market.

SAMPLE NO. 2 (*Agave Vera-Cruz*).—This sample of *Agave Vera-Cruz* fibre from Madras had been badly prepared and incompletely cleaned, a good deal of green matter still remaining attached to it.

The material was of brownish colour, of rather poor strength, and had a length of staple varying from 3 feet 9 inches to 4 feet 5 inches.

On chemical examination the following results were obtained:—

Moisture, per cent.	9·1
Ash, per cent.	3·4
α-Hydrolysis, loss per cent.	19·5
β-Hydrolysis, " " "	21·6
Acid purification, loss per cent.	4·5
Mercerisation, loss per cent.	12·7
Nitration, gain per cent.	38·0
Cellulose, per cent.	72·5

These figures show that in chemical behaviour and composition this fibre closely resembles Sample 1, and the same conclusions may be drawn with regard to the quality of the product.

The commercial experts reported that the fibre was of inferior quality, had not been well cleaned, and was worth from £22 to £22 10*s*. per ton in the London market.

Sample No. 3. Sisal Hemp.—This sample of Sisal hemp from Madras consisted of pale straw-coloured lustrous fibre, which had been well cleaned, and was of fairly good but rather irregular strength. The length of staple varied from 3 feet 9 inches to 4 feet 3 inches.

On chemical examination the fibre furnished the following results:—

Moisture, per cent.	9·3
Ash, per cent.	1·5
α-Hydrolysis, loss per cent.	13·6
β-Hydrolysis, " " "	16·9
Acid purification, loss per cent.	2·9
Mercerisation, loss per cent.	10·8
Nitration, gain per cent.	33·1
Cellulose, per cent.	75·7

These figures show that the sample is of fairly good quality, although somewhat inferior to a specimen of Sisal hemp from Saharanpur, which has also been examined in the Scientific and Technical Department of the Imperial Institute (see table on p. 28). This inferiority is shown particularly in the greater loss sustained on hydrolysis and in the lower percentage of cellulose, and is probably mainly due to the present sample not having been so well cleaned as that from Saharanpur.

The commercial experts reported that the fibre was fairly well cleaned, of medium length and fair colour, and worth from £29 to £30 per ton in the London market.

Sample No. 4. Sisal Hemp.—This sample of Sisal hemp from Lal Bagh, Bangalore, resembled sample No. 3, but was somewhat cleaner and rather coarser. The material was of good strength and had a length of staple 4½ to 5 feet.

The following are the results of the chemical examination of this sample:—

Moisture, per cent.	9·3
Ash, per cent.	1·2
α-Hydrolysis, loss per cent.	11·4
β-Hydrolysis, " " "	16·0
Acid purification, loss per cent.	2·1
Mercerisation, loss per cent.	8·4
Nitration, gain per cent.	41·2
Cellulose, per cent.	77·6

These results show that this fibre resembles the preceding sample of Sisal hemp, but is somewhat superior to it, especially in richness in cellulose. It is, however, inferior to the sample from Saharanpur referred to above.

The commercial experts reported that the fibre was of good quality, length and colour, and had been fairly well cleaned, but contained some hard, imperfectly prepared strands, and that it was worth £31 to £32 per ton in the London market.

SAMPLE NO. 5 (*Agave Wightii*).—This sample of the fibre of *Agave Wightii* from Madras consisted of lustrous, pale straw-coloured fibre which had been fairly well cleaned, but still retained a small quantity of adherent green matter. The material was of rather poor strength and had a staple 2 to 2½ feet long.

On chemical examination it yielded the following results:—

Moisture, per cent.	9·9
Ash, per cent.	2·6
α-Hydrolysis, loss per cent.	16·3
β-Hydrolysis, " " "	18·7
Acid purification, loss per cent.	2·9
Mercerisation, loss per cent.	10·9
Nitration, gain per cent.	14·2
Cellulose, per cent.	75·2

These figures show that the fibre is of fair quality, but rather susceptible to the action of alkali. The greater part of the loss in weight on hydrolysis is sustained, however, during the first five minutes' boiling (α-hydrolysis), and appears to be due rather to the presence of gummy impurities which were not removed during the preparation of the material, than to attack of the actual fibre substance. There can be no doubt that this product would be of good serviceable quality if more care were exercised in its preparation.

The commercial experts reported that the fibre was soft, of fair colour and fairly clean, but contained some coarse ends and hard, imperfectly prepared strands. The value of the material was estimated at £22 to £23 per ton in the London market.

SAMPLE NO. 6. MAURITIUS HEMP (*Furcræa gigantea*).—This sample of Mauritius hemp from Lal Bagh, Bangalore, was of a pale greenish-brown colour, and had been very imperfectly prepared. The product was fairly strong, and from 3 feet 6 inches to 4 feet 3 inches in length.

The results of the chemical examination are as follows:—

Moisture, per cent.	9·3
Ash, per cent.	2·1
α-Hydrolysis, loss per cent.	17·1
β-Hydrolysis, „ „ „	23·9
Acid purification, loss per cent.	6·1
Mercerisation, loss per cent.	12·0
Nitration, gain per cent.	28·0
Cellulose, per cent.	70·3

On comparing these results with those furnished by another Indian sample of *Furcræa gigantea* examined in the Scientific and Technical Department of the Imperial Institute (see table on p. 28), it is apparent that the quality of the present sample is decidedly inferior. This is indicated by the greater losses sustained on hydrolysis and mercerisation, the smaller proportion of cellulose and the smaller increase of weight on nitration, and it is therefore probable that this sample would be less valuable and durable.

The commercial experts reported that the sample consisted of rather short and coarse fibre, which was of a poor, dull colour, had not been well cleaned, and was worth £23 to £24 per ton in the London market.

The results obtained in the chemical investigation of these six samples are collected together in the following table, to which are added, for convenience of comparison, the corresponding values given by other specimens of Indian *Agave* and *Furcræa* fibres previously examined in the Department.

	Samples from the Agri-Horticultural Society.						Samples previously received.		
	No. 1. *Agave Vera-Cruz* from Chickmagalur.	No. 2. *Agave Vera-Cruz* from Madras.	No. 3. Sisal Hemp from Madras.	No. 4. Sisal Hemp from Bangalore.	No. 5. *Agave Wightii* from Madras.	No. 6. Mauritius Hemp from Bangalore.	*Agave species* from India (No. 16,260).	Sisal Hemp from India (No. 8,327).	*Furcraea gigantea* from India.
Moisture, per cent.	9·1	9·1	9·3	9·3	9·9	9·3	9·7	9·1	9·8
Ash, per cent. . .	2·5	3·4	1·5	1·2	2·6	2·1	1·5	0·8	—
α-Hydrolysis, loss per cent. . . .	19·8	19·5	13·6	11·4	16·3	17·1	9·8	8·6	12·3
β-Hydrolysis, loss per cent. . . .	21·4	21·6	16·9	16·0	18·7	23·9	15·7	15·1	14·5
Acid purification, loss per cent. .	5·7	4·5	2·9	2·1	2·9	6·1	2·4	1·6	1·7
Mercerisation, loss per cent. . . .	12·2	12·7	10·8	8·4	10·9	12·0	7·1	12·3	11·4
Nitration, gain per cent.	39·1	38·0	33·1	41·2	14·2	28·0	34·0	37·5	40·6
Cellulose, per cent.	71·4	72·5	75·7	77·6	75·2	70·3	79·6	81·4	77·7

Experiments have been made with the object of ascertaining the comparative strength of these fibres. For this purpose the breaking strain of single fibres (or filaments) of the material was determined, a large number of tests being made with each sample of fibre. A great variation was found in the strength of the individual fibres (or filaments) of any particular sample corresponding more or less with the variation in their diameter. On taking the average of the results in each case, the comparative strength of the samples was found to be as follows, the greatest strength observed, viz. that of sample No. 4, being represented as 100:—

Sample.	Comparative strength.
No. 4. Sisal hemp	100
No. 3. " "	87·5
No. 6. Mauritius hemp	81·0
No. 2. *Agave Vera-Cruz* fibre	62·7
No. 5. *Agave Wightii* fibre	57·9
No. 1. *Agave Vera-Cruz* fibre	55·3

CONCLUSIONS.

The results of this investigation show that the fibres, although of fair, marketable quality, could be considerably improved by the exercise of greater care in their preparation.

It was, unfortunately, impossible to ascertain the influence of the elevation at which the plants were grown on the strength and quality of the fibre produced, since the variation in the degree to which the samples had been cleaned was so considerable as to obscure the inherent quality of the actual fibre substance. In this connection it is interesting to notice that the commercial experts stated that the comparative market value of the various fibres of this class is very uncertain, as most of them are very imperfectly cleaned, and that consequently the value is influenced to an unusual extent by the condition of the fibre.

RUBBERS FROM SIERRA LEONE.

THREE samples of rubber, accompanied by incomplete botanical specimens of the plants from which they were obtained, were forwarded to the Imperial Institute from Sierra Leone in order that their quality and commercial value might be ascertained. The specimens had been collected in the Panguma district of the Protectorate, and the three varieties of rubber are known by the natives as Jenje, Gbogboi and Njawa respectively.

1. *Jenje Rubber.*

The vine which yields this rubber is known by the natives as Poré, and appears to be a species of *Landolphia*, closely related to *L. owariensis*, Beauv., though its identity cannot be definitely determined from the specimens available. It may be noted in this connection that Mr. Scott Elliott brought back from Sierra Leone a sample of "Djenge" rubber, and the corresponding botanical specimens were identified as *Landolphia Heudelotii*, A. DC., var. *Djenge*, Stapf. Further specimens of the Poré vine will consequently be required before its identity can be definitely established.

The sample of Jenje rubber consisted of a large ball which weighed about 12 ounces, and had been formed by the aggregation of fairly thick strips. The rubber was dark brown, slightly sticky in places, and fairly free from vegetable fragments; it exhibited very good elasticity and tenacity.

The chemical examination furnished the following percentage results :—

	Sample as received.	Dry material.
Moisture	3·2	—
Caoutchouc	85·8	88·6
Resin	5·8	6·0
Albuminoid matter . .	2·0	2·1
Vegetable impurity . .	3·2	3·3
Ash	1·98	2·04

These figures show that the sample is of good quality, there being 88·6 per cent. of true rubber in the dry material, whilst, on the other hand, the percentages of resin and albuminoid matter are low.

The sample was submitted to brokers, who valued it at about 3*s*. 9*d*. per lb. in London, when fine hard Para was selling at 5*s*. 5½*d*. per lb.

2. *Gbogboi Rubber.*

This rubber is derived from a tree bearing the same name, and the specimens of the leaves have been identified at Kew as belonging in all probability to *Funtumia elastica*, Stapf, the West African rubber tree.

The existence of *Funtumia elastica* in Sierra Leone is a point of considerable importance, concerning which a great deal of doubt has hitherto existed, and complete botanical specimens of the Gbogboi tree have been requested, so that the above determination can be properly confirmed.

The sample of rubber was a large, dark-coloured ball which weighed about 10 ounces. It was slightly sticky and contained a considerable amount of vegetable impurity, but exhibited good elasticity and tenacity.

On examination it was found to have the following percentage composition :—

	Sample as received.	Dry material.
Moisture	2·1	—
Caoutchouc	80·3	82·0
Resin	4·3	4·4
Albuminoid matter . .	2·5	2·5
Vegetable impurity . .	10·8	11·1
Ash	2·35	2·40

These results show that, so far as chemical composition is concerned, the rubber would be satisfactory if it were not for the large amount of vegetable impurity present. The percentages of resin and albuminoid matter are low, and there is no doubt that, if carefully collected and prepared, this rubber would be of very good quality. The present sample is rather unsatisfactory in physical characters owing to its stickiness, which has probably been caused by over-heating.

The sample was submitted for commercial valuation to brokers, who stated that it would be worth about 2*s.* 3*d.* per lb. in London. There is little doubt, however, that a carefully prepared sample free from stickiness would fetch a much higher price.

3. *Njawa Rubber.*

The plant yielding this rubber is described as a vine, known as Sagba, but its botanical identity remains uncertain.

The sample of rubber, weighing about 8 ounces, consisted of a thick cake which was purplish-black externally but whitish within when freshly cut; it was almost free from vegetable impurity, but possessed a very unpleasant odour. The rubber was rather deficient in both elasticity and tenacity, elongating a little and ultimately tearing when stretched.

The chemical examination furnished the following percentage results:—

	Sample as received.	Dry material.
Moisture	3·6	—
Caoutchouc	71·1	73·8
Resin	21·3	22·1
Albuminoid matter	2·9	3·0
Vegetable impurity	1·1	1·1
Ash	0·41	0·42

These figures show that the rubber is of very resinous character, 22 per cent. of this constituent being present in the dry material, and the composition as shown by the analysis fully accounts for the deficiency in elasticity and tenacity.

The sample was valued by brokers at about 3*s.* 3*d.* per lb. in London.

GENERAL NOTICES RESPECTING ECONOMIC PRODUCTS AND THEIR DEVELOPMENT.

INDIAN ACONITES AND THEIR POISONOUS CONSTITUENTS.

THE genus *Aconitum* belongs to the natural order *Ranunculaceæ*, and comprises nearly two hundred species, which are chiefly inhabitants of the Northern temperate zone. The members of this genus indigenous to India are but a small proportion of these, and are distributed along the mountainous tracts which form the geographical frontier of India, from Afghanistan, Baluchistan, Hazara, Kashmir, Kumaon, Nepal, Sikkim and Bhutan on the north and north-west, to the mountains of Assam, Manipur and Burma on the east and north-east.

Although the medicinal and poisonous properties of these plants have been known to the natives of India from very remote times, botanical and chemical knowledge concerning them has until recently been in a very unsatisfactory state owing to the difficulty of classification and identification, and the confusion caused by the different results obtained by successive investigators.

A systematic study of the alkaloids of the Indian aconites has been carried on for some years past in the Scientific and Technical Department of the Imperial Institute. The material for this investigation has been collected principally by Sir G. Watt, formerly Reporter on Economic Products to the Government of India, and latterly by his successor, Mr. I. H. Burkill. These collections of roots have been sent from time to time to the Imperial Institute, and have been utilised for investigations on the chemistry of the Indian aconites, whereby a number of new alkaloids have been isolated. Side by side with these chemical investigations the physiological action of the various alkaloids has been studied by Prof. Cash at Aberdeen. The botanical side of the question has been worked at by Dr. Otto Stapf, of the Royal Gardens, Kew, who, after an exhaustive study of practically the whole of the existing herbarium material of the Indian aconites, has recently published a monograph (*Ann. Roy. Bot. Gard. Calc.*, 1905, Vol. x., Part 2) embodying the results of his revision and classification.

As the result of this chemical investigation and of the botanical work carried on by Sir G. Watt in India, and by Dr. Stapf in this country, much progress has been made, and it has been considered worth while to summarise the present state of knowledge on the subject in the *Bulletin*.

Classification of the Aconites.

A transverse section of an aconite root exhibits a peculiar marking, which varies in different species, and is of interest, especially as affording a ready means of identifying the various roots as they occur in commerce. Though various attempts were made, notably by Meyer, to utilise the anatomical differences of aconite roots for purposes of classification, it was not until 1901 that any satisfactory results were obtained in this way, and these are due principally to the work of Goris (*De la structure des aconites et de son utilisation pour la détermination specifique des aconites de l'Inde. Bulletin des Scien. Pharmacol.*, 1901, **3**. 103).

This investigator referred the principal Indian species and varieties then known to three types, thus:—

Name of type.	Species and Varieties included in type.
"Napellus."	"*A. Napellus*," "*A. ferox*, var. *laciniatum*," and "*A. ferox*, var. *spicatum*."
"Atrox."	"*A. ferox*, var. *atrox*," and "*A. ferox*, var. *polyschiza*."
"Anthora."	"*A. heterophyllum*" and "*A. palmatum*."

Stapf has greatly extended the examination of the root structure of Indian aconites and recognises three main types.

1. GYMNACONITUM TYPE.—This includes species of annual duration, of which only one is known—*A. gymnandrum*.

2. LYCOCTONUM TYPE.—The roots belonging to this section are perennial, and include of the Indian species—*A. laeve*, *A. luridum*, *A. moschatum*.

3. NAPELLUS TYPE.—The greatest number of species belong to this type; the roots are biennial and normally paired. These

are further sub-divided according to their root structures, into what are essentially Goris' three types, the last being named "*deinorrhizum*" instead of "*atrox*."

1. "Napellus type."	2. "Anthora type."	3. "Deinorrhizum type."
A. soongaricum.	*A. rotundifolium.*	*A. deinorrhizum.*
A. chasmanthum.	*A. heterophyllum.*	*A. Balfourii.*
A. violaceum.	*A. naviculare.*	
A. Falconeri.	*A. palmatum.*	
A. spicatum.	*A. Hookeri.*	
A. laciniatum.		
A. ferox.		
A. heterophylloides.		
A. leucanthum.		
A. dissectum.		
A. (*Jaduar*).		

The new species, *A. spicatum*, *A. laciniatum*, *A. deinorrhizum* and *A. Balfourii*, in the above classification have hitherto been regarded as varieties of *A. ferox*, Wall.

"*Bish*" *or* "*Bikh*" *Root.*

The words "bish" and "bikh" have been used indiscriminately throughout India from the earliest times to designate the poisonous species of Indian aconite, except in Sikkim, where "bikh" is applied more particularly to *A. spicatum.* Owing to this indiscriminate use of the word great confusion has arisen as to what the "bikh" root of European commerce is.

An Indian aconite, "Vatsanabha," is quoted by Susrutas in his *Ayurvedas* as a bulb poison. Dutt gives the same name for "Aconitum ferox," which stands here for all or most of the poisonous aconites of which the roots reach the Indian market. About the eighth century the Greeks and Egyptians included the poisonous Indian aconites in their pharmacopœias under the generic name of "Bish" (Sanskr. *Visha*).

In the beginning of last century Hamilton, who spent a considerable time in that part of the Himalayas which had supplied India with "bish" from the earliest times, said regarding this aconite, "This dreadful root, of which large quantities are annually imported, is equally fatal when taken into the stomach and applied to wounds, and is in universal use throughout India for poisoning arrows, and, there is too much reason to suspect, for the worst purposes. . . . The Gorkhalese pretend that it is one of their principal securities against invasion from the low countries; and that they could so infect all the waters on the route by which an enemy was advancing as to occasion his certain destruction."

In 1817 Wallich procured specimens of "bish" plants from Nepal, and observed variations in the plants, which he assumed were different states of a very variable plant, rather than distinct species, and consequently included all the forms in *A. ferox.* It thus came about that *A. ferox* was considered the source of "bikh," and the name stood for a considerable time for any poisonous aconite found in India. In 1848 and 1849 Sir J. Hooker from his observations concluded that *A. ferox* was the common *A. Napellus* of Europe; but a few years later, when "Nepal aconite" was imported into England for the first time, it was discovered that the roots contained a new alkaloid (*pseud-aconitine*) which is chemically different from the active principle (*aconitine*) of European *A. Napellus.* Hooker's view was thus proved to be incorrect.

As the result of his investigations Stapf states "he is convinced that the European *A. Napellus* does not occur in India, either in its typical form or in what we might be justified in calling varieties of it."

In 1889 Watt, referring to the confusion which then existed with regard to Indian aconites, with the single exception of *A. heterophyllum*, said, "Some are poisonous, others not, and even some of the varieties of one species are poisonous while other varieties are not. The poisonous forms have never been accurately identified, and the result is, that of a given weight of the roots sold in our druggists' shops a certain percentage frequently contains no *aconitine* whatever: indeed, an entire consignment may be perfectly inert."

Bruhl next took up the study of the aconites of India most intimately connected with *A. ferox*, and divided the group *A. ferox*, Wall., into three species: 1. *Moschatum*; 2. *Ferox* (proper); and 3. *Palmatum.* Not only were such markedly different types as *A. Moschatum* and *A. palmatum* included in *A. ferox*, Wall., but several varieties were comprised under his *A. ferox* (proper), six or seven of which are now regarded by Stapf as distinct species. Bruhl's classification was practically adopted by Goris (*loc. cit.*), and by Watt ("The Indian Aconites: their varieties, their distribution and their uses" (*Agricultural Ledger*, No. 3, 1902). By Goris and Watt, *A. ferox*, Wall., was represented as comprising several varieties, although reservations were made concerning certain of these.

It is not yet certain what the "bikh" root of European pharmacy is; Watt and Stapf have stated (*loc. cit.*) that it is probably *A. spicatum*, Stapf. Holmes has arrived at the conclusion that it is probably the root of *A. laciniatum*, Stapf. As will be shown subsequently, *A. spicatum* contains an alkaloid (*bikhaconitine*) which is quite different from *pseudaconitine*, the alkaloid which Hübschmann, Wright, and Dunstan and Carr have each independently isolated from "bikh" root purchased in Europe. It therefore seems improbable that *A. spicatum* is the "bikh" root of European pharmacy. The information at present available concerning the alkaloid of *A. laciniatum* is at present insufficient to afford confirmation of Holmes' statement.

Aconitum chasmanthum, Stapf.

This poisonous aconite occurs widely distributed in Hazara, where it is known as "mohri." It was for some time supposed to be the European *A. Napellus*, but is now recognised as a distinct species. The tubers of the Indian plant are not only smaller, shorter and comparatively thicker, but contain an alkaloid which, although closely resembling *aconitine*—the active principle of European *A. Napellus*—is nevertheless quite distinct. This new crystalline alkaloid, which has been called *indaconitine*, was isolated and chemically examined by Dunstan and Andrews (*Journ. Chem. Soc.*, 1905, lxxxvii. 1620), and its chemical properties have been fully described.

The physiological action of *indaconitine* differs in degree only, and not in kind, from that of *aconitine*, the former alkaloid being slightly less toxic towards warm-blooded animals (Cash and Dunstan, *Proc. Roy. Soc.*, 1905, B. **76**. 468). The European root is at present imported into India for use in medicine, but this will no longer be necessary, as the Indian species can now be utilised for this purpose, and it is possible that this Indian aconite may eventually be used in Europe for the same purpose as the European *A. Napellus*. In this connection the therapeutics and medicinal uses of aconite may be briefly noticed, since all the poisonous aconite alkaloids appear to agree in the nature of their action and differ only in degree.

Aconite—it may be assumed that preparations of the root are administered solely on account of the *aconitine* they contain—is applied for medicinal purposes, either as the tincture or liniment of the root, or as the ointment prepared with the pure alkaloid. Given internally in small doses, it produces tingling of the lips and tongue ; in large doses, tingling often occurs in the extremities, followed by numbness and a feeling of faintness, with weak and often intermittent action of the heart; occasionally there is a considerable increase in the urinary secretion. When an individual is fully under the influence of aconite the pulsations of the heart are diminished in number, as likewise the frequency of the respirations. In dangerous and fatal doses there is loss of sight, hearing and feeling, followed by convulsions, syncope and death. Externally applied, aconite causes at first a tingling of the part, succeeded by numbness and the cessation of local pain.

Aconite has been used externally in the treatment of acute and chronic rheumatism, gout, neuralgia and carcinomatous affections, for the purpose of relieving pain ; in hypertrophy and other diseases of the heart, to allay palpitation ; in dropsy, on account of its diuretic properties. In different forms of neuralgia and in acute and chronic rheumatism and in muscular rheumatism, such as lumbago, its internal administration is often attended with marked relief.

Aconitum deinorrhizum, Stapf, *sp. nov.*

This species is met with west of Nepal to Kunawar, and is stated to be the most important and plentiful of the aconites which grow in this part of the country, and which are collectively designated "mohra."

Roots of this species under the name of *A. ferox*, var. *atrox*, examined at the Imperial Institute, were found to contain the crystalline alkaloid *pseudaconitine* (Dunstan and Carr, *Journ. Chem. Soc.*, 1897, lxxi. 350), which was first examined by Hübschmann in 1868, who used as the source of the alkaloid, Indian aconite roots stated to have been imported into Europe from Nepal.

Pseudaconitine differs from *aconitine* in its chemical characters, but exerts a similar physiological action in a more marked degree.

Aconitum Balfourii, Stapf, *sp. nov.*

Specimens of the mother and daughter tubers of this species collected at Dudatoli (British Garhwal) were examined by Dunstan and Andrews, and found to contain a high percentage of *pseudaconitine*, and the remarkable observation was made that the daughter tubers contained nearly twice as much (1·0 per cent.) *pseudaconitine* as the mother tubers. Two specimens of roots described as *A. ferox*, var. *polyschiza*, from Almora, were also examined and found to be rich in *pseudaconitine*. This result is of some importance, since Stapf had previously classed this supposed variety of *A. ferox* as *A. Balfourii*, and in this way a confirmation of the botanical work from the chemical side was obtained.

Aconitum spicatum, Stapf, *sp. nov.*

This species has hitherto been considered as a variety of *A. ferox*. It is recorded from Garhwal, Nepal, Sikkim and Bhutan, and is generally supposed to be the true Nepal aconite or "bikh" of European pharmacy.

The chemical investigation of this species was undertaken at the Imperial Institute with roots described as *A. ferox*, var. *spicatum*. A new and highly toxic alkaloid which has been named *bikhaconitine* was isolated and examined by Dunstan and Andrews (*Journ. Chem. Soc.*, 1905, lxxxvii. 1636). The results show that it differs in composition and chemical properties from the *aconitine* of English aconite, and resembles *pseudaconitine* both in its chemical and physiological characters. It is, however, quite distinct from *pseudaconitine*. The physiological properties of the alkaloid have been described by Cash and Dunstan (*Proc. Roy. Soc.*, 1905, B. lxxvi. 468).

Aconitum heterophyllum, Wall.

This species is quoted by Susrutas as an ingredient in medicines, and is referred to under the Sanskrit name "Ativisha," which is understood to mean "overcoming poison—antidote." The roots are still regarded by the Hindus as an important medicine and antidote. The species is very abundant on the West Temperate Himalaya, from Kumaon to Kashmir and Hazara, and is extensively exported to the plains of India. The roots can be procured practically in every drug-shop throughout the country, where it is commonly known as "atis" or "atèes."

In Hindu works on materia medica the root is recommended as a remedy in fevers, diarrhœa, dyspepsia and cough. Its utility as a mild and pleasant tonic is universally accepted by native doctors in India.

The roots of *A. heterophyllum* contain an alkaloid, *atisine*, which was first isolated by Broughton in 1873, and was subsequently studied by Wright and by Jowett (*Journ. Chem. Soc.*, 1896, lxix. 1518). This alkaloid is interesting as being non-poisonous in small doses, and in possessing chemical properties quite distinct from those of any of the other aconite alkaloids.

Aconitum palmatum, Don.

This species appears to be distributed from Garhwal through Nepal to Sikkim. At the latter place it is stated to be known as "seto-bikhuma," whereas in the drug-shops of India it is sold under the vernacular names, "bikhma," "bishma," "wakhma" and "vakhma."

The root is traded in throughout India, but is probably mostly used as an adulterant or substitute for "atis" (*A. heterophyllum*). Like those of the latter species, the roots are generally recognised as non-poisonous, but the active principle is not identical with *atisine*, as has been stated by some authorities. The crystalline alkaloid, *palmatisine*, contained in the roots of *A. palmatum* has been isolated at the Imperial Institute. It resembles *atisine* in being non-poisonous.

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THE AUSTRALIAN PEARL-SHELL FISHERY.

THE natives inhabiting the northern coasts of Australia have long been known to carry on an irregular fishing for mother-of-pearl shell, the material being used by them in the manufacture of articles of personal adornment and for making fish-hooks. Ornamented specimens of the shells, which, suspended by a girdle of human hair, serve the purpose of loin-cloths, are to be seen in the Australian Courts of the Imperial Institute. The natives further bartered the shells and the pearls found in them with Malays from Macassar, exchanging them for rice, tobacco, arrac and brightly-coloured cloths.

During the latter half of last century the possibilities of the fishery attracted the attention of Europeans, and at the present day Australian shell holds an important position in the market. It is proposed in the following article to give an account of the present position of the industry, with brief notes on the habits and natural history of the mother-of-pearl oyster in so far as they affect the commercial side of the question.

QUEENSLAND.

The pearl-shell fishery of Queensland is one of the most important minor industries of the State. It is confined to the tropical portion of the Queensland coast-line, being carried out in the immediate neighbourhood of the Great Barrier Reef. The principal localities are Kerr Inlet, Turn Cay, Cook's Shoal, Cook's Reef, Proudfoot Shoal, Booby Island and the Torres Straits. The centre of the industry is at Port Kennedy on Thursday Island, whence expeditions are sent out to the fishing grounds of the Reef, and northwards towards New Guinea. Within recent years discoveries of shell-banks have been made in the north of the Gulf of Carpentaria, and in 1891 Saville-Kent made similar discoveries in the neighbourhood of the Wellesley Islands in the south-east corner of the same gulf.

The Fishery.—The fishery gives employment to nearly three thousand men in all. The divers, with few exceptions, are South Sea Islanders, mainland aboriginals, Japanese, Chinese and Malays; the number of European divers is small, and the men are generally proprietors of their own boats. A considerable proportion of the men are employed ashore at the collecting stations in repairing the boats and gear, and in the preparation and packing of the shell for export.

The vessels engaged in the fishery are generally of small tonnage, the most common type being strongly-built schooners or lugger-rigged craft averaging ten tons' burden. Larger cutters are used as purveyors to the fishing boats, and to bring the shell collected to the home ports. A large proportion of the fleet belongs to New South Wales, Sydney being the port of registry. Each boat is worked by a crew of six hands, including the diver, who acts as sailing-master, a second hand who attends to the life-lines when the diver is at work, and four men who, in pairs, take alternate shifts at the pumping apparatus for supplying air to the diver. The boats, on an average, remain on the fishery grounds for about a month, and provisions for this period are usually taken. It is, however, often necessary to stay out for longer periods, and on such occasions the boats are provisioned by the large collecting cutters.

The Shell.—The pearl-shell oyster of Queensland is known technically as *Margaritifera maxima*, Jameson (*Meleagrina margaritifera*, L.), and is the same as the pearl shell and pearl oyster found in the Malay Archipelago, the Philippines and the Pacific Ocean. The species should not be confused with the Ceylon pearl oyster (*Margaritifera vulgaris*, Schum.), which is a much smaller animal, and differs from the Australian form in several respects.

Two varieties of the oyster are found in the neighbourhood of the Great Barrier Reef. Saville-Kent reports that no differences of internal structure are to be detected in these varieties, whose distinctive characters are to be found only in the shell. In one case this has a well-marked golden edge which readily distinguishes it from the equally abundant form in which the silvery iridescence is uniform throughout. Commercially, the latter variety, which is known in the trade as "White Shell," is more valuable than the golden-edged and other varieties, and always commands the highest price. A third variety is also found closely resembling, except in size, the large black-lipped shell known commercially as the "Tahiti Black." It occurs in the Moreton Bay district, but is most abundant further north; the shell is small, measuring not more than 7 inches in diameter, and weighing 1 lb. to $1\frac{3}{4}$ lb. per pair. This shell has not, up to the present, been put to much commercial use in Queensland, although the development of this branch of the fishery has been urged from time to time, since large quantities of the shell of a closely-allied species are collected off the West Australian coast, chiefly for the sake of the pearls.

Considerable difference of opinion has hitherto existed with regard to the nomenclature of the pearl and pearl-shell oysters. The question is now one of more than purely scientific importance, since the Queensland and other Governments have passed Acts of Parliament providing for the conservation of young immature oysters under a certain specified size. At the time of the drafting of the Queensland Bill, zoologists included under *Meleagrina margaritifera*, L., the small black-lipped variety mentioned above. Saville-Kent's investigations on the Barrier Reef, however, showed that, while the golden-edged, white shell and other forms are merely varieties of the type *M. margaritifera*, the black-lipped shell, which never attains the characters and full dimensions of the type, should be regarded as a distinct species, and therefore the subject of separate legislation, since the Bill, as originally drafted, placed unnecessary restrictions upon the fishery of the black-lipped shell.

Since the passing of the Queensland Act, which was the outcome of Saville-Kent's investigations, an important paper on the identity and distribution of mother-of-pearl shells has been published by Jameson (*Proceedings of the Zoological Society of London*, 1901). The author supports Saville-Kent in his recognition of the black-lipped shell as a distinct variety, and finds that the commercial mother-of-pearl shells found in Australasian waters belong to the following species:—

"White Shell"—*Margaritifera maxima*, Jameson.

"Australian Black-Lip"—*Margaritifera margaritifera*, L.

"Tahiti," "Gambier," "Auckland"—*Margaritifera margaritifera*, L., var. *cumingi*, Reeve.

"Shark's Bay"—*Margaritifera carchariarum*, Jameson.

The trade varieties known as "Manilla," "Mergui" and "Macassar" are merely local races of the "White Shell."

The Australian Shells.—The White Shell is roughly circular in outline, generally with a slightly greater diameter parallel to the "hinge." Specimens are found up to 1 foot in diameter, but the average size is 6 to 9 inches, weighing 2 to 4 lb. per pair. The external surface of the shell is of a uniform light-brown colour when fresh. The nacre is silvery and very white, lustrous, and with or without a golden margin. A form with a pale-pink iridescence is not uncommon.

The Australian Black-Lip is more concave than the preceding species, and measures from 5 to 6 inches in diameter, with a contour having a slightly larger diameter at right angles to the hinge (*cf.* White Shell). The colour and markings of the exterior are very variable, but a characteristic feature is the presence of radial rows of white or yellow spots. The nacre is highly iridescent, often steely in lustre, with a marginal band of dark metallic green, bronze or brassy-yellow iridescence.

Shark's Bay Shell.—A flat shell somewhat resembling a small White in outline. The colour is greenish-yellow or pale grey, with traces of four or five brown or green radial bands. The lustre is not so bright as in the Black-Lip, and has a distinctly yellowish-green tint.

Specimens of these varieties, together with several species of Rock Oyster (*Ostræa*), are on exhibition in the Queensland, New South Wales and West Australian Courts. The West Australian collection is of special interest since it contains the actual specimens described by Saville-Kent in his well-known work, *The Great Barrier Reef of Australia.*

Structure of the Shell.—Pearl shell is composed of three layers, the thickness and colour of the innermost layer or "nacre" determining the value of the shell for commercial purposes. Thus in the pearl oyster of Ceylon the nacre is of singular brilliance, but the thinness of the layer renders the shell of but little value in the arts.

The three layers are:—

(1) The outer delicate horny layer, which becomes more or less worn off in old shells.

(2) The middle or prismatic layer, consisting of polygonal columns of carbonate of lime (aragonite) laid down in an organic matrix.

(3) The inner nacre, formed of numerous delicate alternating lamellæ of organic material and calcareous matter. It is transparent and almost structureless under the microscope, but the layers of which it is composed appear as a series of closely-approximated contour lines. The unequal diffraction of light by the free edges of the lamellæ results in an interference phenomenon to which the characteristic iridescence is due.

Trade.—The pearl-shell industry roughly maintains its relative position of importance among the industries of Queensland in spite of the uncertainty of prices. In 1891 shell to the value of £80,865 was exported, standing eighth in the list of exports. Four years later the export was valued at £71,808, and occupied the ninth place; and in 1903 the tenth place was taken. The following figures show the value of the export in recent years; it will be noticed that a heavy fall occurred in 1904. In each case the figures include those for a small export of tortoise-shell.

Year.	Export.	Year.	Export.
1891	£80,865	1901	£108,824
1895	73,528	1902	131,549
1899	140,503	1903	167,658
1900	131,142	1904	86,080

The greater part of the shell is sent to the United Kingdom, Hong Kong and Germany.

The prices obtained at the present day are much below those of former years, no doubt largely owing to increased supplies from other parts of the world. The industry, further, depends to a considerable extent upon the vagaries of taste in fancy ornamental articles, and is, consequently, liable to unexpected periods of depression. Immediately before the discovery of the West Australian shelling grounds about thirty years ago, prices as high as £320 to £400 per ton were obtained for best Manilla Shell. At the present time the finest shell in the market is that from the Torres Straits banks of the Queensland fishery, and the prices realised at recent sales in London (December 1905) are appended. Prices of shell from other localities are included for comparison.

Queensland:—

Bold, £195 to £235 per ton.

Thin medium, £157 10*s.* to £185 per ton.

Chicken, £162 10*s.* to £170 per ton.

West Australian:—

Bold, £157 10*s.* to £210 per ton.

Thin medium, £155 to £172 10*s.* per ton.

Chicken, £155 to £165 per ton.

Manilla:—

Bold, £150 to £180 per ton.

Legislation.—The Queensland fishery is regulated by the Pearl-Shell and Bêche-de-mer Fishery Act of 1898. The Act was largely the outcome of the scientific investigations of Stephen Pace and Saville-Kent, who, in addition to other important work, determined the size limit at which the oysters could be fished without danger of exhausting the beds, and satisfactorily demonstrated the possibility of artificially cultivating the shell, with the result that experimental farms were established at Thursday Island. By the provisions of the Act the minimum size at which oysters can be fished legally is fixed at 5 inches, and certain regulations are made with regard to the nationality of the men engaged in the industry. A licence is also required, the amount being ten shillings per annum for every boat, and three pounds for every ship of ten tons and under, and ten shillings for every ton or part of a ton above ten tons. Further licences are necessary for the occupation of Crown lands in connection with the industry.

WEST AUSTRALIA.

Pearl-shelling in West Australia commenced in 1868, when shell was to be obtained in large quantities by the simple process of gathering it from the inshore reefs at low tide. Available supplies soon became exhausted, and, at the present time, the fishery is carried out on similar lines to the Queensland industry.

Two varieties of shell are extensively fished, the White Shell (*Margaritifera maxima*) and Shark's Bay Shell (*M. carchariarum*). The former is more or less abundant along the whole coast north of Exmouth Gulf, but the chief fishing operations are carried out between the Exmouth Gulf and King's Sound; prolific grounds are said also to exist between the latter locality and Cambridge Gulf. The value of both varieties of shell is considerably increased by the frequent occurrence in them of pearls, the approximate annual value of the pearls alone being estimated at £30,000.

The Shark's Bay Shell in former years was the object of an important fishery. The utilisation of the American Mississippi mussel for small pearl buttons, for which purpose the Shark's Bay Shell was formerly extensively used, has, however, resulted in a heavy fall in prices, which, were it not for the pearls found with this variety, would render the fishery unprofitable. The shell occurs along the whole northern coast of West Australia, but large quantities are found only at Shark's Bay.

The methods employed in the fishery for this shell are entirely different from those adopted in the case of the White Shell, owing to a marked difference of growth-habit in the two varieties. The latter oyster occurs in the bank as perfectly free individuals, which only in their young stages are attached to the substratum by the bundle of threads known as the byssus. The Shark's Bay oyster, however, is a social form, and occurs in dense clusters attached by a permanent byssus to one another, or to other objects. This peculiarity of habit permits of the fishery being effected, in deep water, by ordinary oyster dredges, one cutter often working as many as four or five dredges simultaneously. A large number are also gathered by hand from shallow banks left uncovered at low tide.

Reckless dredging of this oyster for the sake of the pearls resulted in the serious depletion of the beds, and, on the advice of Saville-Kent, the Government prohibited the taking of immature shell, and closed certain of the overworked banks. The results have been satisfactory. During 1895–7 the Government further tried the experiment of transplanting the large White Shell to Shark's Bay, in the hope of establishing new banks of the more important shell. Up to the present time the experiment has proved quite successful.

In 1903 about 400 vessels were registered under the Fishery Act, representing a tonnage of 5,985, with an approximate value of £221,000. About 2,800 men were employed, chiefly Asiatics and Africans. The banks are worked in blocks which are held under exclusive licence for fourteen years; the blocks were marked out after the Government survey in 1896.

Trade.—During the last ten years over 6,200 tons of shell, valued at £854,000, have been exported from West Australia. Including the pearls taken with the shell, the industry represents for the same period an approximate total value of £1,154,000. Recent prices of West Australian shell are given above under "Queensland."

SOUTH AUSTRALIA.

A small fishery exists around the coasts of the northern territory of South Australia. Mother-of-pearl shell (*M. maxima*) was discovered at Port Darwin in 1884, and a great rush thither of divers from the Torres Straits took place. In 1885-6 the shell collected was valued at over £7,000, but the industry was gradually abandoned owing to the tides and muddiness of the water interfering with the diving operations. A revival occurred in 1891, and in 1903 fifty boats were engaged in the fishery, and the export reached a total of 126 tons, valued at £28,390. As is so often the case, the banks at the present time show signs of overfishing, and the Government Resident in a recent report says, ". . . there should be an amendment of the (Fishery) Act, or regulations (made) enabling the Government to prohibit fishing in certain localities in order that the pearl-shell beds might recuperate, and to proclaim reserves when deemed expedient." The licensing of divers is also proposed.

NEW SOUTH WALES.

There are no shell-banks occurring within the jurisdiction of New South Wales, but a considerable fleet of vessels, belonging to the port of Sydney, visits the banks belonging to other of the Australian States, the most important being those of Queensland.

INSECTS WHICH ATTACK COTTON IN EGYPT.

THE following account of the principal insects which attack the cotton plant in Egypt is principally based on a report prepared by Mr. G. C. Dudgeon, Superintendent of Agriculture in British West African Colonies and Protectorates, in connection with a visit which he has paid recently to the cotton-growing districts of Egypt with the object of studying the cultivation of cotton in that country. A collection of specimens illustrating the report is on view at the Imperial Institute.

Although for many years these enemies of the cotton plant have been prevalent in Egypt, the farmers have been very slow in recognising them as the cause of injury to the crops, but have attributed their effects to other causes, such as unfavourable temperature or an insufficient supply of water. Even now the most destructive insect pest in Egypt, the Egyptian boll worm, has not had much attention paid to it, although it has reduced the yield of many plantations by as much as 75 per cent. In the following paragraphs the pests are considered in the order of their importance.

The Egyptian boll worm, *Earias insulana*, is identical with, and has the same habits as, the insect which attacks the cotton plant in Western India. The eggs are deposited upon the bolls or at the bases of the leaves, and the young larvæ commence feeding by tunnelling into the terminal shoots, attacking the flower-buds and bolls later. The pupa is formed in a closely-fitting boat-shaped cocoon, which varies in colour from brownish-grey to light buff, and is attached to the outside of the bolls or to the stems. The moth is green or olive-brown, with faint medial waved lines. The insect first appears on cotton in very small numbers, but increases enormously in each successive brood. Owing to the fact that one moth will continue laying eggs for a month, the pest is found in every stage of development towards the middle and end of summer. The egg stage lasts two or more days, that of the larva about a fortnight, and the moths emerge from the pupæ in another ten days.

From an examination made in the field by Mr. Dudgeon, in company with Mr. Willcocks, the entomologist to the Khedivial Agricultural Society, it appeared that the destruction of this pest could be more easily carried out than that of many other enemies of the cotton plant, and the following observations were made. The insect does not undergo any regular form of hibernation, that is, although sluggish and retarded in development during the winter months, it does not actually cease feeding. It was not found upon the dry cotton stems which it is customary to uproot and store for fuel upon the roofs of houses, and if cocoons had been formed on the drying bolls the contraction in drying had probably dislodged most of them. The plants, other than cotton, which serve the insect for food appeared to be limited to *Hibiscus*, of which *H. esculentus*, "bamieh," and *H. cannabinus*, "teel," grow commonly in the fields throughout Egypt. On plants of these two species the boll worm was found in every stage of development in December, and it was also found on "volunteer cotton" and ornamental *Hibiscus*. The method usually adopted of burning the uprooted cotton stems for fuel is a good one, but in some places the stems were cut off and were seen standing with shoots upon them in fields where the cotton had been succeeded by "berseem." Then again, *Hibiscus cannabinus*, which is grown for fibre upon the edges of cotton fields, is cut down instead of being uprooted, and thus its young shoots afford an adequate food supply to maintain the small number of insects which suffices to reproduce the enormous broods in the next cotton crop. The remedy clearly lies in the destruction of all *Hibiscus* and "volunteer cotton" for a period which should be of sufficient duration to effect the extermination of the insect. Mr. Dudgeon has suggested that experiments should be made on the action of sunlight upon the pupæ in their cocoons, with a view to ascertaining if the spreading out of the dry cotton plants in the sun for a short time will kill any pupæ which may be left on them. Although several bundles of dry stalks were examined, the insect was not found upon them in any stage of development. It is possible, however, that they may occur to some extent, and may become disseminated by being carried to a distance upon the dried cotton stalks.

The American boll worm, *Chloridea* (*Heliothis*) *obsoleta* (*armigera*).—Mr. Willcocks received several larvæ from cotton grown on the estate of Daira Princesse Amina, Jeftiche Kalandoul, Rodah, Upper Egypt, and was successful in rearing a number of moths which were found to be identical with the Indian and American insects. The species does not appear to have been previously recorded as occurring in Egypt, although it is found widely distributed elsewhere all over the tropical and temperate zones. The spread of the pest should be checked as early as possible. The preventative measures employed in America are the application of Paris green, and the planting of trap crops of maize on which the larvæ feed in preference to the cotton plant.

The Egyptian cotton worm, *Prodenia littoralis*, which is an omnivorous insect, attacks the leaves of the plants and does much harm to "berseem" and cotton in many districts. An excellent account of this pest and the best methods for its eradication has been given by Mr. G. P. Foaden in the *Journal of the Khedivial Agricultural Society*, Vol. vi., No. 6. The eggs are deposited on the under surface of only one or two large leaves near the base of the plant, from 200 to 300 being laid on a leaf. This behaviour is quite different from that of the American cotton worm, *Aletia argillacea*, which lays its eggs on nearly every leaf of the plant, and seldom more than three or four on the same leaf. The worm is hatched out in about three or four days, and commences to feed on the softer parts of the leaves. It does not confine its depredations to the leaves, however, but ascends the plant and attacks the buds and flowers. When fully grown the insect enters the soil and assumes the chrysalis stage. In this respect also it differs from the American cotton worm, which usually forms a cocoon within the folds of a leaf. The moth is of a yellowish-grey or brownish colour and is nocturnal in habit. After one or two days the female moth commences to lay eggs, which will again hatch into worms, the life cycle being thus repeated.

The following preventative measures are recommended. The soil should be thoroughly prepared as long as possible before planting, and the worms will thus be more or less starved out. As soon as any eggs are seen, the leaves on which they are deposited should be gathered and burnt. The crop should be examined every two or three days and the infected leaves destroyed immediately. This method of combating the pest is very successful, but in order to be thoroughly effectual it must be universally practised. The difficulties resulting from the insufficiency of labour to pick the leaves have led to the issuing of a decree by the Government compelling the farmers to collect and destroy the infected leaves, and insisting on the employment of children of a certain age to do the work at fixed periods. Much good will doubtless be done in this way in reducing the numbers, but, owing to the habit of the larvæ of feeding upon several different plants, there can be little hope of stamping it out completely unless the farmers also direct their attention to the collection of the eggs from "berseem" and other crops. This point does not appear to have been considered in drawing up the decree.

The "berseem" and cotton worm, *Caradrina exigua*, feeds upon cotton and "berseem," and sometimes does much damage to the crops.

The cut worm, *Agrotis ypsilon*, occurs more or less in all parts of the world, and eats off the young plants just as they come up. The insect feeds on a number of crops, including "berseem," which it sometimes destroys in patches. Mr.

Willcocks has discovered that the worms are largely attacked by a parasite known as the "tachinid fly," which he has observed in considerable numbers in May. In the United States the chief method adopted for combating the cut worm is to put down poisoned cabbage leaves, under which the larvæ, being night-feeders, crowd for shelter during the day and are destroyed. It is suggested that in Egypt the addition of small quantities of petroleum to the water used for irrigation might assist in the destruction of the pest.

The Egyptian cotton stainer, *Oxycarenus hyalinipennis*, appears to infest the bolls which have been damaged by the boll worm and to feed on the seeds, but does not seem to attack healthy cotton plants. The stains produced on the cotton are due to the insects being crushed in contact with it in the process of ginning. This insect must not be confounded with the true cotton stainer, *Dysdercus species*, which occurs in the United States and in some parts of Africa, and which punctures the bolls and stains the fibre with its yellowish excrement.

Locusts, *Schistocerca peregrinum* and *Acridium hieroglyphicum*. —During the last two years these insects have caused considerable damage in the Sudan, where they destroyed the cotton plants as soon as they came up, and thus rendered it necessary to replant several times.

The "asal fly" (*Aphis sorghi*) is a pest which principally attacks "dhurra" (*Sorghum vulgare*), but has also injured the cotton crops at Kaddaro in the Sudan.

THE MAPLE SUGAR INDUSTRY.

A BULLETIN issued recently by the Department of Agriculture of the United States (Bureau of Forestry, Bulletin No. 59) gives a summary of the information available with regard to the manufacture and output of maple sugar, a product which is still of very considerable interest in Canada, in spite of the fact that it has been largely replaced as a sweetening agent by the cheaper beet and cane sugars.

The American maple trees resemble, and are closely related to, the common British maple. The "Sugar Maple" and the

"Black Maple" furnish the best sugar; a similar saccharine sap is yielded by three other American maples of less importance, the "Red," "Silver" and "Oregon" species. The first, the Sugar Maple, *Acer saccharum*, flourishes in shady places, particularly on glacial drift or on rocky lower slopes of hills, and bears a plentiful crop of fertile seeds, the forest floor being heavily carpeted with seedlings, the somewhat sweet foliage of which is eagerly devoured by all kinds of stock. In the same forests are usually to be seen beech, birch, basswood, yellow poplar, hickory, hemlock-spruce and some of the true spruces. In the extreme northern part of New York State and in Quebec the growth is often almost pure maple, and even considerably further south, mixed with beech and birch, the Sugar Maple holds its own as the dominant species. The mixture is much the same in northern Pennsylvania at an altitude of over 1,000 feet, and in Ohio, Indiana and Illinois, but as the hilly country disappears the maple retreats to the richer and damper soils, leaving great areas to oaks, chestnuts, etc. This is particularly true of the southern parts of these States. On the western and south-western limits of its range the maple only occurs scattered here and there in favourable positions. In southern Michigan the forests are similar to those of New York State, but in the pine region of the north the maple confines itself to the more fertile places. The same is true of Wisconsin and Minnesota, where the Sugar Maple reaches its north-western limit in the United States.

The Black Maple, *Acer saccharum nigrum*, grows in low-lying situations on the banks of streams and in rich alluvial river bottoms. It is found in Vermont on the shores of Lake Champlain, and ranges southward, west of the Alleghanies from Minnesota to Arkansas and eastern Kansas.

The Red Maple, *Acer rubrum*, has the widest range, occurring in low swampy ground along the Ohio, the Mississippi, and their tributaries. It is only to be considered as a sugar tree outside the region where the Sugar Maple is a dominant species.

The Silver Maple, *Acer saccharinum*, ranges from New Brunswick to western Florida, and from southern Ontario to Dakota and Kansas. It reaches its greatest perfection on the banks of the Ohio and the Mississippi. The sap is plentiful and sweet, but liable to discoloration.

The Oregon Maple, *Acer macrophyllum*, is the only species west of the Rocky Mountains which can be considered as a producer of sugar and syrup. It extends from the Canadian border to California.

Forest management conducive to the growth of long straight-stemmed timber does not give the maximum output of sugar. Attempts to combine the yield of timber with the yield of sugar mean loss of productive activity in both directions. Where sugar is the main desideratum, all species except the sugar maples are removed. The bulletin gives sylvicultural particulars of service to those intending to improve or establish maple groves with a view to maximum production of sugar.

Primitive methods of extracting the sap have been practised among the Red Indians from time immemorial, and from them the early white settlers first learned the art of making maple sugar, now a home industry well known to Americans and Canadians. A slanting cut was made in the trunk of the tree with an axe, and a reed or some other primitive form of spout inserted in the lower end of the cut to convey the exuding sap into a receptacle. After being collected the sap was boiled on the spot in the woods, business and pleasure being combined in the annual maple-sugar-making picnics. There was as a rule no shelter from rain and snow. Leaves, bark, ashes, drippings from trees and miscellaneous impurities found their way into the pails and cauldrons. The crude product was consequently dark in colour and variable in quality. More modern appliances are now in use. An auger hole is bored in the tree instead of the old destructive axe-cut, the spout is generally a closed one made of metal, and great improvements have been made in the process of boiling.

The competition of cane and beet sugar, bad seasons, attacks on the trees by the maple worm, destruction of the forests by lumbermen, and adulteration with glucose by the mixers, who now control the trade, have caused a great shrinkage of the producing area, the effect being greater in some parts than in others. In the cane-sugar-growing States of the south the industry has died out to a greater extent than in the north-eastern States. Taking the United States as a whole, the industry was at its height in 1860, fell heavily in 1870, rose again to large proportions in 1880, remained stationary in 1890, and then suddenly fell off almost 50 per cent. in 1900, when the total amount produced was almost a third less than in 1850. The output in the year 1900 was 11,928,770 lb. of maple sugar, valued at 1,074,260 dollars, and 2,056,611 gallons of maple syrup, valued at 1,562,451 dollars.

The early settlers in the maple-sugar States made maple sugar for their own use as an article of food. It was the chief sweetening material they then possessed, as cane sugar from the southern States and West Indies had not yet reached them. But cane sugar has been cheaper than maple sugar since 1875, and has therefore inevitably supplanted maple sugar, to which it is preferable as a food material. On the other hand, maple sugar and syrup contain certain aromatic and condimental bodies which impart to them an agreeable flavour, possibly due to the presence of an ether or aldehyde possessing a high boiling point, so that the flavour remains after the sap has been boiled, while the more volatile constituents escape during the process of boiling.

While the area of production and quantity produced continue to decline, the demand for maple sugar among the wealthier classes is said to be increasing every year owing to the peculiar flavour which renders it an article of luxury, locally much appreciated in the form of candy and otherwise, and saleable at a price higher than that of cane sugar.

MICA IN CANADA.

A GENERAL article dealing with the mining and preparation of mica has already appeared in this *Bulletin* (1904, **2**. 278). The information then given may now be supplemented in some particulars as regards Canadian mica from a monograph entitled *Mica: Its Occurrence, Exploitation and Uses*, written by F. Cirkel, M.E., and issued last year by the Mines Branch of the Department of the Interior, Ottawa.

As a producer of mica Canada is second in importance only to India. In the latter country the mode of occurrence of the mineral and the methods by which this has been mined have been described in considerable detail in a valuable paper by Mr. T. H. Holland, now Director of the Geological Survey.* The present publication performs a similar office for the Canadian product.

After a brief description of the varieties of the mineral, which are of economic importance, the author describes the conditions under which they are met with.

In Canada, as in other parts of the world, large sheets of muscovite or potash alumina mica are practically confined to the coarse variety of granite which is often referred to as pegmatite or pegmatoid rock on account of the "pegmatitic" intergrowth of quartz and felspar usually present. In the same rock, minerals of the rare earths, which are now beginning to have a commercial value, are also met with. In Canada it usually occurs in sheets or lenses in the Laurentian gneiss, apparently conformably to its foliation, but sometimes it sends off spurs into the surrounding rock, or forms masses, dykes or veins, which are clearly intrusive. When a dyke is interrupted and shifted by a fault, contemporaneous with, or but slightly subsequent to the intrusion, the dyke usually forms a double bend and follows the line of fault for a distance equal to the throw. At such points it is thicker and richer in mica than elsewhere.

As a general rule, sheets or dykes of less than 3 or 4 feet in thickness do not contain mica of economic value.

The mica crystals or "books" usually occur more or less throughout the pegmatoid rock, but are especially aggregated near the line of contact with the adjoining formation. Most of the crystals are tabular, but some are tapering, with striated sides.

The best deposits are found in the province of Quebec, in Saguenay county, near the mouth of the river of that name on the north bank of the St. Lawrence. Fifteen tons of rough mica crystals from the McGie Mine produced 2¼ tons of cut mica averaging 3 × 4 inches; the larger sizes measured 7 × 10 inches. Operations are now, however, suspended. Similar deposits have been met with in Charlevoix and Berthier counties.

* See "Mica Deposits of India," *Mem. Geol. Sur. of India*, Vol. xxxiv., Part 2, 1902.

Muscovite mica has also been worked in the township of Villeneuve, nearly thirty miles north-north-east of the city of Ottawa, in the county of the same name, where it is associated with a felspar of remarkable purity that has been employed in the manufacture of china. Marketable sheets of mica up to 2 feet in diameter have been obtained. Other promising deposits are met with in Ontario and British Columbia.

While muscovite is the variety of mica which is principally obtained from the Indian mines, it is phlogopite, or magnesia mica, that is of chief importance in Canada. Cirkel is, however, mistaken in supposing that the occurrence of this mineral on a large scale is confined to Canada, for phlogopite mica of commercial value is found in Brazil and Ceylon, and specimens are placed on the market which are stated to come from the Malabar coast of Peninsular India.

Phlogopite occasionally occurs in the Canadian pegmatoid rocks at their junction with rocks rich in pyroxene, but it is usually found as a constituent of dykes or pockets consisting of pyroxene associated with calcite, apatite and phlogopite. These pyroxene rocks are intrusive in the upper gneisses of the Laurentian rocks of Quebec and Ontario, but often extend through the calcareous layers at the summit of the gneisses into the crystalline limestone above. Where mica crystals occur in the calcite, they are, as a rule, well formed, and give a large percentage of good sheets. Well-defined crystals are also found in cavities. On the other hand, crystals imbedded in the pyroxene have seldom a perfect structure.

In Ceylon phlogopite is frequently found in the neighbourhood of crystalline limestones containing a large percentage of magnesia. It would be of interest to know if the associated limestone and calcite in Canada contain much of the same oxide.

Phlogopite mica sometimes occurs in contact deposits at the junction of the gneiss and the pyroxene, and sometimes in pockets or lenticular bodies which appear to be located in planes of faulting. The contact deposits are more important, as they can be developed systematically and with a minimum removal of dead rock.

Many of the mines were first worked for the apatite, the mica being neglected. At present the reverse is the case, for it is found that the apatite can seldom be worked at a profit.

The author describes at some length the methods of mining in Canada. It appears that drilling is usually carried out by hand, for if machines are used it is difficult to secure that the holes shall be in the exact position required to preserve good sheets from injury. For the same reason the holes are only lightly loaded, so that the explosion may just loosen the rock, which is taken down with a pick, or, in the case of very valuable crystals, with hammer and chisel. Three men, two striking and one turning, can drill in hard pyroxene from 15 to 20 feet in a day of ten hours. The depth of a hole seldom exceeds 4 feet.

In a typical mine 150 to 190 feet deep the cost works out at about £36 10*s*. per ton of mica from 1 × 3 inches and upwards in size. This is, however, exclusive of prospecting and exploring work, which is usually carried on at the same time, to secure a continuous supply of the mineral. In quarries, 750 lb. of thumb-trimmed mica must, as a rule, be extracted from every 100 tons of rock removed to make the material a paying concern. In underground mining the proportion of mica must be larger, and down to a depth of 300 feet, 1,250 lb. of mica must be obtained from 100 tons. The actual amount of crude mica raised will be much larger, say three tons in the former case, and five tons in the latter.

A deposit of fairly good quality should yield about

50	per cent.	of thumb-trimmed	mica	cutting	1 × 3″
30	"	"	"	"	2 × 3″
10	"	"	"	"	2 × 4″
6	"	"	"	"	3 × 5″
4	"	"	"	"	4 × 6″ and over.

Mica cut to 4 × 6 inches and over is known as large-size mica ; some mines give as much as 17 per cent. answering to that description.

Most of the present demand is for the two smallest sizes, which are used for the manufacture of micanite (micaboard) (see Vol. **2**. 285). The method of preparing the mineral for sale is described in some detail. After any rock fragments that may adhere to the mica have been detached, it is split up into flakes a sixteenth of an inch thick; a short-handled knife, sharpened towards the point on both edges, being employed for the purpose. Damaged films and layers of foreign minerals are carefully removed and the plates "thumb-trimmed" by a hand-knife and finally graded according to size. One person can clean and thumb-trim from 35 to 45 lb. of medium-sized sheets in ten hours.

Each size is, by means of a hand-press, packed firmly in a barrel holding about 325 lb., and is forwarded to the trimming works, most of which are situated in Ottawa. There the mica is again thoroughly cleaned, and the sheets more carefully sorted, all those with small cracks or uneven lamination being rejected. The selected plates are split still further and then "knife-trimmed" by machine knives moving on a pivot and operated by means of an eccentric working against a spring. The motive power is electricity. After being cut the sheets are again graded by size and delivered to the thin-splitting department. They are there ground on one edge with fine sand to facilitate the splitting and divided by specially-made knives into films one five-hundredth of an inch in thickness (about 0·05 millimetre or 50 microns), or even less. One person can split 7 to 12 lb. measuring 2 × 4 inches and less in a day of ten hours. The split mica is made up into packages graded according to size and dispatched to electrical firms for the manufacture of micanite.

The larger sizes are not split thin, but after being, in many cases, knife-trimmed, they are shipped in boxes of 125 lb. each.

Scrap mica, the refuse of the cobbing sheds, is worth from 8 to 10 dollars (about 33*s.* to 41*s.*) a ton. It is sold for conversion into ground mica. The grinding is a difficult matter, and in most cases the details of the process are kept secret. Old-fashioned burr stones are stated to be commonly employed. In one factory, on the other hand, the mill consists of a slowly-rotating sheet-iron cylinder 9 feet long and 2 feet 6 inches in diameter, punched in holes three-sixteenths of an inch in diameter. It is set at a slope of an inch and a half to its length. The mica is fed into the upper end and crushed by a number of loose pieces of steel till it is fine enough to pass through the holes. It is then graded by means of rotating sieves. In a factory in Denver, Colorado, the mica is first cut by machines into fragments half-an-inch square; it is then fed through tubes by pneumatic blast into an "atomising" machine which has two rotating shafts carrying spirally-arranged beaters of gun-metal which fit into each other and break the mica into fine fragments; thence it is blown into the sizing-room, where the air current gradually slackens so that the mica settles in different bins according to size. Five tons a day can be thus treated.

In Canada the standards of size vary from 20 to 200 meshes to the inch, and the price from 5 to 10 cents (2½*d.* to 5*d.*) a lb.

Phlogopite is worked in Ottawa county, in the province of Quebec, immediately to the north of the capital of the Dominion. The numerous lakes scattered through the districts are drained by rapid streams, which are utilised as a source of power in working the mines. It is also mined in Frontenac and Lanark counties in Ontario to the north of Kingston and south-west of Ottawa, where the country is similar in character.

Full details are given of the different phlogopite mines and concessions in the two provinces. The value of the output in 1902 was $242,310, or about £49,470, but the production appears to have been in excess of the demand, and in 1903 its value was only $176,334, or £36,000. Most of the Canadian mica, which is not converted into films for micanite, goes in the thumb-trimmed condition to the United States, which levies a heavy duty upon it, though not so large as that on machine-trimmed mica. The export to the United Kingdom is rapidly increasing, and in 1903 was 653,081 lb., as compared with 729,489 lb. that went to the United States. The ground mica is sent to England and Germany, the 25 per cent. duty levied by the United States being prohibitive.

The following are given as the current prices in cents per lb. of mica:—

	Medium quality, muscovite.	Thumb-trimmed mica, phlogopite.
1 × 2″ . . .	12	10
2 × 3″ . . .	25	22
2 × 4″ . . .	40	30
3 × 5″ . . .	75	55
4 × 6″ . . .	100	75
5 × 8″ . . .	—	100

The amount of muscovite produced in Canada is, however, apparently very small. Most of the phlogopite reported from Canada appears to consist of the semi-opaque "silver amber" mica, a variety that also occurs in the Arctic territories of the Dominion and in Brazil, and is in much demand for electrical purposes (*Bulletin of the Imperial Institute*, 1904, **2**. 280, 291). Very little of the clear amber, such as comes from Ceylon, appears to be mined in Canada. Information is needed as to the character of the mineral obtained from different mines, and the relative amounts of the different varieties produced. The principal commercial applications of mica have been dealt with at some length in the article in the *Bulletin of the Imperial Institute*, 1905, **2**. 283, already referred to, but the following additional applications of the mineral deserve notice.

The smaller sizes may be utilised in spectacles to protect the eyes of metal workers from splinters. In Germany these are made one millimetre (a twenty-fifth of an inch) in thickness. Mica may also be used to cover gilding, silvering or colouring, and preserve it from deterioration. Finely-ground mica mixed with a solution of gum arabic makes a good silver paint. A gelatine combination has been used for inlaying buttons. Mica is also employed in producing bronze-like colours which are lighter than the metallic bronzes and are not so liable to be tarnished. Ground mica spread over a coating of asphalt varnish is said to afford a good imitation of granite. For such ornamental purposes muscovite is more suitable, being more colourless and transparent, than phlogopite.

Considerable space is devoted to the subject of the utilisation of mica as a non-conductor of heat, especially for coverings for boilers and steam pipes, and it is stated that it gives results superior to those afforded by any other description of "lagging."

After a brief description of the mica deposits and industry in other parts of the world the report concludes with an abstract of the mining laws of Quebec and Ontario.

GOLD DREDGING IN CALIFORNIA.

As the subject of gold dredging is now receiving attention in several British Colonies, and inquiries relating to this subject have on several occasions been received recently at the Imperial Institute, it may be of interest to refer briefly to a recent bulletin (*Gold Dredging in California*, by Lewis E. Aubury, State Mineralogist) issued by the California State Mining Bureau, describing this industry as practised in California.

After referring to the history of the use of dredges for the recovery of gold, which dates back for nearly half-a-century, the author discusses briefly the different methods of working placer deposits.

Ordinary hydraulic mining is, he tells us, employed when the gravel is easily removed and when water under pressure and a convenient dumping ground for the tailings are available ; drift or underground mining must be resorted to where the gravel is covered by lava or an overburden of great depth ; while dredging can be employed with advantage where there is excess of water and a soft bed rock. If, on the other hand, the latter is too hard for the dredge to deal with and the gold lies in close proximity to it, a large proportion is left in clefts and hollows of the rock and satisfactory results are not obtained. In such cases, if there is not too much water, dredging may be replaced by hydraulic elevators, but where hard rock is accompanied by a large excess of water, there appears to be no effective method of dealing with the gold except, perhaps, by the use of caissons in the manner referred to below.

The numerous experiments which have been made in dredge building have resulted in the evolution of a fairly definite type, though the details may vary according to the conditions under which work is to be carried on.

The hull is a flat-bottomed, punt-like vessel, with more or less vertical sides and approximately rectangular plan, but generally narrowed at the bows.

It is usually constructed of wood. In the centre is the main gantry (scaffolding), on which is hinged the upper end of the digging ladder, a steel girder that slopes down into the water through a longitudinal groove or " well " in the bow. Here it is suspended by cables from another gantry or a hinged boom, and can be adjusted to any level. On this ladder travels an endless chain of buckets, which scoop out the ground below the surface of the water, carry it up the ladder and empty it into a hopper in the centre of the boat.

The buckets are strongly built, manganese and nickel steels being often employed with the best results. The rollers of the ladder are also made of manganese steel. The material dredged is separated by screening under the action of jets of water. The fine silt passes on to the sluicing-tables, where the gold is retained. The coarse stones and boulders are carried as far as possible beyond the stern along another ladder, which is inclined upwards and is known as the stacker.

The pressure of the buckets against the ground that is being dredged is maintained either by a strong steel or wooden spud at the stern, round which the vessel is slowly rotated as the digging proceeds, or by a steel wire line in front, which is attached to a tree trunk buried in the ground. If the material to be dealt with is soft and at no great depth, the steel line may be used with advantage, but in other cases the spud gives better results.

In addition to the spud or head line there are lines by which the dredge is moved, as required, to right or left.

The buckets may either be joined directly together (close connection) or alternate with simple links (open connection). In the former case there are more buckets available for carrying the ground, but in the latter the power required is less, the rate of movement greater, and in hard ground the buckets are better filled. The advantage is with the close connection when the ground is soft. With harder ground its superiority is more doubtful, while if large boulders are present open-connected buckets must be employed or "jamming" will result. The capacity of the buckets varies from 3 to 13 cubic feet. Large buckets can deal more easily with boulders and are more economical in working, but the first cost is greater, and they require better-equipped repair shops.

There are two types of screens in use, flat shaking screens and revolving screens. For clean loose gravel the flat shaking screens are better, as they are not only cheaper in first cost and repairs, but they give a larger screening surface. If clay, however, be present or the gravel be compacted together, the revolving screens should be used, which turn the ground over and subject it on all sides to the force of the water from the jets.

There are also two descriptions of sluicing-tables, those with cross riffles charged with mercury and those with "cocoa" matting and metal network with a mesh of about 2½ inches. In most cases the mercury tables save gold, but if arsenic (which prevents amalgamation) be present it is better to use the cocoa matting. This should be also employed if there be an appreciable amount of platinum, which will not amalgamate easily. When mercury is used it should be provided in large quantities just below the screens, so that the fine gold may come into contact with it as it drops, and it is desirable that shaking screens should be employed so that the material may fall over a large surface of the plates.

From the sluice-tables the silt is usually carried directly into the water by tail sluices, but when the water is shallow and there is a risk of the silt accumulating at the stern of the dredge, it is pumped on to the top of the dump formed by the stacker.

The stacker, which deals with the coarser material, also varies in construction, having either a continuous belt or an endless chain of buckets. The former absorbs less power, but is stated to require more frequent renewal. This, however, is denied by dredge builders in this country, who claim that their belts, in which the centre, where the greatest wearing occurs, is specially reinforced, will last for years. The replacement of a belt takes but little time, while if the chain of buckets breaks down it is a more serious matter. In New Zealand centrifugal stackers have been employed with success.

A dredge with close-connected buckets, shaking screen, sluice-tables with riffles and mercury and a belt conveyor in the stacker is referred to in California as the Bucyrus type, while one with open connection, revolving screen, cocoa matting and a stacker with buckets is known as the Risdon type; but intermediate forms are often constructed.

The power employed is usually electricity, which is obtained at from 0·65 to 1·5 cents (¼*d.* to ¾*d.*) per kilowatt hour. The various moving parts, the chain of digging buckets, the winch that winds the steel wire lines, the pump for the water jets, the screens, the conveyor on the stacker and the sand pump, are all worked by separate motors; the total indicated horse-power in the case of a dredge of the Bucyrus type with 3 cubic feet buckets is 148, and with 4 cubic feet buckets 235—the actual horse-power consumed being 100 and about 140 respectively.

The full crew of a dredge consists of eleven men, skilled and unskilled, besides the superintendent, but a smaller number suffices when several dredges are worked together. The total working costs vary from $1\frac{1}{2}d.$ to $4\frac{1}{4}d.$ per cubic yard, including office expenses, repairs, but not interest on the original cost of the dredge, which ranges from six to forty thousand pounds. A dredge costing the latter sum will raise more than a million cubic yards a year, so that, even if the interest on the cost amounts to two thousand a year, it would be less than a half-penny a cubic yard. The lowest working costs refer to new dredges, which have seldom to be stopped for repair. Those that have been in use for some time cannot be expected to give such good results. Other things being equal, the larger dredges appear to be more economical.

The author lays stress on the importance of careful prospecting to determine not only whether the ground is worth dredging, but what type of dredge should be used. If it is impracticable to sink shafts, drilling should be resorted to. A drilling plant costs about £390 in California. Three men are required to work it, and the cost of sinking in the gravel of the Sacramento River is from five to nine shillings a foot. In harder ground or localities where boulders are numerous the cost would be greater.

A detailed account is given of the different dredging grounds in California, and the dredges employed, and in many cases particulars of working expenses and results are furnished.

Of considerable interest are the operations of the Huron Submarine Mining and Construction Company in the Sacramento River, three miles above Redding, which are carried out by means of a kind of hydraulic elevator working in a caisson. The deposit consists of 8 to 25 feet of gravel, with boulders resting on a very rough igneous bed rock. In the centre of a boat 65 feet long and 24 feet wide, and drawing 2 feet of water, is a steel cylinder which may be extended through water and gravel to any required depth by adding further sections. The upper sections, which measure 8 feet by 11 feet 6 inches, are pointed on the up-stream side; the lower are cylindrical. That at the bottom is closed above by water-tight doors. Down the shaft extends the 10-inch column of a rock pump, and a 2-inch rubber hose conveying water at 100 lb. pressure. A diver works in the lowest section and directs the gravel to the mouth of the pump by which it is carried to the surface. The total cost is said to amount to $1\frac{1}{2}d.$ a yard.

GENERAL NOTES.

Mangrove Barks from the Cameroons.—The Agricultural Experiment Station at Victoria in the Cameroons has examined recently a number of samples of the mangrove barks available in that Colony. It was found that the amount of tannin contained by these ranged from 19·97 to 27·17 per cent., calculated on the air-dried barks containing from 10·6 to 14·6 per cent. of moisture, whence it appears that these mangrove barks are not of particularly high quality for tanning purposes (compare *Bulletin of the Imperial Institute*, 1905, **3**. 346).

The Cultivation of the "Black Wattle" in German East Africa.—The Biological and Agricultural Institute in German East Africa has recently dispatched to Hamburg four bales of black wattle bark, produced experimentally in the Colony. These barks on analysis were found to contain from 27·9 to 41 per cent. of tannin, which compares favourably with the amounts of tannin contained in black wattle bark as exported from Natal and Australia. Samples of the black wattle gum were also sent to Germany by the Institute for valuation. The gum produced in German East Africa by this tree appears to be of the insoluble type, and the samples in question were valued at about ten shillings per cwt. Australian and South African wattle gums sell at about twenty-four shillings per cwt. in London at present.

Cotton Cultivation in Korea.—The following information concerning the cultivation of cotton in Korea is given in a report issued by the Japanese Department of Commerce and Agriculture. The principal districts in Korea producing this staple are Pyeng An, Chol La, Chung-Chang, Kyeng-Sang, Kenng Keni and Whang Hai. The soil of these regions is suitable for cotton, but the methods of cultivation employed by the inhabitants are primitive. The temperature of these districts does not differ much from that of Asaka and Hiroshima, the principal centres of cotton production in Japan. The whole of Korea, with the exception of some parts in the extreme north, is situated south of the 41st degree of north latitude.

Although it is not possible to determine exactly the varieties produced in Korea, the Japanese mention specially, as indigenous to the country, (1) red-ribbed cotton, (2) green-ribbed cotton, (3) the great Korean cotton, and (4) the lesser Korean cotton.

Korean cotton is finer and longer than those of Japan and China, and would be able to compete with Indian cotton if it were more carefully cultivated. The lustre is equal to that of Indian and Chinese cottons but is not so good as that of the Japanese product.

Korea is well suited for the cultivation of cotton. In Japan, on account of the humidity of the climate, it has not been possible to grow American Upland cotton, but as rain is less frequent in Korea, and cultivated varieties actually do well there, it is probable that American cotton might be introduced with success. The plains and coast-lands of Korea appear well suited to the cultivation of American cotton, and its introduction would be a great help to the Japanese cotton-manufacturing industry, which, on account of the high price, cannot import American cotton.

A Japanese company has been formed with the object of cultivating cotton in Korea, and an expert and labourers of Japanese nationality have been sent into the country by this undertaking.

The Manufacture of Sugar from British-grown Beet.—The question of growing beet in the United Kingdom for the manufacture of sugar has again attracted attention since the abolition of the sugar bounties. In this connection a paper has been read recently before the Society of Arts by Mr. S. Stein, in which the extension of this industry in the United Kingdom is strongly advocated.

It is stated that beetroot has now been grown experimentally in nearly every county with satisfactory results, the average sugar content of the roots being 17 per cent. The matter is fully discussed from various points of view, and statistics are given which go to show that the industry, if undertaken on a large scale, is likely to prove remunerative.

Kalamet Wood.—It has long been known that the Burmese ladies employ as a cosmetic the deliciously-scented kalamet wood, which may also be put to other uses, although no details are forthcoming on this point, nor as to the method in which it is made use of for the purpose indicated above. Kalamet is in considerable demand in Rangoon, where its retail value varies from twelve annas to three rupees (1*s.* to 4*s.*) per viss (3·0857 lb.). There is a fairly regular trade in it from Mergui, whence between 1887 and 1903 the average annual export was 28,295 lb., of the value of £195 2*s.*

Kalamet wood bears a general resemblance to sandal wood, and it was formerly supposed that it might prove to be derived from an undescribed species of *Santalum*. Difficulty has in the past arisen by the wood being, quite erroneously, confused with toungkalamet (*Cordia* *fragrantissima*, Kurz.), a wood with different structure and scent. Efforts have been made since 1900 to solve the question, both by Mr. J. S. Gamble and Sir Dietrich Brandis, and Lt.-Col. D. Prain describes in the *Journal of the Linnean Society*, Vol. xxxvii., pp. 250–263, the success which has been achieved through the instrumentality of Mr. Manson, Conservator of Forests in Tenasserim, and the officers of the Calcutta Herrabium. It has been established that there are in Burma two trees yielding woods called "kalamet" by the Burmese; both woods are deliciously scented, but one is dark brown and the other pale golden-brown in colour. Botanical specimens indicate that the trees are at any rate specifically different, but of one only has sufficient material been obtained to allow of complete determination. This proves to be a hitherto undescribed plant, and has been named *Mansonia Gagei*, J. K. Drumm. The genus *Mansonia* is closely allied to the African genus *Triplochiton*, and the two form a new tribe of the *Sterculiaceæ*—the *Mansonieæ*.

The question is rendered more complex by the fact that there is sold also in Burma as kalamet a wood imported from the Straits Settlements, the Malayan name of which is unknown, as also its botanical source.

This may or may not prove to be identical with *Mansonia Gagei*, or with the second and still unidentified Burmese kalamet. All that can be said at present is, that there are recognised in Burma three kalamet woods, two native and one imported. One of the Burmese plants is now known as *Mansonia Gagei*; the sources of the other two kalamets have yet to be discovered.

Cinchona Cultivation in German Colonies.—Despite the present low price of quinine and the likelihood of its over-production in the near future, attention is being directed to the possibilities of cultivating cinchona bark on a large scale, instead of coffee, in German East Africa and the Cameroons. The question is already in an advanced experimental stage, as at the end of the official year 1904–5, 15,000 young plants had been introduced into German East Africa from Java, and the number will shortly be doubled.

The prospects of the industry do not seem very great, owing chiefly to the climatic conditions. The highlands of East Africa are subject to long dry seasons, which are distinctly unfavourable to cinchona cultivation, an even distribution of the rain being desirable. The Cameroons, on the other hand, get rather too much rain, which is also unfavourable.

Of the various districts in East Africa, East Usambara has the best climatic conditions, especially with regard to rain, and it has also the most suitable forest lands. As a general rule the best quinine barks are obtained from the higher regions, and, looked at from this standpoint, West Usambara is more suitable than East Usambara as it is much more hilly.

The possibilities of blight and sickness in the trees must be taken into account, as coffee in Usambara and cocoa in the Cameroons have proved to be very subject to disease.

Utilisation of the Nitrogen of the Atmosphere.—The question of the utilisation of the nitrogen of the air for the production of nitrates, to be used for agricultural purposes, has for some time past been the subject of much consideration both by chemists and agriculturists; the discovery of a new process for the production of nitrogen oxides from the atmosphere is therefore of considerable importance.

A description of this new process has been given recently by Professor S. P. Thompson in a lecture delivered at the Royal Institution, and information regarding the formation of the company working it has been provided in a recent report by H.M. Consul-General at Christiania. The patentees of the process are Professor Berkeland of Christiania University and Mr. S. Eyde, a Norwegian civil engineer. It consists essentially in the production in a special furnace of an electric flame capable of causing the oxygen and nitrogen of the atmosphere to combine.

In the furnace an alternating arc is produced at from 3,000 to 4,000 volts pressure. The electrodes are placed equatorially between the poles of a powerful electro-magnet, the distance between the points of the electrodes being from 1 to 2 millimetres. Under these conditions a disc of roaring flame is produced, and when ordinary air is blown through the furnace at a definite rate the escaping gases are found to be charged with nitrous fumes. These nitrous fumes are collected, allowed to oxidise still further in contact with the oxygen of the air and are then absorbed, either in water towers or in quicklime. In the latter case nitrate of lime is produced, and the product thus obtained has been shown to be suitable for use as a fertiliser.

Cheap electric power is obtained for the working of the process by utilising the power of several of the large Norwegian waterfalls. The cost of electricity at the works already existing is said to be about $\frac{1}{10}d.$ per unit.

The Manganese Ores of British North Borneo.—In the January number of the *Zeitschrift für Praktische Geologie* the attention of German iron and steel makers is called to the manganese ore deposits recently discovered in British North Borneo. These deposits are extensive, particularly in the Marudu Bay district, where they are being exploited by the British North Borneo Exploration Company. From the extent of the deposits as at present known it is estimated that the company will be able to produce 50,000 tons per annum for at least twenty-five years.

The ore consists mainly of psilomelane, containing on the average 50·4 per cent. of metallic manganese and 14·6 per cent. of silica. It is free from copper, arsenic, nickel and baryta, and contains on the average less than 0·05 per cent. each of sulphur and phosphorus.

Extensive deposits of limonite of fairly good quality also occur in the district, and there is an abundance of pure limestone suitable for use as a flux. There is an unlimited supply of wood for mining operations, whilst labour is abundant and cheap. Anthracite is known to occur at the surface in one of the islands off the north-east of Borneo, and it is possible that investigations now going on may reveal the existence of considerable supplies of suitable fuel within easy reach. In any case the exploitation now in progress will probably lead to the establishment of a considerable mining industry.

Several shiploads of ore have already reached Europe, and contracts have been arranged for further supplies. Specimens of these various ores are available for inspection at the Imperial Institute.

The Life-History of the Pearl Oyster.—Two papers by Dr. Seurat (a. *Observations sur l'évolution de l'huître perlière.* Papeete, 1904. b. *Observations anatomiques et biologiques sur l'huître perlière*) dealing with the development of the pearl oyster have recently been published by the French Government. The author, who is the Government Naturalist at Rikitea, Tahiti, has made a complete study of the development and habits of the oyster in its home among the reefs and lagoons of Tuamotu and Gambier. The object was to obtain as full a knowledge as possible of the life-history of the animal, in order that its conservation and possibly its artificial propagation might be undertaken.

The chief point of interest of the papers is that they afford independent confirmation of the results arrived at by Herdman and Hornell (Report published for the Ceylon Government by the Royal Society) in their investigations of the Ceylon Pearl Fishery, a brief notice of which appeared in the *Bulletin of the Imperial Institute*, 1905, **3**. 125–130.

The pearl oyster of the Pacific (*Margaritifera margaritifera*, var. *cumingi*, Reeve) is not the same species as the Ceylon oyster, and besides yielding pearls, is valuable as a source of mother-of-pearl. The earlier stages in its life-history have been completely traced by Dr. Seurat, and his work confirms the results previously arrived at by Professor Herdman for *Margaritifera vulgaris*, Schum. The work was carried out both on the reefs and in tanks in the laboratory, and the development of the animal was traced from the fertilised egg through the free-swimming veliger and "naupionique" stages until they settled down as miniature oysters ("spat") on the fronds of green and red algæ, and finally on the sea-bottom. Dr. Seurat is of opinion that the most critical time in the life-history of the oyster, *i. e.* when the animal is exposed to the greatest number of risks from its enemies, is just before the free-swimming larva definitely assumes the adult form, and therefore, in artificial propagation, special precautions for protection should be taken at this period.

The question of the formation of the pearls was also investigated. As in the case of the Ceylon oyster, the irritant causing the deposition of the pearl substance was shown to be due to encysted larvæ of a tapeworm which passed the second stage in its life-history in the intestines of *Trygon*, a genus of fishes allied to the sharks. The life-history of the parasite was not so completely followed out as in the Ceylon investigations, but there can be no doubt that the essential points are the same in both cases. As has been stated by Hornell, the complete knowledge of the life-history of the parasites may render feasible the artificial regulation of the production of pearls.

NOTICES OF RECENT LITERATURE.

NEW BOOKS.

THE BOOK OF THE ROTHAMSTED EXPERIMENTS. By A. D. Hall, M.A. (Oxon.). Pp. xl + 294. (London: John Murray, 1905.)

In the early part of the nineteenth century the awakening interest in the natural sciences and the important discoveries that were being made, suggested the possibility of improving agricultural practice by means of scientific investigation. A powerful stimulus in this direction was given by the work of Liebig, and by the views he advanced concerning the chemical conditions governing the life and growth of plants.

The attention of Sir John Bennet Lawes (then Mr. Lawes), the owner of the manor house and farm of Rothamsted in Hertfordshire, was drawn to the application of science to agriculture, and as early as 1835 he was making experiments on this subject. These experiments he enlarged, and in 1843 he secured the co-operation of Dr. J. H. Gilbert. These two investigators continued the work at Rothamsted for over fifty years, until their deaths in 1900 and 1901 respectively. The thoroughness of their experiments and the value of the results to practical agriculture can scarcely be over-estimated. Before his death Sir John Lawes placed the fields in the hands of trustees, together with the sum of £100,000, in order that the work should be continued, and the above volume is written by the present Director of the Rothamsted Experimental Station thus constituted.

Over two hundred papers have been published dealing with the Rothamsted investigations, and are to be found in the Rothamsted Memoirs and in numerous agricultural and scientific journals. The author has done good service in presenting a clear and lucid account of the most important problems that were investigated, and of the conclusions arrived at.

One of the most difficult problems in agricultural chemistry was to discover the sources whence plants obtain their nitrogen. Liebig minimised the importance of a supply of combined nitrogen to the plant, and held that if the soil were supplied with the "mineral" constituents removed by the crop, that is, those which appear as ash when plants are burnt and which contain no nitrogen, the crop would be able to grow luxuriantly and obtain for itself all the nitrogen it required. This question, whether nitrogenous manures are of value to the crop or not, was the leading idea in all the earlier field experiments at Rothamsted, and the source and fate of the nitrogen of plants has been the dominant interest up to the death of Lawes and Gilbert. The results obtained showed that in the case of the cereal crops, wheat and barley, and of mangels, a root crop, Liebig's view was mistaken, and that the crops obtained are largely increased when combined nitrogen is supplied in the manure. In the case of beans and clover, however, which are both leguminous crops, it was found that nitrogenous manures were of little or no benefit, and that, in fact, the growth of clover enriched the soil in combined nitrogen to such an extent as to benefit a succeeding cereal crop.

The matter was cleared up in 1886 by the discovery by Hellriegel and Willfarth of bacteria capable of utilising the free nitrogen of the air and causing it to enter into combination. These bacteria are found to grow in certain small nodules on the roots of leguminous plants. Thus Liebig's idea proved true in special cases, and also in the wide sense that it is the vegetable kingdom that transforms both the nitrogen and the carbon dioxide of the atmosphere into complex compounds capable of sustaining animal life.

Among the numerous subjects dealt with are the manuring of various crops, the effect of growing crops in rotation, "clover sickness," that is, the inability of land to grow clover crops year after year without an interval of several years between the crops, feeding experiments with farm animals, nitrification and denitrification of soil, the constituents washed out of the soil in the drainage waters, sewage irrigation and ensilage.

Although the practical treatment adapted to produce the best yields of vegetable products varies with different plants and with the local conditions of soil and climate, yet this work will well repay careful study by those who have to direct the planting and cultivation of any crops, as it affords examples of the methods and principles by which a knowledge of the best practice can be arrived at.

CULTURE PRATIQUE ET RATIONNELLE DU CAFÉIER ET PRÉPARATION DU GRAIN POUR LA VENTE. Par Édouard Pierrot. Pp. 95. (Paris: Augustin Challamel, 1906.)

This volume deals with the methods of cultivation of the coffee plant and the preparation of coffee for the market, operations in which the author has had practical experience as a planter in one of the French Colonies.

A full description is given of the Arabian coffee plant, accompanied by illustrations representing vertical and transverse sections of the berry, showing the two seeds or coffee beans surrounded by the silver-skin, parchment and pulp. The Liberian coffee plant and several hybrids of some importance are also described. Advice is given as to the choice of a suitable locality for planting, special importance being attached to the mechanical condition rather than to the chemical composition of the soil, and it is pointed out that the soil must be one in which there is no excess of stagnant water, while the aspect should be southern rather than northern. There are also notes as to shelter, clearing the ground, cutting trenches, management of the young plants in the nursery, preparation of soil, selection of seed, transplanting, weeding, manures, pruning, gathering the crop, diseases, yield per plant and per acre, and, finally, the pulping, fermenting, drying, hulling, sizing and packing of the beans.

ÉNUMÉRATION DES PLANTES RÉCOLTÉES PAR ÉMILE LAURENT PENDANT SA DERNIÈRE MISSION AU CONGO. By É. de Wildeman. Fascicule i., pp. 1–112; Plates i–xxxviii. Fascicule ii., pp. 113–192; Plates xxxix–xlvi. (Brussels, 1905.)

The economic results of M. É. Laurent's work in the Congo Free State have been dealt with by Dr. Wildeman in a previous publication, *Notices sur des plantes utiles et intéressantes de la Flore du Congo*, reviewed in this *Bulletin* (1905, **3**. 105–6 and 296–7). The present work is limited to a systematic enumeration of the botanical collections made, and in the majority of cases the information given is confined to the name of the plant, its synonomy, references to published descriptions, and a list of the localities where it was collected. In some instances, however, notes are added on the uses of the plant, *e.g.* in dealing with *Tacca pinnatifida*, Forst., attention is directed to a recent paper by Wohltmann in *Der Tropenpflanzer* pointing out the value of the plant as a source of starch and recommending its cultivation.

Similarly with the introduced Para and Ceãra rubber plants (*Hevea brasiliensis*, Müll. Arg., and *Manihot Glaziovii*, Müll. Arg.) it is pointed out that in both instances the results obtained so far have not afforded conclusive evidences as to whether their cultivation will be successful or not. The plants of *Hevea* are too young to allow a final opinion to be pronounced. *Manihot Glaziovii* has been tried in several localities, but does not appear well adapted to local conditions. The trees in some places have suffered severely from a root disease apparently due to the attacks of a species of *Polyporus*, and several illustrations indicate the resultant effects of this trouble.

Many new species are included, and a full systematic description is given of each. Thus of the genus *Raphia*, three new species and a new variety are founded, and the descriptions and notes are accompanied by numerous plates.

The work is of great interest, and forms a valuable contribution to our knowledge of the flora of this region of West Africa.

CHAPTERS ON PAPER-MAKING. Vol. ii. By Clayton Beadle. Pp. vii + 174. (London: H. H. Grattan, 1906.)

A notice of the first volume of this work has been given in the *Bulletin of the Imperial Institute*, 1904, **2**. 212.

The present volume contains chapters on technical education as applied to paper-making and on the use of specially prepared size in dry sheets for paper sizing. The remainder of the book is devoted to answers to questions set in 1901–1903 at the City and Guilds of London Institute Examinations on paper manufacture. The work will no doubt be useful to students for these examinations as well as to those practically engaged in paper mills.

THE MERCHANTABLE TIMBERS OF QUEENSLAND. A report by Philip MacMahon. Pp. 1–68, with 60 plates and 7 maps. (Brisbane: G. A. Vaughan, Government Printer, 1905.)

This report by the Director of the Royal Botanic Gardens

Brisbane, issued by the authority of the Minister for Agriculture, is intended to bring to public notice information regarding commercially important timbers of Queensland. From amongst the 600 and more timbers which occur in the forests of the State only 24 are here dealt with in detail, and the information given regarding these, together with the general facts relating to the distribution of the forests, is summarised in the article on pp. 1–10 of this issue.

In addition there is gathered together a mass of useful information regarding the durability and strength of Queensland timbers, the forest regulations, work in the forest, detailed trade statistics both of Queensland and of Australia generally. Of interest in many parts of the world will be the schedule of Indian and tropical railways, in which, in tabulated form, is given the number of sleepers used per mile, their size and character, notes on the climate, temperature, moisture in the air, number of wet months, the annual rainfall, for many railways.

The section on the identification of the timbers is illustrated with reproductions of the appearance of sections, taken with a very fine plane, as seen under a hand lens.

As indicated above, the volume contains 60 plates, besides numerous maps and tables. The large quarto paper on which it is printed is well adapted to show the illustrations to great advantage, and the book, in addition to its more important use, offers a ready opportunity to those wishing to obtain a representative series of large photographic reproductions of typical Australian timbers and trees, and scenes in the handling of timber.

REPORT OF THE COMMITTEE ON LEATHER FOR BOOKBINDING. Edited for the Society of Arts and the Worshipful Company of Leathersellers by the Rt. Hon. Viscount Cobham and Sir Henry Trueman Wood. Pp. 93, with 11 coloured plates. (London: George Bell & Sons, 1905.)

The inquiry into the decay of the leather used for bookbinding, the results of which are given in this report, was undertaken by the Society of Arts, at the request of a group of persons specially interested in the subject. The report has already been published in part in the *Journal of the Society of Arts*, but it was felt that it should appear in a more permanent form, and contain coloured illustrations showing the actual effect of light and other injurious agents on leather. Thanks to the liberality of the Court of the Leathersellers Company, it has been possible to gratify this desire by the re-issue of the report in its present handsome form.

The book is divided into four sections: (1) an introduction giving a *résumé* of the initiation, method and results of the inquiry; (2) a report by a sub-committee which inspected the actual condition of leather-bound books in a number of public and private libraries; (3) a report by a second sub-committee charged with the task of recommending methods for the preparation of leather for book-binding; and (4) appendices dealing with the preservation of leather-bound books in libraries and the fading of dyed leathers.

The results of the whole inquiry proved that books bound during the last 50 to 100 years exhibited far greater deterioration than books bound at an earlier date, and that many recent bindings were so bad that decay had set in after so short a period as ten or even five years. This deterioration in leather appears to have become general about 1830, though some types, notably calf, remained fairly good till 1860.

The causes of the deterioration are numerous, but the principal ones seem to be the use of unsuitable materials in tanning skins, the excessive paring down of the leather in the process of binding and the unsuitable conditions under which books are frequently stored—gas fumes, sunlight and tobacco smoke all exercising injurious influences on leather.

For the guidance of bookbinders and librarians a number of recommendations are made with regard to these and various other points. It is suggested in particular that the tanning materials used for producing bookbinding leather should be of the pyrogallol type, and it is pointed out that the most suitable tanning agents of this class are sumach, gall-nuts and "sant" or "gambia" pods (the pods of *Acacia arabica*). In this connection it is of interest to note that the Niger goat-skins, which have become somewhat popular of late in this country as bookbinding leathers, are believed to be tanned with "gambia" pods; on the other hand, the East Indian or so-called Persian skins, which are tanned with the bark of *Cassia auriculata*, are particularly unsuitable for bookbinding purposes. These East Indian skins are so sensitive to the action of light that prints may readily be obtained on them by exposure to light under photographic negatives or similar objects, and illustrations of two such prints are given.

The report contains a series of coloured illustrations showing decayed leathers and the effects of various injurious agents on leather. These illustrations are remarkably successful colour prints, and serve admirably their purpose of showing the change in tone and surface of leather strips as the result of the action of the various agents.

Mention may also be made of the excellent samples of leather prepared by various well-known firms of tanners in this country in accordance with the Committee's specifications, which are issued with the report.

GLUE, GELATINE AND THEIR ALLIED PRODUCTS. A PRACTICAL HANDBOOK FOR THE MANUFACTURER, AGRICULTURIST AND STUDENT OF TECHNOLOGY. By T. Lambert. Pp. xi + 153, with index and 25 illustrations. (London: Charles Griffin & Co., Ltd., 1905.)

It is doubtful whether in any other industry, or group of industries, raw material is so thoroughly and completely utilised as in those in which bones and skins form the bases of operations. From the best portions of bones, after appropriate treatment, buttons, paper-knives and a great number of similar useful articles are manufactured, and from the poorer material, grease, glue, gelatine, animal charcoal and bone manures, superphosphates and phosphorus are prepared. From skins, leather is made, and the waste products of the tannery, such as clippings of hide, are largely made into the finer kinds of glue and gelatine, whilst the hair and scrapings are worked up into cheap manures.

Mr. Lambert's book is a comprehensive and practical guide to the conversion of bones, hides and fish refuse into these various products. After a short historical introduction the proper arrangement of a glue factory is discussed, attention being directed to the special plant used for each particular purpose.

Later chapters deal with the manufacture of gelatine, size and isinglass. The necessity for chemical control of these various operations at each stage is insisted on, and an interesting and fairly detailed account of the best methods for carrying out the analyses which comprise the routine chemical work of such factories is given.

Altogether the book should be useful to the producer of the raw material, to the manufacturer who desires a trustworthy guide and *résumé* of processes now in use, and to chemists engaged in supervising work of this kind.

CHEMISTRY FOR ENGINEERS and MANUFACTURERS. Vol. ii. CHEMISTRY OF MANUFACTURING PROCESSES. A practical text-book by Bertram Blount and A. G. Bloxam. Second edition. (London: Charles Griffin & Co., Ltd., 1905.)

This text-book is already so well known to those interested in industrial chemistry, that it is almost unnecessary to call attention to its special features. The first edition was published in 1896, and a reprint has since then been issued. The authors have taken the opportunity afforded by the exhaustion of the reprint to revise the whole book and to bring it up to date, and in this process a considerable amount of new matter has been added.

The book deals with a great variety of topics, such as the manufacture of sulphuric acid, alkali, artificial manures, cements, leather, glue, explosives and matches, and with the industries depending on the utilisation of such natural materials as rubber, gutta-percha, fibres, resins, dye-stuffs, tanning materials, petroleum, clay and coal.

The descriptions given of the operations involved in these various branches of industry are necessarily short, and the aim of the authors has been rather to expound the dominant principles on which the operations are based than to describe the latter in detail. The book is provided with a good index, and there is appended a useful bibliography for the convenience of those desirous of securing fuller information about particular industries than can be given in a general book of this description.

The volume in this revised form is a welcome addition to the useful series of technological handbooks issued by the same publishers.

TECHNICAL METHODS OF ORE ANALYSIS. By Albert Low, B.Sc. Pp. xxxiii + 237. (New York: John Wiley & Sons; London: Chapman & Hall, Ltd., 1905.)

The preface to this book states that it is intended for the use of the technical chemist, and that it deals chiefly with the chemical examination of ores with a view to the determination of metallic contents.

The gravimetric and volumetric methods described are selected mainly on account of the rapidity with which they can be carried out with fair accuracy, and, as is to be expected, no attempt is made to deal with the complete examination of minerals, except in cases where this is a commercial necessity. The methods recommended have been judiciously selected, and are well and carefully described, and many useful modifications and hints are added.

The concluding chapters deal with the analysis of boiler water, coal, and the testing of crude petroleum. Tables of factors and logarithms are given at the end of the book.

No attempt is made to deal with the "dry assay" of ores, or with the examination of minerals containing precious metals. The book will, doubtless, prove useful to the technical chemist as a guide in the "wet assay" of minerals containing the more common metals of commercial value.

ON THE LOCATION AND EXAMINATION OF MAGNETIC ORE DEPOSITS BY MAGNETOMETRIC MEASUREMENTS. By Eugene Haanel, Ph.D. (Breslau). Pp. ix + 132, and 13 plates. Superintendent of Mines, Dept. of the Interior, Ottawa, Canada, 1904.)

This is the first publication in English of the details of the methods of locating deposits of magnetic iron ores by the variations in the horizontal and vertical strength of the magnetic field, which have yielded such satisfactory results in Sweden. Not only can the horizontal distribution of the ore be determined, but the depth at which it lies can be ascertained approximately.

Full particulars are given of the instruments employed and the methods of using them, and the text is supplemented by illustrative charts and tables for calculation.

It is to be regretted that this book, which contains so much valuable material, should suffer from a serious want of clearness, due perhaps to too literal translation from Swedish sources. For instance, some confusion is caused by the employment of "maximum" and "minimum" for values greater or less than normal, instead of the greatest or least value.

The mathematical demonstrations, too, are not well arranged, with the result that they are rendered unnecessarily difficult to follow.

TIN DEPOSITS OF THE WORLD. By Sydney Fawns, F.G.S. Pp. xii + 240. (*The Mining Journal*, 1905.)

The author has compiled, from various sources, including his own observations, a useful collection of facts about tin deposits and tin mining.

The book should be in the hands of all who are interested in this metal.

THE COPPER HANDBOOK. A MANUAL OF THE COPPER INDUSTRY OF THE WORLD. Vol. v. for the year 1904. By H. J. Stevens. Pp. 882 + 74. (Michigan, U.S.A., 1905.)

The earlier portion of this book deals, after a somewhat summary fashion, with the mineralogy, mining, metallurgy and uses of copper.

Five chapters (61 pages) are then devoted to a description of the copper deposits, arranged according to localities; but the chief feature of the book is Chapter xi., which consists of 684 pages, and forms an alphabetical directory of the copper mines of the world. In each case the fullest available information is afforded as to the nature of the deposits, the work that has been done and the financial position and prospects of the enterprise. The final chapter contains some useful statistics relating to the copper industry.

OUR EMPIRE, PAST AND PRESENT. Vol. ii. GREAT BRITAIN IN ASIA. By the Earl of Meath, M. H. Cornwall Legh and Edith Jackson. Pp. xv + 783. Price *7s. 6d.* (London: Harrison & Sons, 1905.)

The fortunes of the races that have flourished from time to time within the Indian Peninsula furnish tales of furious fighting, brilliant victories and stubborn defence, sinister tragedies and hairbreadth escapes that are no whit less wonderful than the marvellous adventures written in the pages of romance. So frequent and sudden have been the rise and fall of dynasties and powers that the history of these races presents an ever-changing scene of kaleidoscopic variety.

The key to the understanding of Indian history is found in the geographical position of the peninsula, separated from the Asiatic continent on the north by an impassable range of mountains. Thus successive waves of devastating invaders have always entered through the passes in the north-west, to fall upon the dwellers in the plains. Down these passes have swept in turn the hordes of Hindus, Muhammadans and Afghans, each becoming paramount, but, nevertheless, unable to destroy or absorb their conquered foes, while the vanquished races, bravely maintaining their customs and beliefs, have waited until dissensions amongst their victors might again furnish an opportunity for retaliation. Many of the earliest primitive races, although they were reduced to bondage, have survived, and they formed a twelfth part of the population in the first census of India in 1872.

Tracing the course of events in historic times, the first to arrive were the Aryan forefathers of the priestly Brahmans, the haughty Rajput warriors and other Hindu races. Then followed the Greek invasion, that is chiefly interesting in so far as Greek influence can to this day be traced in Hindu art. In the seventh century of our era began the series of Musalman invasions that continued for eleven hundred years, after which a Pathan or Afghan Kingdom was founded, but shortly gave place to the great Mughal Empire that reached its zenith in the reigns of Akbar and Shah Jehan. Meantime, following the sequence in the book, European nations sought to discover the country that produced the spices, delicate silks and other costly products that found their way into Western markets, and in 1497 Vasco da Gama, after an adventurous voyage round the Cape of Good Hope, arrived at Calicut on the west coast. The Portuguese were followed by the English and Dutch, and the two East

India Companies of these Northern powers were soon contending for supremacy in the East Indies. In India the Dutch made very little headway, but the arrival of the French quickly led to a struggle for mastery between them and the English. The French were the first to intervene in the disputes of the native rulers, and the astute Dupleix, recognising the unstable condition of the Mughal Kingdom, sought to build up a French Empire in its place. How Clive managed to frustrate the ambitious designs of Dupleix is graphically told, and the brief reference to his boyhood gives colour to the picture.

The establishment of Parliamentary control over the affairs of the East India Company in 1773 by its nomination of the Governor-General, when Warren Hastings was appointed, was made more definite by Pitt's enactment in 1786, which vested the government in the hands of the Governor-General and three Councillors, all appointed by the Crown. Less brilliant than the victories of Wellesley, but not less glorious, were the administrative reforms effected by Lord Bentinck and Lord Dalhousie. These reforms did not, however, bring peace, and the Indian Empire was once again shaken to its foundations by the upheaval of the Mutiny before British rule settled into a more stable condition of equilibrium. A very full account is given of that eventful period when the prestige of British arms was saved by Nicholson, Havelock, Colin Campbell and Rose. Upon the restoration of order, Lord Canning announced at a grand darbār held at Allahabad in 1858, the transference of Government from the East India Company to the Crown. Subsequent events, including the campaigns in the Afghan and Burmese frontiers, are told in the chapters devoted to the description of the growth in solidarity of the Imperial Government, and of the gradual development of that spirit of unity that was so strikingly manifested at the great Coronation darbār, celebrated with magnificent oriental splendour only two years ago.

Of other British dependencies in Asia, Ceylon, the Straits Settlements, North Borneo and Hong Kong are the most important, but the authors also allude briefly to Wei-hai-wei, Aden, Perim, Kamaran Island, the Kuria Muria Islands, the Somali Coast Protectorate, Sokotra, the Bahrein Islands, the Maldives, Laccadives, Andamans and other islands in the Indian Ocean.

Although Ceylon lies like a "pearl-drop" at the foot of India, the East India Company paid little attention to this fertile island. It was constituted a Crown Colony under the Colonial Office in 1801, but nearly half-a-century elapsed before British energy and capital opened up the resources of the country and established the vast trade that exists at the present day. The account of Ceylon given in this book, after referring to the native races and their past history, touches on the cultivation of rice, coffee, tea, the coco-nut palm, cinnamon and other spices, also upon the pearl fisheries.

Turning to the Straits Settlements, full credit is given to the foresight of Sir Stamford Raffles, who laid the foundation of British dominion in the Malay Peninsula by securing the harbour and island of Singapore, and thus prepared the way for the prosperity that has ensued under British occupancy.

The principal incidents related in the chapter on British North Borneo are connected with the failure of European colonists, until the pirates who swarmed in the north of the island were suppressed by the vigorous action of Sir James Brooke and Captain (later Admiral) the Hon. Sir Harry Keppel.

The text of the Convention by which the Kowloon heights forming the hinterland of Hong Kong were acquired by this country in 1898 is given in full, and this measure adopted when Russia proceeded to establish herself in Manchuria leads up to the last chapter narrating recent events in China, and summarising our present position and policy in India.

The task that has been attempted in this book of reviewing the history of so many separate dependencies of the Empire is no easy one, but by judicious selection and arrangement of matter, it is shown how, from isolated portions of territory developed under different circumstances and different government, there has been gradually built up a British Asiatic Empire united under one imperial authority.

The lists of leading dates preceding each chapter enable the reader to pick out the important facts and estimate the duration of successive events; a few good illustrations and maps complete a volume that is characterised by the comprehensive and well-balanced nature of the information it contains.

THE NEWFOUNDLAND GUIDE BOOK, 1905. Edited by D. W. Prowse. Pp. 1–182. (London: Bradbury, Agnew & Co., Ltd.)

The object of this book, prepared at the request of the Newfoundland Government, is to give an authentic account of the Colony, its present condition and future prospects, and towards this end a series of articles by various writers has been brought together under the editorship of D. W. Prowse, who himself contributes an introductory chapter giving a sketch of Newfoundland history. The attractions of the Colony for the sportsman are presented at considerable length, no less than three well-known sportsmen, J. G. Millais, H. Hesketh Pritchard and F. C. Selous, dealing with the caribou; Admiral Sir W. R. Kennedy also gives his reminiscences of the caribou amongst other sporting topics, and Sir Bryan Leighton treats of salmon fishing on the Upper Humber river. Other game is not neglected, and the information thus given, together with the practical notes on camping out, the summary of the game laws, and the list of names and addresses of Newfoundland guides, render the volume very useful to any one desirous of making a sporting trip to the island.

The economic products and resources of the country are dealt with in some detail. Mr. Jas. Howley, Director of the Geological Survey, sketches the general geological features of the island, and there are also notes on the occurrence and value of the principal mineral deposits, namely, coal, copper, iron, slate, marble and gypsum, petroleum and talc. Newfoundland contains much good agricultural land, but is specially adapted for raising sheep, of which there are some 80,000 in the Colony. Much remains to be done by the establishment of model and experiment farms, the need for progress in agricultural matters being evidenced by the fact that Newfoundland imports, to the value of £120,000, products which could be raised locally.

Much attention has been paid recently to the lumber industry, but there is room for great expansion. Small spruce and fir are particularly abundant, and it is anticipated that the Colony will in the future become a large pulp-producing area, owing to the facilities for water power, abundance of suitable wood, cheap labour and proximity to England. The fisheries yield products valued at over £2,000,000 annually, cod contributing considerably more than half to the total.

Statistical information is given of the trade and commerce, and the book, with its large number of illustrations, affords a convenient summary of the available data relating to the oldest of the British Colonies. The chapters on Labrador by F. C. Berteau and Dr. F. Grenfell add considerably to its usefulness.

HANDBOOK OF THE NYASSA COMPANY. Pp. 1–60, with 2 maps.

The Nyassa Company administers, under a charter from the Portuguese Government, the entire district of Cabo Delgado, the northern portion of Mozambique, an area of about 100,000 square miles, bounded on the east and west by the Indian Ocean and Lake Nyassa, on the north by the Rovuma river, and on the south by the Lurio river. In addition, there are some twenty-eight islands, insignificant in size, but commercially important owing to the sponge and coral trades and their pearl fisheries.

The general features of the district are very similar to other portions of the east coast of Africa, and three zones are recognised—the littoral zone, level, warm and humid; the middle zone, consisting of gently-rising plains, with isolated ranges of hills; and the interior mountainous and temperate zone. All are fertile and thickly populated, but whilst in the middle zone development must be undertaken by native labour under European supervision, in the interior zone European colonists can find a permanent home.

Many tropical plants thrive in the district, and attention is especially directed to coffee, cacao, sugar and cotton as being products to which local conditions are well adapted, whilst rubber-yielding plants are abundant in the forests. The turtle fishery affords employment to a large number of natives on the islands, and the industry is capable of development; the pearl fisheries also yield profitable results.

The mineral resources include coal, iron and gold. The Pemba Coal Basin is of large extent and advantageously placed, being close to the fine harbour of Pemba Bay and the site of the new capital, and near to a large deposit of magnetic iron ore. The second coal-field, the Itule, is more extensive, its area being estimated at 500 square miles. The new capital is to be the starting-point of the Pemba-Nyassa Railway, which will run from the coast to Lake Nyassa, and will, it is hoped, secure the commerce of the great central lake district of Africa. Much detailed information is given in the form of abstracts from official reports, and there is also a translation of the charter of the Company.

AGRICULTURE WITHIN THE EMPIRE. Pp. 1–165 and i–xi, 4 maps and 50 plates. (Issued by the Transvaal Agricultural Dept., Pretoria, 1905.)

Shortly after the conclusion of the South African War, Lord Milner, then High Commissioner for South Africa, decided to send a party of Boer delegates on a tour to study and report upon the methods of agriculture and stock-farming practised in various parts of the British Empire. Messrs. W. L. Jooste, J. Moody Lane and H. T. Rood were selected from amongst the prisoners of war at St. Helena, and, accompanied by Captain Kirkpatrick, they visited Great Britain, Canada, Australia and New Zealand. The present volume contains an account of their tour and summaries of their observations, with suggestive and critical remarks as to the suitability of various methods and practices to South African conditions.

Accustomed to the comparatively arid country of South Africa, the delegates were much impressed by the magnificent lakes and rivers of Canada, and the great timber resources of the Dominion. Amongst many admirable agricultural methods noted, special importance is attached to the general adoption of silos for the preservation of fodder, especially maize, and similar methods are strongly advocated for South Africa. Careful attention was paid to live stock, the dairy industry and fruit-farming; in the last of which industries it is noted that South Africa has much to learn from Canada regarding the handling and packing of produce. Between Canada and South Africa a great trade is possible, the latter needing at present timber, flour, dairy produce, agricultural implements and machinery, all of which the former can supply of good quality. In Australia and New Zealand attention was in great measure devoted to typical farms, experiment farms, great business enterprises, the methods employed and results obtained in diverse branches of agriculture and stock-farming, and instances are cited where beneficial results would be obtained in South Africa by the adoption of Australian methods. The irrigation works of New South Wales and Queensland were of great interest, and emphasis is laid on the importance of a well-thought-out scheme of irrigation for South Africa, and suggestions offered as to the method in which good results might be achieved. The final chapter, entitled "Some Impressions and Suggestions," brings together the chief lessons of the tour, and is also of importance as indicating the views of the authors as to the lines along which improvements might be effected in agricultural practice in the Transvaal. The interest of the report is increased by the coloured maps indicating the distribution of the chief agricultural crops and economic minerals in Canada, Australia and New Zealand, and the illustrations of typical homesteads and breeds of cattle in the countries visited.

ZANZIBAR IN CONTEMPORARY TIMES: A SHORT HISTORY OF THE SOUTHERN EAST IN THE NINETEENTH CENTURY. By Robert Nunez Lyne, F.L.S., F.R.G.S. Pp. xii + 328, illustrated. (London: Hurst & Blackett, 1905.)

The story of the rise and decline of the native State of Zanzibar is graphically recounted in this book by Mr. Lyne, who is at present officially connected with the Government of Zanzibar, and his work may be commended to all who wish to gain an insight into the history of East African affairs. The United Kingdom has played a very conspicuous part in the events which are described in the book, and it may therefore be noted that the earliest record of our connection with Zanzibar dates from 1798, when a British squadron visited the island and had a number of the crew murdered by the natives. Long before that date the Portuguese had visited both the island and the adjacent mainland, and in 1509, after several expeditions, they succeeded in establishing a colony in East Africa, which they retained for nearly 200 years. In 1698, however, they were driven from Mombasa, Zanzibar, Pemba and Kilwa by the ruling Sultan of Muscat, and after some vicissitudes of fortune the whole of the territory as far as Cape Delgado, 250 miles south of Zanzibar, became tributary to Muscat. This rule continued until 1861, when a dispute regarding the succession to Muscat and Zanzibar arose, and the questions at issue were submitted to the arbitration of Lord Canning, who was then Governor-General of India. As the result of his award the State of Zanzibar became independent of Muscat, and this arrangement received the approval of the chief European Powers. The next change, which led up to the position as it exists to-day, was in 1885, when Germany established a Protectorate over a part of the Sultan's territory on the mainland. This action was followed at a later date by the proclamation of a British Protectorate over the territory previously administered by the British East Africa Company, and at the same time Zanzibar itself was placed under British protection. Mr. Lyne gives a general sketch of the history of Zanzibar throughout these varied changes, in the course of which he traces the relations of the European Powers with the native State, and the sequence of events which led up to the present situation. The story of the suppression of the slave trade, and the part that the United Kingdom played therein, also receives full treatment.

The recent history of Zanzibar dates from 1892, when the reorganisation of the Government was undertaken by Sir Gerald Portal. At this time the affairs of the island were in a most unsatisfactory condition, but thanks to the able reforms which were introduced this has now been remedied, and a bright future appears to be assured. The island possesses a magnificent harbour, and in view of its advantageous geographical position it seems likely to remain the chief centre of trade in East Africa.

The concluding chapters of the book are devoted to a description of the people, the industries and the climate of the island, whilst statistics regarding the finance, commerce and meteorology of Zanzibar, together with a bibliography, are furnished in a series of appendices. The book is illustrated by maps and a number of interesting photographs.

A JOURNAL OF A TOUR IN THE CONGO FREE STATE. By Marcus R. P. Dorman, M.A. Pp. viii + 192. (London: Kegan Paul, Trench, Trübner & Co., 1905.)

This book gives an account of a journey which the author recently made to the Congo Free State and the French Congo with the object of shooting big game. In the preface Mr. Dorman states that he left England with a prejudice against the Government of the Congo Free State, and returned with a very strong feeling in its favour, so that he felt it to be his duty to publish an account of what he saw for the benefit of those who wish to study the question of the administration of the country. The book, which represents the author's diary, gives an itinerary of the tour, and records his impressions of the country, its people, scenery, climate, etc., and his views on the administration, based upon his own observations and the accounts furnished him by officials, missionaries and traders. Mr. Dorman spent six months in the country, and during that time he ascended the Congo river as far as Stanleyville, and also journeyed up the Ubangi river in the French Congo to Djabir.

RECENT JOURNAL.

ECONOMIC GEOLOGY. A semi-quarterly journal devoted to geology as applied to mining and allied industries. Nos. I. and II. (The Economic Geology Publishing Company, South Lancaster, Pennsylvania, U.S.A.)

It is now twelve years since the *Zeitschrift für praktische Geologie* was founded in Germany in the interests of applied geology in that country, but in spite of the importance of the mining industry in the United Kingdom, its Colonies and Dependencies, as well as in the United States, the journal which forms the subject of the present notice is the first periodical published in English which is devoted exclusively to the economic aspects of the science of geology.

The term "economic geology" appears to be restricted in the United States to the investigation of the mode of occurrence and origin of economic minerals and the rocks in which they occur, while in this country it includes in addition what might be described as economic mineralogy, the study of the composition and characters of such minerals, as well as the different applications in the arts for which they are available.

The new publication starts under favourable auspices, for the Board of Editors, presided over by Professor J. D. Irving, and including Dr. W. Lindgren, Professor J. F. Kemp and other well-known authorities in the United States, is a guarantee of good work.

The first number contains some valuable and suggestive articles.

Professor Kemp discusses the "Secondary Enrichment in Ore Deposits of Copper"; he reviews the evidence which is available as to the mode of genesis of the principal ores of copper, and the stages by which one passes into another. He considers that the original ore was probably in most cases a cupriferous pyrite, and that by its oxidation copper sulphate was formed, which, reacting with unaltered cupriferous pyrite, produced chalcopyrite. By a continuation of the same process chalcocite (Cu_2S), or in some cases covellite (CuS), were, he believes, formed. Although his views can scarcely be regarded, at present, as completely established, they will at least stimulate research in a direction which is of the utmost importance to the mining industry, and at the same time of great scientific interest.

Eugene C. Sullivan writes on the "Precipitation of Copper by Natural Silicates," and as the result of research carried on in the chemical laboratory of the United States Geological Survey, shows that many silicates react with a solution of copper sulphate, the metals of the alkalis or alkaline earths changing places with the copper, so that a copper silicate results.

Another article on a kindred subject is that by Lindgren on "Ore-deposition and Deep Mining," in which he discusses the depths to which ores may be expected to be found, and comes to the conclusion that deposits of gold quartz extend over a vertical range of at least six or seven thousand feet. There is some evidence that the richest ores occur at the original apex of a deposit, and that the conditions of ore-deposition grow less favourable as the depth increases, but the change appears to take place very slowly.

One of the most interesting articles is that on the "Genesis of the Lake Superior Iron Ores," by Charles Kenneth Leith. Whether the explanations of the author be accepted or not in their entirety, the observations he records and some, at least, of the theoretical conclusions he draws from them, will be of the greatest use in determining the value and extent of the deposits in any particular locality. The importance of the subject is not confined to the region dealt with in the paper, for the banded iron-stones and magnetic quartzites of South Africa present many points of resemblance to the ores of Lake Superior.

In an article by Marius R. Campbell on an "Hypothesis to account for the Transformation of Vegetable Matter into the Different Varieties of Coal," after considering the different agencies which have been invoked to explain the change, such as time, earth-movements and heat, gives the first place to the existence of faults or joints by which gaseous hydrocarbons can escape. It has no doubt considerable influence on the result, and it is useful to have this emphasised, but it may be questioned whether too much importance is not attached to it by the author.

The second number fulfils the promise of the first. Among other articles may be mentioned, "Ore Horizons in the Veins of the San Juan Mountains, Colorado," by C. W. Purington, in which the author discusses the vertical variations in the characters of the veins which traverse thick beds of rhyolite and andesite, often brecciated. He shows that the thickness of the veins is considerably greater in the andesite than in the rhyolite, and that the more siliceous the country the poorer the veins.

Mr. Orville A. Derby, whose services have now been secured by the State of Bahia, writes on the "Geology of the Diamond and Carbonado Washings of Bahia, Brazil." He believes that the diamonds are derived from a bed of conglomerate, some 20 or 30 feet thick, situated at the base of a sandstone series, and overlying other sandstones belonging to an older formation.

Another paper by W. B. Philips describes the occurrence of mercury ore in limestones and shales of cretaceous age in Texas, apparently in connection with the presence of lava flows (rhyolite, andesite and phonolite), in which the ore is also found.

Considerable space is devoted to reviews of current literature, and there is a useful bibliography in each number.

COLONIAL PUBLICATIONS.

COPIES of the following publications, descriptive of the resources of the British Colonies, have recently been received. They are available for distribution at the Central Stand in the Exhibition Galleries free of charge, so long as numbers permit, excepting those to which prices are affixed.

Canada.

FOREST, STREAM AND SEA-SHORE. Issued by the Inter-Colonial Railway and Prince Edward Island Railway of Canada, 1905. Pp. 1–183.

This pamphlet provides a popular account of the chief features of interest in the whole of the area served by the Inter-Colonial and Prince Edward Island Railways. With the aid of numerous illustrations, some in colour, information is given regarding the scenery, the principal towns and pleasure resorts, the hunting and fishing districts, and other topics. Economic subjects are touched upon, and brief summaries are afforded of some of the principal agricultural and mineral industries of the country.

THE TIMBER AND WOOD-PULP INDUSTRIES OF BRITISH COLUMBIA. Bulletin No. 21. Bureau of Provincial Information, 1905. Pp. 1–38.

British Columbia is estimated to contain approximately some 183,000,000 acres of forests, or about three times as much as the total area of forests in Norway and Sweden.

Douglas Fir (*Pseudotsuga Douglasii*) is the principal tree, and amongst other important trees are the Giant Arbor Vitæ (*Thuja gigantea*), Yellow Cedar (*Thuja excelsa*), Western White Pine (*Pinus monticola*), other pines and hemlock, oak, poplar, maple, larch, etc. A description is given of each, with information as to the sizes usually procurable, and the uses to which the timber is adapted.

The paper and pulp industries are dealt with in detail, and much general information is given as to the preparation of wood pulp and paper, the world's markets for paper, and the special circumstances which favour British Columbia in competing for a place in these markets. The statistical data include Canadian imports and exports of paper, wood pulp, wood board, and the imports of paper into the various countries of the British Empire, and into foreign countries. The timber regulations of British Columbia are appended.

The pamphlet is illustrated with habit pictures of some of the principal trees, and with scenes in felling and transporting timber.

Australia.

THE YEAR BOOK OF SOUTH AUSTRALIA, 1906. By authority of the Government of South Australia. Pp. 1–174.

A general handbook of information on the State. The duties and *personnel* of each Government Department are summarised.

Amongst many other subjects, agricultural, pastoral and forestry matters are concisely treated, and a *résumé* given of the data relating to the principal minerals and mining acts. The commercial information includes import duties, jetty tolls and excise duties. The book contains a map and a full index.

THE VICTORIAN SETTLER'S GUIDE. Issued under the direction of the Minister of Lands, 1905. Pp. 1–79.

The book is intended to afford settlers and intending settlers an opportunity of obtaining knowledge of the Land Laws of the State, and this is provided in a comprehensive digest of the enactments, conveniently arranged under various headings. In addition there is a series of articles by specialists on the following subjects: Water conservation, rainfall and temperature, the rocks and their resulting soils, timber, education policy, destruction of rabbits and foxes, railway freights; the information in all cases referring directly to Victorian conditions. There is a large number of illustrations, mainly of direct agricultural interest, and six maps, showing irrigation and rural water-supply works, distribution of rainfall, and temperature, the geology of the State, distribution of butter factories, and the areas specially adapted to wheat, pastoral pursuits, fruit-growing, orchards and vineyards, and forest and timber reserves.

Africa.

THE UGANDA RAILWAY. British East Africa. Pp. 1–92.

This book, which is illustrated by a large number of photographs, consists essentially of a description of the country traversed by the Uganda Railway from Mombasa to the terminus at Port Florence on the Victoria Nyanza. A brief outline of the history of the British East Africa Protectorate from the time of the granting of a charter to the British East Africa Company in 1888 serves as an introduction, and brings before the reader the principal facts which rendered the building of the railway a necessity.

In dealing with the country opened up by the line considerable attention is paid to the attractions offered to the sportsman, no small part of the book being taken up with descriptions of the varied fauna of the Makindu and Kiu countries and the famous Athi plains. No serious attempt is made to discuss the present condition or future possibilities of the Protectorate from the agricultural point of view, but the suitability of the highlands as a stock-raising country, and the abundance of fibre plants (*Sansevieria*) growing wild in many districts, notably around Voi, are duly emphasised.

Reference is also made to the valuable work being done by the

Government in encouraging agricultural industries by means of experiment farms. The book concludes with a descriptive account of a trip round the Victoria Nyanza on board one of the Lake steamers.

The return fares from London to Mombasa, and from the latter port to various points on the railway are tabulated, and, in addition, there is a list of the principal hotels in Mombasa and Nairobi.

BULLETIN

OF THE

IMPERIAL INSTITUTE

1906. VOL. IV. NO. 2

SCIENTIFIC AND TECHNICAL DEPARTMENT.

REPORTS ON RECENT INVESTIGATIONS.

TANNING MATERIALS OF THE SUDAN.

THE tanning materials consisted of the barks of "Mudus" (*Parkia filicoidea*) and of "Abu Surug" (*Prosopis oblonga*), and of the pods and bark of the "Sant" tree (*Acacia arabica*). These four products are used as tanning materials by the natives in the Sudan, and it was requested that the samples might be examined and their commercial values ascertained.

Description of Samples.

1. BARK OF MUDUS (*Parkia filicoidea*).—Pieces of bark from three to seven inches in length and one to three inches in width, showing a rough dark-brown outer bark, readily detached from the reddish-brown fibrous inner bark.

2. BARK OF "ABU SURUG" (*Prosopis oblonga*).—Portions of bark about twelve inches in length and two inches in width. The outer surface of each piece was covered by scales of bark varying in colour from pale buff to dark brown; the inner surface was of a fairly uniform dark-brown colour.

3. BARK OF "SANT" TREE (*Acacia arabica*).—Large pieces of bark having a rough outer surface and a smooth dark-brown inner surface.

4. PODS OF "SANT" (*Acacia arabica*).—This consisted of single-seeded fruit segments, each being covered by a soft grey bloom which was easily rubbed off, leaving the brown outer surface of the skin of the pod exposed.

Chemical Examination.

Representative samples of the four materials, selected from the respective consignments, were chemically examined, and subsequently small tanning experiments were made with them on "limed" calf-skin. The results of these investigations are given in the following table:—

	Mudus bark per cent.	*Abu Surug* bark per cent.	*Sant* bark per cent.	*Sant* pods per cent.
Moisture	12·2	11·1	11·5	10·6
Ash	6·1	2·7	6·8	3·7
Total extractive matter:				
Calculated on material as received	15·3	21·2	12·0	50·0
Calculated on material dried at 105° C.	17·4	23·8	13·5	55·5
Tannin:				
Calculated on material as received	12·8	14·4	8·8	35·4
Calculated on material dried at 105° C.	14·6	16·2	9·9	39·4
Nature of leather produced	Produces a harsh dark reddish-brown leather.	Produces a firm reddish-brown leather.	Produces a harsh dark-brown coloured leather.	Produces a soft light-coloured leather.

These results show that only one of these four tanning materials, viz. "Sant pods," contains sufficient tannin to be worth consideration for export in the crude state.

It is somewhat remarkable that the sample of "Sant bark" should contain only 8·8 per cent. of tannin, since in India, where this material is largely used as a tanning agent under the name of 'babul' bark, it generally contains from 17 to 18 per cent. of tannin and furnishes a fawn-coloured leather.

Commercial Valuation.

Samples of the four tanning materials were submitted to a tanning expert for trial on a manufacturing scale and for commercial valuation.

The expert reported that all three barks contain, in addition to the tannin, red and dark-brown colouring matter, which are absorbed by hide and produce dark-coloured leathers. This would lead to a depreciation in value of leather tanned with those materials, and for this reason these barks could only be used for the production of second class or lower grade leathers.

The "Mudus" and "Abu Surug" barks were stated to be worth about £2 10*s.* per ton, and the "Sant" bark only £2 per ton. With regard to the "Sant" pods it was pointed out that small quantities of this material have already been imported into this country from India to be used for tanning, and that although it gives a good tannage, it is slow, and the leather produced is rather soft. The consignments of "Sant" pods so far sold in the United Kingdom have usually fetched about £6 per ton.

CASTOR OIL AND GROUND NUT OIL FROM SOUTHERN RHODESIA.

THESE samples of castor oil and ground nut oil from Southern Rhodesia were forwarded to the Imperial Institute by the British South Africa Company with a request for a report on their composition and commercial value.

Castor Oil.

The sample of castor oil consisted of nearly colourless, very viscous, slightly turbid oil which, on chemical examination, yielded the following results:—

Specific gravity at 15·5° C.	0·959
Acid value (mgms. KOH per 1 gram oil) . .	1·2
" " (calculated as oleic acid), per cent. .	0·6
Saponification value (mgms. KOH per 1 gram oil)	179·6
Iodine value (iodine absorbed by 100 parts of oil)	87

One part of the castor oil was found to dissolve in five parts of 90 per cent. alcohol forming a clear solution.

These results indicate that the product is of good quality although in its present state its value is diminished on account of its turbid condition. The oil can be rendered clear and bright, however, by filtration, and would then, in the opinion of the commercial experts, to whom the sample was submitted, be worth about £26 to £28 per ton.

Ground Nut Oil.

This sample was a light yellow oil, which on chemical examination furnished the following constants:—

Specific gravity at 15·5° C	0·916
Acid value (mgms. KOH per 1 gram oil) . .	2·0
„ „ (calculated as oleic acid), per cent. .	1·0
Saponification value (mgms. KOH per 1 gram oil)	188·1
Iodine value (iodine absorbed by 100 parts oil)	93

These results show that the product is of good quality. If the oil is intended for table or culinary use, the free fatty acid should not exceed the quantity (1 per cent.) contained in the present sample.

The commercial experts report that the oil is decidedly pleasant, probably superior to the highest grade oil met with in this country, and worth about £40 per ton.

It is evident from the foregoing report that these samples of castor oil and ground nut oil are of good quality and value. If the products can be exported from Rhodesia in large quantities they will doubtless prove of considerable commercial importance to the country and will probably meet with a ready sale in the United Kingdom.

TOBACCO FROM JAMAICA.

THIS sample of tobacco was sent to the Imperial Institute by the Director of the Department of Public Gardens and Plantations of Jamaica. It was grown experimentally under shade cloth during the season 1904–1905 from Sumatra seed.

Description of Sample.

The sample consisted of six leaves of the "wrapper" type of cigar tobacco, showing a dull, olive-brown tint. The leaves were of fair length, uniform in colour, thin and free from "stains" and "burns." They were somewhat brittle when handled, but this was probably due to their having been packed between sheets of cardboard, which had absorbed the moisture, rendering the leaves abnormally dry.

When ignited the tobacco burned evenly and steadily, evolving a fairly fragrant aroma and leaving a greyish-white ash.

As the sample was very small, it was impossible to submit it to chemical examination. It was therefore sent to a firm of tobacco experts to be tried for wrapping cigars and for the determination of its commercial value. The experts' report on the tobacco was as follows :—

"The tobacco is of very handsome appearance, thin in texture and therefore highly productive as a 'wrapper' for tobacco; in use it is somewhat 'tender' and does not appear to have quite as much elasticity as Sumatra tobacco of similar texture [see note under "Description of Sample" as to probable reason of this "tenderness"]; the burning is very fair, and the flavour not unsatisfactory. Similar tobacco, well put up, would fetch on the English market up to about 3*s.* per lb. for first lengths, say 2*s.* 3*d.* per lb. for the second lengths, and from 1*s.* 3*d.* to 1*s.* 6*d.* per lb. for the third lengths.

"We feel sure that the soil and climate which have produced this tobacco are suitable for growing 'wrapper' tobacco equal to most in the world, and if labour is plentiful and cheap and the area of suitable ground large enough there is a chance in time of this district of Jamaica becoming a serious competitor of Borneo, Sumatra, and Java."

The experts also suggest that it might be worth while to carry out a similar cultivation experiment in Jamaica with Java tobacco, as this would probably yield a "wrapper" leaf which would be stronger in texture and of even better flavour than the present sample.

The results of the experts' trial of this tobacco show that it is of good quality, and that if a similar quality can be placed on the English market in quantity, it will probably realise remunerative prices.

DAMMAR RESINS FROM THE FEDERATED MALAY STATES.

THESE samples of dammar resins, produced in the Federated Malay States, were forwarded to the Imperial Institute by the Conservator of Forests, with the request that information might be supplied as regards their suitability for varnish-making and their probable commercial values in this country.

Description of Samples.

SAMPLE No. 1 (*Dammar Penak*, No. 1 quality, derived from *Balanocarpus* [*Maximus* or *Wrayi*]).—The sample weighed nearly one pound, and consisted of tears agglomerated into masses of light-yellow transparent resin. It was brittle, readily reduced to powder, and appeared to be quite free from any foreign matter. It was partly soluble in alcohol, completely so in ether, and almost entirely soluble in turpentine, forming a slightly opalescent solution, which when applied to sized wood dried to a brilliant, transparent, hard and almost colourless "coat."

SAMPLE No. 2 (*Dammar Kumus*, from a Shorea sp., rather like *Shorea glauca*).—The sample weighed about four ounces, and consisted of two small masses of reddish-brown resin, which was translucent in thin pieces. It was partially soluble in alcohol, and almost completely soluble in ether. The solution in oil of turpentine was dark coloured, and when applied to sized wood left a fairly hard, brownish "coat" which was not very glossy.

SAMPLE No. 3 (*Dammar Mata Kucking* [Port Dickson]).—This sample weighed about 1·5 ounces, and consisted of small, roughly ovoid, slightly yellow transparent tears of resin. It was hard, and free from foreign matter, and dissolved partially in alcohol and completely in ether The solution in oil of turpentine was clear, and when applied to sized wood left a hard, brilliant, nearly colourless "coat."

SAMPLE No. 4 (*Dammar Soongyi*).—This weighed nearly fourteen ounces, and consisted of irregularly shaped lumps of dark-brown resin, which was translucent in thin pieces. The resin was hard; it dissolved partially in alcohol or ether and completely in oil of turpentine, forming a brown, opaque solution which dried on wood, leaving a light brown, soft, dull "coat."

SAMPLE NO. 5 (*Dammar Meranti*, derived from various *Shoreas*, of inferior quality).—This sample weighed about twenty ounces, and consisted of a single lump of opaque, yellowish-white resin, which was friable and softened readily when rolled between the fingers. It was partially soluble in alcohol or ether, and formed with oil of turpentine an opaque varnish which when applied to wood left a dull and sticky "coat."

SAMPLE NO. 6 (*Dammar Mata Kuching from Jempol*).—The sample consisted of a lump of hard, transparent, pale amber-coloured resin, weighing about seven ounces. It was free from foreign matter and was partially soluble in alcohol and completely soluble in ether. It dissolved in oil of turpentine to form a pale, yellow, transparent solution, which dried on sized wood, forming a hard, brilliant and almost colourless varnish similar to that produced by Sample No. 1.

SAMPLE NO. 7 (*Dammar Rengkong?*).—This weighed about two ounces, and consisted of small pale-yellow, hard and transparent tears. It was partially soluble in alcohol or ether and dissolved completely in oil of turpentine, forming an opalescent solution, which dried on sized wood leaving a "coat" which was hard, but lacked gloss.

SAMPLE NO. 8 (*Dammar Merawan from a Shorea*).—The sample weighed nearly two ounces, and consisted of large translucent, yellowish-white tears of resin. It was partially soluble in alcohol, completely so in ether, and formed an almost colourless solution in turpentine oil, and this on drying left a fairly hard, clear, glossy "coat" inferior to those produced by Nos. 1, 3 and 6.

SAMPLE NO. 9 (*Dammar Strayak*).—This weighed about five ounces, and consisted of lumps of pale yellowish-brown resin showing a laminated structure. It was partially soluble in alcohol or ether. The solution in oil of turpentine dried to a fairly hard "coat," which was devoid of gloss.

Chemical Examination.

The nine samples of resin were chemically examined in the Scientific and Technical Department of the Imperial Institute, and gave the results recorded in the following table:—

	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	No. 6.	No. 7.	No. 8.	No. 9.
Melting point .	90°C	94°C	87°C	180°C	185°C	92°C	200°C	97°C	190°C
Ash, per cent. .	0·26	0·08	0·05	0·52	0·03	0·06	0·04	0·25	0·09
*Saponification number . .	46·7	72·0	38·5	34·3	72·0	33·0	46·7	38·5	55·0
*Acid number .	45·3	72·0	38·5	33·0	72·0	33·0	46·5	38·5	55·0
*Ester number .	1·4	—	—	1·3	—	—	0·2	—	—

**Milligrams of potash required for one gram of resin.*

The results of this examination show that these resins exhibit considerable differences in chemical composition and properties. They are all, however, partially soluble in alcohol and completely soluble in turpentine oil, forming fairly light-coloured varnishes, and would therefore be classed commercially as dammars.

Commercial Valuation.

Samples of the nine dammars were submitted for valuation to commercial experts, who were also informed of the results of their examination at the Imperial Institute. They reported on the samples as follows :—

Number of sample.	Description.	Commercial experts' comment.	Commercial values estimated by experts.
No. 1	Dammar Penak	"clean pale yellow"	55*s*. to 60*s*. per cwt.
,, 2	,, Kumus	"black"	20*s*. per cwt.
,, 3	,, Mata Kuching (Port Dickson)	"pale drop"	70*s*. ,,
,, 4	,, Soongyi	"black"	15*s*. ,,
,, 5	,, Meranti	"chalky"	10*s*. ,,
,, 6	,, Mata Kuching (Jempol)	"bold pale"	60*s*. ,,
,, 7	,, Rengkong	"green, like Ceylon"	35*s*. ,,
,, 8	,, Merawan	"white"	35*s*. ,,
,, 9	,, Strayah	"chalky inferior"	5*s*. to 6*s*. per cwt.

The prices quoted for the better qualities of the dammars included in this series of samples compare very favourably with those obtained at present in the open market in London, thus on the 11th November 1905 the better qualities of Batavian dammar were quoted at from 70*s*. to 80*s*. per cwt. and Singapore kinds at from 30*s*. to 75*s*. per cwt.

ROCKS AND MINERALS FROM BRITISH CENTRAL AFRICA.

THE following specimens have been forwarded from time to time by the Government of British Central Africa to the Imperial Institute for investigation. On arrival they were submitted to such examination as was necessary for their identification, and where the circumstances warranted it, they were subjected to chemical analysis. Details of other consignments of a similar character will be found in the *Bulletin of the Imperial Institute*, vol. ii., 1904, pp. 69 and 73, and in vol. iii., 1905, p. 134. See also *Imperial Institute Technical Reports and Scientific Papers*, 1903, pp. 1–3, 39, 40.

Those included in the first consignment were collected by Mr. J. McClounie, head of the Scientific Department at Zomba, in the course of a journey across the Nyika plateau.

BcM 1 and 2.—From the banks of the North Rukuru River near to Panda Hill.

These specimens are portions of oval cylindrical concretions, formed in argillaceous beds by the action of the organic matter of the roots or stems of plants. They contain nearly eight per cent. of ferric oxide, which is probably the substance that forms the cement of the concretion. The greater portion of each specimen is hard and brown in colour, but in the interior are spaces which are soft and black. The results of the analyses of the internal and exterior portions of one of the specimens are as follows:—

	Hard brown outer portion.	Soft black inner portion.
Silica . . . . SiO_2	64·06	59·40
Alumina . . . Al_2O_3	22·00	21·60
Ferric oxide . . Fe_2O_3	7·90	7·80
Manganese dioxide MnO_2	0·71	6·90
Moisture (by difference)	5·33	4·30

BcM 3 and 4.—From a line of outcrop on the slopes of Namwitawa Mountain and from Masisi Hill.

These consisted of reddish decomposed phyllites containing 27·58 per cent. of alumina, 25·37 per cent. of ferric oxide, and 33·3 per cent. of silica, the amount of the latter having probably been considerably reduced in the process of "lateritisation." Quartzite and red clay are stated to occur in the same neighbourhood.

BcM 5.—From Namwiwi's village on the borders of British Central Africa and North-East Rhodesia.

An altered granulite gneiss. It is practically a haplite consisting almost entirely of quartz and felspar, though a few scattered scales of mica are present.

BcM 6.—Waterworn rock from the dry bed of a stream, tributary of the North Rukuru. Several ridges of a similar nature were seen, all running north and south.

A strongly foliated gneiss, containing quartz and felspar arranged in lenticles and interfoliated with dark bands, which appear to have consisted originally of hornblende; a few traces of that mineral still remain, but the greater part has been converted into opaque alteration products.

BcM 7.—Carbonaceous shale with bands of grit from the banks of the North Rukuru River. Amongst these specimens are some fragments which, though not differing in external appearance from the shale, contain sufficient carbonaceous matter to be classed as impure coals. When freshly fractured they are seen to consist of black carbonaceous material in which are shining patches of purer coal.

The best specimens were analysed, and gave the following results:—

Volatile matter	14·34	per cent.
Fixed carbon	25·13	„
Ash	53·65	„
Moisture	6·88	„

The volatile matter contains very little inflammable gas.

The grit bands are mainly made up of quartz, while flakes of white mica are scattered here and there through the shale.

BcM 8.—From the peak "Nkarabwi," at an altitude of 8,046 feet (boiling point determination), 18 miles west of Deep Bay, Lake Nyasa; it is the south-eastern point of the Nyika plateau.

This specimen consists of quartz and ilmenite, and must form part of a mineral vein. An analysis of the ilmenite showed it to contain titanium dioxide 49·15 per cent., ferrous oxide 40·93 per cent., and manganous oxide 6·39 per cent.

BcM 9.—From the slopes of Nkarabwi Peak at altitudes of approximately 6,000 feet.

The specimens included three varieties of mica schist:

(*a*) Mica schist, composed almost entirely of white silvery mica, probably hydrated.

(*b*) Mica schist, weathered and brownish-yellow in colour.

(*c*) Similar schist, much weathered, and showing fairly large flakes of mica of a deep red colour.

BcM 10.—From the village of Mwiniwanda, on the upper waters of the Lufira, about eight miles from Masisi Mountain. The specimen had probably originally come from the slopes of the range of hills about a mile distant from the village.

It is a decomposed granulite formed of quartz, felspar and a little white mica. Here and there are small cavities containing minute crystals of a black mineral, possibly tourmaline.

BcM 11.—From the slopes of the hills adjacent to the Nkarabwi Peak. The ground is thickly strewn with similar specimens.

This sample includes three different materials:

(*a*) Fragments consisting of decomposed mica schist, showing a yellow tint, and containing finely divided quartz with minute scales of hydrated mica.

(*b*) Fragments of a coarse pegmatoid gneiss, consisting of quartz, decomposed felspar and mica plates up to nearly an inch in diameter; and

(*c*) Quartz with traces of mica.

BcM 12.—Stones picked up in the neighbourhood of Mount Masisi at an altitude of 5,000 feet approximately.

One (*a*) is a felspathic quartzite. It was assayed for gold, but contained no trace of that metal. The other (*b*) consists of fine-grained gneiss, kaolinised felspar, green alteration products of hornblende and a little quartz.

BcM 13.—Unlabelled specimens probably from the localities furnishing BcM 11 and 12. They are as follows:—

(a) *Granitoid gneiss*, containing quartz, decomposed felspar and a little mica.

(b) *Vein quartz*. This was assayed for gold, but none was found.

(c) *Fine-grained felsitic rock*. Without visible quartz or other porphyritic mineral. It is much altered. The outer crust is cream coloured, but a fracture shows a pale green tint probably due to the presence of epidote.

(d) *Muscovite gneiss with kaolinised felspar.*

(e) *Fine-grained compact diorite more or less altered.*

(f) *Fragment of orthoclase.*

(g) *Comby vein quartz.*

A number of specimens previously received from British Central Africa were classified by Mr. T. H. Holland, now Director of the Geological Survey of India, into a series of groups corresponding to the formations of Peninsular India, where the geological formations are very similar to those of Eastern and Southern Africa (*Bulletin of the Imperial Institute*, 1904, vol. ii. p. 69). Herr Bornhardt, who has examined the adjoining portions of German East Africa on behalf of the German Government, has classified the rocks in that area in a manner similar to that suggested by Mr. Holland.

The following table shows the relationship between the two classifications, which do not exactly correspond. Some portions of Herr Bornhardt's "Urschiefer" may be included in Mr. Holland's upper group of schists and gneisses.

Holland's Classification.	*Bornhardt's Classification.*
1. Basic flows and dykes .	Later volcanic (Jung vulkanische).
2. Gondwana (Lower) .	Karoo.
3. Intrusive gabbros and peridotites . . .	Plutonic.
4. Transition Azoic shales and sandstones . .	Cape formation ? Urschiefer.
5. Upper group of schists and gneisses . .	Urgneiss.
6. Granitoid gneiss . . .	

Herr Bornhardt found that the greater part of the country immediately to the north of the Nyika plateau was composed of rocks belonging to his division of "urgneiss," and he maps them as continuing southward to the Nyika plateau. All the specimens included in this collection except BcM 1, 2 and 7 would fall under the "urgneiss" of Bornhardt, while in Holland's classification they would mostly be placed with the upper schists and gneisses, though a few, such as BcM 6, 11b, 13a and 13d, would rather be placed with the granitoid gneiss.

The concretions BcM 1 and 2 from the North Rukuru River and the carbonaceous shale and coal from the same locality must be referred to the Lower Gondwana rocks of India and the Karoo beds of South Africa, which are of the same age. Herr Bornhardt has described this formation as occurring in German East Africa not only on the lower course of the river Ruhuhu on the east of Lake Nyasa, but also between the rivers Kivira and Songwe close to the frontier of British Central Africa north-west of the lake. In both localities there is a lower series of thick compact sandstones, and an upper more friable series characterised by frequent variations in the strata and the presence of calcareous beds. At the summit of the lower series is a comparatively small thickness of shales with intercalated coals. On the Ruhuhu the shales are somewhat thick, but the coals are thin and unimportant. To the north-west of the lake, though they are little more than 20 metres thick, they contain a large proportion of coal. They were traced by Herr Bornhardt southward along the eastern slopes of the Iwogo range between the river Kivira and its tributary the Mualessi, and the eastern slopes of the Kavolo and Matulí mountains to the river Songwe, whence they continued into British territory along the eastern slopes of the Mugaya mountains to the west of the river Makeya.

The exposure in the ravine of the river Kandete, a tributary of the Songwe, in Mount Kavolo about 9° 32½′ south gave a total thickness of 20·8 metres (68 feet) of coal-bearing strata, more than half of which consisted of coal.

The following are the principal groups of seams :—

Numbers.	Thickness. Metres.	Thickness of Coal.	
		Metres.	Feet. Inches.
48–58	2·82	2·10	6 11
30–46	2·39	1·56	5 1
22–26	1·20	0·52	1 9
15–18	2·40	2·05	6 8
2–13	4·90	4·84	15 11

To the northward the coals diminish slightly in total thickness, while to the south they thin out much more quickly. On the slopes of the Matuli hills about two kilometres (1½ miles) north of the river Songwe the total thickness of the coal-bearing strata is reduced to six or seven metres, and of this only 1·53 (about 5 feet) consists of coal, the thickest seam measuring half a metre (1′ 8″).

Two samples of coal had previously been received at the Imperial Institute which were stated to come from the Songwe River, and were no doubt derived from the outcrops described by Herr Bornhardt in the drainage area of that stream or from others in the vicinity. Bornhardt mentions the occurrence of coal in British territory on the landward side of Karonga, just south of the North Rukuru River, apparently at no great distance from the point at which the specimens included in this collection were found. Subsequently other specimens of coal were received from near Deep Bay still further to the south (*Technical Reports and Scientific Papers*, published by the Imperial Institute, 1903, pp. 1 and 3). Bornhardt also mentions the occurrence of coal to the south of Deep Bay at Mount Waller (*Deutsch Ost-Afrika*, vol. vii. p. 142).

There is, therefore, it appears, a more or less continuous line of outcrops of coal on the west of Lake Nyasa and approximately parallel to its coast-line.

The coal in the region between the rivers Kivira and Songwe consists of two distinct qualities, one furnishing but little inflammable gas and the other a caking coal, yielding much gas and producing good coke. The specimens collected in British territory west of Lake Nyasa belong partly to the one and partly to the other of these classes.

The following table gives a comparative view of the composition of the different coals from British and German localities west of Lake Nyasa:—

	Deep Bay.	River Songwe.		North Rukuru River.	Source of River Kandete, north-west of Lake Nyasa.		
		A	B		Average of seams 2 to 13.	Average of seams 15, 16a, and 16b.	Seam 15.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Ash	12·72	15·57	8·04	53·65	18·50	18·88	9·76
Fixed carbon	52·95	57·63	47·46	25·13	60·20	52·45	54·49
Volatile matter (including sulphur)	34·33	26·80	44·54	14·34	16·97	24·18	31·92
Water				6·88	4·33	4·49	3·83
Sulphur	0·49	0·10	0·52	...	0·25	0·25	0·35
	calories.	calories.	calories.		calories.	calories.	calories.
Calorific value	5731	5520	6050		5657	5781	6650
Evaporative power	10·49	10·28	11·27		10·53	10·77	12·38

The calorific value is expressed in calories representing the number of grams of water raised from 0° to 1° C. by the combustion of one gram of coal. The evaporative power is represented by the number of pounds of water at 100° C. converted into steam at the same temperature by the combustion of one pound of coal.

It must be remembered that many of these specimens had suffered in quality from weathering. All of them, except the coal from the North Rukuru River, which has a very high percentage of ash, would be useful coals, though none of them are of first-class quality.

Another consignment of rocks and minerals from British Central Africa, the thirteenth of the series of consignments from the Protectorate examined at the Imperial Institute, was forwarded with a view to identification and ascertaining whether they contained gold or silver or other precious metals.

The specimens were stated to have been obtained in Central and Southern Angoniland in the area contained between the Dzonze Hill and the Lisungwi River. The minerals have been examined in the Scientific and Technical Department of the Imperial Institute with the following results :—

BcT No. 2.—Vein quartz containing pyrite and schorl (black tourmaline) and decomposition products.

An assay was made for gold, silver and platinum, but none of these metals was present.

BcT No. 3.—A mass of green tabular crystals. An examination of its physical characters showed it to be kyanite—silicate of alumina, Al_2SiO_5. It differs from most specimens of this mineral in being pale sea-green in colour instead of deep blue, and in being slightly less hard, viz. 3½ in the usual scale, parallel to the length of the principal face, and 5½ in the transverse direction on the same face. The crystals are broader and more plate-like than those of kyanite usually met with in other parts of the world. They appear to resemble most the broad sea-green crystals found at Windischmatrei in the Tyrol. Flakes of a white mica-like mineral are observable in the cleavage planes. The mineral had the following composition :—

Silica	SiO_2	35·54	per cent.
Alumina	Al_2O_3	59·57	„
Ferric oxide	Fe_2O_3	1·86	„
Ferrous oxide	FeO	0·42	„
Lime	CaO	1·29	„
Magnesia	MgO	nil	„
Potash	K_2O	0·59	„
Soda	Na_2O	0·91	„
Combined water and moisture	H_2O	0·11	„

These figures in general agree with those calculated from the composition of kyanite, viz. 37·02 per cent. of silica and 62·98 of alumina, but taking into account the amount of other bases present there is a distinct deficiency of silica. This and the lime and alkalis must be attributed to the presence of decomposition products, consisting of margarite (lime mica) with a certain amount of the lime replaced by soda and potash as in paragonite and muscovite.

The deep blue clear varieties of kyanite are used as gems, the colour being almost equal to that of sapphire, though the hardness and lustre are inferior.

This sample has, however, suffered incipient decomposition, the micaceous mineral already referred to having been developed. At the same time the colour has changed from blue to green, and the transparency and hardness have diminished. It is probable that with a little search some of the original unaltered material may be found. If satisfactory in colour and sufficiently clear and free from cracks, it may be of some value as a gem. Stones suitable for cutting as gems are found in the river sands of Brazil, the softer or flawed portions having been removed by the abrasion of the pebbles.

BcT No. 4.—A specimen of vein quartz showing specks of pyrites. On a fire assay being made, no trace of gold, silver or platinum was found. The portion soluble in acids contained 0·07 per cent. of copper and 1·33 per cent. of ferric oxide calculated on the whole mineral.

BcT No. 5.—Chlorite schist containing pyrites more or less oxidised at the surface. It was found to contain 12·34 per cent. of ferrous oxide, 0·03 per cent. of nickel, 1·43 per cent. of manganous oxide, 0·18 per cent. of copper, and 3·12 per cent. of sulphur

The sample was assayed for gold, silver and platinum, but none was found. The copper present is probably combined with sulphur and part of the iron is also present as a sulphide.

BcT No. 7.—A gabbro containing pyroxene (mainly augite), felspar (basic labradorite), and pyrites.

BcT No. 9.—A sample of schistose steatite (talc schist).

Analysis showed that the sample contained rather less than 90 per cent. of true steatite.

Compact steatite is widely used for the manufacture of gas burners; meerschaum is a pure white variety, and "French chalk" is a poorer quality used for marking cloth, and in a finely powdered state, as a "filler" for paper or as a dusting powder. More impure material is known as soapstone, and if free from flaws is manufactured into slabs for sinks, vats, electric switch-boards, and the walls of stoves.

The present sample is too impure and flawed to be used for any of the above purposes, but it is possible that a better quality may be met with in the neighbourhood.

BcT No. 10.—Orthoclase felspar with a little quartz, biotite-mica, and pyrites.

The portion soluble in acids was found to contain 4·07 per cent. of ferric oxide, 0·07 per cent. of manganous oxide, and 0·04 per cent. of cupric oxide calculated on the whole mineral. An assay was made for gold, silver and platinum, but none was found.

BcT No. 11.—This specimen appears to consist of magnetite, largely altered into hæmatite.

On analysis the following results were obtained :—

Ferric oxide	Fe_2O_3	87·90 per cent.
Ferrous oxide	FeO	8·98 "
Alumina	Al_2O_3	0·38 "
Lime	CaO	1·09 "
Magnesia	MgO	0·55 "
Copper oxide	CuO	nil "
Sulphur	S	nil "
Arsenic	As	nil "
Phosphoric acid	P_2O_5	0·59 "
Combined water / Moisture	H_2O	0·06 "
Residue insoluble in acids		0·72 "

The percentage of metallic iron is 68·52, and of phosphorus 0·26. This is an iron ore of good quality. The phosphorus percentage is not high enough to interfere seriously with the value of the product, except for the manufacture of steel. If this ore is sufficiently near the local coal and limestone deposits it might be possible to carry on smelting operations with it in the Protectorate.

BcT No. 12.—A mass of irregularly intergrown hornblende crystals in process of alteration into chlorite.

BcT No. 13.—Honeycombed quartz with a little pyrites. It was assayed for gold, silver and platinum, but none was found.

BcT No. 15.—Dull, somewhat porous vein quartz from Central Angoniland; the cavities are lined with an ochreous deposit of hydrated ferric oxide.

BcT No. 16.—Massive quartz containing a considerable amount of iron pyrites; from Southern Angoniland.

Portions of both these specimens of quartz were assayed for gold, but neither of them yielded any of that metal.

BcT No. 17.—Nickeliferous pyrrhotite.

This is a composite ore, consisting mainly of pyrrhotite, with a considerable amount of iron pyrites, some copper pyrites, and several silicates, including hypersthene, hornblende, biotite-mica and felspar.

A representative portion of the specimen was analysed and found to contain the following principal constituents:—

Iron	Fe	40·50 per cent.
Copper	Cu	3·00 ,,
Nickel	Ni	2·75 ,,
Cobalt	Co	0·12 ,,
Lead	Pb	0·15 ,,
Sulphur	Si	25·36 ,,
Silica	SiO_2	13·87 ,,

The undetermined constituents consist of the above-mentioned silicates.

This nickeliferous pyrrhotite will not improbably prove to be worth working if power and fuel be available locally and if the deposit of the mineral is sufficiently extensive. It is similar in character to the nickeliferous pyrrhotite from British Central

Africa, previously examined at the Imperial Institute (*Bulletin of the Imperial Institute*, 1905, vol. iii. p. 135). As there stated the nickeliferous pyrrhotite of British Central Africa appears to be similar to that extensively worked for nickel and copper at Sudbury in Canada, and, like it, may prove to contain platinum.

BcT No. 18. Magnetic iron ore.

This is a typical magnetite, with a black colour and metallic lustre. It contains a large number of small colourless granules of apatite, averaging one millimetre in diameter. A representative portion of the specimen was analysed and gave the following results :—

		Per cent.	
Ferric oxide	Fe_2O_3	70·30	equal to about 68 per cent. of metallic iron.
Ferrous oxide	FeO	24·16	
Lime	CaO	0·70	
Magnesia	MgO	1·13	
Alumina	Al_2O_3	1·19	
Silica	SiO_2	0·24	
Titanium dioxide	TiO_2	1·24	
Phosphoric acid	P_2O_5	0·47	equal to 0·20 per cent. of phosphorus.
Sulphur	S	0·08	
Combined water	H_2O	0·67	

The results show that this is a rich iron ore, but the percentages of phosphorus and titanium present are rather high and would to some extent depreciate its value. The amounts of these constituents present are, however, smaller than in many iron ores at present successfully worked on a large scale, and this ore would doubtless prove remunerative to work if the amount obtainable is large, and fuel, power, and labour are available locally.

GENERAL NOTICES RESPECTING ECONOMIC PRODUCTS AND THEIR DEVELOPMENT.

THE GUAYULE RUBBER OF MEXICO.

THE form of Mexican rubber known as "Guayule" has been known for a considerable time, but it is only recently that full particulars regarding the plant, from which it is derived, have been available, and that attempts have been made to exploit the material on a commercial scale. The plant appears unlikely to be of much importance as a source of rubber outside Mexico, but as it possesses several features of interest a short account may be given of its characters and of the methods employed for obtaining the rubber. The subject has been attracting considerable attention both in America and Europe, and several notices of the plant and of the projects put forward for its exploitation have been published recently in the technical papers, the most important of these being an article by Dr. R. Endlich of Mexico which appeared in *Der Tropenpflanzer*, vol. ix., 1905, p. 233.

The Guayule plant is *Parthenium argentatum*, A. Gray, belonging to the natural order *Compositæ*. It is a small plant, varying from 8 to 40 inches in height, with an average of about 24 inches, and has a much branched stem which bears small silver-grey leaves and yellow flower-heads. In Mexico it flowers during September and October.

The plant occurs over a large portion of the "bush prairies" in northern Mexico, the most important districts being Chihuahua, the northern parts of the states of Zacatecas and San Luis Potosi, the eastern part of Durango and especially the southern districts of Coahuila. It also extends northward into the United States and is met with in Texas, New Mexico and Arizona. Its occurrence has been reported from southern Mexico, and also from Central America and Venezuela, but these statements have not been confirmed and appear to be devoid of foundation. The area in northern Mexico which includes the chief sources of supply is stated to be about 29,000 square miles.

The Guayule plant is not so abundant or so widely distributed as was at first supposed, owing to the fact that it was confused with another composite of the same genus, *Parthenium incanum*, which occurs freely in the same regions. The Guayule is found at altitudes ranging from 3,000 to 5,600 feet, and grows equally well upon the plateaux or upon the hill-sides, being specially abundant on the lower slopes of the larger mountains. The soil in these regions is usually very dry, often rocky and contains a large percentage of lime. In most cases the plants occur scattered amongst the other vegetation, but small areas are occasionally found where the Guayule grows almost exclusively. It is thought from observations upon the wild plants that under favourable conditions it will be possible to reproduce them freely from seed, but experiments will be necessary before this point can be decided. Some authorities believe that plants raised from seed attain the average size of the wild plants in from 8 to 10 years, whereas others fix the time at from 12 to 15 years. Younger plants will furnish rubber, however, in proportion to their bulk. The general opinion in Mexico is that Guayule plants gradually die off after reaching the age of 15 years, but when the stems are cut down it is stated that new shoots soon appear and furnish a new plant in due course. The average weight of the plants as collected for the extraction of the rubber is not more than about 1 lb., the minimum about ¼ lb. and the maximum about 6½ lb.

Parthenium argentatum is the only plant belonging to the natural order *Compositæ* which is at present known to furnish rubber, and it is said to differ from most rubber-yielding plants in the fact that it does not contain a well-developed laticiferous system. The latex is apparently contained in isolated cells which are present in both wood and bark, though principally in the latter. The bark, in fact, furnishes a little more than three-fourths of the total amount of rubber, but it also contains the resinous substances which give rise to the stickiness hitherto characteristic of Guayule rubber. Apparently little or no rubber is present in the young leafy shoots. From the results of practical trials, it is stated that in 100 parts of the dried plants there are on an average 47 parts of wood, 44½ parts of bark, and 8½ parts of leaves and young shoots.

Experiments in connection with the extraction of Guayule rubber have been in progress for a number of years, but it is only within the last two years that the matter has attained commercial importance. Only one factory was actually at work in Mexico last year, but several others were in course of erection, and will commence operations at an early date. A number of different processes have been introduced for the extraction of Guayule rubber, some of which have been kept secret, whilst others have been protected by patents. The methods may be divided into two chief classes: (1) those in which the rubber is extracted by solvents, and (2) those in which it is separated by mechanical means. In processes of the first kind the plants, after crushing, are treated with a suitable solvent, the greater part of which is afterwards recovered by distillation, and the residue is freed from resin by treatment with a hot alkaline solution, or with wood spirit. In the methods involving mechanical treatment, the plants are reduced to a coarse powder which is submitted to a rubbing or beating action, either in the presence or absence of water, until the particles of rubber cohere and can be separated from the vegetable matter. The rubber thus obtained can be treated as above for the removal of the resin, and is freed from vegetable impurities by thorough washing with water. In other processes the crushed plants are heated with an alkaline solution in a similar manner to that used for the preparation of wood pulp, and the separated rubber is washed well with water.

The amount of crude rubber furnished by these processes varies from 8 to 12 per cent., according to the amount of moisture present in the plants treated, and the yield of the purified material may be taken as 7 to 10 per cent.

Guayule rubber as first prepared was usually in flakes, which had a greenish-grey colour when fresh, but blackened on the surface when kept. It was very soft and sticky, owing to the presence of a large amount of resin, and it frequently contained large proportions of water and vegetable impurities. The composition of two such specimens has been recorded by Markwald and Frank as follows:—

	I. Per cent.	II. Per cent.
Ash	1·3	2·68
Mechanical impurities	9·7	—
Water	26·0	20·69
Resin	29·2	19·35
Caoutchouc	33·8	57·28

The caoutchouc present in these specimens was a little sticky, but exhibited considerable tenacity.

The introduction of improved methods for washing the crude rubber and for removing some of the resin has resulted in the production of a much superior material. The crude rubber as at present obtained usually contains about 63 per cent. of caoutchouc and 22 per cent. of resin, the remaining 15 per cent. being water and a small amount of vegetable matter. After purification, however, the amount of caoutchouc is much higher, and Markwald and Frank found 77 per cent. in a sample which they examined. Formerly the rubber was only worth 1*s.* 4*d.* per lb., whereas the improved product can be sold at 2*s.* 4*d.* per lb. or more. It is stated that a small quantity of rubber extracted from the dried plants in Germany by a laboratory process was valued in that country and in England at from 3*s.* 2*d.* to 3*s.* 8*d.* per lb.

It appears certain, therefore, that the Guayule plant will furnish rubber of very fair quality, but it remains to be seen whether the extraction of this rubber upon a commercial scale will prove successful. The plant can be cultivated in sterile regions unsuitable for other purposes, and as it can be collected all the year round, the industry will be continuous. On the other hand, there will be certain difficulties in working on a large scale, as the places at which factories can be established are limited owing to the necessity of having a liberal supply of water, and in some cases the plants may have to be transported some considerable distance before treatment, thereby increasing the cost of production. These points will be cleared up, however, by the experiments now in progress, which will demonstrate the possibility or otherwise of successfully utilising the Guayule plant as a source of rubber.

RECENT PROGRESS IN THE PRACTICE OF GREEN MANURING.

THOUGH "green manuring" has been practised from very early times it is only comparatively recently that advances in chemical, agricultural and bacteriological knowledge have afforded an explanation of how the beneficial results long known to accrue from "green manuring" are brought about.

The following are the principal ways in which green manures may improve the soils to which they are applied :—

(1) The addition of vegetable organic matter to soils deficient in this constituent.

(2) The improvement of the mechanical condition of the soil by the action of the roots of the plants and of the gases evolved when the vegetable matter decomposes in the soil.

(3) The vegetable matter in decomposing gives rise to acids, which act as solvents of the soil constituents, and thus render more material available for plant nutrition.

(4) The fixation of atmospheric nitrogen (*i. e.* its conversion into nitrogenous compounds) by leguminous plants (*e. g.* clover, alfalfa and beans), a change which cannot be as cheaply effected by any chemical or electro-chemical process yet devised.

Of these actions the last is probably the most important. Great improvements have been made recently, however, in the production of nitric acid by electrical means, and it is perhaps possible that in the future atmospheric nitrogen may be "fixed" by this means even more cheaply than by leguminous crops (compare *Bulletin of the Imperial Institute*, 1906, vol. iv. p. 69).

Many theories as to the actual mode of fixation of nitrogen by leguminous plants have been advanced, but until 1886 the true explanation was not known. In that year Hellriegel and Wilfarth found that while most plants when grown in sand free from nitrogen, ceased to flourish when the reserve nitrogen contained in the plant itself had been absorbed, leguminous, plants sometimes overcame this "nitrogen starvation" and grew well. In cases where growth did occur, nodules or swellings were always found on the roots. It was further found that leguminous plants grown in sterile sand soon ceased to grow well, but that if a little water extract of some ordinary cultivated soil was added the plants recovered, formed nodules on the roots and also became capable of absorbing nitrogen. These nodules upon examination were found to be full of organisms which could only have been derived from the water extract of the cultivated soil which was added. From these results it is obvious that the assimilation of free nitrogen by leguminous plants takes place after the formation of root nodules which are caused by some organism present in cultivated soil.

Different species of organisms were at first thought to be associated with different leguminous plants, but it has since been shown that the different forms described are all physiological modifications of one organism to which the name *Pseudomonas radicicola*, Beyerinck, has been assigned, and are produced by variations in the conditions and environment.

Various theories have been advanced as to the actual way in which the organisms cause leguminous crops to take up nitrogen. One of these theories was that the bacteria fixed the nitrogen in the soil, from which the plant then assimilated the nitrogenous matter through its roots. Another theory held that the bacteria acted as a stimulus to the plant and caused the plant itself to assimilate the nitrogen from the air. As it has been proved, however, that the organism itself in certain forms can take up nitrogen and store it up in itself as nitrogenous matter even when it is isolated from the plant nodule, there seems little doubt that the organism in the nodule also absorbs nitrogen in this way.

The present view of the case briefly stated is that, *firstly*, the bacterium in its minute form enters the root of the plant, and, *secondly*, in the root this minute form changes to the rod-like form, multiplies, and fixes nitrogen, and then, *thirdly*, in the nodule it changes to the branched form which is finally destroyed by an enzyme secreted in the plant, and the nitrogenous matter is dissolved and absorbed by the plant, whilst the nodule gradually diminishes in size.

Although green manuring is occasionally practised with other than leguminous plants, the use of such plants can only increase the organic matter in the soil, whereas leguminous plants not only do this but also increase the nitrogen content of the soil by the direct absorption of atmospheric nitrogen, and consequently it seems that the use of non-leguminous plants is much less advantageous. Leguminous green manures are, moreover, of great value, as they may often take the place of other and more expensive nitrogenous manures such as sodium nitrate, ammonium sulphate, guano, etc.

By the use of leguminous crops such as alfalfa (*Medicago sativa*), clovers (*Trifolium sp.*) or cowpeas (*Vigna Catjang*), poor or exhausted soils may be readily improved. Such plants will generally grow upon these soils, if supplied with the requisite amount of phosphoric acid and potash, which constituents are of small cost compared with that of the nitrogen in nitrogenous manures.

As an example of this it may be stated that the United States Department of Agriculture in 1888 commenced some experiments in the Jack Pine Plains of Michigan where the soil is light, sandy and almost barren. Green manures were principally used together with cheap fertilisers, and in three years an improvement was effected, both in the physical character of the soil and in the yield of the crops grown on it.

From the experiments of Hellriegel and Wilfarth and others it is evident that if leguminous plants used as green manures are to fulfil their purpose of the fixation of nitrogen, it is absolutely essential that the specific organism should be present in the soil.

It appears that while many soils contain the necessary bacteria, some do not, or only contain it in a form which has lost its activity and cannot produce the desired effect.

The first remedy suggested for this deficiency was to inoculate the sterile soil with some soil known to contain the organism. This method involves the disadvantage of the cost of transport and labour as well as the danger of simultaneously introducing insect or fungoid pests and objectionable weeds. In order to obviate these difficulties many attempts were made to prepare cultures of the organism on a large scale.

Of these preparations the "nitragin" of Nobbe was probably the most important, which was a culture of the organism in nutrient agar solution, and was said to give good results in Germany, but did not meet with much success in the United States of America.

A complete scientific investigation of the nature of the organism and its action was, therefore, undertaken by the Laboratory of Plant Physiology of the United States Department of Agriculture, the results of which are published in a pamphlet entitled "Soil Inoculation for Legumes" (Bureau of Plant Industry, Bulletin No. 71). In the course of these investigations many very interesting facts have been brought to light, and the conclusions arrived at are of great importance. The most interesting information to the practical agriculturist, however, is that dealing with the inoculation of the soil and the effect produced upon the crops grown.

The materials necessary for inoculation as originally issued by the United States Department of Agriculture consisted of three small packages, one of which contained a mixture of sugar, magnesium sulphate and potassium phosphate, another contained some ammonium phosphate, and the third a pad of cotton wool which had been soaked in a pure culture of the organism and afterwards carefully dried. In this state the organism retains its activity for some months, while if kept in nutrient agar, it loses its activity in a few weeks. It has, however, been found that the dried cultures on cotton are not wholly satisfactory, and further investigations on the subject have resulted in a modification in which the pure cultures of the organism are issued in hermetically sealed tubes. Full particulars of the new method are given in Farmer's Bulletin, No. 240, "Inoculation of Legumes," 1905, published by the Department of Agriculture, U.S.A.

The method of inoculation is as follows. The contents of the first package are dissolved in a certain quantity of clean water and in this nutrient solution is placed the bacterial preparation. The liquid is allowed to stand in a warm place for twenty-four hours, being protected as far as possible from dust, and the ammonium phosphate is then added whereby a further growth of bacteria is induced. After standing for another twenty-four hours the solution becomes cloudy from the growth of the bacteria, and is then ready for immediate use.

Either the seed or the soil itself may be inoculated. In the former case inoculation is effected by thoroughly moistening the seed with the liquid and then drying it in the shade; the seed may then be kept for several weeks before sowing without deterioration. Inoculation of the soil is carried out by moistening some dry soil with the liquid, thoroughly mixing this with a further quantity of soil, and then distributing it over the field. In order to test the efficiency of these methods of inoculation, 12,490 packages of material were distributed free by the United States Department of Agriculture between November 1902 and November 1904. In this way some 12,500 tests were obtained in almost all parts of the United States and in many other countries also. Out of 2,502 tests with various leguminous plants only 26 per cent. of failures were recorded, and many of the latter were due to the experiments having been made in places which were obviously unsuitable for the method of treatment.

The following conclusions may be drawn from the results of these experiments. Inoculation is not likely to produce any beneficial effect upon soils which already contain the necessary bacteria or upon soils rich in nitrogen, or again upon soils which on account of their acidity are unsuitable for the growth of leguminous plants. Inoculation is undoubtedly of value where the bacteria do not already exist in the soil, or have lost their activity, as indicated by failure in the growth of leguminous crops and absence of root nodules.

Experiments have also been carried out by the United States Department of Agriculture with such leguminous plants as are suited to the climate and soil of the districts in which Experiment Stations exist, with a view to discovering their value as green manures and as fodder. The conclusions arrived at from the results of these experiments have been published in a Bulletin (Farmer's Bulletin No. 16), and the fertilising value of some of the plants tested is shown in the following table:—

FERTILISING INGREDIENTS IN 100 LB. OF GREEN LEGUMINOUS CROPS.

Crop.	Moisture. lb.	Nitrogen. lb.	Phosphoric Acid. lb.	Potassium Oxide. lb.
Red clover	80·00	0·53	0·13	0·46
White clover	81·00	0·56	0·20	0·24
Alsike clover	81·80	0·44	0·11	0·20
Crimson clover	82·50	0·43	0·13	0·49
Alfalfa	75·30	0·72	0·13	0·56
Cowpea	78·81	0·27	0·10	0·31
Serradella	82·59	0·41	0·14	0·42
Soy bean	73·20	0·29	0·15	0·53
Horse bean	74·71	0·68	0·33	1·37
White lupin	85·35	0·44	0·35	1·73
Yellow lupin	83·15	0·51	0·11	0·15
Flat Pea (*Lathyrus sylvestris*)	71·60	1·13	0·18	0·58
Common Vetch	84·50	0·59	1·19	0·70

Of these plants the cowpea and soy bean seem especially useful, for if the seeds are allowed to ripen they form a very nutritious food for stock, and as only part of the fertilising constituents is absorbed by the animals the greater part may be returned to the soil in the manure. The seeds of lupins are exceedingly nutritious and are fed to animals in Europe, but the poisonous constituents must first be removed by soaking and steaming ; this renders them less valuable than the cowpeas and soy beans, which need no such treatment.

Experiments in Ceylon.

In 1902 experiments with green manuring plants suited to the climate and conditions of Ceylon were commenced at the Royal Botanic Gardens as Peradeniya, and in August 1905 a Circular was published giving an account of the results obtained up to that time and of the experiments proposed to be undertaken or already in progress.

Experiments have been made with the object of ascertaining the best time for sowing and the species which give the best results in association with different crops, such as tea, cacao, rubber, cocoanuts, and rice. The amount of nitrogen absorbed and the effect of various fertilisers on tubercle activity have also been made the subject of an investigation. Of the plants tried *Crotalaria striata* and other species of *Crotalaria*, *Erythrina lithosperma*, *Arachis hypogæa*, *Vigna Catjang* and other species, *Phaseolus sp.* and *Albizzia moluccana* have been most successful. *Crotalaria striata* has been found satisfactory in young tea clearings, but does not grow well in association with old well-developed tea plants unless sown immediately after pruning and fertilised with some soluble artificial manure. On young tea clearings a crop of *Crotalaria* amounting to 12,000 lb. per acre has been obtained between July and December from 10–20 lb. of seed. A plot of land devoted to cacao gave in a year no less than 14,000 lb. of green material per acre.

As the *Crotalaria* plant in the green state contains from 0·73 to 0·99 per cent. of nitrogen, a crop of 14,000 lb. is equivalent so far as nitrogen is concerned to 1,700 lb. of castor cake or 700 lb. of sodium nitrate. The chief advantages derived from the use of *Crotalaria striata* are (1) cover to ground is obtained in two or three months; (2) the plants being one to three feet high check the force of the rain and so reduce "wash"; and (3) they do not twine round the stems of the main crop. The chief disadvantages are (1) cost of planting; (2) cost of weeding for the first two or three months; (3) the plants must be uprooted twice a year or much woody matter is formed, which is not suitable for digging in.

The thornless "Dadap" (*Erythrina lithosperma*) possesses the advantages of being easily propagated from cuttings; and in five months as much as 4,000 lb. per acre of fresh green material may be turned into the soil, whilst in twelve months 15,000 lb. may be available. The leaves and twigs which are lopped off contain 0·85 per cent. of nitrogen in the fresh state, and the equivalent of at least 2,100 lb. of castor cake per acre per year may thus be grown.

The advantages of the use of "Dadap" are (1) the ground need not be forked before planting as is necessary with those plants such as *Crotalaria striata*, ground nuts, etc., which are propagated from seed; (2) weeding is simplified as it is impossible to mistake the "Dadap" cuttings for weeds, whilst young *Crotalaria* plants might be thus mistaken; (3) the arborescent form is convenient in association with some crops on account of the shade it affords; (4) the large roots tend to split up the hardened foot-trodden soil.

The chief disadvantages of the use of "Dadap" are that (1) the force of the rain is not much checked ; (2) the larger leaves collect some water and lead to a drip on to the soil beneath ; (3) less protection is afforded to the soil than when *Crotalaria* is planted.

Of the other plants tried, cowpeas (*Vigna Catjang*), although suitable for planting with some crops, have the disadvantage of twining round the stems of the main crop. Ground nuts (*Arachis hypogæa*) are also of value under special conditions, and the Pondicherry variety, which yields a large amount of leaf and stem with but little fruit, seems specially useful as a green manure. *Albizzia moluccana* is somewhat difficult to establish as it can only be propagated from stumps or young plants, which have been specially grown ; it is, however, a very rapid grower and the cuttings are rich in nitrogen.

The influence of various fertilising materials upon nodule formation has also been investigated by means of pan experiments, and the results obtained are not in harmony with those of the United States Department of Agriculture : thus, leguminous plants manured with such highly nitrogenous materials as sodium nitrate, ammonium phosphate, and castor cake showed very slight differences from unmanured plants in the number of root nodules formed.

THE SEAWEED INDUSTRY OF JAPAN.

IN consequence of enquiries regarding the utilisation of seaweeds in Japan, concerning which little detailed information was available here, the Foreign Office requested His Majesty's Representative at Tokio to furnish a report upon the subject. The following comprehensive account of the Japanese seaweed industry was accordingly prepared by Mr. C. J. Davidson, of the British Embassy at Tokio, and, as the matter is of general interest, it has been thought desirable with the approval of the Foreign Office to publish it in the *Bulletin*.

The coast line of Japan is estimated at over 18,000 miles, and being of a very broken nature interspersed with numerous bays and inlets, it is naturally exceptionally suitable for the growth of marine plants. More than fifty-one of the various species of seaweeds found on the coasts of Japan are employed for useful purposes, and their collection and subsequent treatment form one of the most prominent industries of the Japanese Empire.

In no other country are seaweeds put to such a variety of uses as in Japan, where they are utilised as food, as plaster and glue, as starch, and even as manure for the rice fields. One of the most important branches of the industry is the preparation of isinglass, the export of which has already reached considerable dimensions. Another is the extraction of iodine, but the methods employed at present for the production of this chemical, though certainly inexpensive, are crude and could doubtless be greatly improved and a larger yield obtained. Moreover, the burning of the seaweed, which is part of the process, is frequently a cause of considerable annoyance to people who live in the neighbourhood of the places where it is carried on owing to the exceedingly disagreeable and pungent fumes given off by the burning seaweed.

During the last few years experiments have been vigorously carried out under Government supervision in many places along the coast, and when the results have been definitely ascertained, it is expected that the annual yield of all kinds of useful algæ will be largely increased. The only species which has been properly cultivated in the past is the laver (*Porphyra tenella*), all other kinds having been gathered indiscriminately, with the result that the supply has in some cases shown a considerable diminution.

The total value of the seaweeds prepared in 1904 exceeded £400,000, and the total value of the exports was £124,651.

The following table shows the exports of seaweeds from Japan to various countries during the five years ending 1904:

Seaweeds.	1900	1901	1902	1903	1904
	£	£	£	£	£
China	68,611	105,239	57,592	80,361	100,467
Corea	1,154	1,048	1,228	1,075	2,015
Hong Kong	2,734	2,577	1,779	2,002	2,435
Other countries	583	426	315	489	498
	73,082	109,290	60,914	83,927	105,415
Seaweeds cut:—					
	£	£	£	£	£
China	14,458	31,684	18,809	19,419	17,067
Other countries	830	856	1,224	1,011	2,168
	15,288	32,540	20,033	20,430	19,235

The preparations which will be specially dealt with in this article are Kanten (Isinglass), Kombu (Kelp), Amanori (Laver), Funori (Seaweed glue), and Iodine.

NOTE.—In Japan the word "Nori" is frequently used to designate useful seaweeds generally, but properly speaking it should only be applied to the laver. There is another word "Nori," meaning paste or mucilage, which is used in the names of those species of "Funori" (*Gloiopeltis sp.*) from which paste or mucilage is prepared, and care must be taken to distinguish between the two.

KANTEN OR SEAWEED ISINGLASS.

The word "Kanten," used in Japan to designate isinglass prepared from seaweeds, means "cold-sky," and probably has its origin in the fact that this product can only be prepared in those localities where the air is cold and dry.

The chief seats of this industry are the prefectures of Osaka, Kioto, Nagano, and Hiogo, where the manufacture is carried on mainly during the winter months.

Kanten is prepared chiefly from seaweeds of the species *Gelidium*, the one principally used being *Gelidium Swansii*, which in Japanese is called "Tengusa," probably a contraction for "Tokoro-tengusa," that is, "Grass for tokoroten" (tokoroten being a product formed in the process of manufacture). Tengusa is found principally in Hokkaido and in the prefectures of Wakayama, Miye, Shizuoka, and Chiba, and is gathered from May to August, when it is most prolific and at its best. It is collected by diving, by appliances such as hooks and drags, and is also gathered on the shore, but this latter is of very inferior quality. The plant varies in length from four to eight inches.

Many other seaweeds can be utilised for the preparation of Kanten, and owing to a considerable decrease in the supply of Tengusa during recent years, such seaweeds as Ego (*Campylœphora hypneoides*), Tori-ashi (*Acanthopeltis japonica*) and Ogo (*Gracilaria confervoides*) are frequently employed as substitutes, or are added to Tengusa in larger or smaller quantities according to the quality of Kanten to be made. None of these species is, however, so good as Tengusa, and the best class of Kanten is made from the latter alone.

After being gathered, the seaweed is spread out on the shore by the fishermen, and, when dried and partially bleached, it is sent to the Kanten manufacturers. In the province of Izu, where some of the best isinglass is prepared, the seaweed is dried on bamboo mats slightly raised from the ground. The average price of this dried and partially bleached Tengusa is from six to nine cents per pound, the inferior qualities fetching from four to six cents per pound.

The first step in the preparation of Kanten is the cleansing of the seaweed, which is effected by placing it in a kind of stone mortar in which it is pounded and from time to time sprinkled with water, whereby the shells and other impurities adhering to it are dislodged. It is then placed in a basket made of bamboo and immersed in water (fresh, running water is best), where it is washed in order to remove the remaining impurities.

The next stage is the bleaching of the seaweed. The choice of season and weather is of the greatest importance in this part of the process, which is usually commenced about the end of August or the beginning of September, when the summer heat has abated slightly. If very rainy weather prevails, the quantity of Kanten obtained is considerably diminished and the seaweed itself will frequently rot. The seaweed is spread out in thin layers on bamboo or rush mats, through which the water drains away, or it may be spread directly on the ground, and it is left in this condition for several days and nights, being from time to time sprinkled with water. When it is partially dry, it is turned over and again left for some time. The time required to complete the process of bleaching varies according to the state of the weather, but usually takes several days, though if the weather is exceptionally favourable, twenty-four hours may be sufficient. Dew greatly facilitates the bleaching. By the time the bleaching is completed, the algæ will have adhered more or less together in sheets, which are then rolled up in bundles of fixed weight and stored.

As previously mentioned, Tengusa is frequently supplemented by other seaweeds, which are bleached in the same way and are added to the Tengusa during the boiling process. There is no fixed rule for the amount of supplementary seaweed which may be added, the quantity and species used being at the will of the manufacturer. The usual proportions, however, are from 20 to 40 per cent. of supplementary seaweed, depending on whether square or slender Kanten is to be prepared. Ego (*Campylæphora hypneoides*) is added in the proportion of 10 to 20 per cent. for square Kanten and from 30 to 40 per cent. for slender Kanten; the proportions of other seaweeds vary according to the quality of Kanten to be made.

The bleached seaweed, prepared as described in the preceding paragraph, is now boiled in fresh water in a vessel holding about 790 gallons, which is placed over a specially constructed furnace. Sometimes steam is used in the place of fire heat, in which case the boiler in which the seaweed is placed takes the form of a wooden tub into which steam is admitted from below. Opinion is, however, divided as to which process is the best. As a rule from 950 to 1,000 gallons of fresh water are added to 165 pounds of seaweed, but sometimes, in consideration of the species under treatment and the clear or cloudy state of the atmosphere, the amount of water may be increased or decreased. If the seaweed used is not of good quality, or if cloudy weather is expected, the amount of water is diminished.

If supplementary seaweeds, such as Tori-ashi and Igisu which take longer to boil than Tengusa, are used, they are usually placed in the boiler about one hour before the latter. The whole mass is made to boil, being stirred from time to time, and when five or six hours have elapsed, $1\frac{1}{2}$ gallons of vinegar or two ounces of sulphuric acid are sprinkled into the boiler. About 39 gallons of fresh water are then added, and the boiling is completed in about 30 minutes after the water has boiled up again. It is best to use a slow fire and boil the seaweed gently for a longer time rather than to cause it to boil quickly with a fierce fire. The effect of the boiling is to extract the gelatin contained in the seaweed, and when the operation is completed, a thick gelatinous liquid is the result.

The next step in the process of manufacture is the straining and solidifying of the gelatinous solution obtained by the boiling process. For this purpose the liquid is strained through coarse cloths made of hemp or cotton, stretched over a frame, beneath which is placed a large vat or tank, into which the solution filters in the form of a viscous fluid. This is usually strained a second time, by placing it in cloth bags through which it is squeezed under pressure exerted either by a lever manipulated by hand or by means of heavy weights, the liquid falling as before into a vat below. The dregs which remain behind in the bags are collected and boiled again for about four hours and strained in the same way. The strained liquid in the vat is then ladled out and poured into wooden troughs, which are sometimes in the form of trays 2 feet long, 1 foot wide, and 3 inches deep, and sometimes divided up into columns 1·5 foot long, 1·4 inch wide, and 1·6 inch deep. If the larger trays are used, the solidified gelatin is cut into oblong shapes by means of iron frames, in order to facilitate the handling of it. In both cases the trays are raised from the ground and are placed perfectly level. The liquid solidifies in about eighteen hours, and when solidified is called "Tokoro-ten."

The last step is the congealing or freezing process. In order to congeal the bars of solidified gelatin, they are spread out on bamboo mats or on boards placed on trestles and elevated above the ground about one foot in an exposed position. The congealing takes place chiefly at night, and, when the weather is very cold, one night may be sufficient to complete the process, though usually from two to three days are required. When thoroughly congealed, the jelly is spread out to dry in some place exposed to the rays of the sun, by the warmth of which the water contained in it is evaporated, leaving the pure Kanten. The Kanten dries gradually from the outer surface, and when it is partially dry it is turned over and such bars as have become bent or crooked are straightened out.

The above is a brief description of the manufacture of Kanten in bars. It is also made into slender sticks, called "Hoso-kanten," and in this case the processes are precisely similar, with the exception that from 16 to 24 pounds more seaweed are mixed with the same amount of water as is used when making square Kanten, and the product is solidified in the form of bars 14·5 inches long, 2·1 inches wide, and 2·5 inches thick. These bars are placed in a kind of wooden pipe, having a grating with small holes at one end and a piston at the other. By forcing the piston down, the jelly is squeezed through the holes in the grating and emerges in the shape of slender sticks, 10 to 14 inches long and about one-eighth of an inch thick. These are then spread out on mats and left to congeal and dry in the same way as the square Kanten, after which they are made up into bundles weighing about eight ounces. The square Kanten, called "Kaku-kanten," is in the shape of rectangular bars 17 inches long, 1·7 inch wide, and 1·6 inch thick.

As the successful manufacture of Kanten depends almost entirely on atmospheric conditions, the time during which it can be carried on is necessarily limited to a fixed season, which is comparatively short, and extends approximately from the latter end of November to February or March of the following year. Many other conditions besides great cold are necessary in order to obtain good results, and there are in Japan only a very few places which possess all of them. Though the appliances are simple, the process is complicated, and the manufacture of Kanten requires a great deal of experience. Care must be taken in the selection of the ingredients and their admixture, and in the choice of the locality where operations are to be carried on, as the conformation of the ground, the nature of the climate and the quality of the water, are all of the highest importance.

The locality said to be best suited for the manufacture of Kanten, is a spot bounded on the north-west by mountains or hills, with a stretch of meadow or plain to the south-east. If there are mountains in the west, the sun will set sooner than if the horizon is unbounded, and congealing will commence early; there will also be no rapid transition from warmth to cold, which injures the Kanten and spoils the colour. The mountains in the north intercept the north wind, which in Japan is the prevalent wind in winter, cause it to deposit its moisture, and send it out as a cold, dry wind, of the highest importance for congealing and drying the Kanten. The meadows to the south are necessary for spreading out the Kanten to congeal and dry, grass-covered plains being the best for this purpose, as sand and particles of dust will not fly about when it is windy.

If such land cannot be obtained, the spot set apart for the congealing process is usually enclosed by a stockade.

The most suitable temperature is between 35° and 25° Fahrenheit, as, should it fall too low, the outer surface of the Kanten will be quickly frozen hard and the water inside will be unable to find an exit, causing the Kanten to bulge in the middle and to be perforated with numerous holes. Too high a temperature is, of course, fatal.

A clear sky, being favourable to frost, is also desirable, for should the sky be cloudy the congealing process will extend over several days, and the Kanten will in consequence turn a blackish colour and shrink considerably. A dry atmosphere is very advantageous, for if it is moist and heavy, the Kanten will never harden properly, and will in addition lose its shape. Rain is very detrimental, but the time immediately after a heavy fall of snow is said to be the most suitable period.

Kanten as supplied to the market is a shiny, translucent, tasteless substance, insoluble in cold water, but readily soluble in boiling water; the solution on cooling congeals into a kind of jelly.

Kanten is used in countless ways for edible purposes, but particularly for preparing jellies, which, mixed with bean paste and some colouring matter added, are to be found of every colour, shape and size, but all equally tasteless. It is also used for clarifying wines and *sake*, for sizing textiles and silks, and in the manufacture of paper. In China it is eaten as a substitute for edible birds' nests, and as such is highly esteemed. In Europe and America it is now also largely used as a cultivating medium for bacteria, for which it is particularly suited as it is quite free from impurities.

The following is an analysis of Kanten contained in a report on the second Exhibition of Marine Products:—

Water	21·79	per cent.
Nitrogenous organic matter .	5·95	"
Carbohydrates	64·59	"
Cellulose	3·54	"
Ash	4·13	"
	100·00	"

The price of square Kanten is 1·5 cent per stick, and of slender Kanten 15 cents per bundle.

The following table shows the amount and value of Kanten produced in and exported from Japan during recent years:—

Year.	Production.		Exports.	
	Amount in Kwan.	Value £	Amount in Kin.	Value £
1900	284,462	115,300	1,444,499	96,432
1901	261,344	106,846	1,584,748	121,719
1902	271,436	95,027	1,665,501	110,854
1903	266,914	90,997	1,391,268	81,817
1904			1,776,098	101,359

1 Kwan = 8·2673 lb. (Avoir.) 1 Kin = 1·32277 lb. (Avoir.)

The greater bulk of the isinglass exported goes to China and Hong Kong, only a very small portion finding its way direct into the European market.

KOMBU.

Kombu or Kobu belongs to the family of kelps (*Laminariacæ*), and is the most prolific seaweed found on the coasts of Japan.

The best, that is the thick and broad fronded varieties, are found principally in Hokkaido, in the north of Hondo and in Chishima, where the sea is very cold. It is used in numerous ways as an article of food, and its preparation is one of the most important industries connected with seaweeds. It is exported in large quantities to China, but scarcely finds any market in Europe or America; the larger portion, however, is consumed in Japan itself, where it is considered a great delicacy.

Kombu is not cultivated in any way, and, although taken in immense quantities every year, there is no apparent diminution in the supply. The season for gathering commences in the middle of July and is continued till the end of September. The fishermen proceed to the kelp grounds in boats and tear the kelp from the rocks by means of hooks, prongs and weighted drags of various shapes. When a boat-load has been secured, they return to the shore and discharge their cargoes, which are heaped up on the shore and afterwards carefully spread out in parallel lines on the sand to dry. When partially dry, the stems and roots are cut off and the fronds trimmed, and when quite dry the kelp is heaped up on mats or dried grass in sheds, where it is left for ten days or more till a gloss comes upon it. It is then tied up in long, flat bundles, the different qualities being kept separate from one another. The best kelp is that cut off 4 or 5 inches above the roots, and is about 4 feet long; the second class is 3 feet 5 inches long; and the third class is 3 feet long. The weight of a bundle of first or second class kelp is about 65 pounds, and that of the third class about 40 pounds. These bundles are then sent direct to the manufacturers.

Kombu is made up in a large variety of ways for purposes of consumption, the most important form being Kizami- (sliced) kombu, which, on account of its greenish colour, is also called Ao- (green) kombu. The best quality of prepared Kombu is made from those varieties which have thin fronds. Kizami-kombu is exported largely to China.

The process of manufacture is as follows :—

The dried kelp, as received from the fishermen, is first of all washed in very dilute salt water, and when all the sand or dirt adhering to it has been removed, it is boiled in large cauldrons for the space of thirty minutes, being stirred from time to time. About eighty gallons of fresh water are added to 132 pounds of kelp. In order to impart a good colour to it, a very small quantity of an aniline dye (malachite green) is put into the water used for boiling. Copper sulphate and other mineral dyes of a green colour were formerly used, but owing to their poisonous properties, their employment has been prohibited by the Government.

The boiled kelp is now taken out of the cauldron and spread out on bamboo or rush mats to dry, or it may be hung up on poles or on ropes.

When the outer surface of the kelp is partially dried, which in sunny weather takes place in from thirty minutes to one hour, the fronds are taken one at a time, cut into equal lengths, and after they have been carefully smoothed out, they are packed one upon another in wooden frames to a height of about 2 feet 4 inches. These piles weigh about 250 pounds. Each pile is then bound transversely in three places with straw ropes and afterwards cut into three equal lengths, so that each bundle is tied in the middle with a single rope.

The bundles are now placed in a compressor which has the form of a rectangular frame, and when this is filled to a uniform height, the kelp is sprinkled with water and then strongly compressed. One side of the frame is afterwards removed and the kelp is shaved off lengthwise along the edges by means of a plane whereby it is obtained in the form of long, slender strips.

The shredded kelp is again spread out on bamboo mats, raised slightly from the ground, and is turned from time to time in order that every portion may be exposed to the air to dry. When the outer surface has become thoroughly dry, the kelp is stored and is ready for use. If stored in a dry place, it may be kept for over a year without spoiling.

Other preparations of Kombu are made chiefly out of Oni-kombu (*Laminaria diabolica*), a coarse-fronded variety. The fronds are dipped in vinegar to make them pliant, and when thoroughly soaked they are first of all dried, and then the outer surface is scraped off on both sides with a small knife, the frond being held down at one end by the foot and at the other by the left hand, the scraper being manipulated with the right. The names under which the various preparations of this kind are known are as follows :—

Black-tororo.—This is the outer surface of the kelp, scraped off as described above. It often contains grit and dirt, and is of inferior quality.

White-tororo.—This is the product of a second scraping, and is a whitish, stringy substance.

Cloudy kombu consists of thin layers of kelp stripped off after the outer surface has been removed.

Thin snow kombu is of a greenish-white colour and melts in the mouth, from which fact it receives its name. It is prepared by making the kelp, from which cloudy kombu has been stripped, into bundles and planing it off as in the case of kizami-kombu.

Golden thread kombu is the heart of the kelp chopped very fine.

White hoar-frost kombu is the heart of those kelps from which only the outer surface has been removed, planed off in slender white threads.

Fire-dried kombu.—After the outer surface has been removed from the kelp, what remains is cut into fancy shapes and roasted over a slow fire; when covered with sugar, they are called "kombu-cakes."

Powdered kombu is roasted kelp pounded and sifted, and has a greenish colour; it is made into cakes covered with sugar, or is eaten mixed with rice.

The species of kelp principally used in the various preparations are the following:—

Naga-kombu (*Laminaria longissima*) is used chiefly in the manufacture of shredded kombu. It sometimes attains a length of over forty feet.

Ma-kombu (*Laminaria japonica*) contains a large percentage of sugar, and is used for making kombu cakes.

Mitsuishi-kombu (*Laminaria angustata*) is named after the district of Mitsuishi in Hitaka. It contains sugar and also iodine in small quantities.

Kuro-kombu (*Laminaria ochotensis*) is also called Dashi-kombu, and is of a dark brown colour. It is boiled and eaten with rice. This species and *Laminaria longissima* are exported very largely to China.

Hosome-kombu (*Laminaria religiosa*) has thin fronds and is of poor flavour. It is roasted lightly, powdered and eaten with rice.

Nekoashi-kombu (*Arthrothamnus bifidus*) and Tororo-kombu (*Laminaria gyrata*) are also species which are often used.

Oni-kombu (*Laminaria diabolica*) contains iodine. Three kinds of prepared kelp are made from this variety: Motosoroi, Hana-ori and Ori-kombu, each of which takes its name from the shape of the bundles into which it is made up. Hana-ori is usually of selected quality, and Ori-kombu is done up in wheel-shaped bundles.

Culinary uses of Kombu.

The prepared kelp is highly esteemed as an article of food by the Japanese, and many of the dishes made from it are very palatable even to European tastes. One of the best is made from kelp cut into small rectangular pieces placed one upon another, compressed and boiled with soy. The kizami or shredded kombu is used chiefly as a vegetable, and is often put in soups, etc., to which it imparts a very agreeable flavour. Powdered kombu is sometimes made into a kind of tea, but is not very palatable; it is chiefly used in soups and is occasionally mixed with rice.

The following is an analysis of *Laminaria longissima* made by Professor K. Oshima of the Agricultural College, Sapporo:—

Water	25·944	per cent.
Proteid	6·724	"
Fat	1·730	"
Soluble non-nitrogenous matter .	31·896	"
Fibre	6·415	"
Ash	27·290	"

The following tables give the total amount and value of the kombu produced and exported during the five years ending 1904:—

PRODUCTION.

Year.	Amount in Kwan.	Value.
		£
1900	6,454,078	60,277
1901	9,216,765	92,816
1902	5,073,689	36,904
1903	7,099,598	60,698
1904	5,043,200	49,691

1 Kwan = 8·2673 lb. (Avoir.)

EXPORTS.

Year.	Kombu.		Kizami-kombu.	
	Amount in Kin.	Value.	Amount in Kin.	Value.
		£		£
1900	30,988,010	73,084	5,053,001	15,288
1901	51,526,468	109,292	9,383,262	32,540
1902	33,021,851	60,914	6,346,523	20,034
1903	43,699,026	83,929	6,808,784	20,430
1904	45,158,836	105,415	5,847,738	19,235

1 Kin = 1·32277 lb. (Avoir.)

ASAKUSA-NORI OR LAVER.

The laver is the only seaweed which is regularly cultivated in Japan and its preparation into an article of food is a very old industry, dating back as far as the last century. The Japanese esteem it above all other seaweeds for edible purposes, but it is scarcely palatable to European taste.

Nori (*Porphyra tenella*), sometimes called Amanori, is found growing round the coast in shallow bays which have rivers running into them, but the supply for manufacturing purposes is drawn almost entirely from the grounds where it is properly cultivated. The most important of such places are Tokio Bay and the prefectures of Hiroshima, Miyagi, Chiba, Miye, Aichi, and Kanagawa. By far the greatest extent of cultivated ground is at Omori on Tokio Bay, where this industry was first originated. Laver was formerly gathered in large quantities around the mouth of the Sumida River in Tokio and sent to Asakusa, one of the wards into which Tokio is divided, in order to be prepared for food, and in consequence it received the name of "Asakusa-nori," which has now become a general name for the prepared article.

The cultivation of Asakusa-nori is very profitable, as the expenses connected with it are small and the *Porphyra* commands a comparatively high price. The price of the prepared product, per bundle of ten sheets, is from five cents for the poorest quality and twenty cents for the best.

In the seven provinces mentioned above the total area under cultivation with this seaweed during 1904 was 4,761,621 tsubo (one tsubo = 3·954 square yards approximately), and the value of the produce was estimated at £74,590.

The ground selected for cultivating *Porphyra* is usually a locality where there is a muddy bottom to the sea, covered at high water by ten to fifteen feet of water. The quality of the laver is greatly influenced by the degree of salinity of the sea, and it has been determined by experiment that about one per cent. of salt in the water gives the best results. If the water contains a great deal of salt the laver will be tough, and if too little, it will not grow to its full size. In some places near the mouths of rivers, the laver, once plentiful, has now quite disappeared owing to the presence of too much fresh water, brought down by the rivers whose mouths have in many cases extended further and further into the sea owing to the deposition of the sand and gravel which they carry down with them.

The method of cultivation is very simple, and consists principally in planting branches of trees, usually *nara* or *kunugi*, species of oak or bamboo, in rows from 30 to 70 yards long, and about eight feet apart, so that boats may pass up and down the rows during the gathering season. The branches stand up out of the mud from six to nine feet and are inclined at an angle of about 45° towards the flowing tide. The object of the branches is to supply a surface for the floating spores of the *Porphyra* to attach themselves, and they are usually set in the ground about the middle of September. The spores grow very rapidly and the laver is fit to be gathered in January, being plucked when the tide is low from the twigs to which it adheres. This operation is carried on by the fishermen who go along the lines in flat-bottomed boats, or sometimes stand in the water bare-foot, although the water is icily cold at the time. The season ends towards the close of March, when the branches, which are now covered with barnacles, are all pulled up and sold for making fences. The average yield of a row about 50 yards long is from 20 to 25 bushels, valued at a little over 20 yen (£2).

The preparation of the laver for eating purposes is, in Tokio, carried on as follows :—

The laver is first of all washed in salt water, and all sand, shells, etc., removed, after which it is placed in a tub filled with salt water, where it is left to stand for one night. On the following morning it is again washed in salt water and then chopped fine by means of hand knives, a knife being held in each hand, after which it is thrown into a vat containing fresh water in the proportion of about twelve gallons of water for every eight bushels of laver. After a while, a kind of froth forms on the surface of the water, and in order to get rid of this a small quantity of rape-seed oil is added. The laver is then scooped up out of the vat and poured into a small rectangular wooden frame without a bottom to it, which is placed upon a small mat of reeds woven together, care being taken to pour in the laver in such a way that it forms a thin, even layer. The frame is then removed and placed upon another mat and the same process is repeated. The size of these mats is 1 foot 2 inches long and 1 foot wide, and when a number have been prepared they are removed with the laver adhering to them, to a sunny spot in order to dry, being set aslant upon a stockade about four feet high, so as to catch the full rays of the sun. When thoroughly dry, the laver is stripped off the mats, cleaned and smoothed out, and finally tied up in bundles of ten sheets each. The size of the sheets varies in different districts, but in Tokio the largest size is 8 inches by 7·5 inches, the medium is 7·5 inches by 7 inches, and the small size is 6·8 inches by 6·4 inches. The sheets are very thin and have a livid brown colour. Large quantities are also done up in hermetically sealed tins after being dried in an oven having a mean temperature of 125° Fahrenheit, which imparts a greenish colour to the laver.

Asakusa-nori is occasionally eaten undried, but the dried laver is usually slightly roasted till it becomes crisp, when it is used in soups, etc. It is also eaten dipped in soy. "Tsuku-dani Nori," laver boiled with soy and beans, is made either with fresh or dried laver, though the latter is considered to be the best. Sometimes the laver is chopped fine, left to saturate for one night in soy, and on the following day boiled with molasses; if fresh laver is used it is first compressed to expel the moisture contained in it, and some flavouring is added to it.

Iwa-nori (Rock nori) is the same as Asakusa-nori, but grows in a natural state on rocks, stones, or on anything which offers a surface to adhere to. It is not much used, but the process of preparation is similar to that described above.

The following is an analysis of *Porphyra* made by the Imperial Fisheries Bureau :—

Water	15·475	per cent.
Proteid	34·350	,,
Fat	0·650	,,
Ash	10·685	,,

The amount and value of the Nori produced during the four years ending 1903 were as follows :—

Year.	Amount in Kwan.	Value.
		£
1900	154,853	51,394
1901	433,501	77,420
1902	249,525	71,158
1903	335,940	89,526

1 Kwan = 8·2673 lb. (Avoir.)

The export of Nori is increasing yearly and exceeds 10,000 yen in value, but no detailed figures are yet available.

FUNORI OR SEAWEED GLUE.

"Nori" or "Funori" are the names commonly given to all those seaweeds from which gum or mucilage can be made, and the mucilage itself is also called "Funori," but the two words are written with different Chinese characters and care must be taken to distinguish between the two.

Although there are a great number of seaweeds which yield mucilage, those principally used in Japan are the various kinds of Funori (*Gloiopeltis coliformis* and other species) and Tsunomata (*Chondrus sp.*), which are of a dark green, dark yellow, or reddish-green colour. They are found all round the coast of Japan, but are most prolific in the warmer parts of the country, and the best Funori comes from Nagasaki and Kagoshima in Kiushiu.

Funori grows on rocks and attains a length of about 3 inches. It is gathered from November to May, being collected sometimes by diving and sometimes by means of hooks and drags; it is roughly dried on the shore like Kombu.

The manufacture of seaweed glue is one of the oldest industries of Japan and dates back to the seventeenth century. The methods of manufacture vary slightly according to the nature of the seaweed used, and the purposes for which the finished product is to be employed. If slender and soft seaweed like Funori (*Gloiopeltis sp.*) is used, it is first of all spread out on the ground and sprinkled with fresh water, after which it is kneaded with the hands and feet. It is then placed in a basket, thoroughly washed by immersion in water, and afterwards spread out evenly in thin layers on straw or rush mats on which it is allowed to dry and bleach. During this process it is sprinkled about every ten minutes with water from a watering-can to prevent the edges from curling and also to assist the bleaching. Sometimes the seaweed is placed in shallow trays, which, when the bleaching is completed, are inverted and the seaweed shaken out in the form of a loose sheet. When the process has reached a stage where a sticky juice begins to exude, no more water is sprinkled upon the seaweed, and it is left untouched for one night, after which bleaching is complete. A very good white colour is imparted to it by allowing dew to fall upon it.

When species like Tsunomata (*Chondrus sp.*) or Ginnanso (*Iridæa sp.*) which have large and tough fronds are used, they are first of all soaked for some time in water and then steamed to render them more pliant; afterwards they are chopped up with hand knives and spread out to dry, the remainder of the process being the same as in the case of Funori.

The seaweed when dry adheres more or less together and takes the form of loose sheets, which are placed one upon another and made up into bundles varying in size from 4 feet by 2 feet to 4·5 feet by 2·5 feet. For the wholesale trade it is often made up into long rolls, about 3 feet long by 6 inches in diameter; that sold for household use is in separate sheets about 14 inches long by 10 inches wide and costs one cent per sheet.

The manufacture of Funori is restricted to the summer months, but care must be taken that the water used for washing is not too warm. In some cases spring water gives the best results, but river water in others, and which to use can only be ascertained by long experience and a thorough knowledge of the nature of the seaweed employed in each particular case.

Funori is made into glue or starch by immersing it in boiling water, in which it readily dissolves. It is used principally for imparting a gloss to textiles and silk, and as starch for stiffening linen, etc.; another kind is used for plastering walls, and still another for decorating china.

The various kinds of seaweeds chiefly used for making Funori are briefly the following :—

Ginnanso (*Iridæa sp.*) is found in the North of Hondo and Hokkaido; it attains a length of three or four inches and is prepared in the same way as Tsunomata.

Mukade-nori (*Grateloupia ficilinus*) is found growing abundantly on the rocks off the coasts of Kiushiu, Shikoku, Kii and Shima, and attains a length of three or four inches. It is also used for edible purposes.

Kotoji-tsunomata (*Chondrus etatus*) is a kind of Irish Moss and is found in the waters of Kazusa, Shimosa, Hitachi and Izu; its length is between four and five inches. In some places in Shimosa, the sea-weed, after being bleached, is melted down, left to cool and solidify, and eaten as a jelly.

Tamba-nori (*Grateloupia sp.*) is found chiefly in Owari, Mikawa, Shima, Kii, Echizen and also to some extent in Shikoku and Kiushiu. It is prepared in the same way as Tsunomata.

Tobera (*Chondrus sp.*) grows mainly on the coasts of Sado, Izumo and Iwami, and attains a length of about ten inches. It is also used for edible purposes.

Saimi (*Gymnogongrus sp.*) is found in Izu and the Shichishima Islands, and attains a length varying from one to four inches; when bleached it turns a yellowish colour and it is used chiefly as starch or plaster.

Yanagi-funori (*Gloiopeltis tenax*) grows on all the coasts of Japan, but is most prolific around Hizen and Itsushima, where it attains a length of three inches. The funori prepared from it is of particularly good quality, and is usually employed for silk textiles.

The following table shows the total amount and value of Funori prepared during the four years ending 1903:—

Year.	Amount in Kwan.	Value.
		£
1900	257,932	15,406
1901	355,481	26,161
1902	284,083	26,794
1903	181,513	16,660

1 Kwan = 8·2673 lb. (Avoir.)

SEAWEED IODINE.

The extraction of iodine from seaweeds has been carried on in Japan on a small scale for several years, but it is only recently that this industry has received careful attention both by private persons and by the Bureau of Fisheries and Marine Products. Experiments are now being carried out under Government supervision at many places along the coast, in order to ascertain the most economical and productive method of extracting this valuable chemical from the seaweeds which contain it. The result of these investigations should be greatly to increase the yearly output, which has already reached considerable figures. The manufacture is carried on at present principally in Hokkaido, and in the prefectures of Chiba, Miye, Shizuoka and Kanagawa.

Iodine exists in larger or smaller quantities in many kinds of seaweeds, but the largest proportion is contained in those species which are of a brown or greenish-brown colour and which turn black on being dried. The seaweeds chiefly used in Japan for this purpose are Kombu (*Laminaria sp.*), which have been already described in this report; Kajime (*Ecklonia cava*), which is found principally on the south-eastern coasts of Japan, where it reaches a length of four or five feet; Arame (*Ecklonia bicyclis*), which grows in profusion all round the Empire, and reaches a length of about two feet; and Hondawara (*Sargassum Horneri*) and Yatsumata-moku (*Sargassum patens*), both of which are found growing on the rocks all round Japan. Kajime is also used for manuring the rice fields, as also are the two species of *Sargassum* mentioned above; Hondanori is also used for decorative purposes at New Year's celebrations.

The amount of iodine contained varies with different species of algæ, their age and time of year. The following figures are taken from analyses contained in a Report of the Second Exhibition of Marine Products:—

Seaweed.	Iodine contained.
Waste Kombu . . .	0·14388 per cent.
Kajime (Stems) . . .	0·14831 „
„ (Fronds) . . .	0·00177 „
Arame	0·00028 „
Nagahijiki (*Cystophyllum*) .	0·00506 „

The following results represent analyses of the various kinds of Kombu (*Laminaria sp.*) found in Hokkaido:—

Name of Seaweed. Wind dried.	Amount of water in 100 parts.	Percentage of iodine.
Mitsuishi-kombu (*L. angustata*)	22·666	0·180
Naga-kombu (*L. longissima*)	25·944	0·173
Ma-kombu (*L. japonica*)	22·968	0·106
Rijiri-kombu	23·986	0·188
Hosome-kombu (*L. religiosa*)	22·754	0·127
Nekoashi-kombu (*Arthrothamnus bifidus*) . .	24·443	0·223

The following are the results of the monthly analyses of Kajime (*Ecklonia cava*) made at Hata, in the province of Awa, by the Government Investigation Station:—

Percentage of Iodine.	Jan.	Feb.	March	April	May	June
In stems . . .	0·092	0·167	0·061*	0·067*	0·147†	0·255
In fronds . . .	0·081	0·167	0·063*	0·060*	0·076†	0·294
	July	August	Sept.	October	Nov.	Dec.
In stems . . .	0·216	0·142	0·267†	0·144	0·145	0·099
In fronds . . .	0·294	0·142	0·232†	0·081	0·112	0·097

* Young stems and fronds. † Old stems and fronds.

The seaweed is gathered off the rocks, principally during the summer months, and dried on the beach. Such as may be cast up by the tide is also collected, but this contains a much smaller percentage of iodine than that gathered off the rocks. The dried seaweed is then either reduced to ash by burning, or it is converted into a substance like charcoal. If it is to be merely burnt, it is heaped up in some spot removed from human habitation, owing to the disagreeable fumes given off, and there set alight, care being taken not to let it burn too fiercely ; sometimes it is burnt in a hollow scooped out in the sand and plastered inside with clay. If it is to be charred, it is burnt in a specially constructed furnace from which the supply of air is cut off. It is found that charring gives the best results, as the iodine is easily dispersed if the seaweed be burnt in the open, and in addition, some valuable by-products are obtained in the charring process.

To extract the iodine from the ash, the latter is dissolved in fresh water, and the solution obtained is evaporated. The concentrated solution contains, in addition to iodine compounds, potassium chloride, sodium chloride, magnesium chloride and calcium sulphate. Sulphuric acid and manganese dioxide are then added to the solution, which is boiled, the iodine escaping from the liquid as vapour and being deposited in a condenser in the form of crystals.

Much dishonesty is practised by the fishermen in the sale of the ash, which they often adulterate with sand or ashes, and various tests have to be used to determine its purity before purchasing it from them.

No statistics can yet be obtained of the yearly output of crude iodine, but the following table gives the exports of potassium iodide for the three years ending 1904 :—

Year.	Amount in Kin.	Value.
		£
1902	3,051	1,482
1903	22,371	10,117
1904	52,012	26,680

1 Kin = 1·32277 lb. (Avoir.)

OTHER USEFUL ALGÆ.

Chigaiso (*Alaria crassifolia*), which is found chiefly on the northern coasts of Hondo and in Hokkaido, is from 15 to 20 inches in length, and is used for eating in the same way as Wakame, but is somewhat tougher than the latter.

Wakame (*Undaria pinnatifida*) is found growing all round the coast of Japan and attains a length of from 20 to 30 inches; it is gathered from February to July by means of long rakes with which it is torn from the rocks to which it adheres. When dried it is largely consumed as a vegetable or salad, being dipped in soy or miso. The best kind is that which comes from Naruto and Shima, and the method of preparation is as follows :—

The seaweed is first of all washed in fresh water, spread out to dry and then washed a second time; after this it is split open, the midrib removed, and the leafy portions hung up on ropes or poles to dry. When partially dry, it is kneaded, and then dried completely and done up in bundles for sale. The root is sometimes dried, cut into thin slices and eaten. Kizami-wakame, or shredded wakame, is prepared by tearing the partially dried fronds into thin strips on the point of a nail. Ito-wakame is another variety, which is dried over a fire, sugared, and then tinned.

Antoku-wakame (*Laminaria radicosa*) is found chiefly on the coasts of Tosa and Iyo in Shikoku, where it grows to a length of 10 inches and is gathered from March to September. It is very prolific, but the flavour is not good, and it is only eaten by the poorer classes; it is also used as manure.

Mozuku (*Mesogloia decipiens*) is usually found growing entangled with Hondawara (*Sargassum Horneri*). It attains a length of 10 inches, and is gathered in April and May. It is preserved in salt and used for edible purposes.

Futo-mozuku (*Mesogloia crassa*) is similar to *M. decipiens*, but grows by itself on rocks.

Matsumo (*Chordaria abietina*) grows chiefly in the north of Hondo, and is gathered from December to March, when it is collected off the rocks at low water. To prepare it for eating, it is washed in fresh water, then in hot water, and finally dried. It is often eaten with *Sashimi* (raw fish), and is also used for preserving mushrooms by placing a layer of it between each layer of mushrooms as they are packed in barrels.

Hijiki (*Cystophyllum fusiforme*) grows chiefly on the Pacific coast, attains a length of from 5 to 6 inches, and is gathered off the rocks at low water, the best being that gathered in January and February, when it is young and tender. When dried, it is eaten after being boiled with soy.

Naga-hijiki (long hijiki) is the same as the above, but grows to a length of 20 inches and is found in Kiushiu and Shikoku.

Haba-nori (*Endarachne Binghami*) grows on rocks in shallow water to a length of 5 inches, and is gathered from November to January. It is dried, preserved, and eaten.

Kuromo (*Chordaria*?) is found off the peninsula of Noto, Etchu and Bungo. It is eaten after being dried and salted.

Ogo (*Gracilaria confervoides*) is found all round the coast growing on rocks, pebbles and shells, and attains a length of 50 inches. If it is boiled and a little lime added to it, it turns a bright green colour, and it is thus eaten with fish. When bleached, it is used as Funori (seaweed glue), or to supplement Tengusa (*Gelidium*) in making isinglass. It is also used as manure.

Shiramo (*Gracilaria compressa*) is a noted product of Hizen, where it is found growing on the rocks. When bleached, it is eaten with finely-chopped vegetables, or, when flavoured with soy, with sushi (a kind of sandwich made of fish seasoned with vinegar and rice).

Kome-nori (*Grateloupia affinis*) is found all round Japan, but chiefly in Sagami and Suruga. It is gathered off the rocks at low water, dried with ashes and stored. If immersed in hot water, it turns a bright green and is used for garnishing fish.

Hirakusa (*Gelidium subcostatum*) is found all round the coast and grows to a length of 11 inches; it is used for making an inferior kind of Kanten.

Higekusa (*Gelidium sp.*) is found off the coasts of Hiuga and Shima; it is more slender and longer than Tengusa, and has the appearance of a bundle of hairs. Very good Kanten is prepared from it.

Kinukusa (*Gelidium Amansii*) is similar to Tengusa and makes the very best Kanten.

Umi-somen (*Nemalion lubricum*) is found chiefly on the southern and western coasts of Japan. It is eaten preserved with salt or lime.

Igisu (*Ceramium Boydenii*) is found growing on rocks entangled with other algæ all round the coast, but principally off Shikoku, Kiushiu and in the Inland Sea. It is gathered in May and June, dried, saturated with vinegar, or dissolved by boiling it in rice water, compressed and eaten.

Tosaka-nori (*Sarcodia Montagneana* ?) grows on the southern coasts of Japan at a depth of 7 or 8 feet and varies in length from 4 to 8 inches. It is gathered from April to September, and is preserved by drying. It is used for eating, and also for garnishing fish; it has lately been exported largely to China.

Otosaka-nori is a larger variety of the same species.

Ego (*Campylæphora hypneoides*) is found growing entangled with Hondawara (*Sargassum Horneri*). After being bleached, it is dyed red and called "Joku-nori"; it is also mixed with Tengusa and made into an inferior quality of Kanten. Sometimes mirin, soy and vinegar are added to it, and it is dissolved by boiling; when solidified it is eaten as a kind of jelly. It is gathered in July and August.

Tori-ashi (*Acanthopeltis japonica*).—This was considered until recently to be of no use, but it is now employed for preparing Kanten, for which it is almost as good as Tengusa. It is gathered chiefly in Shikoku.

Onigusa (*Gelidium japonicum*) is similar to Tengusa and used for making Kanten. It is found chiefly in Shima, Kii and Hiuga, and grows to a length of 3 or 4 inches.

Nagamiru (*Codium elongatum*) is most prolific in Awa and Izu, and has the appearance of long round threads from 20 to 30 inches long; it is gathered in May and June. For eating it is boiled with some flavouring such as soy or vinegar, or it is put into soups.

Miru (*Codium mucronatum*) is found growing on rocks or adhering to shells, and reaches a length of 6 or 7 inches. It is gathered from April to August, dried, preserved with ash, and eaten in soups.

Hiramiru (*Codium latum*) grows on rocks all round the coast and has very broad fronds of a very leathery nature. It is eaten chopped fine in soups, or with soy and vinegar.

Aosa (*Ulva pertusa*) or "Sea lettuce" grows in shallow water all round the coast to a length of 20 to 30 inches. It is gathered in December and January. The young fronds are chopped fine and eaten as a salad or as a substitute for Asakusa-nori. The larger fronds are used for manure.

Ao-nori (*Enteromorpha compressa*) grows in shallow bays and near river mouths, where fresh and salt water mix. It resembles slender threads, and is about one foot in length, and is found adhering to rocks and stones. It is gathered from November to May, and after being dried and preserved, is used for edible purposes. The Ao-nori of Kishu and Tosa, the former being of a deep green colour, and the latter attaining a length of 6 feet, have been famous in Japan from times past.

Mr. Davidson's report is of considerable value and interest, as it not only indicates the varied uses to which seaweeds are put in Japan, but also furnishes particulars regarding the methods of preparation employed. A study of the report suggests that seaweeds could be similarly utilised in many other countries besides Japan, and the information now available regarding the practice in the latter country should prove exceedingly useful in any such attempts.

Seaweeds belonging to the same genera as those utilised in Japan are widely distributed, though of course some of the species mentioned in the report are peculiar to Japanese waters. There is little doubt, however, that other species belonging to these genera could be utilised in similar manner, and the publication of the report will direct attention to the possibility of extending the economic uses of seaweeds in British Colonies.

PRODUCTION AND USES OF MOHAIR.

OF the various animal fibres employed for textile purposes the most important is sheep's wool. An account of the production of this material in British Colonies was published in the *Bulletin of the Imperial Institute*, 1905, vol. iii. pp. 176–185. There are, however, several other fibres of animal origin which have long been used in the manufacture of fabrics. Among these may be mentioned mohair, cashmere and alpaca, which respectively form the hairy covering of Angora, Tibet and Llama goats. As the demand for wool has increased, these products have been called more largely into requisition to augment the supply of raw material.

THE ANGORA GOAT.

Mohair is obtained from the Angora goat, which has long flourished in Asia Minor. It is a graceful animal with a neat, shapely head, a broad forehead and ears, the latter, together with the greater part of the face and legs, being covered with short lustrous hair. The animal has light-coloured, curved, flat horns, which are especially large and well proportioned in the case of the ram. The possession of thick straight horns by an Angora goat is evidence that the animal is not of pure breed.

The average weight of the fleece given by the Angora goat varies from 3 to 6 lb., but this is often greatly exceeded. As in the case of the sheep, the Angora goat in the wild state grows a fine undercoat of woolly hair. The goat, like the sheep, also produces hair of varying lengths on different parts of its body. The result of skilful breeding and rearing is to produce fine hair of uniform length and great lustre.

The principal factors in the successful production of mohair are purity of breed and suitability of climate, environment and food.

Prospective breeders of Angora goats should bear in mind that good lustre and fine silky quality of hair are the main points to strive for, and that these can only be attained by breeding from the best rams, and by the importation, from time to time, of the finest blood that can be obtained.

Mohair can only be produced in countries possessing specially favourable climatic conditions. S. C. Schreiner, a South African mohair expert, in his book, *The Angora Goat*, states that "if the goats are to produce the best fleeces they are capable of, they must have mountain veld (*i.e.* open country which is unused except for grazing stock), and be maintained in uninterrupted good condition; they must have a great variety of food, principally shrubs and aromatic plants, and lead an active life; they must, if possible, have running water to drink and be kept free from dust; they must not be kraalled or shedded, except when absolutely necessary; they must have clean sleeping places and not be crowded together."

The natural habit of the goat is to climb, and in mixed grass and bush lands, this gives it an immense advantage over animals like the sheep, which crop only the growth close to the ground. During the winter when browsing is not possible, the goats may be fed upon coarse fodder with the addition of some kind of grain. In the United States, cotton seed has been used as a supplementary feeding material.

MOHAIR.

If well grown and of good quality, mohair is milky white in colour, and is the brightest and most lustrous of all varieties of wool or hair. It varies in length from four to ten inches or more, according to the time it is allowed to grow before being clipped; in its natural state, the material hangs in close locks which form curly ringlets.

Unlike the fine curly wools such as Australian merino and other similar varieties, mohair does not possess the marked serrations which in the subsequent processes of manufacture cause the fibres of wool to become matted or "felted" together.

When examined microscopically the mohair fibre is seen to be covered with thin, flat, smooth epidermal scales which do not project over one another, and consequently the fibre shows scarcely any serrations. The diameter of mohair fibre varies generally from 0·0006 to 0·002 inch.

The uses to which mohair is applied are to a certain extent limited on account of the somewhat harsh or "wiry" nature of the material. It is principally employed in the manufacture of so-called "lustre" dress fabrics and other bright textile materials such as linings, plushes and braids. In many cases "English" or "cross-bred" wool is employed in admixture with mohair in order to produce a cheaper material. It is interesting to note that a very large proportion of mohair is woven in conjunction with cotton, the latter being used for the warp and mohair for the weft. This is done on account of the superior strength of the cotton and its ability to withstand the somewhat drastic treatment which the fabric has to undergo in the finishing processes, in order that the mohair may exhibit the maximum amount of lustre.

SOURCES OF SUPPLY.

At the present time the principal sources of supply of mohair are Turkey and South Africa, which produce about equal quantities of the material.

Turkey.

The Angora goat has for many centuries been a native of the central plateaux and mountains of Asiatic Turkey. The principal provinces producing mohair are those of Angora and Kastamouni and in Armenia the province of Erzeroum.

Mohair has been grown to great perfection in Asia Minor, where the climate appears to be specially suitable to the Angora goat. It has been said that the length and fineness of the fibre produced are due in part to some peculiarity of the atmosphere. It has also been stated that nearly all domesticated animals introduced into Angora have, in the course of time, produced hair which for their particular species is of unusual length and fineness. Owing to the increased demand for mohair at a time when Turkey was the only country producing the material in any quantity for export, the supply was augmented by crossing the pure Angora goats with the common Kurd goats which bore thick, black, "kempy" fleeces, more like coarse wool than mohair. The result was that although the hardiness of the breed was increased, the mohair was found to depreciate in quality. During recent years, however, the supply has been equal to the demand, and in consequence the farmers have been enabled to keep their flocks pure, and in this way the quality of the hair has been improved.

Much of the mohair received from Turkey is in a very dirty condition, and special precautions have to be taken in order to safeguard the lives of those who handle the material. The mohair which comes from the Van district is exceedingly dangerous, and has caused many deaths from anthrax or "wool-sorters' disease." The hair is very dry and to a great extent free from grease; the germs of the disease (anthrax spores) are found in the dry dust and pieces of skin remaining attached to the hair.

The following note on the climate of Angora, furnished by Mr. H. A. Cumberbatch, sometime British Vice-Consul at Angora, is of interest. "The climate is extreme. In the months of January and February, the thermometer will mark a maximum of 10° F. for several days at a time, and reach as far as 0° F.; whilst in June and July the maximum readings of 85° F. are maintained, day after day, with little or no rain. The country is covered with snow in the winter, rain and snow falling frequently. In 1894 the total rainfall at Angora was 8·12 inches, but that was an exceptionally dry season. For the first six months of 1895 the rainfall was 10·10 inches, which is somewhat above the average, the heaviest rainfall in 24 hours having been 1·20 inch."

The mean altitude of the province is estimated at 2,900 feet.

Cape Colony and Natal.

It will be seen from the above description of the climate of Angora that it corresponds somewhat closely with the Karoo districts of South Africa. These districts are large elevated tracts of country, hot, stony and dry, with small scattered shrubs and an absence of grass pasturage.

The mohair-producing districts of South Africa are said to be much hotter than Angora, but the dryness of the climate, which is such an essential feature in the production of mohair, may counterbalance the excessive heat. Humidity of climate and wet marshy land are specially fatal to the breeding of Angora goats and the successful production of mohair.

The industry has been established in Cape Colony for about fifty years, but until quite recently the product has been much inferior to that grown in Turkey. Of late years, however, great improvements have been effected in the quality of the Cape mohair. Although the average growth is not yet equal in value to that of the Turkish variety, it is nevertheless true that the best Cape quality is in no way inferior to the finest exported from Turkey.

Hitherto, one of the chief defects of Cape mohair has been due to the objectionable practice of shearing the goats twice a year. In this way, although the first clip is of medium length, and would command a fair price, the second clip of only a few months' growth is of very short staple and consequently of diminished value. The English consumers have for some time been taking steps to induce Cape farmers to produce mohair of one season's growth, which would be more suited to trade requirements. To a certain extent double shearing has been necessary on account of the presence in the flocks of blood other than pure Angora, the "cross-bred" animals having an inherent tendency to shed their hair periodically.

The improvement which has taken place of late years in the quality of the mohair from Cape Colony has been due to the constant introduction of pure blood into the flocks, the farmers having realised that the cross-breeding of the Angora with the common goats of the Colony produced a hair which could not hope to compete in the markets with the comparatively pure-bred mohair from Turkey.

Australia.

Some time ago it was stated that an attempt had been made to grow mohair in Australia, but that it was not a success. The first steps were said to be satisfactory, but the hair gradually deteriorated, until finally it approached the type of merino wool. Since then, however, further efforts have been made in the rearing of Angora goats, and samples of Australian mohair which have lately been forwarded to this country have shown that it is possible to produce hair of satisfactory lustre and length. The goats cannot be kept to advantage on the open downs which are so eminently suited to sheep-grazing, but there is no doubt that favourable browsing land exists in Australia, and the fact that the Angora goat is able to survive in times of drought, unfortunately so frequent in Australia, will no doubt lead to further experiments being carried out, in the breeding of Angora goats in that country.

United States of America.

American mohair is usually inferior to the Turkish and Cape varieties, being coarser and more kempy, and therefore of lower value. Samples of mohair, however, which were received recently in this country from the United States were reported by manufacturers to be of excellent quality and were classed as equal to the Turkish product.

Angora goats imported from Turkey are bred principally in the Western States of Oregon, California and Texas. The yearly production of mohair is a little over 1,000,000 lb., and this together with about an equal quantity of imported mohair is used annually in the textile industries of the United States.

From the foregoing statements it will be realised that although at the present time the supply of raw mohair is equal to the demand, yet material of good quality is always sure of a ready sale. Instead of attempting extensive series of experiments to introduce the Angora goat into new British Colonies, it would therefore seem advisable to develop and improve the mohair industry in those Colonies, viz. South Africa and Australia, in which it is at present carried on, so that the mohair produced may be equal or, if possible, superior in quality to that obtained from Asia Minor where the industry has been so long established.

The market price of Turkish mohair during the last ten years has ranged from 1*s.* 1½*d.* to 2*s.* 2*d.* per lb. At present Turkey "average" mohair is quoted at 1*s.* 6½*d.* per lb., and Cape "firsts" at 1*s.* 5½*d.* per lb.

MINERAL PRODUCTION IN INDIA.

IT is twenty-five years since the publication, by the Geological Survey of India, in the year 1881, of Part III. *Economic Geology* of the first edition of the *Manual of the Geology of India.* It was compiled by the late Mr. V. Ball, and is a detailed record of the mineral wealth of India, as far as it was then known.

At that time mining occupied a very subordinate position among the industries of India. In former days its iron and steel products had rivalled those of Europe, while copper, lead (with its associated silver) and probably tin appear to have been extensively smelted, but European competition had reduced the output of these metals to the smallest proportions. Centuries before, the rich gold mines of Southern India had been abandoned after a considerable depth had been reached, on account of the impossibility of dealing with the water without pumping machinery. Coal mining was started towards the end of the eighteenth century, but it was only in the last few years before the issue of *Economic Geology* that it had shown signs of expansion, and the mineral output was still less than a million tons. Upper Burmah had not yet been annexed, and the output of its petroleum springs did not amount to more than two and a half million gallons per annum. The only other minerals which were produced on a large scale were salt and saltpetre.

The quarter of a century that followed has been one of rapid development. The discovery of a valuable reef in the Mysore mine was the commencement of the prosperity of the Kolar goldfield. At the same time the output of coal has risen to over 8,000,000 tons per annum, while with the introduction of modern methods, that of the oilfields of Burma has increased fortyfold. The mining of rubies in the same province has also assumed important dimensions.

In addition to these, there are two mineral products—mica and manganese—which had previously been almost entirely neglected and which are now mined on a large scale for export. In the case of the former, India is easily first among the world's producers.

The greatly increased importance of the mining industry induced the Reporter on Economic Products to publish an annual *Review of the Mineral Production of India*, which appeared for four years, 1894–1897. It was then decided to issue the reviews at longer intervals, and recently Mr. T. H. Holland, F.R.S., Director of the Geological Survey of India, has published a *Review of the Mineral Productions of India during the years* 1898–1903, forming Part I. of volume xxxii. of the *Records of the Geological Survey of India*, being the first of the new series, which will in future be published every five years. A supplementary statement, giving the mineral production during 1904, has also now been issued as Part I. of volume xxxiii. of the same publication.

The following table gives the values of the principal mineral products for which statistics are available in the first and last years of the period under review as well as for 1904:—

	1898.	1903.	1904.
Gold	£1,608,504	£2,303,144	£2,366,079
Coal	957,162	1,299,716	1,398,826
Salt	358,933	336,147	437,530
Saltpetre (potassium nitrate)	265,896	290,196	266,349
Petroleum	67,897	354,365	473,971
Rubies	57,950	88,819	90,612
Diamonds	—	2,579	2,636
Mica	53,890	86,296	97,932
Manganese ore	27,426	151,530	129,632
Jadestone	41,780	55,435	50,726
Iron ore	12,403	14,963	12,617
Graphite	110	16,970	16,726
Tin	2,553	9,153	8,353
Magnesite	—	550	876
Chromite	—	327	4,137
Amber	1,061	414	838

These figures, are, however, as Mr. Holland says, not strictly comparable. Those for saltpetre, mica, manganese ore and jadestone are export values, while coal and petroleum are valued at the locality where they are produced. The figures for salt do not include the duty collected by Government.

Detailed statistics are furnished with regard to each mineral, and in many cases the character of the variations that have occurred is illustrated by diagrams.

Coal.

The importance which coal-mining is now assuming in India is illustrated by the fact that the sea-borne trade in Indian coal amounts to some two million tons per annum, of which a million and a half go to Indian ports and half-a-million to British Colonies and Sumatra.

As is well known, the greater part of the coal raised in India comes from mines in Bengal and Peninsular India belonging to the Lower Gondwana formation, and is but slightly younger than that mined in the United Kingdom. The cretaceous and tertiary coals, on the other hand, which are found in Sind, Baluchistan, Rajputana and in the foot-hills of the Himalayas, as well as in Assam, Burma and the Andaman and Nicobar Islands, belong to a much later period, and contain more moisture and hydrocarbons than the older coals. Some of the Assam coals have a high calorific value, but the total output of these coals from all localities is only about 400,000 tons.

Labour appears to be fairly plentiful in the Indian mines, but the efficiency of each miner does not compare favourably with that in other countries. In Nova Scotia 542 tons and in the United Kingdom 280 tons of coal were raised in the year 1902 for every man employed, while the average for the British Empire, excluding India, was 285 tons. In India, on the other hand, only 75 tons were raised per man in the same year, but this was increased in 1904 to 88·6.

In the matter of accidents, India holds a rather more favourable position. In 1902 the average death-rate per thousand persons employed in coal mining in all parts of the British Empire, excluding India, was 1·54. In India it was only 0·77. On the other hand, while in the rest of the Empire there were 5·41 deaths for every million tons of coal raised, in India there were 10·23.

The freedom from gas and the strength of the roof of the workings, the result of the absence of fissures due to earth movements, are circumstances which considerably diminish the liability to accidents.

Gold.

In the production of gold, India occupies seventh position, coming after Australasia, the United States, the Transvaal, Russia, Canada and Mexico, and it yields only 3½ per cent. of the world's supply.

Outside the Kolar goldfield the chief workings are in the Nizam's Dominions, especially the Hutti mine in the Lingsugur district, where the former workings were found to have reached a depth of 540 feet. Gold mining was also carried on near Wuntho in Upper Burma up to 1903, when the pay chute was lost and the mine was closed.

Alluvial gold is mined on a small scale in many places in India, but no trustworthy returns are available.

Dredging for gold has been carried on in Upper Burma with results which were considered sufficiently satisfactory to warrant an increase in the number of dredgers. Little prospect, however, is held out of the discovery of rich alluvial deposits in Peninsular India or other localities affected by the Monsoon rains and dependent on them alone for the supply of the rivers. For concentration of gold a comparatively equable current is stated to be essential, a condition rarely found in the gravel beds of India, which are almost dry in the cold weather and roaring torrents in the rains.

Iron.

In spite of the existence of rich iron ores, but little iron is smelted. The Bengal Iron and Steel Company has two blast furnaces in operation at Barakar, and a small quantity of ore is employed in the steel furnaces of the East India Railway Company's workshops at Jamalpur. There are also numerous small native furnaces which are still at work in the Central Provinces and other parts of India. In the Central Provinces the output is stated to vary from 2,400 to 4,800 tons per annum. Steel is also manufactured on a small scale.

Manganese.

Indian manganese was first mined in the Vizianagram State, but it is now obtained near Nagpur and other localities in the

Central Provinces as well as in Jhabua in Central India. Many other occurrences are known.

The Nagpur ore occurs in irregular lens-shaped bodies in quartzites, schists and gneisses. It consists of a mixture of braunite (hydrated sesquioxide of manganese), and psilomelane (the hydrated dioxide), though in some cases the former alone is present. The mode of occurrence in the deposits near Vizianagram is usually similar, but occasionally the ore occurs as nodules in crystalline limestone.

The average composition of the mineral raised is as follows:—

	Nagpur. Per cent.	Vizianagram. Per cent.
Manganese	51–54	45–50
Iron	5–8	7–13
Silica	5–9	2–5
Phosphorus	0·05–0·12	0·12–0·27
Moisture	usually less than one per cent.	1·10–1·80

Mica.

Mr. Holland treated the subject of Indian mica so fully in the recent Memoir of the Geological Survey on the subject, that there is little in the present review that will not be found in the earlier publication. The unsystematic methods of work still continue, involving not only unnecessary expense and injury to the mica, but considerable risk to the workmen employed (compare this *Bulletin*, 1904, vol. ii. p. 286).

Petroleum.

The article in this *Bulletin*, 1904, vol. ii. pp. 97–103, brought the statistics for petroleum down to the end of 1902.

The year 1903 was marked by an enormous increase from 56,607,688 to 87,859,069 gallons, and in 1904 the output reached 118,491,382 gallons. At the same time the importation of foreign oil fell from 98,886,205 in the financial year 1901–1902 to 70,590,858 in 1904. The production of the Burma oilfields increased from 54,848,980 gallons in 1902 to 115,903,804 gallons in 1904, and that of Assam from 1,756,759 to 2,585,920 gallons.

The Punjab deposits hold out, the author states, no prospects of adding materially to the output, as the great bulk of the oil, that once existed in this region, has been lost by the erosion of the summit of the anticline in which it was collected.

In the Burma oilfields steps are now being taken towards the adoption of the bulk system of transport and distribution. A pipe line has been laid from the oilfield at Yenangyat through the Singu field to Yenangyaung, the principal oil-producing area, a distance of more than 50 miles, and arrangements are now being made to connect the last-mentioned field in the same way with the refineries at Rangoon, 275 miles distant. At the same time tank steamers have been purchased and storage tanks have been constructed at the principal Indian ports.

Salt.

We learn that 61·8 per cent. of the total output of salt was obtained from sea-water, 27 per cent. from sub-soil and lakes, and only 11·2 by mining or quarrying rock-salt. The most important source of salt belonging to the second class is the Sambhar Lake in Rajputana, from which 4,000,000 tons have been removed since 1871. In recent years the quality has deteriorated on account of the increased proportion of other substances such as the sulphate and carbonate of soda and sulphate of potassium, which have not been extracted from the brine and have been allowed to flow back to the lake.

The principal salt mines occur in the Punjab and North-Western Frontier Province and Mandi State. Although over 1,000,000 tons of salt are produced in India a considerable importation occurs, amounting to 471,096 tons in 1904.

Saltpetre.

In spite of the development of large deposits of sodium nitrate on the Pacific coast of South America, the Indian production of saltpetre (potassium nitrate) is well maintained. The material occurs with common salt in the soil around villages. The two salts are dissolved out together and then separated by fractional crystallisation, the ordinary salt is consumed locally, while the saltpetre is sent to refiners for further purification before export.

Tin.

Tin ore is found in the Hazaribagh district of Chota Nagpur and other localities in India proper, but it has only been worked to any extent in south Burma. The total output in 1904 just exceeded seventy tons. It is sent to the Straits Settlements, from which the greater part of the tin imported into India is obtained. The metal is mainly employed in India to form a coating in the inside of copper cooking utensils, which is renewed from time to time. The consumption, however, shows no signs of increase.

The Indian jadestone is mainly jadeite, a silicate of alumina and soda. It is chiefly mined in Burma, and is exported to the Straits Settlements and China. Magnesite is found in the Chalk Hills near Salem in the Madras Presidency. It is employed in the manufacture of fireproof bricks.

Mr. Holland then proceeds to deal with a number of mineral substances, in the case of which no definite statistics can be obtained. A few of these may be mentioned. Steatite, which is employed in making pots, is widely distributed. Amber is found in Upper Burma, but is at present mined only in a desultory fashion. Corundum is largely employed in India for abrasive purposes, but is only exported on a small scale. Alum was formerly prepared to a considerable extent from decomposed pyritous shale and saltpetre or wood ashes. This industry, has however, almost entirely succumbed to European competition. Mr. Holland refers to the occurrence among the laterites of material as rich in aluminium as the typical bauxite of France, but which is at present entirely neglected. (See also remarks on laterite in the General Report of the Geological Survey of India for the period April 1903 to December 1904, *Records of the Geological Survey of India*, Part I. vol. xxxii. p. 141.)

The author draws attention to the fact that the progress of the mineral output during the period under review is almost entirely confined to two groups of minerals, those that can be utilised at once or after a very simple treatment, and those that are raised mainly for export. Little or nothing has been done to establish the more complex chemical and metallurgical industries, that have mineral substances for their basis, although the products are in many cases widely consumed in India.

The average annual value of such products imported into India amounted, he states, during the years 1901–3 to over ten millions sterling.

He believes that the future development of mining in India is dependent upon the establishment of such cognate industries in the country.

The coal consumption of India is, he says, not likely to be fully developed till the metalliferous ores, especially those of iron, are smelted in the country. The iron ores are not, at present, exported, but large quantities of manganese are sent to Europe as ore and return in the form of manganese steel. Alum too is largely imported from Europe in spite of the abundance of bauxite in India. To prepare alumina and its salts from the Indian material would require the use of caustic soda, which is not at present made in the country. If this were manufactured by the most recent process—the electrolytic decomposition of brine—chlorine, which could be utilised for the manufacture of bleaching powder, would be obtained at the same time. Both caustic soda and bleaching powder are employed in making paper, which is largely consumed in India.

A large number of industries, including many of those concerned with the treatment of mineral products, involve the use of sulphuric acid. It is, for instance, necessary for the manufacture of super-phosphates from bones which are exported to Europe, though phosphatic manures are urgently needed in India for agricultural purposes. It is also required for the treatment of the by-products in coke making, for the purification of mineral oils, and in numerous other processes. It forms, too, a necessary link in the chain of operations involved in the manufacture of the alkalis, which are required in so many industries.

At present some 2,269 tons are imported at a price over £14 per ton. The greater part of this cost is due to the precautions required in transporting it, for in England it is sold at less than £2 a ton. The much higher price in India seriously interferes with the development of Indian industries.

The manufacture of sulphuric acid requires, however, an abundant supply of sulphur or sulphides. Of sulphur itself, the deposits in India are inconsiderable. The sulphides of iron, copper, lead and other metals are, however, found in many localities. Mr. Holland suggests that although it may not pay to work the sulphides for the metal alone, yet it may be possible, especially in the case of the copper ores, to make a profit, if the sulphur be utilised at the same time for the production of sulphuric acid or the commercially valuable sulphates.

THE COALFIELDS OF CAPE COLONY.

COAL is found in large deposits in the eastern part of the Colony, probably as an extension of the Natal and Zululand coalfields. The quality of the fuel is rather poor, but owing to the distance from which other coals have to be brought, it finds a ready market in the neighbourhood of the collieries, and has been much used on the Cape railways.

The geological age of the coal is the same as that of all the South African coalfields, and the strata in which the seams are found have been correlated, as shown in the following table, with those of India and New South Wales :—

India.	*New South Wales.*	*South Africa.*
Panchet	Hawkesbury	Stormberg
Raniganj, Barakar	Newcastle	Beaufort
Talchir		Ecca

Coal is found in three groups of strata in India, viz. Talchir, Barakar and Raniganj, belonging to the Gondwana system. The Ecca beds of South Africa, corresponding to the Talchir beds of India, do not contain coal of any economic importance. Thin beds have been found in the Beaufort series, as is seen on the Komsburg escarpment, where a nine-inch seam of bright coal occurs, but it is unsuitable for burning under ordinary conditions as it crumbles immediately when attempts are made to make a fire with it, owing to the large amount of water it contains. The ash is low, 6·8 per cent. Other thin layers occur on the Leeuw River and at Buffels Kloof, but in no case are they of commercial value.

Not only in Cape Colony, but also in Natal and the Transvaal the Molteno beds of the Stormberg series are coal-bearing. The beds consist of shales, mudstones and sandstones, usually grey or greenish in colour, and contain abundant plant remains. *Glossopteris*, the characteristic plant of the Indian coal formation, is also typical of South African coal beds. The productive beds extend from the Stormberg end along the lower slopes of Drakensberg, in East Griqualand as far as the Natal border, and also on the northern slope of the great watershed, although it is only in the Stormberg-Indwe region that any work has been done on the seams. There appear to be two horizons on which workable coal has been found: the lower extends from Sterkstroom eastwards to Indwe; beyond Indwe towards Engcobo the coal has been followed, but not worked to any extent. The upper is that to which the Molteno seams belong, and is some hundreds of feet higher than the Indwe coal; its extent is not well known beyond the neighbourhood of Molteno, but it may be represented by some thin coal seams in the Cola pass, some 300 feet above the Indwe coal.

The coal seams are rarely over eight inches in thickness, but at places several occur together, so that in a band of rock composed of coal and shale, six feet in all, about four feet of the whole may be coal. The coal is usually laminated and contains thin layers of silt.

The beds probably do not represent the position in which the original plants which supplied the carbonaceous matter grew, but, as in the case of Natal coal, were carried a considerable distance by water and deposited over the floor of the lake in the same manner as the silt. This silt accounts for the high percentage of ash in the Stormberg coals. The abundant intrusion of dykes and especially sheets of dolerite have also had an injurious effect on the quality of the fuel, the chief of these being the driving off of the volatile constituents and the partial coking of the coal.

Some of the principal coal-producing areas have recently been described by Mr. A. Russell before the Mining Institute of Scotland.

In the Stormberg district coal has been worked or prospected at the following places :—Near to the township of Sterkstroom, 190 miles from East London on the Eastern Railway of the Colony, and the point of junction of the Indwe Natal Railway, three distinct coal seams occur, but there is only one of workable thickness, containing 32 inches of coal with interbedded shale. The analysis showed fixed carbon 51·38 per cent., volatile matter 18·26 per cent., ash 30·36 per cent. Very little mining has been done on this seam. A few miles north of Sterkstroom five coal seams are exposed along the railway cutting, and consist of alternate bands of shale and coal; the lowest of these is 2 feet 9 inches thick.

To the north-west of Sterkstroom, in the neighbourhood of Cyphergat, coal has been worked at two places. At both, the coal is reached by inclined shafts, and the seam, 3 feet 8 inches thick, consists as usual of alternate bands of coal and shale.

The principal mines of this portion of the Cape coalfields are in the neighbourhood of Molteno, which is 213 miles from East London by rail. At the Pardekraal and Penshaw Collieries the seam has the following section :—Coal 8 inches, shale 6 inches, coal 10 inches, shale $3\frac{1}{2}$ inches, coal $2\frac{1}{2}$ inches, shale 4 inches, coal 11 inches. To the north-west of Molteno there are several collieries with small outputs.

The only other important district where coal is worked is in the neighbourhood of Indwe, 67 miles from Sterkstroom and 256 miles from East London. The seam has a thickness of 13 feet 10 inches, consisting of about 12 bands of coal separated by shale. It is easily worked by "adits" driven into the hill-side, and from 1895 to 1903 the quantity of coal raised was about 810,000 tons.

In the eastern portion of the coalfield there are several exposures of coal seams where coal has been worked a little by natives. None, however, is of sufficient importance to be worth recording except perhaps that on the Cola river.

The quality of the coal of Cape Colony is in all cases decidedly inferior. This is owing to the occurrence, as mentioned above, of thin layers of shale probably deposited as silt with the coal. So intimate is the association that Mr. Russell is of opinion that it would be almost impossible to separate it by washing. It would, however, be desirable to have some systematic washing trials carried out in order to test this point.

Another difficulty which the miner has to contend with is cleaning of the coal from the bands of shale. In this operation quite a large proportion of the coal itself is wasted.

Analyses of coal from various parts of the field are given in the following table :—

	Cola. Per cent.	Indwe. Per cent.	Molteno. Per cent.
Fixed Carbon	68·51	54·44	49·30
Volatile matter	9·50	25·05	23·62
Ash	19·70	19·38	24·82
Sulphur	0·79	trace	0·85
Moisture	1·50	1·13	1·37

The average selling price of Cape Colony coal at the mine is 15*s.* 6*d.* per ton. Formerly the diamond mines and town of Kimberley absorbed the whole supply, but Natal is now competing for this market and supplies a superior quality of coal (compare this *Bulletin*, 1905, vol. iii. p. 380).

Since 1899 the output has been practically stationary, as shown by the following table :—

Year.	Coal raised.	Price.	Employees.		Output per native employee per annum.
	Tons.	Per ton. *s.* *d.*	White.	Native.	Tons.
1899	208,655	12 10	143	2,843	73·4
1900	198,451	15 4½	171	3,286	60·4
1901	205,810	17 6	128	2,462	83·7
1902	185,424	17 1½	141	2,055	90·2
1903	207,493	17 3	131	2,169	95·7

THE OCCURRENCE OF PLATINUM.

PLATINUM is largely employed in chemical industries for the construction of vessels in which corrosive liquids such as strong acids are to be dealt with. The metal is sparsely distributed, and in recent years, owing to the great extension in industrial chemistry which has taken place, the demand for platinum has exceeded the supply and its price is rapidly becoming almost prohibitive. In addition to its use in chemical industries the metal is also employed in electrical work and to a small extent in photography. It has also been used in jewellery. In view of the increasing demand for the metal special interest attaches to its occurrence in hitherto unexploited situations.

Platinum Minerals.

The mineral known as "native platinum" consists of an alloy of platinum, iridium, palladium, and sometimes osmium, gold, iron and copper. The usual forms of the mineral are nuggets, scales or irregular grains. In colour it varies from silvery-white to dark-grey and it has a metallic lustre. The hardness varies from 4 to 6; the fracture is hackly, cleavage none. It is malleable, ductile and sectile, and has a specific gravity of 14 to 18.

The composition of platinum nuggets from various localities is shown in the following table:—

Source.	Russia.	British Columbia.	New South Wales.
Platinum	76·40	72·07	75·90
Iridium	4·30	1·14	1·30
Rhodium	0·30	2·57	1.30
Palladium	1·40	0·19	trace
Osmium	—	—	—
Ruthemum	—	—	—
Iridosmine	0·50	10·51	9·30
Gold	0·40	—	—
Iron	11·70	8·59	10·15
Copper	4·10	3·59	0·41
Sand	1·40	1·69	1·22

The metal also occurs in some few localities as the mineral sperrylite, an arsenide of platinum ($PtAs_2$) containing a little rhodium and antimony. This mineral has been found at Sudbury, Ontario; North Carolina, and at the Rambler Mine, Wyoming, U.S.A.

Sperrylite is of a tin-white colour, has a metallic lustre and gives a black streak. Its hardness varies from 6 to 7; specific gravity 10·6. It crystallises in the pyritohedral class of the cubic system presenting considerable resemblance in form to iron pyrites. When slowly roasted in an open tube sperrylite gives a sublimate of white arsenic and melts easily. At present this source of platinum is of little or no commercial importance.

Mode of Occurrence.

(1) "*Placers.*"—Almost the entire output of platinum is obtained from "placer" deposits, typical examples of which are those of the Urals, Columbia and Brazil and British Columbia. The platinum of "placer" deposits is probably in most cases derived from basic igneous rocks.

(2) "*Veins.*"—Platinum (as sperrylite) has been found associated with covellite at the Rambler Mine, Wyoming. It occurs native with gold at Tilkerode in the Hartz Mountains, Minas Geraes in Brazil, Santa Rosa, California, and Beresovsk, Russia, also with tetrahedrite and bournonite at Guadalcanal, Spain.

(3) *Platinum disseminated in eruptive rocks.*—(*a*) It occurs associated with nickeliferous pyrrhotite, copper pyrites and other nickel-copper ores in a hypersthene gabbro or norite at Sudbury in Ontario. (*b*) Native platinum is met with in peridotite and other basic eruptive rocks rich in olivine intimately associated with chromite.

LOCALITIES FROM WHICH PLATINUM HAS BEEN OBTAINED.

Europe.

Platinum has been found in very small quantities in Austria, Hungary, France, Germany, Great Britain and Norway.

Russia.—Over 90 per cent. of the world's output of platinum is obtained from Russia. The production in 1904 amounted to 161,139 ounces troy of the crude product. The metal is known to occur over a wide area, but the districts in which it is obtained on a commercial scale are comparatively few; the chief of these are situated along the eastern watershed of the Urals, the eastern portion of Perm and on the western watershed further south. The most important are the Nijni-Tagilsk, Goroblagodat and Bisersk districts.

The richest deposits of the two latter districts lie along the river Iss. The area is largely composed of peridotites, olivine-gabbros and their serpentinous products.

The deposits, which average 4 feet in thickness, are of the "placer" type, and extend from 200 to 800 feet on each side of the present river. They have an overburden of peat or turf which varies from 5 to 20 feet in thickness.

In extracting the mineral the turf is stripped off, and the gravel transported to the sluices or to the mechanical washers, the latter being more usually employed in operations on a large scale.

The washer consists of a cylindrical tub at the bottom of which is a circular iron pan 15 inches deep, perforated with holes five-eighths of an inch in diameter. Round the top of the pan runs a cast-iron pipe from which jets of water play into it. In the centre is a vertical shaft carrying a stirrer, which revolves about twenty-five times per minute. The gravel is fed continuously, and while the large stones remain on the pan the sands and clayey matter pass with the water through the holes direct to the riffle tables. Washing is carried on without intermission for about eleven hours, the concentrates are then washed on the tables several times, until reduced to a fine grey slime from which the gold is removed by means of mercury.

The residual material is sold as crude platinum. Dredges have recently come into use in the Iss valley in connection with this industry.

Spain.—Platinum in small amount has been found at the silver mines of Guadalcanal.

Asia.

Burma.—Platinum is known to be associated with the gold of the "placer" deposits at Ava in Upper Burma.

Borneo.—It also occurs at Goenoeng, Lawack, in south-eastern Borneo, and is occasionally obtained in gold washings.

Japan.—Platinum together with iridosmine is reported to occur in the sands of the river Yubari, Ishikari.

Africa.

Algiers.—Platinum is said to occur with galena near Algiers, but the report lacks confirmation.

British Central Africa.—Traces of platinum have been found in a nickeliferous pyrrhotite received recently at the Imperial Institute from British Central Africa. No information as to the amount of this ore obtainable is available (compare page 112).

America.

Canada.—Platinum has been found in the sands obtained near Edmonton on the North Saskatchewan River in Alberta province. The gold washings of south-west British Columbia yield platinum in small quantities. The production in 1904 amounted to 35 ounces of the crude material valued at £2 10*s.* per ounce. This quantity was obtained from one working, viz. Granite Creek in the Similakmeen, from the sluice boxes employed in washing for "placer" gold. In 1902 platinum was found in the black sands at several points on the Quesnal River, Cariboo district. Assays of these sands showed gold to be present in amounts varying from 0·2 to 121 ounces per ton and platinum from 0·14 to 7·8 ounces per ton. The Consolidated Cariboo Co. in 1904 reported the presence of appreciable quantities of platinum in the heavy concentrates remaining in the sluice boxes after the "clean up," and they are now taking steps to collect and treat these concentrates. The platinum, palladium and osmiridium occur in minute metallic grains which are enclosed in fragments of chromite and magnetite.

Platinum has also been found in the copper sulphide obtained from the Yale district; the amount present, however, would not admit of its commercial extraction, unless it were recovered from the slimes after electrolytically refining the copper.

Platinum occurs as sperrylite in the copper-nickel ores of Sudbury, Ontario. The nickel-copper matte as exported contains about one ounce of platinum per 1,000 lb. Some of this is now recovered by the Oxford Copper Co., of Constable Hook, N.J., in refining this matte.

The metal is reported to occur on the south bank of the St. Lawrence river in the eastern townships of Quebec.

United States.—The United States in 1904 produced 200 ounces of platinum valued at $2,600. The greater quantity of the metal was obtained from the gold "placer" deposits in Trinity and Shasta countries, California. Platinum is known to occur in the "placer" deposits of Washington, Oregon, Idaho, Montana, Colorado and Alaska, but in quantities insufficient for commercial working.

It also occurs as sperrylite ($PtAs_2$) associated with covellite (CuS) in the Rambler District, Wyoming, and it was estimated that platinum to the value of $6,000 was contained in the slimes from the copper ore raised in 1904.

South America.—The production in 1904 amounted to 9,625 ounces; this was largely obtained from Colombia. This country ranks second to Russia as a producer of the metal. The most productive district is El Choco in the provinces of Atrato and San Juan, the latter being the larger producer.

Australasia.

New South Wales.—The production of crude platinum in 1904 was 535 ounces valued at $10 per ounce as compared with 530 ounces in 1903.

This yield was almost entirely obtained from an area of about two square miles at Fifield. The working is a deep alluvial lead containing platinum and gold, the sinking being through 60 or 70 feet of loam, having some bands of barren quartz and drift. The wash dirt contains 5 to 12 dwts. of platinum and 1 to 3 dwts. of gold per ton, but owing to the scarcity of water the deposits are only worked during a few months of the year.

Platinum has also been found in the sands at Aberfoil river, on the seacoast between Richmond and Clarence rivers, and in felsite and granite at Broken Hill.

Queensland.—Traces of platinum together with gold and tinstone have recently been reported in the beach sands of the south-east coast. The sands contain from 0·12 to 0·64 per cent. of tinstone (3·4 to 18·2 lb. per ton), and from 5 grains to 1 dwt. 19 grains of gold per ton and 3 dwts. to 7 dwts. 2 grains of silver.

Tasmania.—Platiniridium is obtained along the Savage river and platinum from the sands of the Wilson river. The "placer deposits" of western Tasmania are of commercial importance on account of the iridosmine they yield. Platinum has been reported to occur together with vanadium in the ash of certain Australian coals.

New Zealand.—Platinum is known to occur over a wide area, usually associated with gold washings.

Some of the river sands in the southern part of Middle Island

and those of the east coast of Otago are said to yield the metal; it has been reported also to occur in eruptive rock near the Takaka river.

The following observations made by Mr. J. F. Kemp of the United States Geological Survey as to the indications of the occurrence of platinum give a useful summary of what is known on this subject :—

(1) Experience so far gained leads to the conclusion that platinum is very sparsely distributed in its mother rock and the chances of finding it in quantities sufficient to mine are small.

(2) Large and permanent "placers" are to be looked for only in very old land areas which have been subjected to protracted degradation and concentration.

(3) In the assay of antimonial, arsenical and other copper ores, but especially of tetrahedrite (grey copper or "fahlerz"), it is worth while to look for small percentages of platinum.

(4) Deposits of chromite deserve similar testing.

It may be stated that pyrrhotite, the lower sulphide of iron, often contains traces of platinum, especially when nickel, copper and cobalt are present.

It must be remembered that mercury does not readily amalgamate with platinum. Therefore in methods of working auriferous "placer" deposits in which the gold is saved by means of mercury, the platinum is liable to be lost unless special means are taken to preserve it. If, therefore, traces of platinum are suspected or known to occur, the gold and platinum should, as in Siberia, first be collected by riffles or "blanketing" and the separation subsequently effected by means of mercury.

Even in the use of riffles or other mechanical means of retaining platinum more care is required than in the case of gold.

GENERAL NOTES.

The Export of Fibres from China.—A report recently issued by the German Consulate at Shanghai gives the following particulars with regard to the export of raw fibres from China.

China is now producing cotton which is of good quality and in no way inferior to the best Indian varieties. Although the area devoted to cotton in China is no doubt slowly extending, the prospects of shipments to Europe show no improvement, since an increasing quantity of the product is being used in the Chinese mills and nearly the whole of the remainder is exported to Japan. Complaints are made that the traders in Shanghai water the cotton in order to increase its weight, and, for this reason, the Japanese send their own agents into the interior of China to buy direct from the growers. The Japanese are paying particular attention to the Yangtse Valley, and it is considered that if more care were taken to improve the seed, Shansi would become of considerable importance as a cotton-growing centre. The exports of cotton from China amounted to 759,521 piculs (about 101 million pounds) in 1903, and 1,228,588 piculs (about 163 million pounds) in 1904.

Reference is also made to the exportation of China grass and jute from China. The so-called China grass (*Bœhmeria nivea*) has a regular market throughout the year and the greater part of this product is exported to Japan. The fibres of the jute class (*Hibiscus cannabinus*, etc.) which are available for export go partly to Japan and the remainder is almost exclusively shipped to the United Kingdom. On account of the large local consumption of these fibres, the formation of an important export industry is not possible. The total exports of textile fibres (excluding cotton) amounted to 182,144 piculs (about 10,820 tons) in 1903, and 208,603 piculs (about 12,390 tons) in 1904.

Sida Fibre from the Transvaal.—Samples of the fibre of a species of *Sida*, probably a variety or form of *Sida rhombifolia*, have been received recently from the Transvaal, and examined in the Scientific and Technical Department of the Imperial Institute. The product had not been very well cleaned and prepared and contained a certain amount of gummy impurity. The colour of the fibre varied from brown to pale grey, and the length from about 5 feet to 7 feet.

Commercial experts to whom the specimens were submitted reported that the fibre was of fair colour and good length, and, if found suitable for spinning with jute machinery, would probably be worth from £14 to £17 per ton.

As *Sida* fibre has never yet been received in this country in sufficient quantity for its suitability for machine spinning to be established, it has been suggested that a consignment of the carefully cleaned fibre should be forwarded for the practical determination of its spinning qualities by manufacturers.

Burma Teak.—The exploitation and export of teak-wood constitute one of the chief resources of Burma, which together with Siam produces the bulk of this valuable timber that finds its way into commerce. So far the supply has seemed inexhaustible, but recently Conservators of Forests have reported a great diminution in the output of teak from the forests and on the market.

Serious apprehensions are now entertained by those engaged in the teak industry, that the scarcity of timber may lead to the employment of other woods instead of teak, and to the displacement of Burma from its position as the world's principal source of supply of this timber. Java teak and jarrah-wood from Australia are, it is said, being used in place of Burma teak for various purposes where the latter alone has hitherto been employed.

The imports of teak to Europe, which have been as high as 54,500 tons, have fallen to 18,000 tons; prices have risen from £11 to £19 per load, and timber in the form of planks has increased from six per cent. to forty-six per cent. of the total exports. Stocks in England are said to have diminished fifty per cent. In addition a falling tendency must be noted in the exports from Burma to Peninsular India, which in 1898 were 144,000 tons, but only 106,000 tons in 1904, in consequence of the competition of Siam and Java, and also owing to a large proportion of the wood being unsuitable for Indian purposes.

Siam teak has made considerable progress in the Indian market. From 24,000 tons in 1894 the exports advanced to 61,000 tons in 1903, and the decrease in the exports from Burma corresponds with an increase in the exports from Siam.

The falling off in the exports of Burma teak is attributed to the following causes:—

1. The diminished number of trees of large diameter in the Burma forests.

2. The increasing cost of obtaining the timber owing to the necessity for penetrating the less accessible forests in search of timber.

3. The increasing cost of elephants, which are used as transport animals.

4. The Government taxes and the rigid regulations relating to labour.

Exceptionally high prices for teak have ruled in London since the beginning of 1905. Notwithstanding the fact that the high prices have prevented engineers and architects from prescribing the use of teak except where it is absolutely essential, the demand was greater throughout 1905 than in 1904. In spite of the exports from Java, the stocks of teak in Europe are said to be at the present time insufficient to meet the demand. Merchants are thus obliged to have recourse to their reserve stocks at Rangoon, Moulmein and Bangkok, for there are no means of bringing the teak from the forests to the port of shipment, except in the rainy season. Under these conditions the Java timber is being exported in increasing quantities, although it is inferior both in quality and in size to the best Burma and Siam teak.

Animal Pests Legislation. This was the subject of the Presidential Address delivered by Mr. F. V. Theobald, M.A., at the meeting of the recently formed Association of Economic Biologists at Liverpool in December 1905, and published in full in the "*Proceedings of the Association of Economic Biologists*," vol. i. p. 29. The necessity for legislative powers to deal with animal pests was recognised as long ago as A.D. 942, when Howel Dda "The Good," of Wales, formulated laws for the suppression of Sheep Scab or Soab. Very little was done until the last ten years, when innumerable laws, proclamations and ordinances have been passed. The author deals, in a comprehensive summary, with various diseases and the means taken for their prevention or cure, in British Colonies and also in the United States, Germany, Tunis, etc., and lays emphasis on the need for similar legislation in the United Kingdom, where, whilst care is taken to prevent the introduction of diseases to cattle, and to stamp out such diseases in the country, there are no regulations to prevent the importation of diseased plants or to eradicate diseases amongst our domesticated plants. In the Colonies the paper will be of great interest because of the extensive series of typical laws relating to injurious insects printed as an appendix.

NOTICES OF RECENT LITERATURE.

NEW BOOKS.

DER ÖLBAUM. *Seine geographische Verbreitung, seine wirtschaftliche und kulturhistorische Bedeutung.* By Prof. Dr. Theobald Fischer. Petermanns *Mitteilungen Ergänzungsheft*, Nr. 147. Pp. 87 and map. (Gotha: Justus Perthes, 1904.)

After thirty years' study of several countries bordering upon the Mediterranean, the author gives in this monograph a summary of the literature of the olive. The oil was used as a food, as an illuminant, and for domestic and ceremonial purposes very early in history. According to Aristotle the Phœnicians exported olive oil from Syria to Egypt. In Roman times there was a large trade in olive oil, the principal producing countries being Greece, Barka, Tripoli, Tunis and Spain. Italy exported the oil to the country which is now France. Among the ruins of an oil-merchant's store in Pompeii are to be seen some vessels which once contained oil: almost every house had its store of olive oil. In countries of Southern Europe which had no butter, olive oil filled the place in domestic economy occupied by butter in northern lands. In fact, olive oil was and is still employed for many of those purposes for which we use animal fats. It was one of the most indispensable of products. During the Middle Ages the oil was exported from the Mediterranean to Flanders and even to China, Italy having for a time almost a monopoly of the trade.

Generally speaking, the tree is not found to grow at its best, so far as quality of oil is concerned, either on plains in the immediate vicinity of the sea or at high altitudes far inland. It prefers barren rocky positions on the lower slopes of hills, and being exceptionally indifferent as regards chemical composition of the soil, affords an interesting study from the point of view of climate and physical condition of the soil. Botanically, as well as in its geographical distribution, the olive tree is characteristic of the flora peculiar to the Mediterranean.

Sections of the monograph are devoted to the methods of cultivation, chief varieties, diseases, and extraction of the oil. Individual countries are dealt with separately, all available information being brought together with regard to the distribution of the olive in each. The Iberian peninsula is now the greatest olive-growing region, and Italy next, the number of trees in both being very large. Next in importance are Southern France, the Balkan peninsula, Asia Minor, Syria, Mesopotamia, Persia, Egypt, Barka, Tripoli, Tunis, Algeria, Morocco. In many of these, but not in Asia Minor, the tree appears to have almost reached its possible range of distribution. That is not the case as regards countries beyond the Mediterranean area, such as California, Mexico, Chili, Peru, Argentina, where introduction is of later date. Still less would maps showing the area occupied by the olive tree in Cape Colony and Australasia satisfactorily represent its possible cultural distribution in those parts of the world.

L'OLIVIER. By M. Couput, Directeur du service pastoral de l'Algérie, Bibliothèque des cultures coloniales. Pp. 74. (Paris: Bureaux de la Revue des Cultures Coloniales.)

M. Couput's memoir opens with a general account of the introduction of the olive tree into Northern Africa, and indicates the present localities and area of the olive groves of Algeria, with which the writer is particularly concerned. The greater part of the paper is devoted to the question of the conversion of wild into cultivated groves by means of grafting. Several points subsidiary to this are dealt with, such as the selection of suitable land, methods of grafting and propagation, characteristics of the different varieties of olive met with in Algeria, cost of production, and value of the crop. Attention is given to the use of fertilisers and the diseases to which the tree is subject, while the processes of extraction of oil of different grades are fully described. It is suggested that the establishment of co-operative oil-mills should be encouraged, as under existing circumstances the native inhabitants of Algeria are seldom able to extract the oil while the olives are fresh, this being no doubt largely due to lack of adequate appliances.

ALL ABOUT VANILLA. Pp. ix + 43, with one plate. (Colombo, Ceylon: A. M. and J. Ferguson, 1905.)

This book is essentially a compilation of notes published in planting and other journals of similar scope during recent years, dealing with the cultivation and preparation of vanilla. To these have been added some original contributions from planters having actual experience of vanilla cultivation in Mauritius and elsewhere.

THE CULTIVATION OF *Ficus elastica;* the India Rubber of the East. By Claud Bald. Pp. 32, with photographs. (London: W. Thacker & Co.; Calcutta: Thacker, Spink & Co.)

Although *Ficus elastica* occupies a secondary position amongst the rubber trees which are now being grown systematically in many parts of the world, it has been found that this tree is very suitable for cultivation in certain situations, and increased attention has been devoted to it recently in several countries. Large plantations of *Ficus elastica* have been established in Assam, the natural habitat of the tree, and latterly it has been planted on a smaller scale in the Malay Peninsula, and some of the neighbouring islands. It has been proved in these countries, that the tree will yield rubber of excellent quality, and it seems probable that its cultivation will be extended there in situations which are unsuitable for the growth of the Para rubber tree.

The pamphlet under notice will be of interest and value to planters contemplating the cultivation of *Ficus elastica*, as it supplies concise and practical instructions regarding the various operations involved in establishing plantations of the trees. Information and advice are given as to the selection of a suitable site for the plantation, the best methods of raising the trees from seed or from branches (in the latter case by a modified form of layering), the subsequent planting out of the trees, the tapping, and the preparation of the rubber.

The pamphlet supplies in convenient form, information from official reports not easily accessible to the planter, and also gives the results of the author's own experiments in planting *Ficus elastica*, which should be useful to planters intending to cultivate this tree.

COTTON CULTIVATION. By W. Arthur de Silva, J.P. Second Edition—Revised. Pp. 14. (Colombo: A. M. and J. Ferguson, 1905.)

The cotton plant has existed in Ceylon from very early times, a reference to it having been made as long ago as 543 B.C. About fifty years ago a large area was devoted to cotton growing and the product was employed locally for textile purposes. The cultivation gradually declined, however, as it was not considered by the villagers to be sufficiently remunerative. During the last two or three years attention has been again directed to cotton growing in Ceylon. A small consignment consisting of Egyptian and Sea Island cottons has recently arrived in this country, and the former variety has realised $9\frac{1}{2}d.$ per lb. and the latter $1s.$ per lb.

The pamphlet under consideration gives a short account of cotton growing and is intended especially for the information of planters. After a brief historical review of the cotton industry in Ceylon, attention is given to the following subjects—the varieties of the cotton plant, soils suitable for cotton cultivation, preparation of the land, the selection of seed, the cultivation of annual and perennial cottons, the application of manure, methods of combating the attack of insect pests, picking and ginning, and the cost of production.

The work will doubtless be of service to those undertaking cotton cultivation for the first time.

DE KATOENCULTUUR. By R. A. Monchy, Jr., Secretary of the Association for the Promotion of Cotton Cultivation in the Dutch Colonies. Pp. 127. (Henglo (Ov.): April, 1905.)

This work contains a general account of the cotton plant and its cultivation. Attention is given to the subjects of the varieties of cotton, climate, soils, manures, the seed and sowing, insect and fungoid pests, picking, ginning, marketing, pressing and baling, and the cost of production. Special chapters are devoted to the Sea Island variety, and the utilisation of the bye-products of cotton, and an interesting account is given of the cultivation in the Dutch Colonies.

The book is written in the Dutch language, and is well illustrated.

OFFICIAL REPORT OF THE SECOND INTERNATIONAL CONGRESS OF DELEGATES AND REPRESENTATIVES OF MASTER COTTON SPINNERS AND MANUFACTURERS' ASSOCIATIONS. Pp. 140. (Manchester, 1905.)

The recent crisis in the cotton trades which was brought about by the deficiency of the raw material and the consequent excessive speculation led the English Master Cotton Spinners' Federation to consider the advisability of attempting to form an International Federation to safeguard the common interests of the industry. Definite action was first taken in December 1903, when a movement was initiated which resulted in the first International Congress being held at Zürich in 1904.

The second congress was held in Manchester and Liverpool in June 1905, and the organisation has now been placed on a sound and satisfactory basis. Regulations and bye-laws were adopted for the efficient working of the International Federation and a permanent secretary was appointed. Steps are being taken to complete the affiliation, with the International Federation, of the Associations in all cotton spinning and manufacturing countries whose interests with regard to the supply of the raw material and in connection with many other matters are identical. It is anticipated that this Federation will ultimately become a great factor in the regulation of the cotton industry of the world. One of the chief advantages which it is considered will be secured is the obtaining of a much greater control over the supply of raw cotton, an adequate provision of which, at a reasonable price, is vital to the success of the industry. It is hoped that such a combination of the users of cotton will be sufficiently powerful to combat speculative operations which result in the violent fluctuations in price which are so detrimental to the welfare of all branches of the cotton trade. As another means to this end the Federation is endeavouring to promote the cultivation of cotton in the Colonies and Dependencies of European nations.

The Report of the Proceedings of the Second Congress contains the constitution and rules of the Federation, and includes the address of the President (Mr. C. W. Macara), and papers on the moisture content of commercial cotton, on the use of the metric system of weights and measures, and on the cultivation of cotton in the Colonies of Great Britain and in those of other European countries.

A TROPICAL DEPENDENCY. An outline of the ancient history of the Western Soudan, with an account of the modern settlement of Northern Nigeria. By Flora L. Shaw (Lady Lugard). (London: James Nisbet & Co., Limited, 1905.)

The continually increasing output of literature relating to the condition and prospects of the Colonies and Dependencies of the Empire is a satisfactory evidence of the keen interest now taken in this country in everything relating to the Colonies, and of the widespread desire existing for recent information regarding them.

It is safe to say that a perusal of *A Tropical Dependency* will do much to stimulate interest of this kind, so far as Northern Nigeria is concerned.

The earlier chapters of the book are devoted to showing how at the period of Moorish ascendency in Spain, the inhabitants of the Western Soudan were in contact with the highest civilisation then existing, and that the commercial prosperity of the country was at that time proverbial. Though the natural routes to the sea, south and west, were barred by the primitive savages who inhabited the coastal regions, the ways to the north were open, and free exchange of commodities took place between the prosperous towns of the Soudan and the cities in Morocco, Tripoli and Spain.

This condition of things was entirely changed with the expulsion of the Moors from Spain, which resulted in what was then the only practicable outlet for Soudanese trade being closed, and in bringing about the conquest of the Soudan by the Moors. During the latter period the Soudan was practically unknown to Europe, and kingdoms and empires rose and fell in it in rapid succession.

The history of these two periods is told in such a way as to make clear the conditions of the peoples of the Soudan under the various conquerors, and the story is brought down to date by the relation of the histories of the several Sultanates in existence at the time when the country was brought under British influence, and which have since then been brought into subjection.

Later chapters deal with the early attempts to penetrate into the interior from the coast and the gradual growth of British trade and influence along the Niger, terminating with the replacement of the Royal Niger Company by the Imperial Government as the administrative body.

The Imperial Government has as yet only administered the country for five years, but already great progress has been made in the settlement of the country, the organisation of the administration, the construction of roads, the institution of a just and equitable system of taxation, and the gradual abolition of slavery.

The last two chapters deal with the economic resources of the country and the development of trade. The economic resources of the country are as yet unknown, though a considerable export trade is already done in rubber, gum, oil seeds and similar products. Some account has already been given in this *Bulletin* (1905, iii., p. 49) of the possibilities of cotton cultivation in the country, and the authoress rightly insists on the great importance of the development of cotton cultivation.

Of scarcely less importance are the development of the rubber resources and the encouragement of the cultivation of such products as tobacco, which is already grown by the natives and produced in a form suitable for sale in Europe. It is pointed out that much has been done already to stimulate trade, especially by the construction of good roads, the adequate protection of caravans and the reduction of tolls, but that no great development in trade can be expected until the natural resources of the country can be made available by the provision of railway communication and of steamboat services on the navigable waterways.

ORANGE RIVER COLONY LAND SETTLEMENT. Pp. 1–8. (Published by the Imperial South African Association, 66, Victoria Street, S.W.)

This pamphlet contains particulars of a scheme of land settlement arranged for between the Imperial South African Association and the Government of the Orange River Colony. Briefly, the scheme provides for a year's instruction in the best methods of colonial farming, and for the placing of the settler upon the land at a minimum of expense and risk to himself. Each settler is required to possess a capital of at least £500, and to sign an agreement with the Association.

BLOEMFONTEIN. By E. L. Calverley. Pp. 1–71. (The Argus Printing and Publishing Coy., Bloemfontein, 1905.)

This book, which was prepared in connection with the visit of the British Association to South Africa in 1905, is essentially a guide to the city of Bloemfontein, and is illustrated with several photographs and plans. A brief history of the Orange River Colony and a short account of the actual and possible resources of the country is added.

FARMING IN THE ORANGE RIVER COLONY. By Edmund Bourdillon. Pp. 1–22, with map. (Argus Printing and Publishing Coy., Bloemfontein, 1901.)

The body of these notes appeared originally in *The Times*, and, with a few alterations and additions, the subject matter has been reprinted from the columns of that paper. In dealing with the agriculture of the Colony, the author divides the country into four divisions, which may be roughly described as southern, western, eastern, and central-northern. The eastern division, including the Wepener, Rouxville, Ladybrand, and Ficksburg districts, is dealt with in some detail, since of the four divisions it is the one in which conditions most closely resemble those of the mother country, and where the knowledge and practice of the English farmer would be most useful; it is the only division in which, owing to the more regular rainfall, wheat and oats can be grown without irrigation. A series of general suggestions deals with the practical question of the amount of capital necessary to commence farming in the Colony, and the questions of price of stock, cost of labour and facilities for education are gone into. An appendix has been added, pointing out the advantages which should result to the settler from the recently-established Agricultural Department.

THE PROBLEM OF PRODUCTION IN NATAL. By Maurice S. Evans. Pp. 1–51. (P. Davis & Sons, Durban, 1905.)

This book, written at the suggestion of Sir Gilbert N. Parker, deals with the products of Natal and the possibilities of their future development. At the outset, emphasis is laid upon the fact that the country presents great variety in contour, differences which account for the well-known varied character of the agriculture carried on in the Colony. The principal industries are then dealt with, and in a discussion of the methods ot farming by the native Indian immigrant and the European, the problem of production is brought before the reader. Briefly put, it is that, with favourable meteorological conditions, an intelligent body of white colonists, large protected markets immediately at hand and fair transport facilities, the agriculture of the Colony has not advanced at the rate which might have been expected, and that while products which could be produced locally are imported to the annual value of over two millions sterling, farmers still do not find it possible to compete with the imported article. In the opinion of the author the principal reasons for this state of affairs are the firm hold which importers have upon the market, the unnecessarily large size of the average farm, and the lack of co-operation among the farmers, who, generally speaking, are well-to-do. Probably the first reason is the most important, since it is much more satisfactory to the middleman to deal with regular supplies of goods of established reputation than with the small and irregular consignments of the local producer, even though the quality of the goods should be excellent.

THE GAMBIA COLONY AND PROTECTORATE. AN OFFICIAL HANDBOOK. By Francis Bisset Archer. Pp. 1–364. (St. Bride's Press, Ltd.)

The author, who is Treasurer of the Colony, has prepared this volume to provide a useful medium of reference for those directly concerned with the region and for the larger public interested in the development of the British Empire. The comprehensive nature of the work will best be appreciated by indicating briefly the principal contents. The book is divided into nine parts. Part I. deals with the history and development of the Gambia. The story of the extension of the British sphere of influence since 1783, when the territory administered was only 300 yards by 400 yards, to the present, when some 5,000 square miles are under control, is described in detail, together with much information concerning the early explorers. The chief events in the history of the Colony are arranged in chronological order, and the interspersed notes on the principal products render these chapters a valuable source of information concerning the economic development of the country.

In Part II. particulars are given of the people, natural features, products, and conditions of the five districts, each under the care of a Travelling Commissioner, into which the country is divided.

Part III. treats of the Colony during the past decade, and special attention is devoted to trade, agriculture and industries, the progress made in education and treatment of diseases, climate, and public health.

The next portion contains statistics of the districts of the Protectorate, including their boundaries, chief towns, population, chiefs, and native tribunals. In Part V. are reprinted the chief enactments in force.

The notes on direct marches through the Protectorate, with the distances between towns and villages, and the accompanying information given in Part VI. should be of great use to travellers. The annual stipends of the native chiefs are also included in this section.

An English-Mandingo dictionary of some 800 words in common use comprises Part VII.

Part VIII. includes the service regulations, statistical data, the customs tariff, and a local directory, whilst in the concluding portion there is a summarised record of the services of the chief officers of the Colony.

COLONIAL PUBLICATIONS.

COPIES of the following publications descriptive of the resources of British Colonies have recently been received and are available for distribution, free of charge so long as numbers permit, from the Central Stand in the Exhibition Galleries.

Canada.

AGRICULTURE IN BRITISH COLUMBIA. Official Bulletin No. 10. Published by authority of the Legislative Assembly. 4th Ed. Pp. 1–155. 1904. The bulletin is designed to supply information which should anticipate all reasonable inquiries of prospective settlers with regard to farming in the Province. The physical features and climate are described in considerable detail. Full notes, mainly by practical men, are given of the principal actual or potential agricultural industries. There are several illustrations of farms, ranches, cattle and stock, fruit, etc. The volume has a full index.

VICTORIA, BRITISH COLUMBIA, BOARD OF TRADE ANNUAL REPORT. Pp. 1–89. Oct. 1905. This, the twenty-sixth annual report, summarises the work of the year. A series of appendices contains a considerable amount of statistical and other information relating to the Province, *e.g.*

land regulations, mineral production, fisheries, etc. There are many illustrations, mainly of industrial scenes.

BRITISH COLUMBIA. Issued by the Canadian Pacific Railway. Pp. 1–64. A general illustrated account of the Province and its resources, specially written for the prospective settler. Farming, fruit-growing, ranching, mining, lumbering, and the fisheries are all discussed. Hints on capital required, and other useful notes, are added, and there is a map of the country.

NELSON, BRITISH COLUMBIA. Issued by the authority of the Nelson Board of Trade. Brief notes on the situation, industries, social life and climate of Nelson, the capital and commercial centre of the Kootenay country.

BRITISH COLUMBIA. THE MINERAL PROVINCE OF CANADA. Issued by the Authority of the Legislative Assembly. Pp. 1–39. 1905. Gold, coal and coke, copper, silver and lead, are the principal minerals worked in British Columbia. In 1904 the mineral production of the Province was approximately equal to that of all the other provinces combined, excepting the gold from the Yukon territory. This pamphlet summarises in a useful way information relating to the chief minerals, and also to those which are not at present extensively worked, including, for instance, an unfavourable report on the recently found oil shale in Cariboo. Full statistical data derived from official sources, and good illustrations of quarries, works, etc., enhance the value of the publication.

INNISFAIL, ALBERTA, CANADA. Issued by the Innisfail Board of Trade, 1905. Innisfail, about 75 miles north of Calgary on the Canadian Pacific Railway, is the dairying centre of the Great North-West. The principal agricultural and pastoral industries of the region are described with the help of some illustrations.

West Indies.

WEST INDIAN FRUIT AND PRODUCE. Pp. 1–32. Royal Mail Steam Packet Company, London. A popular account of the principal fruits and vegetables of the West Indies, with especial reference to the efforts being made to develop a trade in them between the Colonies and the Mother Country. The pamphlet is copiously illustrated, bananas and banana cultivation being dealt with in some detail. The views illustrating the planting and the shipping of bananas, and of the "right" and "wrong" kind of suckers to plant are of considerable practical value.

AN IDEAL VOYAGE TO THE WEST INDIES. Issued by the Imperial Direct West India Line. Pp. 1–52. A popular guide book to Jamaica, with numerous illustrations, some in colour.

BRITISH GUIANA. GENERAL INFORMATION WITH REGARD TO THE GOLD, DIAMOND AND FOREST INDUSTRIES. Issued by the Government of British Guiana, 1903. Second edition. Pp. 1–30 and i–xxxiii.

This publication, which is edited by the Secretary of the Institute of Mines and Forests of British Guiana, was originally drawn up at the suggestion of the Secretary of State for the Colonies to give shortly the necessary information regarding the gold and diamond industries, the land and mining regulations, and to supplement the information contained in the *Handbook to the West Indies*, issued by the Emigrants' Information Office. A digest of the mining laws, notes on the geology, hints as to equipment, and other matters of vital importance make it a most useful publication.

LIBRARY.—RECENT ADDITIONS.

Books and Publications, exclusive of Government Publications, presented by Publishers and others to the Library of the Imperial Institute since March 1st, 1906.

The Problem of Production in Natal .	By Maurice S. Evans. (*Author.*)
Proceedings of the Royal Institution of Great Britain, Vol. xvii., Part 3, No. 98	(*The Secretary.*)
Catalogue of Japanese Printed Books and Manuscripts in the British Museum, acquired during the years 1899–1903 .	By Sir Robert Kennaway. (*The Trustees.*)
Report on Colonial Exhibition, 1905.—The West Indian Court . . .	(*The West India Committee.*)
Walch's Tasmanian Almanac for 1906 .	(*Messrs. J. Walch & Sons.*)
Report of the Rangoon Chamber of Commerce, 1905	(*The Secretary.*)
Royal Society of Edinburgh:—Proceedings, Vols. xxiv., xxv., Parts 1 and 2; Transactions, Vols. xl., Parts 3 and 4; xli., Parts 1 and 2; xliii. . . .	(*The Secretary.*)
The Fauna of British India, including Ceylon and Burma. Rhynchota.—Vol. iii. (Heteroptera—Homoptera) . .	By W. L. Distant. (*Under-Secretary of State for India.*)
Sands' Sydney, Suburban and Country Commercial Directory for 1906 . .	(*Mr. John Sands.*)

British South Africa Company: Directors' Report and Accounts, 1904–5 . .	(*The Secretary.*)
Proceedings of the Madras Chamber of Commerce, 1905	(*The Secretary.*)
Jahresbericht der Deutschen Gerberschule zu Freiberg in Sachsen, Nos. 16 and 17, 1904–5	(*The Director.*)
Report of the Ceylon Chamber of Commerce for the half-year ending 31st December, 1905	(*The Secretary.*)
The Source of the Blue Nile, with a note on the religion, customs, etc., of Abyssinia, and an Entomological Appendix by E. B. Poulton, LL.D., F.R.S. .	By Arthur J. Hayes, L.S.A. (*Messrs. Smith, Elder & Co.*)
Report of the Singapore Chamber of Commerce for the year 1905 . .	(*The Secretary.*)
Calendar of the Auckland University College, 1906	(*Registrar.*)
Handbook of Jamaica, 1906 . . .	(*Crown Agents for the Colonies.*)
Directory and Chronicle for China, Japan, Straits Settlements, Philippines, etc., 1906	(*The Editor, "Hong Kong Press."*)
Transvaal Chamber of Mines: Memorandum on the Effect of arresting the importation of Chinese Labour	
The Transvaal and Orange River Colonies: Speech by Lord Milner in the House of Lords, 26th February, 1906	
A Transvaal View of the Labour Question	By R. W. Schumacher. (*Imperial South African Association.*)
Directory of Paper Makers, 1906 . .	(*Messrs. Marchant, Singer & Co.*)
Handbook of Turks and Caicos Islands .	By J. H. Pusey. (*The Commissioner of Turks and Caicos Isles.*)
A Complete Pronouncing Gazetteer or Geographical Dictionary of the World	Edited by Angelo and Louis Heilprin. (*Messrs. J. B. Lippincott & Co.*)

Farming in the Orange River Colony .	By Edmund Bourdillon.
A Guide to Bloemfontein, with a short history and description of the Orange River Colony	By E. L. Calverley. (*The Government Librarian.*)
Journal of the Mining Society of Nova Scotia, Vol. ix.	(*The Secretary.*)
Bibliotheca Chemica: A Catalogue of the Alchemical, Chemical and Pharmaceutical Books in the Collection of the late James Young of Kelly and Durris, Esq., LL.D., F.R.S., F.R.S.E., 2 Vols. .	By John Ferguson. (*Trustees and Family of the late James Young of Kelly.*)
The Cultivation of *Ficus elastica*: The Indiarubber of the East . . .	By Claud Bald. (*Messrs. Thacker, Spink & Co.*)
The National Physical Laboratory: Report for 1905	(*The Director.*)
Port Natal: Illustrated Handbook of general information relating to Durban—Port Natal—and Railway connections .	Compiled by C. W. Francis Harrison. (*The Agent-General for Natal.*)
Associação Commercial do Porto: Relatorio da Direcção no anno de 1905 .	(*The Secretary.*)
The Asylum Press Almanac, Dictionary and Compendium of Intelligence for 1905	(*India Office.*)
The India List and India Office List for 1906	(*India Office.*)
Royal Commission, St. Louis International Exhibition, 1904. The British Section	Compiled by Sir Isidore Spielmann, F.S.A. (*The Secretary.*)
Jahresbericht des Export-vereines für Böhmen, Mähren und Schlesien in Prag für das Jahr 1905 . . .	(*The Secretary.*)
Reports of the Bombay Chamber of Commerce for the years 1902, 1903 and 1904	(*The Secretary.*)

Through Newfoundland with the Camera .	By R. E. Holloway, B.S., B.Sc. (*Government of Newfoundland.*)
South African Traveller's Blue Book .	(*Mr. George Gilchrist.*)
Journal of the Canadian Mining Institute, Vol. iii., 1905	(*The Secretary.*)
The Royal Bank of Canada: Report for 1905	(*The Secretary.*)

BULLETIN

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SCIENTIFIC AND TECHNICAL DEPARTMENT.

RECENT INVESTIGATIONS.

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

SANSEVIERIA FIBRES FROM BRITISH EAST AFRICA.

THESE samples of *Sansevieria* fibres were forwarded to the Imperial Institute for examination by the Director of Agriculture, Nairobi, British East Africa.

SAMPLE NO. 1.—This consisted of about ½ lb. of slightly lustrous, brownish-coloured fibre, which had been badly cleaned. It was harsh to the touch, fairly strong, and varied in length from 2 feet 3 inches to 3 feet 3 inches.

The corresponding botanical specimen was identified at the Royal Gardens, Kew, as *Sansevieria Ehrenbergii*, Schweinf.

On chemical examination, the fibre gave the following results.

	Per cent.
Moisture	9·5
Ash	1·7
a-Hydrolysis (loss)	13·4
β-Hydrolysis (loss)	17·3
Acid purification (loss)	5·7
Cellulose	64·4

Length of ultimate fibre 1·3–2·8 mm. (0·05–0·11 inch).

On comparing these results with those yielded by other specimens of *Sansevieria* fibres examined (see table on page 193), it is evident that the present sample of fibre contains a low proportion of cellulose, and is very susceptible to attack by boiling dilute alkali (*a*- and *β*-hydrolysis). There can be no doubt that this inferiority is due to the defective preparation of the sample.

The commercial experts to whom the sample was submitted reported that the fibre was harsh, dry, of yellowish colour, fair strength, had been roughly cleaned, and was worth about £28 per ton in the London market.

SAMPLE NO. 2.—This consisted of about ½ lb. of *Sansevieria guineensis* fibre, which was of a cream colour with brownish stains, had been very imperfectly cleaned, was harsh, slightly lustrous, of poor strength, and from 3 feet to 3 feet 9 inches long. It was of much coarser character than the sample of *S. guineensis* from Sierra Leone referred to in the table on page 193.

The results of the chemical examination are given below, and show, as in the case of sample No. 1, that the fibre is of comparatively poor quality, due chiefly, if not entirely, to its having been incompletely cleaned.

	Per cent
Moisture	8·9
Ash	1·2
a-Hydrolysis (loss)	11·5
β-Hydrolysis (loss)	15·3
Acid purification (loss)	3·8
Cellulose	62·0

The commercial experts reported that this fibre was softer than the preceding sample, was of fair length, mixed yellowish colour, partly tender, only half cleaned, and contained some hard ends, and was of nominal value £27 to £28 per ton.

SAMPLE NO. 3.—This, described as the fibre of *S. Ehrenbergii*, consisted of about 1½ lb. of pale brown fibre, which had been very badly cleaned, the ends of the leaves having been left untouched. The material was harsh, fairly lustrous, somewhat weak and brittle, and varied in length from 4 feet 3 inches to 5 feet 9 inches.

On chemical examination, this fibre gave the following results. The remarks made with reference to the results obtained with samples Nos. 1 and 2 are equally applicable to this sample.

	Per cent.
Moisture	9·4
Ash	1·0
α-Hydrolysis (loss)	16·0
β-Hydrolysis (loss)	21·8
Acid purification (loss)	1·6
Cellulose	59·2

The commercial experts reported that the fibre was "rough and pithy," of good length, only half cleaned, and worth about £26–£27 per ton.

SAMPLE NO. 4.—This consisted of about 1 oz. of fibre, which was of a cream colour and had been fairly well cleaned, but contained a small amount of adherent green tissue. The material was fairly lustrous, less harsh than the three previous samples, of fair strength, and about 2 feet long.

The corresponding botanical specimen could not be identified in the absence of flowers.

The results of the chemical examination are given below :—

	Per cent.
Moisture	9·8
Ash	1·0
α-Hydrolysis (loss)	10·8
β-Hydrolysis (loss)	14·1
Cellulose	76·1

On comparing these figures with those obtained with other *Sansevieria* fibres (see table on page 193), it is seen that this fibre is of good quality and, in its chemical composition and behaviour, closely resembles the sample of *Sansevieria zeylanica* received from Assam.

The commercial experts reported that the fibre was short, soft, of mixed strength, and worth £24 to £25 per ton.

Steps are being taken to ascertain the botanical origin of this fibre.

SAMPLE NO. 5.—This consisted of about 2 oz. of pale brown fibre of a stiff, brush-like character. The material was of good strength, but somewhat brittle, and was about 1 foot 6 inches long.

The corresponding botanical specimen was identified at the Royal Gardens, Kew, as *S. guineensis*, Willd.

On chemical examination the fibre gave the following results:—

	Per cent.
Moisture	9·1
Ash	0·7
α-Hydrolysis (loss)	8·3
β-Hydrolysis (loss)	12·6
Acid purification (loss)	1·2
Cellulose	61·6

On comparing these figures with those yielded by a sample of *S. guineensis* fibre from Sierra Leone (see table on page 193), it is evident that there is a great difference in the proportion of cellulose contained in these materials. A corresponding difference appears in the general character of the fibres, that from Sierra Leone being much finer and softer and possessing none of the stiff, brush-like nature, which marks the present sample. This variation may be due to a difference in the age of the plants, or of the leaves from which the fibres were extracted, or to some local circumstances affecting the growth of the plant and the character of the fibre produced. This sample of *S. guineensis* fibre appears to have been better cleaned than sample No. 2, but is much coarser.

The commercial experts reported that the sample consisted of short, stiff fibre, fairly well cleaned, of good strength and worth from £20 to £22 per ton.

In the following table, the results obtained in the chemical investigation of these fibres are collected and compared with the corresponding figures furnished by some other specimens of *Sansevieria* fibres previously examined in the Scientific and Technical Department.

	Sansevieria Fibre No. 1.	*Sansevieria* Fibre No. 2.	*Sansevieria* Fibre No. 3.	*Sansevieria* Fibre No. 4.	*Sansevieria* Fibre No. 5.	*Sansevieria guineensis* from Sierra Leone.	*Sansevieria zeylanica* from Angoorie, Assam.	*Sansevieria trifasciata* from Nazira, Assam.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Moisture . .	9·5	8·9	9·4	9·8	9·1	10·6	9·4	9·0
Ash	1·7	1·2	1·0	1·0	0·7	0·4	0·7	0·6
α-Hydrolysis (loss) . .	13·4	11·5	16·0	10·8	8·3	8·9	11·8	10·0
β-Hydrolysis (loss) . .	17·3	15·3	21·8	14·1	12·6	13·9	14·9	12·6
Acid Purification (loss).	5·7	3·8	1·6	—	1·2	1·8	1·4	2·3
Cellulose . .	64·4	62·0	59·2	76·1	61·6	78·0	75·6	74·4

The results of the investigation of these *Sansevieria* fibres lead to the conclusion that these products are of good commercial value and would probably repay cultivation. In preparing these materials for export, more care should be exercised in their extraction and cleaning. The commercial experts stated that none of the present samples were in good marketable condition and consequently the values given must be regarded as nominal, but added that if the products were properly cleaned they would probably realise several pounds per ton above the prices quoted.

Many other samples of *Sansevieria* fibres have been received from British East Africa, of which the most important are three collected in the neighbourhood of Voi and forwarded to the Imperial Institute with corresponding botanical specimens by Mr. A. Grenfell, formerly of the Forestry Department of the Transvaal.

The condition of these fibres showed that they had been incompletely cleaned in the process of extracting them from the leaves. The chemical examination was therefore carried out on specimens which had been further cleaned as far as possible in the Scientific and Technical Department by hackling. Unfortunately, however, the results of the chemical examination of fibres which have been imperfectly prepared are not of great value as evidence of the qualities of the true fibre substance since these are more or less obscured by the impurities present.

SAMPLE NO. 6 (*Sansevieria Volkensii*, Gurke?).—This fibre was derived from a plant which was regarded at Kew as probably *Sansevieria Volkensii*, Gurke. It was of uneven colour varying from yellow to buff with occasional greenish portions. The fibre was not very well prepared and contained a small quantity of the pulpy matter of the leaves adhering to it. The diameter was irregular, varying from 0·0025 inch to 0·01 inch. The greater part of the fibre had a length of 2 to 3 feet, but some shorter fibre, about 14 to 18 inches long, was also present.

On chemical examination, the following results were obtained, which are discussed later.

	Per cent.
Moisture	8·4
Ash	1·6
α-Hydrolysis (loss)	9·8
β-Hydrolysis (loss)	15·2
Acid purification (loss)	2·7
Cellulose	68·0
Length of ultimate fibre	0·75–3·1 mm. (0·03–0·12 inch).
Diameter of ultimate fibre	0·02–0·03 mm. (0·0008–0·0012 inch).

The commercial experts reported that the fibre was worth about £28 per ton and would probably be readily saleable.

SAMPLE NO. 7 (*Sansevieria guineensis*?).—This fibre was derived from the flat *Sansevieria* leaves, which are usually regarded as those of *Sansevieria guineensis*. It was stated at Kew, however, that it is impossible to say whether this identification is correct until better specimens including flowers have been examined.

The fibre was badly cleaned and prepared, and contained some of the leaf pulp. A good deal of fine tangled fibre was present. The better cleaned portions were nearly white and of good strength. The diameter was more regular than that of samples 6 and 8 and varied from 0·0035 to 0·012 inch. The greater part of the fibre was from 2 feet 6 inches to 3 feet 5 inches long, but some of it was only about 1 foot 6 inches in length.

When submitted to chemical examination the fibre yielded the following results:—

	Per cent.
Moisture	8·1
Ash	1·4
α-Hydrolysis (loss)	14·0
β-Hydrolysis (loss)	16·6
Acid purification (loss)	4·2
Cellulose	72·4
Length of ultimate fibre	1·5–5·1 mm. (0·06–0·20 inch).
Diameter of ultimate fibre	0·02–0·035 mm. (0·0006–0·0014 inch).

The commercial experts reported that the fibre was of poor quality and varying length, and was worth about £22 per ton c.i.f. London.

Sample No. 8 (*Sansevieria Ehrenbergii*?).—This fibre was derived from a species of *Sansevieria* which bears leaves 8 or 9 feet long, and has been provisionally regarded by Mr. Grenfell as *Sansevieria Ehrenbergii.* It is considered at Kew, however, that the plant is probably a new species of *Sansevieria.*

This fibre possesses a peculiarity which has been observed at the Imperial Institute in several other specimens of *Sansevieria Ehrenbergii* (?) from British East Africa, and which seems to be a definite characteristic of the fibre of this particular species. This peculiarity is a very marked variation in the diameter of the strands or filaments of fibre. The fibre from the interior of the leaf is fine, whilst that from the more external portions is very coarse. The diameter of the finer fibre varies roughly from 0·001 inch to 0·0055 inch whilst that of the coarser attains to as much as 0·018 inch.

As the question has been raised as to the possibility of separating the coarser fibre into finer strands by means of a degumming process, it may be said at once that this is practically impossible from the nature of the material. It is of course the case that both the coarse and fine strands alike are composed of a mass of ultimate fibres into which they can be resolved by chemical processes. These ultimate fibres are however extremely short (about 0·05 inch to 0·2 inch), and are united to one another by a lignified thickening of their walls. The effect of chemical treatment is to cause the solution of the middle lamellae between the thickened ultimate fibres, and so to cause eventually the disintegration of the whole strand into these extremely short portions. It is therefore highly improbable, if not altogether impossible, that any process, either chemical or mechanical, could be devised which would be capable of resolving the coarser strands into finer strands without at the same time sacrificing the length of the material.

The sample of fibre varied in colour from pale brown to white, and in some parts had a greenish tinge. It was badly prepared, the finer fibre being much tangled, and the whole still retaining a considerable quantity of the pulp or softer tissue of the leaf. The coarser fibre was harsh, whilst the finer fibre was soft and weak. The length of the fibre was about 3 to 4 feet, but some small specimens obtained from single leaves were from 6 feet to 6 feet 6 inches long.

In the process of hackling the product in order to clean it and render it fit for chemical examination, the finer fibre owing to its tangled state was entirely removed, so that the chemical results in the following table represent the behaviour and composition of the coarse fibre only.

	Per cent.
Moisture	8·8
Ash	1·7
α-Hydrolysis (loss)	8·8
β-Hydrolysis (loss)	15·6
Acid Purification (loss)	2·2
Cellulose	65·7

Length of ultimate fibre (from the finer material)	1·5–5·1 mm. (0·06–0·2 inch).
Length of ultimate fibre (from the coarser material)	1·3–3·7 mm. (0·05–0·15 inch).
Diameter of ultimate fibre in each case	0·025–0·04 mm. (0·001–0·0016 inch).

Representative specimens of the darker and the lighter coloured fibre were submitted to the commercial experts. The product was reported to be a well-grown fibre of good length, but badly cleaned. The darker portion was valued at £22 per ton, and the lighter at £24 per ton, and it was stated that if the fibre were thoroughly cleaned, it would realise £4 or £5 per ton in advance of these prices.

For convenience of comparison, the results of the chemical examination of these three fibres are collected in the following table, together with those furnished by certain other similar samples of *Sansevieria* fibres previously examined in the Scientific and Technical Department.

	No. 6. *S. Volkensii* (?).	No. 7. *S. guineensis* (?).	No. 8. *S. Ehrenbergii* (?).	*S. Ehrenbergii* from Somaliland.	*S. guineensis* from Sierra Leone.	*S. Ehrenbergii* from British East Africa.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Moisture . . .	8·4	8·1	8·8	11·2	10·6	9·5
Ash	1·6	1·4	1·7	2·0	0·4	1·7
α-Hydrolysis (loss) . . .	9·8	14·0	8·8	10·7	8·9	13·4
β-Hydrolysis (loss) . . .	15·2	16·6	15·6	14·1	13·9	17·3
Acid purification (loss) . . .	2·7	4·2	2·2	3·5	1·8	5·7
Cellulose . . .	68·0	72·4	65·7	74·0	78·0	64·4

A consideration of these figures leads to the following conclusions.

Sample No. 1, which in general character resembles the fibre of *Sansevieria Ehrenbergii* from Somaliland, is evidently somewhat inferior to the latter, since it contains less cellulose, and is rather more susceptible to the action of dilute alkali as shown by the result of the hydrolysis. It may be mentioned that a small consignment of this Somaliland fibre which was forwarded to the Imperial Institute, was sold in the London market at £32 per ton in November 1905.

Sample No. 2 is similar to the fibre of *Sansevieria guineensis* from Sierra Leone, but is shown by the results of the chemical examination to be of decidedly inferior quality, which is no doubt largely, if not altogether, due to its defective preparation.

Sample No. 3 is of the same character as samples of *Sansevieria Ehrenbergii* (?) from British East Africa, which have been examined previously, but appears to be slightly superior to the latter.

There is at present great uncertainty with regard to the botanical identity of the various species of *Sansevieria*, owing to the lack of authentic material (including flowers) on which to base determinations. For the present, therefore, it will be the best plan to distinguish provisionally the three plants yielding the fibres described, as *Sansevieria Volkensii*, *S. guineensis*, and *S Ehrenbergii.*

There is no doubt that all these fibres are ot a character which renders them of great utility for rope manufacture and capable of securing a ready market.

The following points must be observed if the fibres are to realise good prices. (1) It is essential that the product should be cleaned as thoroughly as possible. After leaving the machine it is desirable that the material should immediately be washed in order to remove the juice of the leaf, which, if allowed to dry on the fibre, is liable to stain and weaken it. (2) After being dried, the product should be brushed by means of one of the machines specially designed for this purpose, so that the fragments of dry pulp adhering to the fibre may be removed. (3) It is advisable that the fibre should be roughly graded, according to length, before export, since the presence of short fibre in a consignment which is mostly of good length (4 feet or more) considerably lessens its value.

TOBACCO FROM BRITISH HONDURAS.

THIS sample of tobacco grown by natives was sent to the Imperial Institute for examination by the Governor of British Honduras.

The leaves measured from 15 to 19 inches in length, and from $5\frac{1}{2}$ to $7\frac{1}{2}$ inches in width. They were clean, fairly uniform in colour, free from spots and mildew, and, though fairly tough and elastic, were too thick to be suitable for wrapping cigars. The tobacco had a fair aroma and burned well when ignited.

Chemical Examination.

A representative sample of the tobacco was chemically examined, and gave the following results:—

	Per cent.	
Moisture	20·2	
Nicotine	3·4	*Calculated on material dried at* 105° *C.*
*Ash	19·3	
Sand	1·4	
Sugar	nil	
Acidity	2·1†	

* *The ash was greyish-white and contained only a trace of ferric oxide.*

† *Grams of sodium hydroxide required to neutralise* 100 *grams of tobacco.*

These results show that so far as chemical composition is concerned, the tobacco is of fair quality. It is, however, more acid and contains rather more nicotine than the light tobaccos in general use in this country. These two defects probably result from insufficient fermentation.

Commercial Valuation.

A portion of the sample of tobacco was submitted to a firm ot manufacturing tobacconists for technical trial and commercial valuation. They reported as follows:—

"We find that the tobacco appears to be ripe and well fermented, but too dark for cigar requirements if intended for use as wrappers. The leaves are also too thick, and the texture too heavy for it to be advantageously used for wrapping cigars. As regards the flavour, it is too pungent to be used alone for cigar filler, but, when mixed with other cigar fillers, in the proportion of about 30 per cent., it blends satisfactorily. As far as concerns burning qualities, we are glad to be able to give an entirely satisfactory report, as the leaf comes out well in all respects.

"In its present condition we should value the tobacco at about 4*d.* per lb. for cigar purposes, or it might be used for manufacturing tobacco, for which purpose we should expect to be able to buy it at rather less than 4*d.* per lb.

"If it is the intention of the growers to raise this tobacco for cigar requirements, it will be necessary to pay great attention to texture, as cigar manufacturers require a tobacco much thinner and more bulky than the samples submitted. This has a very important bearing on the value of the tobacco, as manufacturers require the largest possible number of leaves combined with sufficient strength and silkiness of texture.

"With reference to colour, efforts should be made to produce a tobacco much lighter than the samples submitted, 'colorado' and 'claro' being the colours most sought after by cigar buyers.

"Judging by the samples, we are of opinion that with experience in growing and handling the tobacco, there should be a ready market in this country and on the Continent for the Honduras leaf."

These results show that there is reason to suppose that tobacco suitable for the European market can be produced in British Honduras, since the present material prepared by natives and without any special attention being paid to European requirements is valued here at 4*d.* per lb., a price similar to that obtained for much of the American manufacturing tobaccos now exported to European countries.

INOY KERNELS FROM WEST AFRICA.

A SMALL sample of "Inoy" kernels from West Africa was received at the Imperial Institute from Messrs. Alexander Miller Brother and Co. of Liverpool, in June 1905, and, as the results of the preliminary examination appeared to be promising, a larger quantity was obtained from the same source for further investigation. The "kernels" have been identified at Kew as the seeds of *Poga oleosa.*

Description of Sample.

The kernels were ovoid in shape and were covered with a brownish-black, thin shell; they were soft and white internally, and very oily.

A few of the kernels were bad and had become brown internally. These were not used in the examination.

Results of Examination.

The oil was extracted from the kernels by means of light petroleum, and its examination gave the following results:—

The oil is pale yellow in colour, with a rather unpleasant, oleaginous taste and a peculiar odour. It does not become solid on keeping or deposit solid matter.

The kernels contained 60·8 per cent. of oil, which had the following constants:—

Specific gravity at 15° C. .	0·896
Saponification value . .	184·49 *milligrams of potash required for* 1 *gram of oil.*
Iodine value	89·75 *per cent.*
Hehner value	93·00 *per cent.*
Reichert-Meissl value .	1·45 *cubic centimetres of decinormal potash required to neutralise the volatile acid from* 5 *grams of oil.*
Acid value . . .	5·2 to 7·8 *cubic centimetres of decinormal potash required for* 1 *gram of oil.*
Titer test (solidifying point of the fatty acids) . .	22° C.

The following table shows the composition of the dry residual meal after extraction of the oil. No determinations of moisture in the meal were made as most of the water was taken out by the dry light petroleum used in extracting the oil from the ground kernels.

		Calculated on dry material. Per cent.
Proteids		41·51
Sugars	Reducing	1·32
	Non-reducing (sucrose) . . .	2·50
Other carbohydrates		36·92
Crude fibre		9·00
Ash		8·75

The ash contained 49·1 per cent. of phosphoric acid (expressed as P_2O_5) in the form of phosphates.

The oil resembles, on the whole, cotton-seed oil, but has a lower "titer" number, which is an important constant from the point of view of the soap-maker. It would for this reason be unsafe to state that the oil from these "Inoy" kernels could be used as a substitute for cotton-seed oil, even if it could be produced as cheaply. In fact, there seems hardly any commercial application for an oil of this kind, unless it could compete in quality and price with ground-nut, olive or sesamé oils for edible use.

In order to determine the suitability of the oil for edible purposes, it will be necessary to have a consignment of a few hundredweights of the kernels so that the oil could be expressed on a commercial scale, and specially examined from this point of view. If the oil thus obtained should prove to be of edible quality, the question of exporting the kernels from West Africa would be worth consideration.

The meal compares favourably in composition with linseed and cotton-seed cakes. The figures given above for the dry, oil-free material, show that the "Inoy" kernels may be expected to yield a nutritious cake suitable for feeding cattle. The thin shell on the kernels is not so hard as that on cotton seed, which is left in the cake, and it is unlikely that there would be any objection to a similar course in the case of the "Inoy" kernels. The thin shell surrounding the kernel should not be confused with the thick hard shell of the "Inoy" nut itself, which would have to be removed previous to export. Feeding trials would be necessary to determine the exact value of the cake as a cattle food.

At the present time *the kernels* are valued, as an unknown oil seed, at the nominal price of £9 to £10 per ton in this country.

RUBBERS FROM UGANDA.

THESE samples of rubber were collected by Mr. M. T. Dawe, the Officer in Charge of the Scientific and Forestry Department of Uganda, during his recent journeys through the forests of the Protectorate (see this *Bulletin*, 1905, **3**. pp. 41 and 236), and were forwarded by him, on his arrival in this country, to the Imperial Institute for examination and valuation. The rubbers were derived respectively from *Funtumia elastica*, *Clitandra orientalis* and *Landolphia Dawei*, and the samples from these different plants are treated separately in the following report.

Funtumia elastica.

The specimen of this rubber was obtained from the Budongo Forest and consisted of a thin "biscuit" of rubber weighing about three ounces. The rubber was rather dark coloured, but otherwise it possessed satisfactory physical characters ; it was free from vegetable impurity, had only a slight surface stickiness, and exhibited very good elasticity and tenacity.

The chemical examination furnished the following percentage results :—

Moisture	1·7
Caoutchouc	84·6
Resin	6·4
Albuminoid matter	6·5
Ash	0·8

The analysis shows that so far as chemical composition is concerned the rubber is of good quality, although the percentage of albuminoid matter is a little high and above that found in some samples of *Funtumia elastica* rubber which have been forwarded to the Imperial Institute from West Africa.

The sample was submitted to brokers who valued it at 5*s*. 6*d*. or 5*s*. 7*d*. per lb. in London.

Clitandra orientalis.

The specimen of rubber from this vine was also collected in the Budongo Forest and consisted of a thin cake weighing a little over two ounces. The rubber was dark brown, clean and free from stickiness ; it was very strong and elastic.

The rubber was found to have the following percentage composition :—

Moisture	2·8
Caoutchouc	77·9
Resin	8·8
Albuminoid matter	9·4
Ash	1·1

In this case the percentage of albuminoid matter is distinctly higher than is desirable and as the amount of resin is also a little high the proportion of true rubber present is correspondingly reduced.

The sample was valued by brokers at 5*s.* 9*d.* per lb. in London.

Landolphia Dawei.

Three small samples of the rubber of this vine were forwarded for examination: (1) From the Budongo Forest, (2) from the Buddu Forest, and (3) from the West Ankole Forest. These all consisted of thin sheets of rubber and the total weight was only one ounce. The rubber was clean and of a pale colour; it was slightly sticky on the surface but exhibited very good elasticity and tenacity.

The results of the chemical examination were as follows:—

	Per cent.
Moisture	4·9
Caoutchouc	76·2
Resin	14·1
Albuminoid matter	2·0
Ash	2·8

The percentage of albuminoid matter is much lower in this case than in the Funtumia and Clitandra rubbers, but, on the other hand, the resin is very much higher, amounting to 14·8 per cent. in the dry material, with the result that the percentage of true rubber is the lowest of the series. This high percentage of resin is probably not a constant feature of the rubber of *Landolphia Dawei*, as a previous specimen, examined at the Imperial Institute, contained only 8 per cent. of resin in the dry material. The amount of resin may possibly be found to depend on the age of the vine.

The rubber was valued at 5*s.* 9*d.* per lb. in London.

For comparison with the above quotations it may be stated that the current London price for fine hard Para rubber from South America was 5*s.* 5*d.* per lb., whilst Para "biscuits" from Ceylon and the Straits Settlements were quoted at 6*s.* 3*d.* per lb.

MINERALS FROM CYPRUS.

DURING his visit to Cyprus for the Colonial Office in 1904 Professor Dunstan obtained a number of mineral specimens in the districts he visited (see *Report on the Agricultural Resources of Cyprus*, Parliamentary Paper, Cd. 2717, 1905).

These specimens have since been examined and, where necessary, analysed in the Scientific and Technical Department of the Imperial Institute. The results obtained are of interest as affording some indication of the mineral resources of the island, which are at present comparatively little known, although in ancient times it was famed for its mineral wealth.

In the following notes on these specimens the numbers which are prefixed to the different minerals are those under which they are registered.

Cy D 1. *Copper Ore. Limne Copper Mine.*—This is a dark powder with a tinge of green, and consists mainly of quartz, copper pyrites ($CuFeS_2$) and bornite (Cu_3FeS_3).

Cy D 2. *Copper Ore. Limne Copper Mine.*—This is a powder similar to Cy D 1, but more finely ground and lighter in colour. The two specimens were analysed, and gave the following results :—

		Cy D 1. *Per cent.*	Cy D 2. *Per cent.*
Copper	Cu	6·19	4·29
Lead	Pb	0·06	0·05
Iron	Fe	9·74	12·78
Cobalt	Co	0·09	0·19
Alumina	Al_2O_3	1·02	4·10
Lime	CaO	0·47	0·55
Magnesia	MgO	0·28	2·11
Sulphur	S	27·21	17·36
Residue insoluble in acids		54·91	58·68

These are rather low-grade copper ores. The presence of a small quantity of cobalt is interesting, especially in connection with the considerable development in Cyprus of crystalline rocks rich in magnesia, with which cobalt is sometimes associated.

Cy D 3 and Cy D 4. *Basic sulphate of iron.*—These samples are practically identical, consisting of a bright yellow powder, which on heating changes to a fine dark red evolving acid fumes (probably sulphuric acid). It is insoluble in water but dissolves easily in acids.

These specimens were analysed with the following results:—

		Cy D 3. *Per cent.*	Cy D 4. *Per cent.*
Silica	SiO_2	0·55	1·00
Alumina	Al_2O_3	0·31	0·58
Ferric oxide	Fe_2O_3	49·29	49·35
Potash	K_2O	0·38	0·40
Soda	Na_2O	5·59	5·76
Sulphur trioxide	SO_3	32·35	31·76
Water (combined)	H_2O	11·29	11·63

They consist, therefore, of a basic double sulphate of iron and soda having the composition: 3 molecules of ferric oxide, 4 of sulphur trioxide, 1 of alkali (mainly soda), and between 6 and 7 of water. They may therefore be considered a variety of karphosiderite. It differs from other occurrences of this mineral in containing an appreciable amount of soda and somewhat less water. It could probably be used as a mordant with logwood and similar dyes.

The mineral, if obtainable in quantity, might be used as a local source of Nordhausen sulphuric acid, which, as already stated, is evolved on heating. The residue of ferric oxide left on heating can be utilised as rouge for polishing purposes. Much of the commercial rouge is, in fact, prepared by this method.

Similar material, containing more sulphur trioxide and alumina and no soda, has been described under the name of cyprusite by P. F. Reinsch (*Proc. Roy. Soc.*, 1881, **33**. p. 119), and J. Delny (*J. R. Micr. Soc.*, 1884, **4**. p. 186), from the neighbourhood of Kynoussa in the district of Khrysokhou in Cyprus. It is stated to occupy wide veins in igneous rocks.

Cy D 5. *Asbestos from the south-east slopes of Mount Troodos.*—This is a pale-green fibrous mineral occurring in narrow veins rather less than half-an-inch in diameter, the fibres being at right angles to the walls of the vein. From its optical characters it appeared to be chrysotile asbestos like that obtained at Thetford and Black Lake in the Quebec province of Canada. (Compare this *Bulletin*, 1905, **3**. 277.)

An analysis gave the following result. The composition of a specimen of the Thetford material is given for comparison :—

		Cyprus Chrysotile. *Per cent.*	Thetford Chrysotile. *Per cent.*
Silica	SiO_2	40·54	40·57
Alumina	Al_2O_3	1·09	0·90
Ferrous oxide	FeO	4·87	2·81
Magnesia	MgO	39·02	41·50
Combined water	H_2O	13·47	13·55
Moisture		1·13	—

The figures are very similar, though there is a little less magnesia and more ferrous oxide in the Cyprus mineral, but the difference in composition is too small to have any appreciable effect on the quality. A large portion of the "amiantos" or "Karystian stone" employed in ancient times for textile purposes appears to have come from Cyprus, and there is reason to believe that this was chrysotile and that much of it was obtained from the same locality as the present specimen (see Evans, *Mineralogical Magazine*, 1906, **14**. 143). The veins now exposed are too narrow to be of much value, and the broader veins, which were no doubt exposed when the mine was formerly worked, have probably been exhausted.

It is quite possible that by judicious mining similar veins may yet be discovered and worked at a profit, for there is a steady increasing demand for asbestos of the chrysotile type.

Cy D 6. *Rock from Mount Troodos, above Government House.*—This is a Harzburgite, a rock containing the minerals bronzite and olivine, more or less altered into serpentine.

Cy D 7. *Rock from Mount Troodos.*—This is a peridotite consisting mainly of olivine largely altered into serpentine.

These rocks from Mount Troodos were examined in thin sections and found to agree in character with those described by Dr. Alfred Bergeat in his paper, "Zur Geologie der Massigen-Gesteine der Insel Cypern." (*Min. Petr. Mitt. Tschermak*, 1892, **12**. 293).

The mineral composition of these rocks shows them to consist mainly of silicates rich in magnesia. They are not in themselves of any economic importance, but it must be remembered that in many parts of the world they are associated with chrysotile-asbestos (as in Cyprus), diamonds, chrysolite (an ornamental variety of olivine), cobalt, nickel, chromium and platinum. A trace of nickel was found in the serpentine from Troodos by Gaudry (*Géologie de l'Isle de Chypre*), *Mém. Soc. Géol. de France*, 1862 [ser. ii.], **7**. 182, and Bergeat, *op. cit.* p. 294.

Cy D 8. *Micaceous iron ore.*—This specimen varied in colour from reddish-brown, when much quartz was present, to steel grey.

The following are the results of an analysis :—

		Per cent.	
Ferric oxide	Fe_2O_3	84·32	Together equal to metallic iron, 63·94 *per cent.*
Ferrous oxide	FeO	6·32	
Silica	SiO_2	6·02	
Alumina	Al_2O_3	0·80	
Magnesia	MgO	0·75	
Lime	CaO	0·41	
Moisture and combined water		1·59	

Probably some of the rock-forming silicates are associated with the quartz. If the material could be obtained free from these impurities, which are the source of most of the silica, lime and magnesia, the ore would be of excellent quality.

Cy D 9. *Analcime.*—This is a hydrous silicate of alumina and soda. The mineral has been found in the valley of Pyrgos in Tylliria in the west of the island, and near Phourni Chiftlik, between Athienou and Larnaka, and is known as the "Paphos or Cyprus diamond," though this name appears to be also applied to specimens of quartz or rock crystal.

Some of the crystals of analcime are clear and transparent, and might possibly be used as gems. They are not, however, so good in quality as the specimens obtained from the Cyclopean Islands near Catania, Sicily, and from the Fassathal in the Austrian Tyrol.

Cy D 10. *Analcime and other hydrous silicates.*—These are of poorer quality than Cy D 9, and are of little or no value.

Cy D 11. *Chrysotile asbestos.*—A specimen similar to that registered as Cy D 5 (*see above*).

Cy D 12. *Ancient Scoria or Slag.*—This is a dull black heavy slightly scoriaceous slag. Analysis shows it to have the following composition :—

		Per cent.
Silica	SiO_2	20·42
Titanium oxide	TiO_2	0·65
Alumina	Al_2O_3	7·80
Ferric oxide	Fe_2O_3	20·18
Manganous oxide	MnO	36·09
Manganic dioxide	MnO_2	1·33
Cupric oxide	CuO	1·45
Magnesia	MgO	2·85
Lime	CaO	1·27
Barium oxide	BaO	0·34
Potash	K_2O	0·39
Soda	Na_2O	0·69
Sulphur trioxide	SO_3	0·18
Sulphur	S	trace
Phosphorous pentoxide	P_2O_5	trace
Water (combined)	H_2O	6·33

The sulphur trioxide and barium oxide are combined to form 0·52 of barium sulphate.

If, as is stated to be the case, this is a slag from ancient copper smelting, the metal has been removed very efficiently. It is believed that the Romans cleaned the slags of previous workers. The presence of so much manganese is of considerable interest. Either the original copper ore must have contained a large percentage of manganese as is the case with the cupriferous manganese ore known as lampadite, or the manganese has been added in the course of metallurgical operations. In either case it may be anticipated that deposits of manganese ore may be discovered in Cyprus, as it is scarcely likely that the material was imported. Similar slags rich in manganese oxide are described by Gaudry (*op. cit.*) from Lithrodonta, Korno, Lefkara, Politou Chrysokou and Lysso, the percentage of manganese oxide (estimated as Mn_2O_3) varying from 30·7 to 38·8 per cent. (*op. cit.* p. 242).

Cy D 13. *Rock from Mount Troodos or neighbourhood.*—This is a peridotite more or less serpentised like that registered as Cy D 7 (*see above*).

Cy D 14. *Material containing copper.*—This is a coarse grit containing quartz and decomposed felspar. There is a little copper pyrites as well as finely disseminated malachite (carbonate of copper), which gives the mineral a pale green colour.

It was not thought necessary to analyse this specimen as the percentage of copper was clearly very small. It was assayed for gold, and found not to contain that metal.

Cy D 15. *Alum from Kokkinourachos near Lefka.*—This is a dull, yellowish-white concretionary deposit. Numerous crystals of gypsum ($CaSO_4 + 2H_2O$) are visible under the microscope. In some pieces silky fibres probably of so-called magnesium "alum" ($MgSO_4Al_2(SO_4)_3 + 22H_2O$) are seen. There is little or no potash or soda alum present, the alkali oxides being probably combined with part of the silica, alumina and lime in felspathic material. On analysis the following results were obtained:—

		Per cent.
Silica	SiO_2	11·30
Alumina	Al_2O_3	5·15
Ferric oxide	Fe_2O_3	3·34
Magnesia	MgO	2·48
Lime	CaO	18·14
Potash	K_2O	0·19
Soda	Na_2O	0·72
Sulphur trioxide	SO_3	21·77
Water (by difference)	H_2O	36·74

This material is of little or no value. It might perhaps be used locally in place of gypsum as a source of calcium sulphate for agricultural purposes.

Cy D 16. "*Terre Verte.*"—A dark green mineral of the texture of clay. It is stated by Bellamy and Jukes-Browne (*The Geology of Cyprus*, Plymouth, 1905) that it is found among the weathered basalts of the lower mountains and in the neighbourhood of Malounda, and that an export trade in it was carried on some years ago. Gaudry (*op. cit.*) says that it was exported to Holland for use as a pigment. On analysis the results given in the first column were obtained. Another analysis quoted by Bellamy and Jukes-Browne (*loc. cit.*) is given for comparison:—

		Analysis made at the Imperial Institute. *Per cent.*	Analysis quoted by Bellamy and Jukes-Browne. *Per cent.*
Silica	SiO_2	62·46	52·50
Titanium oxide	TiO_2	0·95	—
Alumina	Al_2O_3	9·90	—
Ferric oxide	Fe_2O_3	5·07	—
Ferrous oxide	FeO	2·05	26·44
Manganic oxide	Mn_2O_3	trace	—
Magnesia	MgO	2·27	0·84
Lime	CaO	3·02	—
Potash	K_2O	2·49	15·72
Soda	Na_2O	0·89	—
Combined water	H_2O	4·07	—
Moisture		1·98	4·50

The term "terre verte" is usually applied to green clay-like material belonging either to the mineral celadonite or to glauconite. None of the analyses of these minerals agree with that of this sample, as there is always less silica and more potash. On the other hand, none have so much potash as is given in the analysis quoted by Bellamy and Jukes-Browne.

The material is probably an impure variety containing a considerable amount of ordinary clay. Its value as a pigment is stated by Bellamy and Jukes-Browne to consist in its freedom from copper and arsenic, so that it can be used where poisonous pigments are inadmissible.

Cy D 17.—This sample consists of quartz vein-stuff, coloured green with carbonate of copper. It is of no value.

Cy D 18. *Vesicular Lava.*—This sample is dark bluish green in colour. It contains a number of rounded cavities due to the expansion of steam. Its composition is as follows:—

		Per cent.
Silica	SiO_2	58·79
Titanium oxide	TiO_2	0·85
Alumina	Al_2O_3	16·19
Ferric oxide	Fe_2O_3	5·74
Ferrous oxide	FeO	2·70
Manganous oxide	MnO	0·50

		Per cent.
Magnesia	MgO	2·70
Lime	CaO	6·05
Potash	K_2O	1·40
Soda	Na_2O	2·76
Combined water	H_2O	1·33
Moisture		0·97

This is the composition of a typical lava of intermediate acidity. It is of no value except as "road metal."

Cy D 19. *Cupriferous water deposits from Arkougaidaros and Prasinoudi, three miles west of Campos.*—This material shows laminae of various shades from pale to malachite green. On analysis it gave the following results:—

		Per cent.
Silica	SiO_2	30·85
Alumina	Al_2O_3	1·72
Ferric oxide	Fe_2O_3	0·64
Cupric oxide	CuO	33·82
Magnesia	MgO	0·63
Lime	CaO	0·50
Loss on ignition, principally water		31·65

These results show that the material is chrysocolla (hydrous copper silicate). This mineral is stated by ancient writers to have been obtained from Cyprus. It would make a useful copper ore, if it could be obtained in sufficient quantity, but this does not appear to be probable. The existence of this substance may indicate the presence of copper in the neighbourhood.

This small collection of minerals from Cyprus is of importance, as indicating the possibility of the occurrence of deposits of some commercial value, which might be discovered, if a careful and systematic search were made for them.

Reference has already been made to the minerals which may be expected to occur in connection with the igneous rocks rich in magnesia occurring in the neighbourhood of Mount Troodos, and these are not unknown in the northern range. The marbles which occur in the latter may also prove to be a commercial product of considerable value. Whether the copper deposits can ever compete with the rich deposits of other parts of the world is very doubtful. The ancients in all probability mainly worked the secondary deposits formed by the decomposition of the sulphide ores, though these latter were also mined. Such of the secondary deposits as occurred at or near the surface appear to have been exhausted at an early period, but it is by no means impossible that similar ore may be found to extend for some distance under the pliocene and pleistocene beds, where it would still be intact. The manganese ore, which probably existed in considerable abundance and of high quality, may also be met with under the same conditions. Although none of these specimens contain zinc, it may be noted that Galen refers to the presence of calamine (silicate or carbonate of zinc) of good quality in the hills and streams, apparently near Soloi (*De simplicium medicamentorum*, ix., 11 and 22). A mineral survey of Cyprus, conducted by Government on the same lines as those now proceeding in Ceylon, in Northern and Southern Nigeria, and in British Central Africa, would be the best method of settling some of these questions and of ascertaining as precisely as possible the nature and extent of the present mineral resources of the island.

CHINA CLAY FROM QUEENSLAND.

TWO samples of china clay collected from deposits near Brisbane were forwarded to the Imperial Institute by the Agent-General for Queensland, in order that they might be examined and their commercial value ascertained.

Description of Samples.

Sample No. 1.—This weighed about four pounds and consisted of a soft, white powder, quite free from grittiness.

Sample No. 2.—This specimen weighed about four pounds, and consisted of a soft, faintly buff-coloured powder. When rubbed between the fingers it was found to be slightly gritty.

Chemical Examination.

The composition of the samples was found to be as follows :—

		Sample No. 1. *Per cent.*	Sample No. 2. *Per cent.*
Alumina	Al_2O_3	28·54	29·57
Ferrous oxide	FeO	0·58	1·03
Ferric oxide	Fe_2O_3	0·81	0·87
Lime	CaO	0·45	0·35
Magnesia	MgO	0·68	0·46
Soda	NaO	0·41	0·58
Potash	K_2O	1·77	0·91
Silica	SiO_2	58·42	54·90
Moisture and combined water		8·30	11·44

Technical Trial.

Sample No. 1.—When mixed with water this forms a "body" possessing good plasticity, and which is readily shaped, and on firing yields a "biscuit" free from cracks and almost white.

Sample No. 2.—The "body" prepared from this clay is buff-coloured and somewhat gritty, but is sufficiently plastic to be shaped by "throwing." When baked, the slight buff colour of the clay disappears, leaving a "biscuit" of an almost pure white colour. The "biscuit" shows no signs of cracks, but is somewhat rough owing to the presence of the gritty material already referred to.

The foregoing results show that although these clays contain rather more silica than is desirable in china clay, yet their plasticity, colour and firing qualities are quite satisfactory and would enable them to be used for the manufacture of pottery.

Neither of these clays in their present condition is suitable for use for the purposes to which the best kaolins are applied. The clays could be improved by careful elutriation, but their physical properties could be made equal to that of commercial kaolin of average quality by "grinding" and "pugging."

GENERAL NOTICES RESPECTING ECONOMIC PRODUCTS AND THEIR DEVELOPMENT.

PRODUCTION AND USES OF OIL OF TURPENTINE.

DURING the last few years the increasing utilisation of oil of turpentine in the arts has led to a considerable advance in the price of this material. Further, since the production of the oil on a large scale is limited practically to three countries, viz., Russia, France and the United States of America, and as the output in the two first named countries is for various reasons scarcely available except locally, it has come about that the United States of America has practically a monopoly of international supplies. As oil of turpentine is a most important raw material for a number of industries which are carried on in the United Kingdom, British merchants and manufacturers have made efforts to secure new sources of supply especially in British Dominions; and it has been thought worth while to prepare a general statement regarding the present production of oil of turpentine, and to draw special attention to those areas, British and foreign, in which extension of production may be looked for.

Sources of Oil of Turpentine.

This material is obtained by the distillation of the crude turpentine, which exudes from various species of *Pinus* including the common "Scotch fir," *Pinus sylvestris.*

The method of preparing oil of turpentine as practised in the United States of America is as follows:—

In the winter, *i.e.* from November to March, labourers are employed in the section of forest to be worked over, in making cavities, technically known as "boxes," in the trunks of the trees. For this purpose a long narrow axe of special construction is used.

The "boxes" are made at about one foot from the ground and are shaped like a distended pocket; the bottom of this pocket being about 4 inches below the lower lip and 8 inches below the upper lip. The "boxes" are usually made large enough to hold a quart. Three such "boxes" are made at about the same level in a tree of moderate size (stem 12 to 18 inches in diameter).

After the cavities have been cut, the bark is slightly hacked just above each cavity, and from this wound turpentine begins to flow in March, and runs into the "box" below, gradually filling it. From the "box" the turpentine is periodically removed by means of a ladle and placed in barrels for transport to the distillery. Here it is poured into copper stills and distilled without the addition of water. The distillate constitutes oil of turpentine, whilst the residue remaining in the still is ordinary "rosin" or "colophony." In France, the crude turpentine is collected by making a shallow incision in the tree about 12 inches above the ground and affixing a suitable vessel into which the turpentine can flow, just below the incision. This process is stated to be less wasteful than that practised in America.

PRODUCTION OF OIL OF TURPENTINE.

United States of America.

American oil of turpentine is the product of two species of pine, the "swamp pine" (*Pinus palustris*) and the 'Loblolly or Rosemary pine" (*Pinus taeda*), both of which grow in large quantities in North and South Carolina, Georgia and Alabama. The pine forests of Carolina and Georgia are said to be becoming exhausted, and so the turpentine industry of the United States of America is gradually being transferred to Florida. It is difficult to obtain exact figures of production for turpentine oil in the United States, but the exports for the last five years for which figures are available are as follows:—

	Quantity. Gallons.	Value. Dollars.
1901 . .	20,240,851	7,715,029
1902 . .	19,177,788	7,431,248
1903 . .	16,378,787	8,014,322
1904 . .	17,202,808	9,446,155
1905 . .	15,894,813	8,902,101

The imports into the United Kingdom for the last five years have been as follows:—

	Total Quantity. Cwts.	Total Value. £	From the U.S.A. Quantity. Cwts.	Value. £
1901 .	643,846	842,742	618,972	819,327
1902 .	532,455	888,538	496,389	851,484
1903 .	533,109	1,028,934	460,324	938,184
1904 .	528,112	1,006,369	462,079	925,060
1905 .	526,679	1,104,300	424,892	972,693

It will be seen from these figures that by far the largest proportion of the oil of turpentine used in this country is imported from the United States of America, and consequently the artificial limitation in production which is now said to be taking place in the United States is a somewhat serious matter for consumers in the United Kingdom.

France.

"French or Bordeaux oil of turpentine" is derived from a single species of pine (*Pinus maritima*), of which vast forests occur in Southern and South-western France, especially in the Department des Landes, where also large tracts of land have been re-afforested with *Pinus maritima* with a view to improving the climate and soil, which suffered from lack of rain. French oil of turpentine differs to some extent, in certain physical properties, from American turpentine oil, but it is equally applicable to all ordinary purposes.

No figures are available as to the production of oil of turpentine in France, but it is certain that the oil produced is, for the most part, consumed in the country itself. The total export of oil from France in 1904 amounted to 118,100 cwts. The imports of oil of turpentine from France into the United Kingdom during the last five years have been as follows:—

	Quantity. Cwt.	Value. £
1901 . .	2,748	3,321
1902 . .	5,298	8,150
1903 . .	14,816	27,711
1904 . .	9,150	17,591
1905 . .	28,154	56,521

Russia.

The source of turpentine oil in Russia is the Scotch fir (*Pinus* *sylvestris*) which occurs more especially in the districts bordering on the Black Sea.

The Russian oil is inferior in quality to American and French turpentine oils. It has a peculiar odour, turns brown on exposure to air and leaves a considerable residue when allowed to volatilise. For these reasons it is unsuitable for many of the purposes to which turpentine oil is applied, and consequently is of less value than the two other varieties which occur in commerce.

The annual imports of Russian turpentine oil into the United Kingdom during the period 1901–1905 are shown in the following table:—

	Quantity. Cwts.	Value. £
1901	21,956	19,882
1902	27,875	24,249
1903	56,304	60,155
1904	52,709	58,147
1905	68,754	67,117

Austria.

A small amount of turpentine oil is produced in the State forests of the Austrian Tyrol, but the amount is insufficient to meet even local demands and large quantities are imported from the United States. The source of the Austrian oil is the Corsican pine (*Pinus laricio*) which is tapped for turpentine principally in the neighbourhood of Voeslau in the Tyrol.

India.

As far back as 1884 the Indian Government considered the possibility of producing oil of turpentine in the North-West Provinces on a scale large enough to supply the Indian market.

Increasing demand for turpentine oil in recent years has again directed attention to the possibility of its production being taken up on a large scale in India.

The turpentine-producing trees of India are numerous, but only those which are of commercial interest need be mentioned here.

Pinus girardiana, Wall., is a moderate-sized tree, found principally on the North-west Himalayas and in Garwhal, generally at an altitude of 6,000 to 12,000 feet. According to various reports it affords an abundant supply of a fine turpentine oil.

Pinus khasya, Royle, one of the principal Indian pines, is widely distributed on the Khasia Mountains of Chittagong and the hills of Burma at a height of 3,000 to 7,000 feet. The turpentine oil obtained from its oleo-resin was examined for the Imperial Institute by Professor Armstrong in 1896, who reported favourably on it.

Pinus longifolia, or the "long-leaved pine," the most important of the Indian pines from the present point of view, is a large gregarious tree growing chiefly on the dry Himalayan slopes. In North-west India, including Kashmir and the native states, it covers an area of 2,000 to 4,000 square miles, and its turpentine is more freely collected and used than that of any other Himalayan conifer. The turpentine oil obtained from it is reported to be of good quality, but has a tendency to darken in colour, and leaves a considerable residue on distillation. These defects are no doubt due to careless preparation, and can probably be remedied.

The only other Indian pine of importance is *Pinus Merkusii* of the Shan States, Martaban, and Upper Tennasserim. Although the turpentine oil produced by it is dear, owing to the small quantity available, there is no doubt that the area of growth could be considerably increased.

The turpentine oil industry in India is still in little more than an experimental condition, although turpentine oil and rosin have been manufactured on a small scale there for some years. The industry is confined to the pine forests of the Himalayas in the United Provinces and the Punjab, and the first distillery was erected at Dehra Dun in the United Provinces by the Imperial Forest School in 1888. Unfortunately the factory at Dehra Dun is situated about one hundred miles from the forests, and the crude turpentine has to be carried that distance by country carts or pack animals.

The turpentine is collected in this case from *Pinus longifolia* (Chil pine), chiefly in Jaunsar and the leased forests of Jehri-Garwhal at Daragadh, Winur, Obra, Sangared, etc. The trees are tapped soon after the rains are over in October, "cuts" or "blazes" being made in the stem and the exuding oleo-resin collected in cups at the base.

The distillation goes on all the year round. The following figures give an idea of the amount of crude turpentine collected there per annum :—

1900–1	1,701 maunds.*
1901–2	1,628 „
1902–3	1,602 „

* *The maund is equal to* 82·6 *lbs.*

The crude turpentine on distillation yields 72 to 77 per cent. of rosin, and 14 to 18 per cent. of turpentine oil.

Until four years ago the factory at Dehra Dun was run at a profit, but since then at a slight loss, owing to the price of rosin (colophony) having fallen from ₨5·2 per maund to ₨2·7 per maund.

In order to facilitate transit and lower transport charges, arrangements were made in 1895 for the introduction of the turpentine distilling industry to Nani Tal, which has the advantage of close proximity to the railway. In 1900–1 the manufacture was pronounced a success, the prices realised for oil of turpentine and colophony being equal to those obtained for the imported articles, and no difficulty was experienced in disposing of the products. In that year, over 22,000 trees were tapped and 1,450 maunds of oleo-resin collected, this yielding 1,600 gallons of turpentine oil and 817 maunds of colophony. The industry next year was even more successful, and in 1902–3 43,000 trees were tapped and 3,000 maunds of crude turpentine distilled. The profit accruing from this was estimated at about ₨4,500.

A third factory was established in Nanpur in the Kangra division of the Punjab in 1899, but no trustworthy figures concerning its production are yet available. The annual supply of crude turpentine within easy reach of this distillery is estimated at 10,000 maunds, and this quantity should give 15,000 gallons of turpentine oil and 7,500 maunds of colophony. About 1,200 maunds of crude turpentine were collected in the Kangra district in 1900. Reductions in freight charges have been obtained from the local railways, and these concessions should enable the oil of turpentine to compete with the imported article as far as the seaports.

At present India still depends mainly on the United States to supply the considerable local demand for turpentine oil, but if the industry could be firmly established in the pine forests of the Northern Provinces it would prove a source of great profit, as the home market at least could be easily supplied.

Indian turpentine oil seems to answer local requirements well, and is being used in the medical stores and military departments, by the railway companies, and by paint and varnish makers in India. Until the production can be considerably extended and improved and the cost lowered, however, there is little prospect of it competing successfully with American turpentine oil in the European markets. Samples of Indian rosin and turpentine oil prepared from the crude turpentine of *Pinus longifolia* are at present under examination in the Scientific and Technical Department of the Imperial Institute with a view to determining their commercial value and devising processes for rendering them suitable for European markets.

British Honduras.

Towards the end of 1904 the Government of British Honduras accepted an American offer to pay one cent. each for the privilege of tapping 12,500,000 pine trees for turpentine. This concession is granted for twenty-six years, and all the pine products obtained will be exempt from export duty.

About one-third of the colony is said to be covered with pine ranges, consisting almost wholly of *Pinus cubensis.* Nothing is known as to the yield of turpentine obtainable from this species of pine or as to the quality of the oil yielded by it.

SUBSTITUTES FOR OIL OF TURPENTINE.

The comparative scarcity of American oil of turpentine in recent years has caused much attention to be paid by consumers to the question of substitutes for this material, and a large number of these are now on the market. Although many of them give excellent results and can be used for almost every purpose to which turpentine oil is put, their introduction has as yet had little effect on the price of the natural product. In the majority of cases these substitutes contain no turpentine oil at all, but are mixtures of well-graduated and selected fractions of petroleum, watergas-tar, or coal-tar hydrocarbons having approximately the same specific gravity and boiling-point as the real oil. Others are made up of light petroleum or shale naphtha with an addition of Russian oil of turpentine in small proportion to give the characteristic smell. Rosin spirit, the product of the destructive distillation of colophony, also enters largely into the composition of some turpentine substitutes. This spirit is water white and has a peculiar and characteristic terpene odour. It is generally heavier than oil of turpentine. Only the best refined "rosin spirit" can be used for making turpentine substitutes, as many of the poorer grades contain rosin oil, which has a detrimental effect on the drying properties.

Besides these artificial substitutes for turpentine oil, a new industry is being developed, especially in North Minnesota, for the production of a turpentine oil substitute by distilling the resinous stumps of fir trees, which have been commercially valueless hitherto. The process occupies five days, and the product obtained is said to differ considerably from the ordinary oil of turpentine of trade. It is stated to have a rather unpleasant smell, and is slightly acid. These defects at first prevented its general use, but further experiments are said to have shown that it is suitable for use for many purposes in place of true turpentine oil. This industry has only just been commenced in Minnesota, but it is stated that already thirty barrels of turpentine, fifty barrels of tar, and thirty barrels of tar oil are being made by this process each month.

USES OF TURPENTINE OIL AND ROSIN.

Turpentine oil is employed for a great variety of industrial purposes, but the most important are its use as a solvent for resins in the manufacture of varnishes and as a diluent and vehicle for pigments in the manufacture of oil paints. Its solvent properties also make it of value as a cleansing agent, and it is employed to a small extent in medicine, in the manufacture of rubber cements, and for a great variety of similar purposes. Russian oil of turpentine, which is not so well suited for the above purposes, is said to be principally employed in this country in the preparation of certain disinfectants.

Rosin, the other product of the turpentine industry, finds its principal application now in the manufacture of cheap yellow household soaps, though considerable quantities are also used in making cheap varnishes. Much is also destructively distilled in making rosin spirit and oil to be used in preparing lubricants, and considerable quantities are used in the preparation of metallic resinates now applied to various technical purposes.

RECENT WORK ON AFRICAN RUBBER VINES.

THREE new species of *Landolphia*, which have been named *Landolphia Dawei, L. ugandensis* and *L. subturbinata* by Dr. Stapf, have been discovered during the last two years in Uganda by Mr. M. T. Dawe, the Officer in Charge of the Forestry and Scientific Department at Entebbe. Accounts of Mr. Dawe's journeys through the forests of the Protectorate, in the course of which the above discoveries were made, will be found in this *Bulletin* (1903, **3**. pp. 41 and 236), and also in a recently issued Parliamentary Paper [Cd. 2904].

Two of the new species of *Landolphia*, *L. ugandensis* and *L. subturbinata*, are unfortunately of little economic value as sources of rubber, but are of botanical interest. *L. ugandensis* is a small vine with a slender stem and small globose fruits. The vine now described as *L. subturbinata* was at first thought to be the well-known *L. owariensis*, which it closely resembles in leaves and flowers. The fruit, however, proves to be quite distinct, and there is no doubt that the plant is a separate species. The earlier statement that *L. owariensis* occurs in Uganda must consequently be withdrawn.

The other new species, *Landolphia Dawei*, has proved to be of exceptional interest in several respects. It furnishes an excellent rubber, samples of which, prepared by Mr. Dawe, have been examined in the Scientific and Technical Department of the Imperial Institute. A report upon the composition and value of three rubbers from Uganda is published in this number of the *Bulletin* (p. 202), from which it will be seen that the rubber of *L. Dawei* was recently valued in London at 5*s*. 9*d*. per lb., when fine hard Para rubber from South America was quoted at 5*s*. 5*d*. per lb., and Para "biscuits" from Ceylon and the Federated

Malay States at 6*s*. 3*d*. per lb. This vine, therefore, promises to be of considerable value as a source of rubber in Uganda.

An important and interesting fact in connection with the distribution of *L. Dawei* in tropical Africa has been ascertained recently by M. Chevalier, whose investigations on this subject have also afforded an explanation of the discrepant statements which have been made regarding the value of *L. florida* as a source of rubber. An account of M. Chevalier's researches on these points will be found in the *Bulletin de la Société Botanique de France*, 1906, p. 17.

It was at one time generally believed, from the statements of a number of African explorers, that *Landolphia florida* furnishes good rubber, but nearly all later authorities have declared that this vine is useless as a source of rubber, the product obtained from the latex being at first sticky and becoming hard and brittle on keeping. The only recent testimony of weight in favour of the older view was that of Dr. Preuss, who asserted that the *L. florida* occurring in the Cameroons, on Mount Cameroon, furnishes rubber of very good quality. Dr. Preuss conducted a number of experiments with these vines, and succeeded in raising a number of the plants, some of which, it appears, he sent to Monte-Café, in the island of San Thomé. Schlechter, whose own researches on *L. florida* in West Africa showed the vine to be valueless, threw doubt on the accuracy of the identification of the species growing on Mount Cameroon, but the point at issue was never satisfactorily settled.

M. Chevalier recently spent some time in San Thomé, and during his stay he visited a small botanic garden at Monte-Café which had been formed by a previous German Consul in the island. Here he found specimens of two species of *Landolphia*, one of which he at once recognised as *L. Kirkii*, but he was unable to identify the other with any previously described species, although both flowers and fruits were available. The vine had large leaves resembling those of *L. florida*, but the structure of the flower proved the plant to be quite distinct from the latter.

On his return to Europe M. Chevalier visited Kew in order to compare his specimens with the new species recently described by Dr. Stapf, and it was then found that the unknown

Landolphia growing at Monte-Café in San Thomé is identical with the *L. Dawei* from Uganda.

The origin of the vines at Monte-Café was not known with certainty in the island, as the Consul who established the garden had long been gone, but there is no doubt that some specimens of the supposed *L. florida* from the Cameroons were forwarded to Monte-Café for cultivation. It seemed highly probable therefore that Dr. Preuss had mistaken the identity of the vine growing on Mount Cameroon and yielding good rubber, and that the species which he assumed to be *L. florida* was in reality *L. Dawei*. In order to confirm this supposition, M. Chevalier has examined the specimens of the supposed *L. florida* from the Cameroons, which are preserved in the Botanic Gardens at Berlin, and has found that the leaves correspond exactly with those of *L. Dawei*.

This conclusion disposes of Preuss's statements regarding the economic value of *L. florida*, and the worthlessness of this species as a source of rubber may now be regarded as fully established.

The discovery that *L. Dawei*, which was found at an altitude of 4,000 feet in Uganda, also occurs on Mount Cameroon, in West Africa, is of distinct interest as indicating a wide distribution of the species in tropical Africa. It may be noted in this connection that Mr. Dawe's explorations have established the fact that *Funtumia elastica*, the West African rubber tree, extends eastwards into Uganda.

Some interesting particulars are given by M. Chevalier of the rate of growth of *L. Dawei* at Monte-Café. It is stated that there is no difficulty in getting the fresh seeds to germinate, but the growth is at first slow, and the plants, although raised in a nursery on good soil, only attain a height of 15 cm. in six months. Schlechter measured some plants of this species, two-and-a-half years old, which were growing at Soppo in the Cameroons, and found the stems to be 5 metres in height, but less than 1 cm. in diameter. Preuss records that the vines at Monte-Café, when five years old, had reached the summits of the supporting trees—25 metres—but he does not give the diameter of the stems. These same vines when seen by M. Chevalier last year were twelve-and-a-half years old, and had attained the size of the fully-grown vines occurring in the forests of tropical Africa. Two stems which he measured were 45 cm. and 50 cm. in circumference at the surface of the soil, and 40 cm. at a height of two metres; another measured 45 cm. in circumference at 20 cm. above the soil, and at 30 cm. divided into four branches, each of which was 25 cm. in circumference. M. Chevalier states that none of the other species of *Landolphia*, of which he has had the opportunity of measuring specimens of known age, show such rapid growth as these vines of *L. Dawei* at Monte-Café.

In conclusion M. Chevalier considers that *L. Dawei* is likely to prove one of the most valuable of the rubber-yielding *Landolphias*, on account of its rapid growth and the large yield of rubber which can be very easily prepared from the latex. The vine apparently flourishes at considerable elevations, and he considers that it will be found to be very suitable for cultivation throughout tropical Africa at altitudes between 500 and 2000 metres, and probably at lower elevations also in situations where the rainfall is well distributed throughout the year. Monte-Café, where the conditions appear to be exceptionally favourable, is situated at an altitude of 700 metres, and has an average temperature of 18° to 20° C., with an annual rainfall of 1·5 metre. It rains there for nine months in the year, but even in the dry season the air is humid, and fogs are frequent in the morning and evening. Specimens of *L. Dawei*, believed to be twelve years old, were also found in San Thomé, at Porto-Aleger, which is almost at sea-level, and although not so vigorous as those at Monte-Café, they showed good growth, the stems being 12 metres high and as thick as a man's arm.

Specimens of the rubber of *L. Dawei* prepared by M. Chevalier in San Thomé were valued in Paris at twelve francs per kilo, which is equivalent to 4*s.* 4*d.* per lb., the current quotation for fine Para rubber being 5*s.* 4*d.* per lb.

NIGERIAN SORGHUM IN QUEENSLAND.

THE following is a report, supplied to the Imperial Institute by the Agent-General for Queensland, of the results of a trial made in that state with "Mazzagua corn" derived from a variety of sorghum indigenous to Northern Nigeria, where it is grown as a dry season crop. The advantage of "Mazzagua" is that it grows well without rainfall or irrigation, and yields a good white flour, which makes a pleasant bread. It is obvious, therefore, that it would be a useful grain for introduction into some of the districts of Queensland and other British Colonies which are especially liable to drought.

The plot in which this plant was tried consisted of heavy black soil formation, even in character throughout. It was deeply and thoroughly worked, after a crop of "Broom Millet" had been taken off the previous season. Two ploughings to a depth of eight inches were applied, and the soil was brought to a good tilth by harrowing.

A Massey-Harris seed drill was used to drill in the seed in rows three feet apart, and the seed was sown at the rate of six pounds to the acre, on October 10th, 1905, after the copious rains at that time.

Very dry weather had been experienced prior to the middle of October, and late frosts prevented the seed being sown earlier, but the plant got a good start and flourished vigorously throughout the late spring and summer. At the time of sowing the soil was very favourable for germination and growth, being warm and moist, and as a result the crop sprang up rapidly.

The paddock in which the crop was grown is rather exposed, and is not sheltered from the westerly winds, but the stems being very strong and thick protected it from a common trouble experienced in growing "Sorghums," viz., "blowing down," which renders cultivation between the drills a matter of difficulty.

The only cultivation given the crop after the plants were up was to stir the soil well with a horse-hoe in order to keep down weed growth and retain soil moisture.

Two cultivations were given before the rapid growth prevented a horse from walking between the drills, but no more cultivation was found necessary. The vigorous nature of the plant prevented weeds from gaining a hold.

Throughout November, December, and January the crop grew splendidly, and by the end of February had attained a height of eleven feet, but no signs of 'heading' appeared.

During March it had grown to a height of twelve feet with an abundance of "flag."

The stems at the base were 4¼ in. in circumference, and resembled somewhat maize stalks, possessing adventitious roots. Early in April a few heads began to appear, but up to the end of that month, when light frosts made their appearance, only a few plants here and there had "headed." These heads were flowering in the beginning of May, but it is unlikely that matured seed will now be obtained (the report is dated May 8th, 1906), as the frosty mornings are beginning to leave their mark on the plant.

We are cutting the crop now for ensilage, and by all appearances there is every reason to believe it will be adaptable for this purpose.

The plant in its native land is planted in November and cut in June, occupying the ground for about seven months. This would necessitate its being sown in Queensland as early as possible after the frosts occurring in spring, in order to have the seed ripe by April.

The heads which formed are seven to eight inches in length, thick and closely packed, and very much resemble the heads of "Dhurra" or "Egyptian corn."

The crop will run from forty to fifty tons to the acre when sown in drills. The plant "stools" out well, ranging from six to nine stalks to the "stool," and in consequence it would be advisable not to sow too thickly. In its green state good chaffed ensilage should be made from it, but some difficulty may be found in chaffing it, on account of its thick and strong stem.

In its younger state, "Mazzagua" should be of great value, fed to cattle and pigs; both the stems and "flag" are succulent and palatable.

It is a plant, which will do well in our district, and if it can be acclimatised and made to seed before frosts occur on the Southern Downs, should be cultivated if only for its green seed.

The plant has not yet been analysed in order to determine its nutritive value as a fodder.

The rainfall during growth was as follows:—

	Inches
November	1·65
December	3·50
January	1·74

	Inches.
February	1·94
March	5·19
April	0·21

Since the first of April no rainfall whatever has been experienced.

RECENT DEVELOPMENTS IN GERMAN EAST AFRICA.

THE Usambara railway, which is some 80 miles in length, has already been laid in the northern part of German East Africa. A second railway, now being built from the capital, Dar-es-Salaam, to a point 135 miles inland in the direction of Lake Tanganyika, will open up the central districts. A third line, known as the Southern railway, running like the other two from the east coast inland towards the lakes, will, if constructed, open up the southern half. The route of this proposed third line is described in a report recently published as "*Beihefte zum Tropenpflanzer*. Band. vi. Sept. 1905." As the report gives a great deal of information regarding planting developments and prospects in this German Protectorate, it has been thought well to give a short *resumé* of it here. (See also this *Bulletin*, 1903, **1**. 124, and 1904, **2**. 256.)

The Southern railway, starting from one of the east coast ports, probably Kilwa, will be about 400 miles in length, and will have its western terminus on Lake Nyasa. German colonists demand this new line on the ground that the Uganda railway in British East Africa has begun to draw the trade of the Victoria Nyanza region through British territory. They believe that if a German Nyasa railway is not constructed before the proposed Portuguese-British Nyasa railway, the latter will divert trade from the southern half of German East Africa just as the Uganda railway has from its northern half. The German Colonial Economic Committee, therefore, sent out an expedition to explore a route. Their instructions to the leader included the drawing up of plans for the projected railway: collection of information relating to the hydrography of ports with a view to the choice of a coast terminus, and tabulation of data as to quantities of each article exported and imported: measurement of distances: selection of districts in which to establish settlements of natives along the railway route: study of soils, vegetation, altitude, rainfall, density of population, quality of labour in each locality, present cost of transport on caravan routes, prospects of finding coal east and west of Lake Nyasa, resources of the lake districts, amount and nature of the trade passing through British hands down the Shiré-Zambesi route; and estimation of the amount of this trade which it may be possible to divert through German territory by means of the new railway.

The southern half of German East Africa has been neglected as regards railway development, although it is believed to be as rich as the northern half in natural resources. Ivory, beeswax, and rubber bear the present cost of transport to the coast; but bulky products, such as cotton, palm-kernels, ground-nuts, sesamé, maize, and timber cannot be brought down in large quantities from the hinterland and exported until there is a railway to carry them. In the southern half of the colony caravan routes are not always safe, and the southern ports, instead of being visited by mail steamers, are served only by local coasting steamers and by dhows. The values of the total exports from the three principal ports in the southern half of the Protectorate in 1904 were Kilwa, 1,063,564; Lindi, 725,603; and Mikindani, 225,559 marks. Rubber forms more than half the total exports of Kilwa, the value of the rubber exported in 1904 being 664,532 marks, while the products next in order of value were grain, copra, ivory, sesamé, timber, wax, and copal. The values (in marks) of the principal exports from Lindi and Mikindani were: wax, 303,427; rubber, 201,404; sesamé, 166,221; matama (sorghum), 117,871; ivory, 69,531; tobacco, 37,540; ground-nuts, 37,379; copal, 29,740; maize, 9,368. In addition large quantities of native products are sent by sea without passing through the customs to the northern parts of the colony. Lindi thus shipped in 1902–3 the following quantities: matama, 4,782,046 lb.; ground-nuts, 373,798 lb.; maize, 209,682 lb.; pulse, 79,737 lb.; sesamé, 72,760 lb.; tobacco, 37,464 lb.: with the exception of the more valuable products—ivory, rubber, wax, and tobacco—all the exported products come from the coast districts. Of the imports into Kilwa, Lindi, and Mikindani, cotton piece-goods constitute two-thirds.

Every kind of produce coming from the interior to the coast, and *vice versa*, has to be carried by native carrier at present in the form of a head-load. A recent attempt to start wheeled traffic from Kilwa to Lake Nyasa failed owing to Tsetse fly. Most of the interior is sparsely inhabited, but thousands of Wanyamwesi from the more thickly populated districts pass through each year to and from the coast. Settlements could be established like those on the Usambara railway where 5,000 Wanyamwesi are cultivating "viasi," "chirokko" (*Phaseolus Mungo*), "mohogo" (cassava), and maize, in settlements instituted three years ago. If similar settlements are formed along the Southern railway, it will be possible for the native settlers first to grow food to live on, and afterwards products for export such as cotton, sesamé, and ground-nuts. Maize and matama (sorghum), rather than rice and mohogo (cassava), are recommended as the best crops for the native labourers on the railway to grow as food, and it is proposed to erect handmills or windmills here and there near the railway to grind food grains. The principal crops grown by the natives in the southern half of the colony are matama (sorghum), maize, rice, "mohogo" (cassava), sesamé, ground-nuts, "kunde" (*Vigna sinensis*), "chirokko" (*Phaseolus Mungo*), cotton, and copra.

1. *Kilwa to Liwale.*

Along the coastal section of the proposed line the natives grow sesamé, ground-nuts, and cotton. Almost all German East African cotton is grown by the natives. They have recently, at the instigation of the German colonial authorities, planted 10,000 acres of cotton near Kilwa, from which a yield of 4,000,000 lb. is expected. In the same district some of the white settlers will in future grow cotton as their chief crop. The coast belt is about 30 miles broad; further inland, where the country becomes undulating, there is, for a short distance, a good road three yards in breadth; but this is succeeded by nothing but bush-paths as far as Liwale. On their march westwards the expedition passed through flat country, with dried-up watercourses, and trees here and there in sufficient quantity to furnish fuel for the railway for some time to come. The soil is principally loam or clay loam, but becomes more sandy further west. A stretch of 48 miles, avoided by caravans, is devoid of water during the hot season, which lasts from October to February. The crops most abundant along the route are matama (sorghum), maize, beans, mohogo (cassava), sesamé and ground-nuts.

2. *Liwale to Wiedhafen.*

Dondeland is noted for its rubber, derived from *Landolphia dondeensis*, and in 1903 exported 100,000 lb. viâ Kilwa to Europe. Besides being the greatest rubber-producing district in German East Africa, Dondeland is surrounded by rubber-yielding areas, viz. Mahenge to the north, Ungoniland to the west, Kissi to the north-east, and the Makonde table-land to the south-east. Liwale, the chief town in Dondeland, is 1,640 feet above sea-level, but has an unhealthy climate. The annual rainfall is about 40 inches, the rainy months being December to May, and as the other months are practically rainless, live stock of all kinds is scarce. Egyptian cotton promises well, but is not yet grown on a large scale, only primitive appliances for ginning and pressing being available.

West of Liwale a mountainous, sandstone country, cut up by deep ravines, is entered. Still further west the hills are not so high. Tsetse fly makes wheeled traffic impossible. The expedition came upon a farm in an isolated spot 168 miles from the coast and 2,297 feet above sea-level, where a German settler is growing millet, maize, potatoes, and beans, and is trying Ceara rubber (*Manihot Glaziovii*) and cotton. The cotton has to be sent to Liwale to be ginned. Failing a railway, the outlook for a settler in such a place is not encouraging, as it is very difficult to dispose of produce except to natives. Proceeding farther westward the expedition entered the lightly-wooded undulating country characteristic of the high table-land of Ungoniland—average elevation 3,000 to 4,000 feet above sea-level—the sloping red sandstone hills, with crags of gneiss projecting through them, being cut up by streams. The Wangoni, the principal inhabitants, are related to the Zulus, and came northward only fifty years ago from the border of Natal. They drove out the earlier inhabitants of the table-land, and penetrated to the coast. Even so late as fifteen years ago they attacked the coast towns, carried off women and children as slaves, and were only bought off by the Indian traders of Kilwa by an annual tribute of cotton piece-goods and salt. Songea, the chief town of Ungoniland, has just ceased to be a military and become a civil German administrative station. The dry season is a prolonged one, and consequently there are not many cattle: for the same reason this is not likely to become a tea-growing country; but cotton and coffee are grown with success. Beeswax is produced everywhere, and there is still some rubber, but the Wangoni have lately taken to migrating in large numbers during the rubber season to collect rubber in Dondeland and Mahenge.

Ungoniland is noted as a grain-growing region, and in the best parts much of the land is under cultivation. There are plenty of streams of good water, and as regards fuel for the railway there is a sufficient supply of timber. Waggon traffic could be established, as one of the caravan routes is free from Tsetse fly. The natives have fields of an indigenous long-staple cotton of good quality, and although German planters are experimenting with Egyptian and American cottons, it is believed that the indigenous variety will do best, and that altitudes of 2,000 to 3,000 feet are most suitable here.

The expedition crossed, at an elevation of 5,200 feet, the Livingstone range of granite and gneiss mountains, which run north and south down the east side of Lake Nyasa, interrupted only by a gap through which the railway could run alongside the river Ruhuhu to where the latter enters Lake Nyasa at Wiedhafen, the proposed terminus.

3. *Wiedhafen.*

Wiedhafen has been declining rather than advancing in recent years as regards commercial enterprise, and unfortunately this is true generally of the Lake Nyasa country. Two of the principal German firms, the German East Africa Company and Hansing and Co., have lately removed their establishments from Wiedhafen. German as well as British residents, the latter at Karonga in British Central Africa on the west side of the lake, are equally of opinion that only a railway to the Lake country can stimulate commercial activity.

4. *The Lake Country.*

The arrival of the expedition on the east shore of Lake Nyasa marked the conclusion of the survey of the railway route. Beyond and north of the terminus, however, are the important regions of the lake country. Coal beds have been discovered in two localities a few miles north-east of Lake Nyasa, as well as at a place between Lake Nyasa and Lake Tanganyika. (Compare *Imp. Inst. Tech. Rep.* p. 3.) But even assuming that the coal proves to be of better quality than an examination of the first samples indicated, coal will not be much used by the steamers on the lake or by the railway, as these districts have enough timber to provide cheap fuel for several years; and it is doubtful whether the railway will be able remuneratively to carry the coal 400 miles to the coast for export. Iron ore has been found at the north-east end of the lake, near the coal. As regards agriculture, the lake country not only grows most of the crops already mentioned, but also possesses characteristics of its own, the rainfall being far more copious and evenly distributed throughout the year than in the eastern parts of the colony, and there is no month without rain; moreover, the complex intersection of a series of extensive table-lands of high elevation—Nyika, Tanganyika, and other plateaux—by broad depressions such as that of Lake Rukwa, contributes to diversity of agriculture. Near Lake Rukwa, the natives used in former times to grow considerable quantities of cotton, the cotton area extending approximately 50 miles east and 100 miles west of the lake. Like other districts near the great lakes, the Lake Rukwa depression is thickly populated. The country north of Lake Nyasa has far more cattle and stock of all kinds than the drought-stricken eastern districts. Another prominent feature of the lake region is the abundance of leguminous and cereal crops, including a little wheat, which is not grown in the eastern parts of the colony. Coffee and bananas are grown at the north-west end of Lake Nyasa, and rice in alluvial valleys partly submerged each year by overflowing rivers. Where the soil is of volcanic origin the land is especially fertile. Near Langenburg the annual rainfall at 4,800 feet is 90 inches. Langenburg is the centre of a network of good roads, one of them, 240 miles in length, having been constructed recently on the German side of the German-British frontier from Lake Nyasa to Lake Tanganyika, parallel to the "Stevenson road" in North-Eastern Rhodesia.

GEOLOGY OF TOGOLAND.

AN interesting account of the geology of this German Protectorate has been presented recently by Dr. L. von Ammon to the Munich Geological Society, and as the subject is of some interest in connection with the geology of the neighbouring British Protectorates and Colonies, a short *résumé* of the results may be of use to those interested in the mineral development of these countries.

Dr. von Ammon has been somewhat handicapped throughout by his lack of personal acquaintance with the country he describes, but this difficulty has been largely overcome by a detailed examination of several collections of carefully located specimens, and a diligent study of the existing maps of the country, and of the literature bearing upon the subject. Unfortunately such methods preclude any but the slightest reference to the character and evolution of the present surface of the land.

Togoland is a narrow strip of country, approximately 350 miles long by 150 miles broad, wedged in between French Dahomey on the east and the British Gold Coast Territories on the west. The Protectorate is roughly bisected by a mountain system striking S.S.W. to N.N.E., reaching in places a height of 1,000 metres above the sea. It is now fairly well established that this dividing range is the continuation of the system, which begins north of Accra with a W. to E. extension, and wheels round to the north beyond the Volta. Not only is the system crystalline throughout, but the same types of rock exist both in the Gold Coast Colony and in Togoland, and in the south-east margin of the Protectorate the individual beds themselves can be traced curving northwards with the strike of the mountains.

The geology of Togoland is comparatively simple. The crystalline rocks of the central range cover by far the largest part of the surface. Granites, gneisses, schists, quartzites and amphibolites apparently occur in endless variety. To the west, in the valley of the Oti, occurs the Oti sandstone series of shales, sandstones and conglomerates assigned by Dr. von Ammon with some hesitation to the Palaeozoic period.

The sandstones are hard, compact and superficially reddened, but show a grey or greenish tint on a fresh fracture. They pass frequently into shaly sandstones with manganese dendrites. The shales vary from grey to red, and have as yet yielded no fossils. On the east, in the lower course of the Monna, limestone yielding fossils of old tertiary (probably eocene) age is exposed in the river bank near Tokpli, beneath a covering of loose red sands and loams of recent origin. This indicates the presence of an eocene series in the neighbourhood stretching eastwards into Dahomey. On the extreme northern boundary of the Protectorate crystalline rocks again occur.

Iron ores of good quality are found associated with the crystalline schists throughout the whole of Togoland, and have been worked in many places formerly by the natives. Now, however, iron smelting is confined to the provinces of Basari and Boem. In Basariland the ore is found in lenticular masses interbedded with quartzites and forming numerous isolated hills up to 250 metres high. The most important of these are the iron mountains of Banyeri, Kabu and Basari. At Banyeri the ore is a massive haematite pierced now and again by threads of quartz and weathered superficially to a dark red laterite. The ore gives on analysis 98·43 per cent. ferric oxide (Fe_2O_3), 1·54 per cent. silica (SiO_2), and 0·03 per cent. phosphoric oxide (P_2O_5). In Boem the ore occurs in a similar manner. In Adele, near Bismarckburg, all gradations can be traced from quartz schists with disseminated haematite, through itabiritic quartz schists to true itabirites or haematite schists.

In this connection Dr. von Ammon proceeds to discuss the question of the possibility of finding gold in Togoland. In the Gold Coast Territories adjoining Togoland, haematite-bearing gneisses, quartzites and itabirites carry, according to Gumbel (*Beitrag zur Geologie des Schutzgebietes Togo:* Berlin, 1898), finely divided gold. Similar rocks are now described from Togoland for the first time, and are apparently widely distributed throughout the central range. The fact that the latter is apparently the continuation of the Gold Coast range increases the probability of gold being found in the Togoland schists. Dr. von Ammon, however, has so far found no trace of gold in the samples he has examined, and although these show a very great superficial resemblance to specimens of gold-bearing schists from the Gold Coast in his possession, the microscope reveals certain differences in structure, the importance of which can only be ascertained by an examination of a greater number of specimens.

Dr. von Ammon points out further that there is an unfortunate discrepancy between the views of German and English observers upon the actual mode of occurrence of the gold on the Gold Coast. Gumbel, as already mentioned, refers the gold to the quartzites and itabirites. McCarthy (*Mining Journal*, July, 1882), on the other hand, is of opinion that the gold is principally concentrated in a series of quartz reefs which cut the older schists, that these reefs have arisen along fault lines striking approximately north and south, and that a dioritic rock is always associated with the more productive reefs. Dr. von Ammon expresses the hope that the time may soon come when a capable geologist will be sent out to the British Gold Coast Colony to obtain some reliable information upon the nature of the gold-bearing rocks in that part of West Africa. In the meantime he urges that attention should be directed not only to the itabiritic quartzites of Togoland, but also to hornblendic rocks and quartz dykes, especially when these follow a N. to S. elongation.

In the appendix, Dr. von Ammon has some interesting notes on the production of salt in West Africa. On the Guinea coast the natives have long been accustomed to manufacture their own salt from sea water. In Togoland the amount produced is small on account of the unsuitability of the coast formation. The lagoons of the French Dahomey coast produce a considerable quantity of salt, but the principal place for its manufacture on the Slave Coast is the great Kitta lagoon in British Territory between Lome and the mouth of the Volta.

OCCURRENCE AND USES OF CORUNDUM.

As many inquiries relating to corundum have been received recently at the Imperial Institute, it has been considered desirable to give in the *Bulletin*, a brief account of the occurrence and uses of this mineral.

PROPERTIES OF THE MINERAL.

Corundum crystallises in the hexagonal system, the commonest forms being six-sided pyramids and prisms. It may be colourless or red, blue, yellow, green, purple, or almost black. Its specific gravity is usually about 4, and in hardness it is inferior only to the diamond among minerals, being 9 in Moh's scale. When fresh and pure, its lustre and fracture are similar to those of ordinary glass, excepting that the lustre is more brilliant, approaching somewhat to the adamantine lustre of the diamond. When coloured it shows a striking dichroism, being deeply coloured when viewed along the direction of the vertical axis, and paler-coloured when viewed at right angles to this direction. In consequence of this dichroism the red variety (ruby) can be distinguished readily from garnet and spinel, which sometimes resemble it in appearance. Its refractive index is fairly high (1·76), and its birefringence low (about 0·009).

Corundum crystals often show "twinning" on the rhombohedral faces, in consequence of which they exhibit a kind of cleavage parallel to these faces; but as this cleavage does not occur on untwinned crystals, it is called a pseudo-cleavage or a "parting." A pseudo-cleavage or "parting" may also arise along the basal plane as the result of alteration. These "partings" are often of service in helping to identify the mineral. They are also of great importance in connection with its commercial value. A crystal of fresh, untwinned corundum breaks with either an irregular or a shelly fracture, and this is the mode of fracture best adapted for mechanical purposes. If the mineral is permeated with parting planes, it splits along these and forms small platy fragments of low abrasive efficiency; and in this condition it is also valueless for boring with a view to its use in wire-drawing and in making watch jewels.

Corundum is infusible in the blowpipe flame; and its powder assumes a blue colour when moistened with cobalt nitrate and intensely heated before the blowpipe.

The pure mineral consists almost entirely of anhydrous alumina (Al_2O_3), with generally two or three per cent. of a mixture of silica, ferric oxide and water. The crude corundum of commerce, however, is often impure, and may contain appreciable quantities of magnetite, haematite, spinel, garnet and other minerals.

OCCURRENCE.

Corundum is now known to be very widely distributed, and occurs in nearly all varieties of igneous and metamorphic rocks. It is seldom, however, that the rocks contain sufficient of the mineral to pay for crushing and concentration. The igneous rocks from which it is most abundantly mined for abrasive purposes are syenites and peridotites, of which the syenites are the more important. In these rocks the corundum occurs in the form of comparatively large, well-formed and fairly pure crystals, which are of primary origin, having crytallised out from magmas containing an excess of alumina. The principal mineral associated with the corundum in syenites is felspar, while in peridotites the associated mineral is mainly olivine. Among metamorphic rocks, corundum occurs principally in schists and crystalline limestones. In these it is sometimes of primary and sometimes of secondary origin.

It has been suggested that corundum may arise from the alteration of lime-felspars, and this explanation has been given to account for the origin of the rubies in the crystalline limestone of Burma. It is also supposed that corundum arises as a secondary mineral from the metamorphism of bauxitic shales. In this connection it is interesting to note that corundum can be made artificially by subjecting bauxite to a high temperature in the electric furnace.

Corundum also occurs in certain alluvial sands and gravels derived from igneous and metamorphic rocks by the various processes of weathering and denudation, and deposited in stream beds or river valleys. In these gravels it occurs in association with other minerals which resist decomposition, such as quartz, zircon, spinel, garnet, etc. Nearly all the gem corundum of commerce is obtained from such gravel deposits.

VARIETIES OF CORUNDUM AND THEIR DISTRIBUTION.

The different varieties of corundum may be classified into

(1) Those used for making gems.

(2) Those used as abrasives, including (*a*) corundum proper and (*b*) emery.

Gem Corundum.

For gem-making it is important that the mineral should be transparent or opalescent, free from flaws, and possess the correct shade and depth of colour. Specimens possessing all these qualities are rare, and, as already mentioned, they are usually obtained from gravels. The following list from Bauer's *Precious Stones*, translated by L. J. Spencer, shows the varieties of corundum gems in use and the names by which they are generally known :—

Variety.	*Colour.*
Ruby ("Oriental ruby")	Red.
Sapphire ("Oriental sapphire")	Blue.
Leuco-sapphire	Colourless.
"Oriental aquamarine"	Light-bluish-green.
"Oriental emerald"	Green.
"Oriental chrysolite"	Yellowish-green.
"Oriental topaz"	Yellow.
"Oriental hyacinth"	Aurora red.
"Oriental amethyst"	Violet.

Of these the best known and most popular varieties are the ruby and sapphire, which generally occur in association with each other, but of the two the ruby is rarer, and on that account more valuable. In the case of the sapphire, the price *per carat* is independent of the size of the gem ; but in the case of the ruby, the price of large stones is proportionately much higher than that of small ones. The principal sources of ruby and sapphire, in quantity as well as quality, are Burma and Siam, where the mineral occurs in crystalline limestone, though it is principally mined in surface gravel. In Burma the ruby is the more abundant of the two varieties, while in Siam the sapphire is more common. Other localities of importance in the production of ruby and sapphire are Ceylon, Kashmir in India, various parts of Australia, particularly New South Wales, and Montana in the United States.

The other varieties of gem corundum mentioned in the above list are comparatively rare and occur sporadically in association with ruby and sapphire.

A considerable amount of gem corundum of inferior quality is used for making the jewelled bearings of watches and various electrical instruments; and a small amount is also used for wire-drawing. For these purposes, colour and transparency are of little account, and all that is necessary is that the mineral should be pure, free from parting planes, and break with a conchoidal fracture. Kunz states that from ten to twenty millions of watch jewels are sold annually.

The method of winning gems from the surface gravels in which they occur is usually very simple. The gravel is excavated and carried off in baskets by men working in small parties of three or four. It is then washed to free it from earthy matter and the lighter ingredients, after which the gems are picked out by hand. Recently, however, hydraulic separators have been introduced into Burma, and attempts are being made to wash the gravel on a larger scale.

Abrasives.

There are two sorts of corundum of commercial importance as abrasives, having different characters and modes of occurrence.

(a) *Corundum proper.* This is the variety which has already been referred to as occurring in the form of comparatively large and well-formed crystals in coarse-grained igneous rocks, of which the most important are syenites and peridotites.

The province of Ontario, in Canada, is the principal source of this variety of abrasive. Here the parent rock is a syenite, which occurs in the form of veins and occasional bosses intrusive in gneiss. The corundum is disseminated through the syenite in crystals of considerable size and purity; analyses of the crude rock as mined show a variation from 5 per cent. to 15 per cent. of corundum.

Corundum syenites, somewhat similar to those of Ontario, are also successfully mined in Montana, United States of America.

A considerable amount of corundum is also mined in various parts of Northern Carolina and Georgia, United States of America. Here the mineral occurs as veins and border segregation in peridotites, which are intrusive in gneisses. The corundum is always most abundantly developed in the contact region, and in some cases occurs in masses of very large size. These large masses are commonly called "block corundum," and they are comparatively difficult to mine, as they are very hard and compact. On this account corundum mining in peridotites is not so successful as that in syenites.

Abrasive corundum is somewhat widely distributed in India, both in acid and basic rocks; but it is nowhere mined on a large scale, and the trade is at present small and insignificant.

An account of the corundum found in the Kinta District of Perak in the Federated Malay States has already been given (this *Bulletin*, 1904, **2**. 229). This variety is suitable for use as an abrasive.

(b) *Emery*. This occurs as compact impure masses in which the corundum is permeated by iron ores, spinel and other impurities. The principal localities from which it is obtained are Naxos Island in the Grecian Archipelago, and various parts of Asia Minor. From these places the material is collected at Smyrna and shipped to all parts of the world. In the localities mentioned the emery occurs as irregular or lenticular masses associated with metamorphic limestones of Archean age. In many cases the limestones have been disintegrated by weathering, and blocks of emery have been left behind in the residual soil from which they are readily mined.

Other important localities where emery is obtained are Peekskill, New York, where it occurs in norites, and Chester, Mass., where it is associated with amphibolites and schists. Much of the United States emery is obtained from these localities, but there is severe competition between it and the material imported from the East.

EXTRACTION.—In some cases corundum is mined in a fairly pure condition, and after crushing, may require little or no dressing to prepare it for the market. This is the case with the veins and blocks, which occur in peridotites.

In other cases, as with emery, although the crushed ore is impure, it has often to remain in this condition, as the impurities are mixed with the corundum too intimately to permit of separation.

With syenite, however, the crushed rock is very impure, and may contain not more than 5 or 10 per cent. of corundum. In this condition it would be practically of no use as an abrasive, and it is necessary to subject the crushed rock to various processes in order to get rid of the felspar and other impurities. In Canada the crushings are first screened to secure uniformity of grade, and then washed. By this means the felspar and mica are mostly got rid of. The residue of corundum and other heavy minerals is then dried and afterwards submitted to electro-magnetic treatment to eliminate the iron ores, hornblende, etc. The non-magnetic residue of corundum thus obtained contains very little impurity.

The Canadian material marketed has a value ranging from twenty to twenty-five shillings a ton, according to quality. Ordinary emery, such as that from Naxos, is much inferior to this in quality, and has a value of only about sixteen shillings a ton.

USES.—Corundum is used as an abrasive for a variety of purposes, sometimes in a powdered form, or in the form of emery paper, and sometimes in the form of abrasive wheels, discs or bricks. Corundum wheels are made by cementing corundum grains of uniform size into a compact mass. The grade of corundum used and the size and shape of the wheel depend on the purpose for which it is to be applied. Three varieties of corundum wheels are made: (1) *Vitrified wheels.* In these the cementing medium is a prepared clay, in which the corundum grains are thoroughly mixed, the whole mass being gradually heated in a furnace up to about 3,000°, at which temperature the clay fuses, and on cooling makes a strong bond. For this purpose it is important that the corundum used should be free from readily fusible minerals, such as garnet. (2) *Chemical wheels.* In these sodium silicate is the binding medium. (3) *Cement wheels.* These are softer, the binding material consisting of shellac, rubber, or other feeble cementing medium, according to the purpose for which it is required. Other substances used for abrasive purposes are (1) "alurundum" (artificial corundum) made at Niagara by heating bauxite in the electrical furnace; (2) "carborundum," also made electrically; and (3) crushed steel. Between these artificial substances and natural corundum there is much competition.

CLASSIFICATION OF COALS.

THE gradation of one form of natural fuel into another, such as is seen in the passage of lignite through bituminous lignite to non-caking bituminous coals, and again of bituminous coals into anthracite, suggests a relation between the varieties, which is seldom noticed under the system of classification now in use, which divides fuels roughly into five varieties, as follows:—

WOOD.

Wood and the remains of plants consisting principally of cellulose may be considered as the substance from which all fuels are originally derived. The mean composition of the organic matter of well-dried wood is:—

	Per cent.
Carbon	50·0
Hydrogen	6·0
Oxygen	42·0
Nitrogen	2·0
Ash	1·2 to 2·3

Air-dried wood, containing 20 per cent. of moisture, is classed as "hard" or "soft" according as its specific gravity is above or below 0·55. Wood is readily combustible and gives a long flame, but the calorific intensity is small, and the large amount of hygroscopic water it holds renders it unsuitable as a fuel where high temperatures are required.

PEAT.

This may be considered as the first product resulting from the decay of plant tissue. It is formed in the temperate zones hiefly from the decay of the mosses *Sphagnum* and *Hypnum*.

The composition of the organic portion of peat varies considerably according to its age, and from data collected by the late Professor Roberts-Austen may be considered to lie between the following figures:—

	Per cent.		Per cent.
Carbon	49·6	to	63·9
Hydrogen	4·7	„	6·8
Oxygen	28·6	„	44·1
Nitrogen	0·0	„	2·6

Good air-dried peat generally contains about 25 per cent. of hygroscopic water, and the ash varies greatly, but is rarely below 8 per cent. Air-dried peat has a calorific value of 3,000 calories or less, but prepared peat and briquettes, the form in which this fuel is now generally used (this *Bulletin*, 1905, **3**. 166), may go considerably above this figure. The specific gravity varies according to the state of preparation from 0·113 to 1·039.

LIGNITE OR BROWN COAL.

This occupies an intermediate position between peat and bituminous coal, and is the characteristic fuel of the tertiary period. Four distinct classes are met with, viz.—(1) *fossil wood or fibrous brown coal* (German lignite); (2) *earthy lignite*, without structure and with an earthy fracture; (3) *conchoidal lignite*, without any distinct vegetable structure and with a conchoidal fracture; (4) *bituminous lignite*, a black shining fuel sometimes resembling anthracite in appearance and having a conchoidal fracture.

When freshly raised, lignites may contain as much as 33 per cent. of moisture, but they lose half this amount when air-dried. The proportion of ash varies from 3 to 30 per cent. The mean composition of the various lignites is as follows:—

VARIETY.	Carbon. Per cent.	Hydrogen. Per cent.	Oxygen. Per cent.	Calorific power. Calories.
Fibrous	57 to 67	5 to 6	28 to 37	5000
Earthy	45 ,, 70	5 ,, 6	25 ,, 30	5700
Conchoidal	65 ,, 75	4 ,, 6	21 ,, 29	6500
Bituminous	70 ,, 80	6 ,, 8	12 ,, 24	7000

The first three types only are useful in metallurgical processes, the fourth being used largely for the production of tar and gas.

COALS.

These are generally of greater age than lignites, and have been subjected to greater pressure. They are distinguished by their black shining lustre and streak, greater density, and the smaller proportion of water yielded on distillation. They are generally more friable, the fracture is more lamellar, and they are less hygroscopic. The specific gravity of good coal varies from 1·2 to 1·4. Coals may be classified according to the length of flame and the character of the residue they leave when subjected to destructive distillation. In the classification of Grüner they are divided into five types as follows:—

(1) *Non-caking coals with long flame.* These most nearly approach the lignites, and when subjected to dry distillation leave 55 to 60 per cent. of pulverulent carbonaceous residue (coke). The composition varies within the following limits, exclusive of ash:—

	Per cent.		*Per cent.*
Carbon	75	to	80
Hydrogen	4·5	"	5·5
Oxygen, Nitrogen	15·0	"	19·5

The ratio of oxygen to hydrogen varies from 3 to 1, or 4 to 1. The calorific value is from 8,000 to 8,500 calories.

(2) *Caking, long flame, gas coal.* These coals give off 32 to 40 per cent. of "volatile matter" on distillation, leaving 60 to 68 per cent. of a friable, porous coke. The calorific power varies from 8,500 to 8,800 calories, and the composition lies within the following limits:—

	Per cent.		*Per cent.*
Carbon	80	to	85
Hydrogen	5	"	5·8
Oxygen, Nitrogen	10	"	14·2

The ratio of oxygen to hydrogen is 2 : 1 or 3 : 1.

(3) *Bituminous or Furnace coal.* Varieties of this coal soften and intumesce in the fire, leaving 68 to 74 per cent. of swollen coke, and giving off 15 to 16 per cent. of gas. The calorific value is 8,800 to 9,300 calories, and the composition as follows:—

	Per cent.		Per cent.
Carbon	84	to	89
Hydrogen	5	"	5·5
Oxygen, Nitrogen	5·5	"	11

The ratio of oxygen to hydrogen ranges from 1 : 1 to 2 : 1.

(4) *Caking coals, with short flame.* These coals yield 12 to 15 per cent. of gas, and leave 74 to 82 per cent. of compact coke on distillation. The calorific value is from 9,300 to 9,600, and the composition as follows:—

	Per cent.		Per cent.
Carbon	88	to	91
Hydrogen	4·5	"	5·5
Oxygen, Nitrogen	5·5	"	6·5

The ratio of oxygen to hydrogen is 1 : 1.

(5) *Anthracitic coals.* These burn with a short flame, producing very little smoke, and include the so-called "steam coals." They are found in South Wales and Pennsylvania. On heating they leave 82 to 92 per cent. of pulverulent coke, and yield 8 to 12 per cent. of gas. Their calorific value varies from 9,300 to 9,600 calories, and the composition lies between the following limits:—

	Per cent.		Per cent.
Carbon	90	to	93
Hydrogen	4	"	4·5
Oxygen, Nitrogen	3	"	5·5

The ratio of oxygen to hydrogen is about 2 : 3.

ANTHRACITE.

This, or graphite, is the ultimate product of the action of pressure and age on vegetable matter. Its colour is jet black, and it has a characteristic and shining lustre. It burns without flame, and in Pennsylvania is used in the manufacture of pig iron. It yields on distillation only 3 to 7 per cent. of volatile matter. The calorific value is about 8,000 calories, and the composition as follows:—

	Per cent.		Per cent.
Carbon	93	to	95
Hydrogen	2	"	4
Oxygen, Nitrogen	3·0		

The above classification, it will be seen, is dependent on the physical characteristics, such as colour, density and structure, and the behaviour of the coal when burnt.

CLASSIFICATION ACCORDING TO COMPOSITION.

There is a general gradation in the chemical composition of the fuels from wood to anthracite, showing an increasing percentage of carbon, a decreasing percentage of oxygen, a general increase in calorific value, and a decrease in moisture. Attempts, which have not proved very successful so far, have been made to classify fuels according to their composition. The latest effort in this direction is that of Mr. M. R. Campbell, and is the outcome of a systematic series of tests of American coals, carried out at the Louisiana Purchase Exposition, during the summer of 1904 (*Geol. Survey U.S.A. Professional Paper*, No. 48).

The general results obtained are briefly as follows :—

One of the characteristic features of lignite is the large percentage of *moisture* it contains, and it has been proposed that fuel having a larger percentage of moisture than 10 per cent. should be classed as lignite. The method, however, fails in practice, because certain black lignites contain less, and some bituminous coals rather more than this amount.

The relation of the *fixed carbon* in fuels found in proximate analyses of American coals was found to show a gradually increasing percentage, and an arrangement on this basis proved useful, except in the lower grades of fuel. Of those quoted the figures vary from 34 per cent. for brown lignite to 89 per cent. for anthracite.

An arrangement according to *calorific value* would place some of the highly bituminous coals, rich in hydrogen, above the anthracites.

The only classification based on composition found to be workable was the ratio of the percentages of carbon and hydrogen, which is expressed, as a group index number, by the quotient of the percentage of carbon by the percentage of hydrogen.

The utility of this system will be seen best by quoting some of the results.

Name of Sample.		*Name of coal bed or field.*	*Carbon-hydrogen ratio.*
Pennsylvania.	No. 3.	Groups A (∞) B (to 30) C (30? to 26?) (Anthracite)*	26·7
		Group D (*semi-anthracite* 26? to 23)* *Not represented*	
		Group E (*semi-bituminous* 23 to 20)*	
Arkansas.		Shadra bed	20·7
		Group F (*bituminous* 20 to 17)*	
West Virginia.	No. 11.	Pocahontas bed	19·6
,, ,,	No. 6.	New River field	17·8
		Group G (*bituminous* 17 to 14·4)*	
West Virginia.	No. 4.	Upper Freeport bed	16·1
,, ,,	No. 2.	Pittsburg bed	14·4
		Group H (*bituminous* 14·4 to 12·5)*	
Indian Territory.		Hartshorne bed	14·3
Missouri.	No. 4.	Morgan county	12 6
		Group I (*bituminous* 12·5 to 11·2)*	
Iowa.	No. 2.	Marion county	12·4
,,	No. 5.	Lucas county	11·2
		Group J (*lignite* 11·2 to 9·3)*	
New Mexico.	No. 1.	Black lignite, Gallup field	11·2
Texas.	No. 1.	Brown lignite, Houston county	9·4
—		Group K (*peat* 9·3 to ?)*	
			9·1
—		Group L (*wood cellulose* 7·2)*	

* *The figures in brackets are the proposed group index numbers.*

Only the highest and lowest figures of each group are quoted, and in each group is given the term at present in vogue, and the proposed ratio which is to determine to which class a coal belongs. With American coals the results are said to be entirely satisfactory, and the classification (of which a portion is quoted above), to be usual. The author, therefore, proposes "the carbon-hydrogen ratio as the basis of a new scientific classification of coals, which is applicable to all varieties from the highest class of anthracite to the lowest grades of brown lignite and peat."

He concludes by stating that the evidence upon which the scheme is based is not sufficient for its final acceptance, but it is put forward in a tentative way as a basis for further investigation.

A method of classification based on chemical composition rather than on physical characters is fundamentally sound, but the crucial test of its suitability will lie in the possibility of applying it to coals of different countries. At the first glance the variations in the ratios for brown coals appear small (when the number of varieties is considered), compared with the differences shown by the several classes of bituminous coals.

The separation by means of fractions of a unit seems hardly necessary when the variation in the ratio of the following analyses are considered. As far as bituminous and anthracitic coals are concerned, the method on the whole classifies the British varieties fairly well. The exceptions occur in coals in which, while the percentage of oxygen is normal, the hydrogen is from half to one per cent. above the normal, as often occurs in gas coals. In such cases the ratio is reduced below the correct values for such coals to a figure too near the value for lignites. In the ratio given for lignites in the American tables this failure is not so evident, but in the values obtained for European varieties the two classes (lignites and bituminous coals) are brought within the same division, and, in fact, overlap.

Whilst the valuable fuel constituents of a coal are carbon and hydrogen, it is the percentage of oxygen in the fuel that indicates and determines its character. A ratio suitably combining the oxygen figure would eliminate the difficulty mentioned above. By dividing the percentage of carbon by the sum of the percentages of hydrogen and oxygen, the influence of oxygen would at once be seen in the new value. This is brought out clearly in the following table:—

Locality.	Carbon. Per cent.	Hydrogen. Per cent.	Oxygen. Per cent.	Ratio. Carbon. / Hydrogen.	Ratio. Carbon. / Hydrogen. Oxygen.
Lignite or brown coal.					
Thallern, Austria	65·15	5.05	29·80	12·9	1·87
Riestedt, Prussia	62·27	5·18	32·55	12·0	1·65
Wettenberg on the Oder .	66·29	5·20	28·51	12·7	1·96
Hessen Cassel	66·49	5·33	28·18	12·4	1·98
Cannel coal.					
Wigan	80·07	5·53	8·10	14·5	5·87
Tyneside	78·06	5·80	3·12	13·4	8·74
Boghead	65·72	9·03	4·78	7·3	4·76
Bituminous.					
Scotch: Wellwood . . .	81·34	6·28	6·37	12·9	6·51
Kilmarnock, Skerrington.	79·82	5·82	11·31	13·7	4·66
Eglington.	80·08	5·50	8·05	12·3	5·50
Lancashire: Ince Hall, Pemberton Yard . . .	80·47	6·68	7·53	12·9	5·66
Newcastle, Haswell, Walls-end	83·47	6·68	8·17	12·5	5·62
Anthracitic coals.					
Welsh, Nixon's Merthyr. .	90·27	4·12	2·53	21·8	13·6

The above analyses are specially chosen as showing the defects of the proposed carbon-hydrogen ratio and the separation at once effected even in the most difficult case, *e.g.*, Boghead Cannel Coal, by the inclusion of oxygen in the ratio is apparent. On the $\frac{\text{Carbon}}{\text{Hydrogen} + \text{Oxygen}}$ ratio, the values of the determining constant would be approximately as follows:—

Peat	1·0 to 1·5
Brown coal (lignites) . .	1·5 to 4·0
Bituminous coal . . .	4·0 to 8·0
Anthracitic coal . . .	9·0 to 13·0
Anthracite	13·0 to 19·0

GENERAL NOTES.

Fibre of Nannorhops Ritchieana from India.—A sample of fibre, obtained from the leaves of a dwarf palm, *Nannorhops Ritchieana*, known as "Mazari," which grows abundantly in the Kuram Valley, Baluchistan and Sind, has been received recently at the Imperial Institute, and examined in the Scientific and Technical Department. The fibre is said to be largely employed in India for the manufacture of rope, whilst the leaves are made into baskets, mats, fans and other articles.

The sample consisted of pale greenish-brown fibre, which was rather coarse, non-lustrous, harsh to the touch, not very well cleaned, and about 2 feet 3 inches long.

The strength of the material was somewhat inferior to that of Sisal hemp and similar fibres of average quality.

On chemical examination the fibre yielded the results which are given in the following table. The corresponding figures furnished by a sample of a somewhat similar fibre from Victoria, derived from the leaves of *Dracaena Draco*, which has also been examined in the Scientific and Technical Department, are added for comparison:—

	Nannorhops Ritchieana from India. *Per cent.*	*Dracaena Draco* from Victoria. *Per cent.*
Moisture	10·3	11·2
Ash	2·0	1·7
α-Hydrolysis (loss)	14·2	18·6
β-Hydrolysis (loss)	20·7	22·1
Acid purification (loss) . . .	3·8	10·0
Cellulose	65·2	69·2
Length of the ultimate fibre	1·1–2·5 mm. (0·04–0·1 inch).	1·5–2·5 mm. (0·06–0·1 inch).

These results show that the *Nannorhops* fibre resembles that of *Dracaena* in general chemical behaviour and composition, but contains a somewhat lower proportion of cellulose. The product is evidently not a fibre of very high quality, since, like the *Dracaena* fibre, it suffers considerable loss when boiled with dilute alkali (a- and β-hydrolysis), and is particularly poor in cellulose. It must be remarked, however, that the fibre would probably yield rather more satisfactory results if it were more carefully prepared.

Commercial experts to whom the sample was submitted reported that the product was a dry, harsh fibre, of poor, dull colour, of doubtful spinning quality, fairly strong but brittle, and probably worth from £12 to £15 per ton in the London market.

It is evident, therefore, that the fibre of *Nannorhops Ritchieana* is not of very promising quality, although perhaps more carefully prepared specimens would exhibit somewhat better characters than those of the present sample.

Although the fibre is doubtless very serviceable to the natives, it appears to possess no distinctive property which would render it of value for any special purpose, and consequently it is not very likely that it would be able to compete successfully with the many superior fibres produced in India.

Ostrich Feathers from British East Africa.—A number of samples of ostrich feathers have been received recently at the Imperial Institute from British East Africa for valuation. The first set of samples was received early in 1905. These were collected from birds shot on the Athi plains. They consisted of a number of large white feathers and several small dark-brown ones. The samples were submitted to commercial experts, who divided them into four classes valued at 160, 140, 70, and 20 shillings per pound respectively. A second set of samples was received towards the end of last year. These consisted of dark-coloured feathers of various lengths. They were divided by commercial experts, to whom they were submitted for valuation, into three classes, valued at 90, 35 and 20 shillings each respectively.

Leaves and Fruit of the Baobab Tree.—Samples of the leaves and fruits of this tree (*Adansonia digitata*) have been sent recently to the Imperial Institute by the Governor of Sierra Leone in order to ascertain if they are likely to be of value in medicine. The leaves are stated to be employed by the natives as a prophylactic against fevers during the rains: also to check excessive perspiration and as an astringent. The pulp surrounding the seeds is employed in native medicine in the treatment of fevers and in dysentery.

The leaves were examined in the Scientific and Technical Department, and found to contain sodium chloride, potassium acid tartrate and tannin, and it is no doubt to the presence of these three constituents that the medicinal value of the leaves is due.

The pulp surrounding the seeds in the fruit was also examined and found to contain free tartaric acid, potassium acid tartrate, and in addition a large quantity of mucilaginous matter. These results confirm and extend the observations of several previous investigators who have examined the fruit pulp of the baobab and related trees. Heckel and Schlagdenhauffen (*Nouveaux Remèdes*, 1888, p. 385) first observed the presence of tartaric acid and potassium acid tartrate in the pulp, and more recently Walter (*Arbeiten aus Pharm. Inst. Berlin*, p. 343) has confirmed this observation. It is interesting to note that Slocum (*Amer. Journ. Pharm.*, 1877, p. 254) found that the fruit pulp of a closely related tree, probably *Adansonia madagascariensis*, contained potassium acid malate in place of tartrate, and this was subsequently confirmed by Millard (*Pharm. Journ. Trans.*, 1890, p. 829).

The leaves, fruit and bark of the baobab have from time to time been suggested by medical men as suitable for use in medicine, but no development of this kind has taken place, and although these drugs are no doubt suitable for local use it is difficult to see how a market could be found for them in Europe, where several well-known drugs having similar properties are already in common use.

Native Drugs from Uganda.—Two samples of barks collected by Mr. M. T. Dawe, of the Scientific and Forestry Department, Uganda, were sent to the Imperial Institute early in 1904, with a view to their investigation. They have been subjected to a preliminary examination in the Scientific and Technical Department, and have given the following results :—

Musali bark.—A botanical specimen of the tree yielding this bark, which was supplied by Mr. Dawe, was identified at the Royal Gardens, Kew, as *Garcinia Buchanani.*

The bark was found on chemical examination to contain the following constituents :—

1. An inert, insoluble resin, which was devoid of taste, and probably possessed no physiological action.
2. A substance possessing the properties of a phlobaphene or tannin anhydride.
3. An amorphous tannin-like substance.
   The amount of these two substances (Nos. 2 and 3) taken together, present in the plant is 19 per cent.
4. Gummy and brown extractive matters.

Of these substances the tannin-like material alone seemed to be worth further examination. Its composition is represented by the formula $C_{19}H_{18}O_{10}$. It furnishes a microcrystalline *pentacetyl* derivative $[C_{19}H_{13}O_{10}(CO.CH_3)_5]$ which melts at 160°–162° C. On fusion with caustic potash the tannin yields protocatechuic and acetic acids. When boiled with dilute mineral acids it undergoes condensation yielding a phlobaphene apparently identical with that contained in the bark.

No traces of any substance of an alkaloidal or glucosidal nature could be found in the bark.

"Musali bark" is said to be employed by the natives of Uganda as a diuretic, but it is difficult to understand how it can possess diuretic properties in view of the fact that its principal constituent is a tannin.

Some experiments were made to ascertain whether the bark could be used as a tanning agent, but it was found that the tannin of the bark was only slowly absorbed by hide, and that consequently the material would be of little or no value for this purpose.

Moosa bark.—The botanical specimen of the tree yielding this bark was identified at the Royal Gardens, Kew, as probably derived from *Kigelia Moosa.*

The powdered bark is said to be used by the natives as an application to sores.

The bark is sweet and devoid of any bitter or nauseous taste and is without odour. No alkaloid or glucoside or similar substance likely to be of medicinal value could be detected in it, but the bark contains an unusual quantity of sugar (dextrose), namely 10·5 per cent.

Production of Prussic Acid by Plants.—The current number of the *Proceedings of the Royal Society* (1906, Vol. 78 B., p. 145–158) contains two papers by Professor Dunstan, Dr. Henry and Dr. Auld, embodying the results of further investigations on this subject which have been conducted in the Scientific and Technical Department of the Imperial Institute. The first of these is entitled "The Occurrence of Phaseolunatin in Common Flax (*Linum usitatissimum*)," and the second, "The Occurrence of Phaseolunatin in Cassava (*Manihot utilissima*)." A general account of the results of these and other investigations recently conducted at the Imperial Institute on this subject will be given in the next issue of the "Bulletin."

The Venezuelan Pearl Fisheries.—The fisheries are carried on in the coastal districts of the state of Bermudez in the eastern part of the Federal district, particularly between Cumana and Carupano, and along the coasts of the Islands of Margarita, Coche and Cubagno.

From the earliest times of the Spanish conquest, Spaniards were more or less actively engaged in this industry, but the fisheries were abandoned at the beginning of the eighteenth century, and it is only since 1895 that they have been revived.

The oysters are collected either by divers or by an implement known as the "arrastra." The latter is a small drag, provided with a net, into which the oysters fall as they are detached by the drag. This implement is drawn over the oyster beds by small sailing-boats, each of which uses two "arrastras" and is manned by a crew of four or five. The diver's dress owing to its relatively great cost is used only to a limited extent. Fishing is carried on all the year round at depths not exceeding 40 metres.

A boat furnished with two "arrastras" can collect in a day four or five bags of oysters; a diver in the same period can obtain as many as 15 bags. The weight of a bag of oysters is about 50 kilograms.

Between four and five thousand men are occupied in the fisheries, and the number of vessels employed is estimated at 1,000. The proceeds are easily disposed of to the pearl buyers, Syrians for the most part, who purchase them on the spot.

Venezuelan pearls are white, usually with a yellowish reflection. The pearls, without any sorting, are sold at rather more than 3 bolivars a carat. The finest pearls may fetch from 3,000 to 4,000 francs each. Since 1899 the Government has levied an export duty of 50 bolivars per kilogram. (25 bolivars are equal to £1.)

According to the official statistics the exports of pearls during the fiscal year 1903–04 amounted to 301, 147 grams, valued at 1,432,047 bolivars. The exports went almost exclusively to Paris and London. The figures given are probably less than the quantity really exported, as contraband exports are said to take place on a considerable scale.

In accordance with a law of the 16th July, 1903, every pearl fisher must obtain a licence or patent, which is issued monthly and varies in cost according to the method of fishing employed. Each boat fishing by means of the "arrastra" pays 30 bolivars. A diver's licence costs 100 bolivars.

Geology of British New Guinea.—In *The Salient Geological Features of British New Guinea*, a paper read by A. Gibb Maitland, Esq., before the Western Australian Natural History Society, on the 11th April, 1905, the succession of rocks in this Colony, so far as they are at present known, is stated to be as follows :—

Quaternary .	Kevori Grits . . .	Grits, sandstones and conglomerates.
Tertiary (*Pliocene*)	Port Moresby Beds.	Greenish sandy shales, limestones and siliceous beds.
(?)	Boioro Limestones .	Greyish limestones.
Cretaceous . .	Purari River Beds .	Blue limestones and green sandstones.
Jurassic . . .	Strickland River shales	Indurated calcareous shales.
Devonian . .	Tauri Limestone.	
	Crystalline schists and other Metamorphic rocks.	

One of the most striking characters of the deposits is the extent to which limestones are developed. In some cases these rest directly on the schists, in others on igneous rocks. The latter are also interstratified with the limestones. Volcanic action has continued down to the present time.

Gold-bearing quartz veins are met with in the crystalline schists. In their general character the rocks of the auriferous country are believed to resemble those of the goldfields of Northern Queensland.

The Utilisation of Rare Earths and Metals in Electric Glow Lamps. —Considerable developments have taken place recently in the introduction of new materials for use as filaments in incandescent electric lamps. One of the most interesting of these is the use of a mixture of zirconia and yttria earths as "glower" in electric lamps of the Nernst type.

The composition of the "glower" is roughly zirconia, 85 per cent., and yttria earths 15 per cent. The source of the former is the mineral zircon (zirconium silicate), which contains the equivalent of about 65 per cent. of the oxide. The zirconia is separated from the other constituents of the mineral by a special process, which yields the oxide in a suitable physical condition.

The sources of the yttria earths are the minerals yttralite and gadolinite. In practice it is found that the yttria earths possessing the highest atomic weights give the best results as "glowers," but owing to the difficulty and expense of isolating these various earths, nothing is done commercially beyond giving preference to supplies of the mineral rich in the earths of high atomic weight. The yttria earths are separated from the other constituents of the crude minerals employed, in the form of their oxides. In preparing the rods of filaments, a mixture is made containing yttria earths 15 parts, zirconia 85 parts, and starch 5 parts, this is kneaded into a hard dough and squirted by pressure through a die. The "strings" thus produced are broken up into suitable lengths and roasted at a white heat in a platinum box and are then ready for attaching to the lamp terminals.

Among the various metals which have recently been experimented with for use as "glowers" in electric lamps is the comparatively rare metal tungsten. This subject has occupied the attention of several investigators in Germany, notably Dr. Just and Dr. Kuzel.

The process devised for its use by the former is based upon the fact that when carbon filaments coated with tungsten are heated *in vacuo*, combination takes place between the carbon and the metal with the formation of a carbide, and that the carbon can subsequently be removed from the carbide, leaving a filament of metallic tungsten. The filament of tungsten carbide first produced is stated to be quite homogeneous, and no carbon core can be detected at the point of fracture. The process of manufacture is as follows: Carbon filaments 0·02 to 0·06 mm. in diameter are submitted to the action of the electric current in an atmosphere of tungsten chloride and hydrogen. By this means metallic tungsten is evenly deposited on the carbon. When sufficient metal has been deposited, the filament is heated by an electric current to incandescence in a rarefied atmosphere of hydrogen, thus causing the formation of the carbide referred to above.

The carbon is now removed by heating the filament of carbide in an atmosphere of steam and reducing gases by means of the electric current. The filament of metallic tungsten remaining is fused into glass bulbs in the usual way.

In the process devised by Dr. Kuzel, colloidal solutions of the metal are used and the filament is produced by the ordinary "paste" process. Recent tests of tungsten filaments made by Dr. Kuzel's process on 30-volt lamps are stated to have shown satisfactory results, but it still remains to be seen if lamps of a higher voltage will work as well.

The Auer Gas Co. also manufacture a tungsten filament by kneading the trioxide or hydrated acid with excess of ammonia until the whole forms a viscous mass, which is then converted into filaments by the "paste" process. The filaments in 100–220 volt lamps thus made are stated to give a pleasant white light and to be capable of withstanding a considerable excess pressure of current. This Company also manufactures a lamp in which the filament is composed of a tungsten-osmium alloy.

NOTICES OF RECENT LITERATURE.

NEW BOOKS.

HANDBOOK OF SERICULTURE. By Nitya Gopal Mukerji, M.A., Bengal Provincial Civil Service. Pp. iv + 298. (Calcutta: Bengal Secretariat Book Depôt, 1906.)

In 1894 the author of this work prepared a manual of sericulture in the Bengali language for the use of the peasants of Bengal. At the request of the Director of the Department of Lands and Records an English translation of this work was prepared in 1896, which forms the basis of the present handbook. The work has been revised and arranged in such a manner as to be of service to those engaged in the rearing of silkworms both in India and the Colonies.

The author has been employed for nearly ten years by the Government of Bengal in investigating the diseases of silkworms, and is, therefore, well qualified to deal with the subject of the epidemics which cause such havoc among silkworms when reared on a large scale. In Part II. of the handbook, information on this subject is given which is founded on the author's observations and the results of experiments which have been confirmed in practice in most of the silk districts of Bengal. In this connection it may be mentioned that a school for silk culture has been established at Rampur Boalia, the chief object of which is to afford instruction in the methods of avoiding silkworm epidemics.

The handbook is divided into four parts, which deal respectively with the mulberry and the mulberry silkworm, the diseases of silkworms and of the mulberry tree, the various kinds of silkworms and the methods of rearing them, and the manufacture and commerce of silk.

The author has shown considerable skill in adapting the best practice of European sericulture to the requirements of the Indian peasantry.

SETA ARTIFICIALE. By G. B. Baccioni. Pp. ii + 231, with 26 illustrations. (Milan: Ulrico Hoepli, 1906.)

This manual gives an account of the various efforts which have been made with a view to the production of artificial silk, and describes the principal processes employed in manufacturing and spinning the product. The prospects of the establishment of a large industry in artificial silk fabrics, the economic importance of the subject, and the chief advantages and disadvantages of the new product, are discussed. One chapter is devoted entirely to the question of dyeing the material, whilst another contrasts the behaviour of natural and artificial silk towards various chemical reagents, and gives a comparative account of their microscopical characters. The work concludes with a review of the patents which have been taken out in connection with various chemical processes devised for the manufacture of artificial silk (compare this *Bulletin*, 1904, **2**. 266). A bibliography of the subject is appended.

The book is written in Italian, is well illustrated, and is bound in cloth made wholly of artificial silk.

REPORT ON MISCELLANEOUS COTTON INSECTS IN TEXAS. Bulletin No. 57. Bureau of Entomology, United States Department of Agriculture. Prepared under the direction of the Entomologist (L. O. Howard) by E. Dwight Sanderson. Pp. 63. (Washington: Government Printing Office, 1906.)

The insects which cause the most extensive damage to the cotton crop, such as the boll-worm, the boll-weevil, and the leaf caterpillar, have already been exhaustively studied and accounts of their habits and life-histories and of the means of combating them have been published in several Bulletins issued by the United States Department of Agriculture. Besides these pests, however, there are numerous insects which invade the cotton field and which, although of less importance, yet nevertheless frequently cause more or less injury to the plants, but have hitherto received but little attention. A special investigation has now been made of these minor cotton insects of Texas, and the results are incorporated in the report under consideration.

It was formerly considered less costly to submit to the losses occasioned by these insect pests than to take any measures to control their depredations. With the advent of the boll-weevil, however, it has been found necessary to restrict as far as possible the damage occasioned in this way in order that the small margin of profit obtainable in the weevil-infested districts may not be further reduced. Any insect which attacks the young plants, and thus weakens them or checks their growth, renders the crop more susceptible to injury by the boll-weevil, whilst insects which attack the crop later in the season after the boll-weevil has completed its ravages still further increase the planter's loss. For these reasons, it is imperative that the minor insect enemies of cotton should be kept under control.

The report gives a detailed account of the miscellaneous cotton insects of Texas, and contains records of observations on their life-histories together with data regarding their natural enemies. Methods of destroying the insects and of limiting their ravages are suggested. It is considered that artificial remedies, such as poisons, are not generally applicable in the case of these minor cotton pests, but that control by general methods of cultivation, including destruction of their native food plants, rotation of crops, and thorough ploughing in the winter or early spring will be found more practicable.

The work is divided into sections dealing with (1) insects affecting the young plants, (2) leaf-eating caterpillars, (3) insects affecting the stalks, and (4) insects affecting the fruit. It is well illustrated and will doubtless be of great service to the cotton planter.

COMPTES RENDUS DES TRAVAUX DE LA PREMIÈRE RÉUNION INTERNATIONALE D'AGRONOMIE COLONIALE. Pp. 595. (Paris: Felix Alcan et Guillamin, 1906.)

The first meeting of the "International Association of Colonial Agriculture" was held in Paris in the summer of 1905 on the invitation of the "French Society of Colonial Agriculture." During the meeting an international committee, of which the Director of the Imperial Institute is a member, and including representatives of the principal colonising countries, was constituted to carry on the work of the Association, and the second meeting took place in Marseilles this year during the course of the Colonial Exhibition held in that seaport.

This bulky volume, containing an account of the work done and the papers read at the first meeting of the International Association, is divided into six sections, viz. (1) Economic botany, (2) Industrial utilisation of Colonial products, (3) Applied zoology and entomology, (4) Zootechny, (5) Colonial hygiene, (6) and the subject, "Economie Rural des Colonies," for which there is no simple English equivalent. Numerous papers by well-known experts were contributed in each of these sections, and the most important of them are reprinted in full in this report.

The subjects which have naturally attracted most attention are the cultivation of rubber, gutta-percha and fibrous plants, and the industrial utilisation of oil seeds, tanning materials, and natural dyes.

In the section of colonial hygiene, a series of useful papers on the nature and prevention of various tropical diseases is printed, which, as embodying the experience of medical officers in the various French Colonies, in treating such diseases should be of great value.

There can be no question of the usefulness of an International Association of Colonial Agriculture to all interested in the development of tropical colonies, and it is to be hoped that the varied and useful character of the papers read at the first meeting will serve to stimulate interest in the Association among British Colonists, Colonial Officials, and others interested in the development of our Crown Colonies.

ANNUAL REPORT OF THE DEPARTMENT of AGRICULTURE OF THE PROVINCE OF ONTARIO, 1904. Vols. i. and ii. (Printed by order of the Legislative Assembly of Ontario.)

The report opens with an account of the work carried out at the Ontario Agricultural and Experimental Farm during the year 1904, but the greater part of these volumes is taken up with the annual reports of the numerous agricultural associations existing in the Province, the papers read at the meetings and the discussions arising therefrom being given in full detail. One of the most important reports is that of the Fruit Experiment Stations. It contains a description of the principal fruits of Ontario by the Secretary of the Board of Control and Fruit Experiment Stations. The paper is intended to place in the hands of fruit-growers reliable scientific descriptions of the fruits grown in the Province, with information as to the amount of success which has attended their cultivation in different localities. Some eighty fruits are described, including apples, pears, plums, peaches, grapes, blackberries and quinces. The illustrations, which are from life-size photographs, form a most valuable feature of the paper.

ORANGE RIVER COLONY. FIRST ANNUAL REPORT OF THE DEPARTMENT OF AGRICULTURE, 1904–05. Pp. 1–271. (Government Printers, Bloemfontein.)

The Department of Agriculture in the Orange River Colony was established towards the end of 1903, and definitely organised during 1904. This, the first annual report, covers a rather longer period of time than is indicated in its title, an historical introduction and notes being added of work during 1903.

The Director of Agriculture contributes a general report, whilst the heads of the various departments fill in the details with reference to the work under their immediate supervision. The general plan of the report thus follows that of the U.S.A. Department of Agriculture, and modern departments in the British Colonies. It is naturally too soon yet to be able to record very definite results, and attention has been directed rather to laying a sound foundation for future development. The establishment of the Tweespruit Creamery, which has been successfully worked on a co-operative basis, and the ready manner in which farmers have combined with the Department in attempts to eradicate scab, locusts, and other pests, are events full of promise for fruitful co-operation in the future. Seeds have been distributed for experimental purposes, and in the Forestry Division new trees have been introduced and work inaugurated to improve methods of planting and cultivation.

Educational work has been attended to, and by means of lectures, publications and practical demonstrations, help has been afforded to farmers of all classes. It proposed to establish an Agricultural School.

The principal economic plants, weeds, poisonous plants, insect diseases, stock and other important topics are discussed in detail, and much information is brought together which should prove of considerable practical value to all engaged in, or thinking of taking up, agricultural work in the Colony.

NATAL PLANTS. By J. Medley Wood, A.L.S., and Maurice S. Evans, M.L.A., F.Z.S. 1898–1905. Vols. i.–v. (Bennett & Davis, Durban, and Robinson & Co., Durban.)

This work, which is published under the auspices of the Durban Botanic Society, was originally started in 1898, with the intention of arousing interest amongst colonists and others in the flora of Natal, which, even at the present time, is imperfectly known. It further afforded an opportunity, pending the completion of the *Flora Capensis*, for putting on record accurate botanical descriptions and figures of new or noteworthy plants found in the Colony.

The system adopted in the description of the plants is a compromise between the purely technical description used by the critical botanist and the simply-worded account necessary for the ordinary inquirer who has received no special instruction in the science. In carrying out this idea, however, effort has been made to avoid any looseness of description which would detract from the scientific value of the work. The plants, with the exception of the grasses, are dealt with in no recognised botanical sequence. The natural order and tribe of each is indicated and a detailed botanical account of the plant is followed by information regarding the habitat and native names. When of sufficient importance the economic uses of the plants are given, but beyond native drugs, the grasses, and a few trees used locally for timber, the plants described are of little economic value, the most important being *Indigofera arrecta*, Hochst. This plant, which is widely distributed over South Africa, is regarded as one of the best species for the manufacture of indigo, and large quantities of seed have recently been exported from Natal to India and Java for the indigo plantations.

The importance of a complete knowledge of the grasses indigenous to a country largely depending upon stock and sheep farming for its prosperity is recognised in the reservation of two volumes to the description of these plants. The authors express the hope that the correct identification of the species may lead to a better knowledge of their grazing value, a desideratum at present much hindered by the confusion or total absence of vernacular names.

Each plant described is illustrated, and the botanical value of the drawings is much enhanced by the figures of important dissections.

ASBESTOS, ITS OCCURRENCE, EXPLOITATION AND USES. By Fritz-Cirkel, M.E. Pp. xiv + 169, with diagrams, photographs and maps. (Mines Branch, Department of the Interior, Ottawa, Canada, 1905.)

This report, the result of a visit by the author to the asbestos region of the eastern townships of Quebec, contains much valuable information. The term asbestos is applied commercially to all minerals which break up easily into flexible fibres; whilst those mineral fibres which, though long and slender, are wanting in flexibility, are known in Canada as actinolite, independently, it would seem, of their chemical composition.

Material described as actinolite is chiefly mined in the townships of Elzevir, in Hastings county, Ontario, where it is milled and sold for use in the manufacture of boiler coverings and plaster. In composition it appears to be allied to anthophyllite, but contains more water than the fibrous variety of that mineral mined in the United States. It approximates to the formula $Mg_5FeH_4Si_8O_{24}$ or $(Mg, Fe)_3H_2Si_4O_{12}$.

Some interesting deposits of asbestos, presumably chrysotile, occur in the Laurentian rocks north of Ottawa, where the mineral forms a layer on the surface of serpentine masses in crystalline limestone. It contains but little iron, is light in colour, has a fine silky fibre and is well adapted for spinning. A blue-black variety has been found. No analysis of either the light or dark variety appears to be available, though several are given of the associated serpentine. The principal deposits are at Templeton and at Denholm, near the river Gatineau. In the latter locality it is said to have been mined at a profit.

The report is, however, mainly devoted to a detailed account of the methods of mining and milling chrysotile asbestos in the Thetford and Black Lake region of the Eastern Townships, which affords the greater part of the world's supply of fibrous mineral products.

The mode of occurrence of this mineral has already been described in this *Bulletin* (1905, **3**. pp. 277–285). Mining operations are mainly carried on in quarries, as it is found difficult to locate the veins underground. The rock is removed in steps or benches, and the bore holes are drilled parallel to the longest free side of the bench. They are usually 8 to 10 feet in length and may be as much as 12 or 15 feet. Short drills are first employed, and longer ones subsequently substituted.

The "crude" asbestos obtained directly from the vein by a process of hand cobbing now forms but a small part of the output. By an elaborate process of milling the smaller fibre which was formerly neglected is separated from the rock and made available for use in the arts. For the details of the process the report itself must be consulted. It is sufficient to say here that the material is dealt with in turn by rock breakers, driers, rotary crushers, rolls, "fiberisers," in which the fibres are separated from one another, fans, which remove the fibres by means of air currents, and settling chambers, in which they are collected. There are also numerous accessory appliances. The individual mines and mills are carefully described and illustrated. Some account is also given of asbestos deposits and asbestos mining in other parts of the world, especially in the United States and Russia. A chapter on the commercial applications of asbestos follows, and the report closes with an abstract of the Mining Laws of Quebec.

CORUNDUM AND ITS OCCURRENCE AND DISTRIBUTION IN THE UNITED STATES. By Joseph Hyde Pratt. *Bulletin*, No. 269, United

States Geological Survey. (Washington: Government Printing Office, 1906.)

This *Bulletin* is a revised and enlarged edition of a former issue (No. 180), published in 1901. It has been brought up to date by the insertion of a considerable amount of new matter, and in its present form is a comprehensive monograph on corundum. It gives a detailed account of the characters, uses and modes of occurrence of the mineral, as well as of its distribution, not only in the United States, but also in other countries.

Among the new items inserted, there is a useful summary of the work of Morozewicz and others on the formation of corundum in artificial magmas, which has thrown much light on the conditions under which the mineral is formed in igneous rocks. The book contains a number of misprints. Thus, on page 22 the value of the international carat is given as 250 in place of 205 milligrams. On the same page sphalerite is stated to have a hardness of 3·54, which is obviously a misprint for 3·5 to 4.

The *Bulletin* is well illustrated, and will be found useful by all interested in corundum, either scientifically or commercially.

REPORT OF THE COMMITTEE APPOINTED TO INVESTIGATE THE DIFFERENT ELECTRO-THERMIC PROCESSES FOR THE SMELTING OF IRON ORES AND THE MAKING OF STEEL. Pp. 223. (Department of the Interior, Canada, 1905.)

At the end of 1903, Mr. Clifford Sifton, the Minister of the Interior for Canada, commissioned Dr. Eugene Haanel, Superintendent of Mines, to proceed to Europe for the purpose of investigating and reporting upon the different electro-thermic processes employed in the smelting of iron ores and the making of the different classes of steel. The special object was to ascertain the feasibility of introducing successfully such processes into Canada. The results of these investigations, together with a report of a special commission appointed to investigate the Marcus Ruthenburg process of electric smelting of magnetite, and an appendix on the electro-metallurgy of steel, iron and copper, are included in this volume, which is profusely illustrated with diagrams and reproductions of photographs.

The different processes and results discussed are briefly as follows:—

At Gysinge, in Sweden, the process of smelting iron ores invented by Mr. Kjellin is employed. The furnace has a capacity of 225 H.P., is without electrodes, and is of the induction type, consisting essentially of an annular groove with walls composed of magnesite or silica bricks. A primary alternating current of 90 ampères and 3,000 volts induces in the charge, forming the single turn of the secondary circuit a current of 3,000 ampères at 7 volts. In a series of trials the production with this furnace averaged 4,100 kilograms of metal in twenty-four hours. The efficiency of the furnace is 45½ per cent., and the cost of power is $11·50 per E.H.P. year. The cost of the furnace is $4,000.

The Héroult electric process is used at La Praz for making steel from scrap iron, melted down and recarbonised by carburite. The furnace is of the tilting pattern. It consists of an iron casting lined with dolomite and magnesite bricks, and the current is conducted through two electrodes which pass through the roof. An alternating current of 4,000 ampères is regulated by the narrow air gap left between the slag and the electrodes. The cost of the furnace and machinery to work the electrodes and bath is £2,000. The electrodes are made of gas coke. The absorption of energy per ton of steel amounted to 0·153 E.H.P. year.

The Stassano furnace, used at Turin, is of a rotating type, and consists of a cylindrical outer casing of iron surmounted by a conical roof. It is lined with magnesite bricks. A three-phase alternating current of 90 volts between the phases and 400 ampères is distributed to three electrodes, which nearly meet at the interior of the furnaces. The cost of the furnace is £1,000. The output of metal per day is four to five tons.

The most important experiments witnessed by the Commission were those made by Keller, Leleux and Co., at their works in Livet. Some 90 tons of magnetite were used to demonstrate the feasibility of making pig iron and steel direct by the electric process.

The furnace employed for these experiments is that used in making ferro-alloys. It is of the resistance type, and consists of two iron casings, forming shafts, communicating at their lower ends by means of a lateral canal. The casings are lined with refractory material, and the base of each shaft is provided with a carbon block, in electric communication with the exterior by means of copper bars. Large carbon electrodes are introduced into the shafts from the top.

In starting, the charge is introduced between the carbon blocks of the base and the ends of the electrodes, which are then in their lowest position. The current passes from one electrode through the material, to be reduced to the carbon base, and by means of copper conductor to the carbon block of the second shaft, and then to the second electrode. As the metal becomes reduced, conduction takes place in the bath, and the current then passes direct from one electrode to the other. The energy absorbed per ton of pig iron produced is given as 0·475 E.H.P. year, with a furnace of 1,000 H.P. capacity and an average current of 11,000 ampères at 60 volts. The cost of making one ton of pig iron is said to be $10·71, of which the ore cost $2·76, coke $2·38, and electric energy $2·25.

In the Marcus Ruthenburg process of treating magnetite the furnace is included between the poles of an electro-magnet, which are covered with brass drums. The parts to which the working current is distributed and which form the electrodes are armed with carbon plates. The magnetite is first crushed and magnetically concentrated, and the resulting iron sand is mixed with a slight excess of carbon. This is placed in a bin and passed by a shoot to the centre of the gap where partial reduction takes place, which is supposed to be completed in the pit below. The results of the investigation, in the opinion of the Commission, however, demonstrated that the process failed in agglomerating and fritting the finely divided ore and in producing any useful reduction to metal.

The book concludes with four articles on electro-metallurgy explanatory of the working of the processes referred to and of the reactions involved in the various operations.

The conclusions arrived at by the metallurgist attached to the Commission may be briefly stated as follows:—

(1) Steel equal in all respects to the best Sheffield crucible steel can be produced either by the Kjellin, Héroult or Keller processes at considerably less than by the crucible method.

(2) At present, structural steel to compete with Siemens or Bessemer steel cannot be economically produced in the electric furnaces, but high-class special steels can.

(3) Pig iron can be produced on a commercial scale at a price to compete with the blast furnace only when electric energy is very cheap. With the latter at $10 per E.H.P. year and coke at $7 per ton, the cost is approximately the same as by the blast furnace. Under ordinary conditions electric furnaces cannot compete with the blast furnace.

MINING REGULATIONS FOR BRITISH GUIANA. Under the provisions of the mining regulations recently issued for this Colony, prospecting licences for one year are issued on payment of five dollars. When a claim is located a mining licence may be obtained subject to a payment of five dollars per annum in the case of gold, and twenty cents per annum for each acre in the case of precious stones. It is unlimited in duration as long as the conditions are observed. Royalties amounting to 70 cents per ounce for gold, 4 cents per ounce for silver, and 4 cents for each cubic yard of ground removed in the search for precious stones are also payable. In the last-mentioned case an additional fee of twenty dollars is payable if the working is considered to be in the nature of an alluvial working. Precious stones found by a person without a licence are subject to a royalty of one-tenth of their value. A gold claim must not measure more than 1,500 feet in length or 800 feet in breadth. In the case of precious stones the claim must not exceed 500 acres in area, but it may not be *less* than 1,500 feet long or 800 feet wide. Beneath the surface the boundaries of claims are the vertical planes in which the surface boundaries lie. Provision is made for granting larger concessions under special circumstances.

The calculation of the royalty on the gross output is now unusual in other gold producing colonies. It has been found to discourage the working of low grade properties. This will probably also prove to be the case with royalties on ground removed.

THE SOURCE OF THE BLUE NILE: with a Note on the Religion, Customs, &c., of Abyssinia. By Arthur J. Hayes, L.S.A. (Lond.). Pp.

xi + 315, with illustrations and maps. (London: Smith, Elder, & Co., 1905.)

This book furnishes a record of an expedition to the source of the Blue Nile undertaken during 1902–3 by two officers of the Egyptian Irrigation Department, for the purpose of obtaining trustworthy information regarding the head waters of this important river. The author accompanied the expedition as medical officer, and the volume under notice has been prepared from the diary kept during the journey. No attempt has been made to include the scientific results of the expedition, in so far as these relate to the survey of the river, as they have been fully stated already in Sir William Garstin's official Report on the Sources of the Nile.

The Blue Nile issues from the southern end of Lake Tsana, situated in the mountainous region of Western Abyssinia at an elevation of 6,372 feet. The greatest length of the lake from north to south is approximately forty-five miles, and its breadth on the twelfth parallel of longitude is about thirty-seven miles. Dr. Stecker, the German traveller, estimated the superficial area of the lake to be 2,980 square kilometres.

The journey was made from Khartoum along the Blue Nile to Abu Haraz, and thence *viâ* Gedaref and Gallabat into Abyssinia. Lake Tsana was thus approached from the northern side. A complete circuit of the lake was made and visits paid to Debra Tabor, a mountain on the east of the lake, and to the first falls on the Blue Nile, which are situated twenty-one miles below the outlet from the lake. On the completion of their survey, the travellers retraced their steps to Gallabat and returned *viâ* Kassala and the Atbara river to Berber.

The book is cast in the form of an itinerary and gives the writer's impressions, recorded day by day, of the country traversed, its people, and its flora and fauna. Western Abyssinia is still a comparatively unknown land, and in the course of the narrative many interesting glimpses are obtained of the manners and customs of the people. The last hundred pages of the volume are occupied by a connected account, compiled by the author from various sources, of the origin of the Abyssinian people, their religion and clergy, and their customs.

The book is well illustrated by photographs and maps, and forms a readable account of this portion of Africa. In an appendix Professor E. B. Poulton furnishes identifications of a collection of insects made by Dr. Hayes in the vicinity of Lake Tsana.

THE PHILIPPINE ISLANDS. By Fred W. Atkinson. Pp. vi + 426. (Ginn & Co., Boston, New York, Chicago and London, 1905.)

In this work, which is written by the first American General Superintendent of Education in the Philippines, an account of the geography, climate, resources and history of the islands is given, and also a description of the inhabitants. The archipelago, which includes more than 1,600 islands, and which extends over an area somewhat larger than that occupied by the United Kingdom, is remarkable for the number of different races and tribes to be found in it; these are in various stages of civilisation ranging from the Negritos who do not even build huts, to the Tagálogs of Manila and Central Luzón who present the highest development of the Malayan race in the Philippines.

The author gives an account of the steps that have been taken to establish a system of government in which the natives take a part. Special efforts have been made in promoting elementary education as one of the chief agents for elevating the people and increasing their prosperity; but the formation of bureaus for agriculture, mining, surveying and other scientific purposes has not been neglected. The author visited practically every part of the archipelago, and had interviews with prominent Filipinos in the course of his duties.

The book is provided with numerous illustrations of the people and scenery.

A COMPLETE PRONOUNCING GAZETTEER OR GEOGRAPHICAL DICTIONARY OF THE WORLD. Edited by A. and L. Heilprin. Pp. x + 2053. (London: J. B. Lippincott and Co.)

Though London appears on the title-page as the place of issue, this handsome volume has been compiled in the United States, and deals in an exhaustive manner with the topography of the great republic. Its possessions beyond the seas and Canada are dealt with in an almost equally liberal fashion, while it is claimed that with regard to Cuba and Central and Southern America the book fills a gap in geographical literature. Other parts of the world are also well represented.

Such a compilation cannot fail to be of great use as a book of reference, but it is inevitable that in a work involving such a wealth of detail there should be a number of omissions and inaccuracies which could only have been avoided by constant reference to those possessing the necessary local and technical knowledge. No reference, for instance, is made to the Kolar goldfield in India, which produces gold to the value of more than two million sterling per annum. Sudbury, Ontario, is mentioned, but nothing is said about its important nickel mines except, curiously enough, in the preface, which contains no apology for the omission in the text. Riveralta, the great rubber centre of Bolivia, has also been passed over; as well as Huaqui, the terminus of the La Paz Railway, and now the principal Bolivian port on Lake Titicaca.

The method of indicating the pronunciation of the names of places is not very scientific, but serves its purpose fairly well. Here, too, there are a few slips. In Guayaquil on the west coast of South America, the "g" should be omitted in the pronunciation, and the Beni, a Bolivian river, should not be accented on the last syllable as indicated in the gazetteer.

A reference may be made to the extraordinary manner in which place-names in the United States are repeated. There are, for instance, forty-two "Salems" besides eight more places where the same word forms part of the title, and there are no less than sixty-one Lincolns and sixty-seven Washingtons. A similar want of originality in nomenclature occurs in many of the British Colonies and Spanish republics.

THROUGH NEWFOUNDLAND WITH A CAMERA. By R. E. Holloway, B.Sc. Pp. 1–135. (Dicks & Co., St. John's, Newfoundland. Sach & Co., Victoria Street, London, 1905.)

The letterpress in this volume occupies only twenty-two pages, the remainder of the book being well filled with a map and 120 views illustrating the resources and scenery of Newfoundland, selected from a series taken during a period of over twenty years. In the introductory matter a brief account is given of the physical features of the Colony, its industries and the attractions it offers to the sportsman and tourist. The artistic nature of the views enables any one to acquire in a very pleasant manner a good deal of useful information about the scenery and the conditions of life in and around the oldest colony of the Empire.

HANDBOOK OF THE TURKS AND CAICOS ISLANDS. J. H. Pusey. Pp. 1–144. (Colonial Publishing Co., Jamaica, 1906.)

The author has brought together in this book a store of information concerning the history, physical features, products and resources, laws and administration of this small dependency of Jamaica. The general plan is based on that of the larger "Handbook of Jamaica" which is reviewed below. Salt, the staple product of the group of islands, is fully dealt with, but it is to be regretted that the printer has not been able to do greater justice to the illustrations on this and other subjects. An account is also given of the efforts made to develop a fibre industry, and past reports on the fibre plants which occur are summarised. For a future edition it would be well to have the scientific names carefully revised. These blemishes are, however, of minor importance, and the book affords a useful summary of information.

HANDBOOK OF JAMAICA. J. C. Ford and A. A. C. Finlay. Pp. 1–582, with a map. (Ed. Stanford, London, 1906.)

Detailed notice is unnecessary in the case of this well-known publication, which has now reached its twenty-sixth year. It is a mine of historical, statistical and general information, and should be consulted by every one desirous of knowing the present condition of the Colony, including the dependencies of the Turks and Caicos Islands, the Cayman Islands, and the Morant and Pedro Cays.

Some thirty pages are devoted to agriculture. Lists are given of the sugar, coffee, banana, and cacao estates, with their acreage, owners' and attorneys' names, and in the case of the sugar estates details are added as to the equipment of machinery, and the crop in 1904. The constitution and functions of the Board of Agriculture and the Agricultural Society are summarised, as well as other information of general interest.

Mr. W. Harris, Superintendent of the Hope Gardens, contributes an article enumerating the common and botanical names of the fruits and vegetables of Jamaica, the seasons at which they are to be obtained, and their prices in Kingston Market. In a similar way he deals with products such as coffee, annatto, fustic, divi-divi, kola nuts, to mention only a few examples.

THE TRINIDAD AND TOBAGO YEARBOOK, 1906. J. H. Collens. Pp. 1–248, i–xxi, and 1–120. (Government Printing Office, Trinidad.) The book contains a mass of useful information of the kind usually found in directories, and should be of great service to all who wish to have, within the compass of one volume of moderate size, a general account of the Colony. In the introductory chapter there is a brief sketch of the history, climate, physical features and natural resources of Trinidad and its dependency Tobago. A Visitors' Guide contains short notes on the chief buildings, institutions, clubs, etc. Statistical information, lists of estates, the *personnel* of the civil service, a professional and commercial directory, are amongst some of the other contents.

COLONIAL PUBLICATIONS.

COPIES of the following publications, descriptive of the resources of British Colonies, have been received recently for distribution, free of charge, from the Central Stand in the Exhibition Galleries.

Australia.

THE PRODUCTS OF AUSTRALIA. By the Hon. J. G. Jenkins, Agent-General for South Australia. February 1906. Pp. 1–26. In this paper, read before the Royal Colonial Institute, the author gives an account of the great industries of the State, and presents a concise and interesting summary of the natural resources of the land, and the possibilities for its future development.

PRODUCTION AND TRADE OF AUSTRALIA. Sir J. Forrest. Pp. 1–19. 1906. In this address, delivered by the Treasurer of the Commonwealth, at the Australian Chamber of Commerce, London, the trade and production of Australia are reviewed. Minerals, wool, irrigation and the conservation of water, the immigration question, railway communication and the shipping trade are amongst the topics discussed.

AUSTRALIA. HER TRADE AND COMMERCE. Sir J. Madden. Pp. 1–14. Issued by the Agent-General for Victoria. A report of a speech by the Chief Justice of Victoria, demonstrating by means of figures the progress achieved by the various States during recent years.

VICTORIA. MINERAL WEALTH OF THE STATE. Pp. 1–4. Gold being the chief mineral product of Victoria, attention is principally devoted to it, and information is given as to the yield, dividends from mines, and mode of working for 1904. The Government is, under certain conditions, prepared to assist, financially, companies and prospecting parties.

VICTORIA. RURAL INDUSTRIES OF THE STATE. Pp. 1–4. Notes on the cereal crops, pastoral resources, wine, fruit, poultry, and other industries of the State.

VICTORIA. PRODUCTS OF. Pp. 1–4. A list of the products of Victoria, grouped under such headings as cereals, wool, meats, fruits, vegetables, etc.

VICTORIA. VICTORIAN FINANCE. Pp. 1–2. A general summary of the manner in which the finances of the State have been employed.

VICTORIA. THE JOURNAL OF AGRICULTURE. Vol. iv., Parts 1, 2, 3. January–March, 1906. This illustrated monthly publication of the Department of Agriculture of the State includes within its covers articles on a great variety of subjects, dealt with in a practical manner, with special regard to local conditions and requirements. The "Closer Settlement" Studies, showing results attained on definite farms, are of especial value to those desirous of becoming acquainted with profitable agricultural methods in Victoria. The report on the varieties of wheat and oats grown at the Northern Experimental Fields in 1905 is of considerable interest.

VICTORIA. INDUSTRIAL PROGRESS OF THE STATE. Pp. 1–3. Information is given on the manufacturing industries, the number of factories, capital invested, value of production, hands employed, rates and regulation of wages, and the cost of living.

VICTORIAN PRODUCE. A statement, in tabular form, of the quantity and value of dairy produce, meat and fruit exported in 1904 and 1905.

VICTORIA. THE RESOURCES OF COLAC. Brief notes on the agricultural industries, available lands, and conditions of tenure at Colac, which is described as the centre of the largest dairying industry in Victoria.

THE YEARBOOK OF NEW SOUTH WALES, 1906. By Authority of the Government of New South Wales. Pp. 1–166, with a map. This annual publication affords concise information on almost all subjects of importance concerning the natural characteristics, history, resources, and administration of the State. A full index and several illustrations increase its usefulness.

NEW SOUTH WALES. A LAND OF REWARD FOR CAPITAL AND INDUSTRY. By means of a set of 24 full-page illustrations and short explanatory notes, a good idea is given of the agricultural and pastoral resources of the State.

THE YEARBOOK OF SOUTH AUSTRALIA, 1906. By Authority of the Government of South Australia. The plan and contents of this volume are similar to those of the corresponding publication for New South Wales noted above.

LAND SELECTION IN QUEENSLAND. (LEAFLET A.) Department of Public Lands, Brisbane. January 4, 1906, pp. 1–4. This pamphlet, which includes a map of the State, gives concise information regarding the several modes of land selection which are provided for. These include (1) Agricultural Selections, (2) Grazing Selections, (3) Scrub Selections, (4) Unconditional Selections, (5) Prickly Pear Selections. The rental, condition of tenure and maximum allotment of each is given.

LAND SELECTION IN QUEENSLAND. Issued by Authority. Pp. 1–2. A leaflet, prepared for use in Great Britain, giving an outline of the conditions on which land is offered for selection as agricultural farms.

FARMING IN TASMANIA. By the Agent-General for Tasmania. General advice to those thinking of taking up farming in the State. For farming on a small scale a capital of £500 is generally advisable, but under certain conditions there are openings for men with from £200 to £300.

THE "GARDEN ISLAND" OF AUSTRALIA. An illustrated account of an interview with the Hon. A. Dobson, Agent-General for Tasmania, reprinted from the *Colonizer*. Special attention is directed to the possibilities of Tasmania for emigrants, the general advice with regard to means being the same as in the previous publication.

INDIAN AND COLONIAL COLLECTIONS.

THE BRITISH EAST AFRICAN COURT.

THE exhibits in this new Court comprise samples of all the principal products of the country, and include cereals, legumes, rubber, oil-seeds, mangrove bark, timbers, cotton, fibres and wool; the collection of fibres is especially valuable. A key map, indicating the districts in which the various crops are most successfully grown, is exhibited. In addition, an interesting collection of native weapons and curios has been lent provisionally, and these, together with the sporting trophies already in the Court, form an important feature of the exhibit.

British East Africa lies between latitudes 4° N. and 5° S. of the equator. It may be roughly defined as the territory under British protection lying between Lakes Victoria and Rudolf and the coast. On the north, the country is bounded by the Italian possessions and the Juba river, and on the south by German East Africa; the north-western and Abyssinian frontiers are not yet clearly defined. The principal towns are the ports of Mombasa, Lamu, Kismayu, Malindi and Vanga, and the best-known inland stations are Nairobi, Machakos, Naivasha, Nakuru, Mumias and Kisumu. The country is traversed by the Uganda Railway, stretching from Mombasa on the coast to Kisumu on the shores of Lake Victoria; the actual terminus of the railway on the Lake is known as Port Florence. In consulting all but the most recent maps, it should be remembered that in 1902 all the Uganda provinces east of Lake Victoria were placed under the administration of British East Africa.

Comparatively little is known concerning the geography and resources of the great stretch of country between 1° and 4° N. of the equator, and at the present time practical interest is centred upon the southern half of the Protectorate, comprising the seven provinces of Jubaland, Tanaland, Seyidie, Ukamba, Kenya, Naivasha and Kisumu. Situated, as these provinces are, as a belt on either side of the equator, they would naturally be credited with a normal tropical climate, but owing to the elevated character of a considerable portion of the country, large areas possess a cool and invigorating climate which allows of the cultivation of the ordinary crops of temperate regions. The Protectorate naturally falls into two divisions, the Lowlands and the Highlands. The former extend inland from the coast as a belt about 250 miles wide, and further include the basins of the Juba and Tana rivers, and the district around Lake Victoria. The climate varies from tropical to sub-tropical, and although not unhealthy for the tropics, the Lowlands are not considered suitable for European colonisation. The most important products of these districts are coco-nuts, timber, fibre, rubber, maize and rice; further experiments have shown that cotton can be cultivated with considerable success, and it is not improbable that the conditions will be found suitable for tobacco.

The Highlands comprise the central plateaux situated in the provinces of Ukamba, Naivasha and Kisumu, and may be said to commence at Kiu on the Uganda Railway, 267 miles from Mombasa. Kiu is at an altitude of 4,861 feet, and situated on the edge of the Athi plains which end at the base of the Kikuyu escarpment. Westwards the country descends to the Great Rift Valley, a depression about 30 miles wide and some 2,000 feet lower than the surrounding upland districts, which contains enormous areas of excellent grazing and agricultural lands. Across the Rift Valley the Mau escarpment rises to a height of 9,000 feet, and thence westwards and northwards the country gradually falls to the hot plains surrounding the Lake.

The climate of the Highland districts is pleasant and healthy, and the country has been proved to be suitable for the cultivation of many temperate crops, and for stock-raising and dairy work.

In a country such as is described above, the agricultural possibilities must needs be as varied as the climatic conditions, and this fact is well borne out in the diverse character of the products exhibited in the East African Court of the Imperial Institute. In the present article it is proposed to enumerate the products shown and to indicate the present position and prospects of their cultivation in the Protectorate. Except where otherwise stated, the samples were presented by the Agricultural Department of British East Africa.

VEGETABLE PRODUCTS.

Cereals.

MAIZE (*Zea mais*).—Next to potatoes, maize is the principal crop grown by the European settlers, and its cultivation has met with great success. It is also largely grown by the natives and used principally as a food-stuff and for feeding to stock. Some of the best varieties have created a good impression when exhibited in this country, and, were it not for the present high rates of transport charges, it is not improbable that an export trade would soon arise. The varieties found to be most suited to the country are Cuzco, Hickory King, and an unnamed American variety. They grow well in the Nairobi district and are of excellent quality; the yield is reported to be abundant.

Samples exhibited:—

1. "Hickory King," grown in Nairobi district.
2. "Cuzco" " " "
3. An American variety " " "
4. Native Maize " " "
5. Native Maize, grown by Indian settlers at Kibos. Presented by D. D. Waller, Esq.

WHEAT (*Triticum vulgare*).—The cultivation of wheat is still under trial, and, except in certain districts, no very satisfactory results have been as yet obtained. The country in the neighbourhood of Machakos is one of the most promising districts for this cereal, and the quality of the grain raised is very good.

Samples exhibited:—

1. Wheat grown at Lumbwa. Presented by J. Cushney, Esq.
2. Wheat grown at Athi River, near Machakos.

BARLEY (*Hordeum vulgare*).—This grain, which has been very favourably reported on, is successfully grown in many parts of the Highlands, especially in the neighbourhood of Nairobi. Samples of East African barley have been classed as equal to Australian.

Sample exhibited:—

Barley grown in the Nairobi district.

SORGHUM (*Sorghum vulgare*).—This cereal, which is very extensively grown, constitutes one of the staple food-stuffs of the native population. It is locally known as "M'tama grain."

Samples exhibited:—

1. "M'tama grain" (Red Millet), grown at Nandi. Presented by Captain Monckton.
2. "M'tama grain" (Red Millet), grown at Kisumu.

RICE (*Oryza sativa*).—Two varieties are cultivated, a "Mountain Rice" grown without irrigation, and "Almaria Rice" cultivated in the ordinary way on alluvial flats. Large areas in the Witu district and on the banks of the Tana river are said to be very suitable for rice cultivation. The grain is used locally as a food-stuff.

Samples exhibited:—

1. Mountain Rice.
2. Almaria Rice, grown in the Vanga district.
3. Padi Rice, grown under irrigation.

BUCKWHEAT (*Fagopyrum esculentum*).—Grown to a small extent in the neighbourhood of Nairobi, and in the districts farther towards Lake Victoria.

Sample exhibited:—

Buckwheat, grown in the Nairobi district.

"WIMBI" (*Euchlaena coracana*).—A grain considered as a luxury by the natives, who carry it with them in small bags. Wimbi is eaten raw without any previous preparation.

Sample exhibited:—

Wimbi seed, grown at Nandi. Presented by Captain Monckton.

"CANARY SEED" (*Setaria* sp.)—A "millet" which grows well in the cooler districts of the Protectorate.

Sam le exhibited:—

Canary Seed.

Beans.

Beans constitute an important crop, and several varieties are cultivated by the settlers and natives. They are used chiefly as a local foodstuff and for feeding to stock, but some varieties cultivated by the Europeans, *e. g.*, the true and so-called "Canadian Wonder," have been exported in considerable quantities to England for seed purposes.

Samples exhibited:—

1. True "Canadian Wonder," grown in the Nairobi district.
2. "Canadian Wonder" of colonists.
3. "Maragwe" beans, grown at Kisumu.
4. Native beans, presented by Samweli Kangawo, Esq.
5. Native beans (white).
6. Green gram.

Oil Seeds.

CASTOR OIL SEEDS.—The castor oil plant (*Ricinus communis*) is indigenous to the country and is abundant especially in the coastal districts. It is cultivated by the natives for their own use, and the Europeans have been very successful in raising crops from superior varieties of imported seed. Good prices have been quoted for the better qualities of the bean, and there is a large local demand for the oil for use on the Uganda Railway.

Samples exhibited:—

1. Castor oil seed raised from imported seed.
2. Castor oil seed raised from native seed.

LINSEED (*Linum usitatissimum*).—Considerable success has attended the cultivation of this plant, which up to the present has been grown chiefly for seed. (See under "Fibres.")

Sample exhibited:—

Linseed, grown in the Nairobi district.

SIM SIM.—The seeds of *Sesamum indicum* are the source of the valuable sim sim, sesamé or gingelly oil. The plant does not fruit in the Highlands and can be grown with success only in the hotter districts of the Protectorate.

Samples exhibited:—

Sim Sim, grown at Kisumu.

Sim Sim (dark).

SUNFLOWER SEED (*Helianthus annuus*).

Sample exhibited:—

Sunflower seed grown in the Nairobi district.

Fibres.

The fibre industry promises to be one of the most important of the country. Up to the present the principal indigenous fibre-yielding plants (*Sansevieria* and *Musa*) have not been cultivated in plantations, but are collected from concessions. Other fibres have been planted experimentally, the chief being ramie and flax in the Highland districts, and sisal and Mauritius hemp in the tropical and sub-tropical districts. A number of these fibres have been examined in the Scientific and Technical Department of the Imperial Institute, and summaries of the results published in the *Bulletin of the Imperial Institute* (1905, **3**. 226; and 1906, **4**. 189).

Highland Fibres.

Samples exhibited:—

1. Wild Banana (probably *Musa Livingstoniana*).—The plant is found fairly abundantly in many of the smaller valleys, especially those in which streams occur. The fibre yielded is of very good length and quality, and three crops may be obtained annually. The plant is propagated by seed only, which should be collected from June to August. Various grades of this fibre have been examined at the Imperial Institute, the commercial value varying from £20 to £50 per ton (*loc. cit.*).

   Rope made from banana fibre by natives at Nandi, presented by F. W. Isaac, Esq.

2. Ramie (*Boehmeria tenacissima*).—The Agricultural Department has imported a large number of plants from India for experimental purposes. The crops have been very good, notably in the Nairobi and the Kikuyu districts, and especially good results are obtained when the plants are grown in damp localities or in irrigated fields. Up to the present, however, the ribbons have not been exported to any extent. Experiments with regard to degumming and decortication are now being carried out in the Protectorate.

3. Flax (*Linum usitatissimum*).—Up to the present flax has been grown almost entirely for seed. The straw is of sufficient length for fibre purposes, but its strength and other qualities have not yet been tested. No specimen is exhibited.

Sub-tropical and Tropical Fibres.

Samples exhibited:—

4. Sansevieria, Bow-string Hemp. — A most important and promising fibre. (See *Bulletin of the Imperial Institute*, 1906, **4**. 189.) Several species of *Sansevieria* are found in the Protectorate, the chief being *S. Ehrenbergii* and *S. sulcata*. The former is much the more important, but both are common,

especially in the Voi country; other species, which have not yet been identified botanically, are also met with.

The fibre has been dealt with on a commercial scale by the Afro-American Company at Voi, who use a locally improved Mexican Prieto scutching machine, which has turned out 100 tons of prepared fibre in six months. Samples received in England have been valued at £26 to £28 per ton. Fibres of several species are shown:—

1. Fibre from *Sansevieria Ehrenbergii*, grown and prepared by the Afro-American Company at Voi.
2. Fibre from *S. sulcata*, grown and prepared by the Afro-American Company at Voi.
3. Fibre from *S. zeylanica*, presented by Messrs. Ali Dina Visram.
4. Fibre from *S. guineensis.*
5. Fibre from *Sansevieria*, sp.
6. Rope made from Sansevieria fibre by natives of Tanaland. Presented by G. Denhardt and Co.
7. Rope made from Sansevieria fibre by the Afro-American Company at Voi.

5. SISAL (*Agave rigida*, var. *sisalana*) has been planted with considerable success in German East Africa, and experiments at Voi, Nairobi and on the coast have met with promising results.
   1. Fibre grown at the Government farm at Nairobi, and prepared by the Afro-American Company at Voi.
   2. Samples of fibre and rope from German East Africa.
6. MAURITIUS HEMP (*Furcraea gigantea*) is found wild and has been planted experimentally with good results.

   Sample grown at Mazeras and prepared by the Afro-American Company at Voi.
7. COIR FIBRE AND ROPE.—Prepared from the fibrous husk of the coco-nut (*Cocos nucifera*).
8. BAOBAB FIBRE.—Prepared by the natives from the inner bark or bast of the Baobab tree (*Adansonia digitata*). The tree is common along the coast, and is found inland to an altitude of nearly 4,000 feet. The fibre is largely used locally for cordage purposes, and was formerly employed in this country in the manufacture of strong packing papers, but its use for this purpose has been superseded by that of wood-pulp.
9. RAFFIA.—Obtained by stripping the cuticle from the young leaves of a palm (*Raphia nilotica*). The similar fibre obtained from *Raphia ruffia* is largely used by gardeners for tying purposes. The specimens, which are from the Gazi district, include the fibre in bundles and in rolls as prepared for the market.
10. HIBISCUS DIVERSIFOLIUS.—The fibrous inner bark is used by

the natives for making string and cordage. The plant is a common under-shrub found growing along the banks of streams, especially in the Kikuyu valleys.

11. NATIVE STRINGS.—Prepared from the barks of various trees and used for tying purposes and for making bags, samples of which are exhibited.

12. KAPOK. — Obtained from the seed pods of *Eriodendron anfractuosum*, the silk-cotton tree, which is cultivated on the coast, especially in the Malindi district. The silk is used locally for stuffing cushions and pillows. A general account of the properties of Kapok is given in the *Bulletin of the Imperial Institute*, 1905, **3**. 221.

The sample is from Lamu.

COTTON.

Cotton (*Gossypium*, spp.) has been grown for a long time past by the natives, and the efforts of European settlers have also met with considerable success. In the Highlands cotton will not succeed as a paying crop, since, owing to the comparatively cool climate, the bolls do not readily ripen. In the Lowland districts, however, the climate is very suitable for the crop, and successful experiments have been carried out in the coast lands, Voi and Tavetta districts, the valleys of the Tana and Juba rivers, and at other places. The coastlands give the best results, and Sea Island, Abassi and Mitafifi varieties have been cultivated. The Egyptian cottons are the most successful, and Abassi is especially recommended by the Agricultural Department.

A number of samples of cotton from British East Africa have been examined in the Scientific and Technical Department of the Imperial Institute, and were shown at the Cotton Exhibition recently held. (*Bulletin of the Imperial Institute*, 1905, **3**. 139.)

Samples exhibited:—

1. Egyptian (Mitafifi) cotton, grown at Malindi. Valued (January 1906) at $6\frac{1}{2}$*d.* to 7*d.* per lb.
2. Egyptian cotton, grown at Malindi.
3. Egyptian cotton, grown at Kikuyu.
4. Egyptian cotton, grown at Makindu.
5. Sea Island cotton, grown by the Agricultural Department.
6. Cotton, partly cleaned, presented by Messrs. Nanji, Rowji and Dowji, Lamu.
7. Egyptian cotton seed.

Other Products.

COFFEE.—The area under coffee is being rapidly extended, and the product promises to be one of considerable importance to the Protectorate. Up to the present the yield has been heavy, and no serious disease has attacked the plants. The crop has been especially successful in the Kikuyu country.

Samples exhibited:—

1. Mocha coffee (*Coffea arabica*), grown by the Roman Catholic Mission at Kikuyu.
2. Mocha coffee.

TOBACCO.—Tobacco (*Nicotiana Tabacum*) grows well, and a coarse variety is a common native crop. Plants have also been raised from Turkish seed.

Samples exhibited:—

1. Tobacco grown from native seed in Vanga district.
2. Tobacco grown from Turkish seed in Vanga district.

TACCA ARROWROOT.—The natives prepare a valuable starch used as a foodstuff and known as Wanga arrowroot, from the rhizomes of *Tacca pinnatifida*, a plant common in the neighbourhood of Mazeras and the Coast Hills. The arrowroot has been examined in the Scientific and Technical Department of the Imperial Institute, and valued, but a good price is obtained locally.

The sample was prepared in the Mazeras district.

RUBBER.—Several species of rubber-vine occur in abundance in most parts of the country, the most important being *Landolphia Kirkii*. The vine occurs very commonly in the coastal regions, but in the drier districts is found growing only near the rivers. The principal rubber-yielding districts are the coastal belt varying in width from five to twenty miles, the Kitui area, and Laitokitok, Ravine, Kumasia, Nandi and Lumba. Large areas of land have been leased to rubber collectors, chiefly Indian and Arab.

Samples of rubber from *L. Kirkii*, *L. Watsoniana*, and *L. Petersiana* have been examined at the Imperial Institute, and reported to be of good quality. The commercial valuation of the samples varied from 2*s.* 3*d.* to 3*s.* 3*d.* per lb. (See *Bulletin of the Imperial Institute*, 1903, **1.** 68, 70, and 1904, **2.** 153, 221.)

Experiments are now being made at the Government Experiment Stations near Mombasa with Landolphia, Funtumia, Para and Castilloa rubber plants. The two first mentioned promise well.

Samples exhibited:—

1. Landolphia rubber (*L. Kirkii*). Presented by the Antwerp Trading Company.
2. Landolphia rubber (*L. Kirkii*). Presented by C. W. R. Lane, Esq.

MANGROVE BARK.—The dense growth of mangroves (chiefly *Rhizophora mucronata*) fringing the coast is systematically cut for the sake of the bark of the trees, which affords a valuable tanning material, largely exported to Europe. The creeks and islands around Lamu yield the best qualities of bark. (*Bulletin of the Imperial Institute*, 1905, **3.** 346.)

Samples exhibited:—

1. Mangrove Bark from Nandi. Presented by C. Anderson, Esq.
2. Extract of the bark (solid) from the Vanga district. Presented by C. Anderson, Esq.
3. Extract of the bark (liquid). Presented by Messrs. G. Denhardt & Co.

COPRA.—The dried kernel of the coco-nut yields the valuable coco-nut oil, largely used in soap making and for other purposes. It is estimated that the number of coco-nut palms (*Cocos nucifera*) in the Protectorate considerably exceeds half-a-million, the best trees being found on the islands near Lamu to the south of Mombasa. There are also valuable plantations near Malindi.

Sample exhibited:—

Copra from Lamu.

Timber.

British East Africa possesses extensive forests of valuable timber, but the full extent of the forestry resources of the country are as yet but imperfectly known. The trees present great variety, but the species are restricted in their distribution. The chief forests are those of Arabaku and Mweli, the coast districts, and the valleys of the Tana and Juba rivers. The Department of Forestry is engaged in the experimental planting of several varieties of trees, and among the more important may be mentioned the Australian Wattle (*Acacia mollissima*), yielding a valuable tanning bark, and Teak (*Tectona grandis*).

Samples exhibited:—

KIKUYU M'TARAKMA (*Juniperus procera*).—A large tree about 100 feet high, common in the Kikuyu, Escarpment, Mau and Ravine country. The red durable heartwood is short-grained, brittle, easy to split, and, when green, weighs 44 lb. per cubic foot. The specimen was obtained from the Mau forest. (See *Bulletin of the Imperial Institute*, 1906, **4**. 15.)

MOTAMAYU, M'TAMYU (*Olea chrysophylla*).—A tree reaching a height of about 40 feet with a girth of 6 feet. It is common at Nairobi and in the Escarpment, Mau and Ravine districts. The heavy, hard, brown-coloured timber weighs 80 lb. per cubic foot when green.

MAKINDURI (*Croton Eliottanus*).—A large tree common in the Nairobi district and attaining a height of 70 feet and a girth of 6 feet. The timber is white, hard and durable, but warps, and is somewhat difficult to work; it is largely used locally for general farm purposes.

MBAMBAKOSI (*Intsia cuanzensis*).—A tree found in the coastal regions, and reaching a height of about 35 feet with a girth of 30 inches.

MOGAITA.—Grows in the Highland districts at an altitude of from 6,000 to 8,000 feet. It attains a height of 65 feet with a diameter of 30 inches.

MAIROTHI.—A tree found growing at an altitude of from 5,000 to 6,000 feet. It is about 50 feet high, with a diameter of 18 inches.

MHOGU.—A tree reaching a height of about 80 feet, with a diameter of 18 inches. It is found in districts below an altitude of 6,000 feet.

M'RIHI (*Albizzia*, sp.).—This wood is allied to M'Gambo, but is of a rich red colour with a fine grain. It works well and takes a fine polish. The weight is 57½ lb. per cubic foot (dry).

M'PINGU (*Diospyros*, sp.).—A good variety of ebony of a uniform black colour throughout. The grain is finer than that of most varieties.

BAMBA-KOFI (*Afzelia*, sp.).—Resembles teak in general appearance and hardness, and weighs 52 lb. per cubic foot.

M'GAMBO.—A deep red wood about as hard as maple. It is somewhat difficult to work, but its comparative softness and lightness are in its favour as a furniture wood. Weight 63·9 lb. per cubic foot.

M'GATE.—A timber of comparatively small value. Weight 67½ lb. per cubic foot.

M'KHU.—A hard dark reddish-brown timber with a large proportion of soft tissue, which affords a good figure, but renders the wood difficult to polish.

M'GURURE.—A very dark handsome timber with a fine grain and good polishing properties. It should prove a valuable furniture timber. Weight 62½ lb. per cubic foot.

M'GUVI.—Closely related to African oak, but with a finer grain and less mineral deposit. It is rich red in colour, and as hard as box. Weight 75 lb. per cubic foot.

M'BEBEDA.—A dark handsome timber as hard as box, and very suitable for furniture making. Weight 64·1 lb. per cubic foot.

MUHUHU.—A light-coloured even-grained wood. Weight 54 lb. per cubic foot.

MANGROVE (*Rhizophora mucronata*).—A polished specimen, presented by Messrs. G. Denhardt & Co., Lamu.

Tea Table made from local woods by Messrs. C. C. Moula Bux & Son, Nairobi. Lent provisionally.

Tea Table made from local woods. Lent provisionally by Jee Vanjee, Esq.

Podocarpus, spp.—Large trees affording a valuable yellow timber, which is straight grained and easily worked. The timber of *P. falcata* has been reported upon at the Imperial Institute. (See *Bulletin of the Imperial Institute*, 1906, **4**. 15.)

Other important timbers found in the Protectorate are :—

MWIZI (*Pygeum africanum*).—A large tree common between the Escarpment and Limoru. The hard, durable timber weighs, when green, 67 lb. per cubic foot.

MSHARAGI (*Olea saurifolia*).—A large tree common in the Mau and Ravine country, and affording a hard, heavy and durable timber, which was used in the construction of temporary works in connection with the Uganda Railway.

MOSHAMI (? *Allophylus abyssinicus*).—A large tree affording a timber much used by the Nairobi carpenters for furniture making.

Miscellaneous.

CANE SUGAR, grown at Kibos.

NATIVE TREACLE, prepared from coco-nut toddy.

NATIVE SEALING WAX.—Presented by Karsandras Lilladher, Esq., Lamu.

SEEDS of *Strychnos*, sp.—Presented by Karsandras Lilladher, Esq., Lamu.

ORCHELLA WEED.—A lichen (*Roccella tinctoria*) used for preparing the purple dye litmus.

KHAUMA, a native drug.

SOAP, made from coco-nut oil by Messrs. Anderson and Mayer at the East African Soap Factory, Mombasa.

ANIMAL PRODUCTS.

Stock-raising and sheep-farming are industries which promise well in several districts of British East Africa, the most favourable country being the vast areas of grazing land which exist in the upper Highlands, notably in the Rift Valley. It has been found advisable to improve the stock by cross-breeding with imported pure-bred bulls rather than by the importation of heifers, since during the time taken by the animals to become acclimatised, the risk of loss from disease is considerable.

A promising dairy industry has arisen in the neighbourhood of some of the chief European settlements, especially at Nairobi. The milking cows are principally the native animal, but progress is being made in the raising of cross-breds between the native cows and imported bulls, the most successful of the latter up to the present being Shorthorns, Herefords and the Polled Angus. Pig-breeding is regarded as a promising industry.

The native sheep is practically worthless as a wool-bearer, but considerable success has attended the efforts of the Agricultural Department and settlers in crossing the native animal with imported rams. The Merino has given the best results, and Lincolns, Welsh and Ryelands have also been tried.

Experiments have been carried out with the Mohair goat.

Samples exhibited :—

1. Hair of native sheep; scoured clip weighing $\frac{3}{4}$ lb.
2. Wool from cross between imported Welsh ram and native ewe. Grown at Naivasha.
3. Wool from cross between Merino ram and native ewe.
4. Wool from merino imported two years ago; scoured clip weighing $3\frac{1}{2}$ lb.
5. Mohair from imported Angora ram; scoured clip weighing 6 lb.

BEESWAX.—Quantities of beeswax are collected by the natives from wild bees.

Samples exhibited:—

1. Beeswax from the Machakos district.
2. Beeswax from Nandi. Presented by W. Mayer, Esq.

OSTRICH FEATHERS.

Samples exhibited:—

Specimens of feathers from ostriches shot on the Athi plains. (See *Bulletin of the Imperial Institute*, 1906, **4**. 252.)

SPORTING TROPHIES.

1. Lion. Shot on the Athi Plains by Rear-Admiral Montgomerie, C.B., C.M.G., A.D.C.
2. Elephant Head.
3. Elephant Tusk. Lent provisionally by Ali Dina Visram, Esq.
4. Rhinoceros Head. Shot by Rear-Admiral Montgomerie.
5. Antelope Heads and Antlers.

NATIVE WEAPONS AND CURIOS.

1. Masai and Kavirondo spears.
2. Spears. Presented by K. Macdougal, Esq.
3. Wakamba bows and arrows, for hunting and war purposes.
4. Shields.
5. Head-dress worn by Masai warriors.
6. Head-dress worn by Kavirondo warriors.
7. Kavirondo chief's hat.
8. Fur mantles.
9. Kavirondo arm ornament, wooden.
10. Kavirondo bangles, ivory.
11. Wakamba bracelets, brass and copper.
12. Wakamba chains, iron and copper.
13. Bamboo ear ornaments, worn by Kavirondo men.
14. Leather sandals. Presented by Messrs. Nanji, Rowji and Dowji, Lamu.
15. Kavirondo tobacco pipes.
16. Kavirondo beer strainer.
17. Agricultural implements.
18. A "Utio"; a basket used in winnowing grain.
19. Shells used as aprons.
20. Kavirondo stool.
21. Native mats made from leaves of the wild date palm.
22. Sleeping mat. Presented by Messrs. Nanji, Rowji and Dowji, Lamu.
23. "Komafi" and "Kauma," native drugs.
24. Calabash.
25. Mwokia; a root used by the Wakamba natives for tattooing the face.

PHOTOGRAPHS ILLUSTRATING LIFE AND SCENERY IN BRITISH EAST AFRICA.

MOMBASA :—

1. Two general views.
2. On the Harbour, Mombasa.
3. Government House, Mombasa.
4. Vasco-da-Gama Street, Mombasa.
5. Mombasa Cathedral.
6. Mombasa Cathedral, Interior.
7. National Bank of India, Mombasa.
8. Salisbury Bridge, Mombasa.

NAIROBI :—

1. Three general views.
2. In Parklands, Nairobi.
3. Nairobi Chrysanthemums.
4. Nairobi Roses.

NAIVASHA :—

1. On the Government Farm, Naivasha.

UGANDA RAILWAY :—

1. In the early days of the Uganda Railway.
2. Gorge between Nandi and Lumbwa Hills.
3. Through the Mau Forest.
4. A clearing in the Mau Forest.
5. In the Kedowa Valley.
6. An American-built Viaduct, Uganda Railway.
7. Uganda Railway: s.s. *Winifred* in dry dock, Lake Victoria Nyanza.

GENERAL :—

1. Stream in Bamboo Forest, 8,500 feet.
2. Forest near Nairobi.
3. Elbolosat, Settima Mountains.
4. Mathioya River.
5. Mamba River near Mount Kenya.
6. Londiani River.
7. Kedong River.
8. Kavirondo Gulf, Victoria Nyanza.
9. Crossing the Guaro Nyiro River.
10. Falls on Maragwa River, Kenya Province.
11. The Eburn Hills.

CORONATION ADDRESS

IN AN IVORY CYLINDRICAL CASE FROM THE MOMBASA INDIAN ASSOCIATION.

LENT BY HIS MAJESTY THE KING.

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Wie kann die heimische Cognacindustrie und der deutsche Weinbau gefördert werden?	By D. Sandmann.
Obstbau und Obstverwertung in Nordamerika	By D. Sandmann. (*H. S. Hermann.*)
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Proceedings of the Anglo-Russian Literary Society, February, March and April, 1906	(*The Secretary.*)
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Bengal Chamber of Commerce: Report of the Committee, 1905. Vol. i. .	(*The Secretary.*)
Minnesota Plant Diseases . . .	By E. M. Freeman, Ph.D.
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A Text-Book of Mining Geology for the Use of Mining Students and Miners .	By James Park. (*Messrs. Charles Griffin & Co., Ltd.*)
The British Guiana Directory and Almanac for 1906	(*The Colonial Secretary.*)
Tweede Verslag van de Selectie-Proeven met de Natal-Indigoplant . . .	By G. Wilbrink. (*Department of Agriculture, Java.*)
Geological Literature added to the Geological Society's Library during 1905 .	(*The Geological Society.*)
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Mission Émile Laurent (1903–1904). Énumération des plantes récoltées par Émile Laurent pendant sa dernière Mission au Congo. Fascicule iii. . (*The Author.*)

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Report of the Council of the Incorporated Chamber of Commerce of Liverpool, 1906 . . . . (*The Secretary.*)

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On some Foraminifera and Ostracoda from Jurassic (Lower Oolite) Strata, near Geraldton, Western Australia . . By Frederick Chapman, A.L.S., F.R.M.S.

New or little-known Victorian Fossils in the National Museum, Melbourne. Part 1. Some Palaeozoic Species. Part 2. Some Silurian Molluscoidea . . By Frederick Chapman, A.L.S., F.R.M.S.
(*Royal Society of Victoria.*)

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On an Undescribed Species of Cryptocarya from Eastern Australia . . By R. T. Baker, F.L.S.
(*The Authors.*)

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COMMERCIAL INTELLIGENCE BRANCH OF THE BOARD OF TRADE.

THE Commercial Intelligence Branch of the Board of Trade (73, Basinghall Street, London, E.C.) supplies information with regard to the following subjects:—Commercial Statistics; Matters relating to Foreign and Colonial Tariffs and Customs Regulations; Lists of firms abroad engaged in particular lines of business in different localities; Foreign and Colonial Contracts open to Tender; Sources of Supply, Prices, etc., of Trade Products; Forms of Certificates of Origin; Regulations concerning Commercial Travellers, etc. There is a Sample Room at the Offices of the Branch, where, in addition to samples illustrative of reports of H.M. Consuls, or of the Correspondents or Special Commissioners of the Board of Trade, specimens of special interest that may be received from the Imperial Institute, India, or the Colonies, etc., are exhibited from time to time.

The Governments of India, Canada, Cape of Good Hope, and Queensland have established, in proximity to the Commercial Intelligence Branch, at 73, Basinghall Street, special offices for dealing with trade matters.

The *Board of Trade Journal* is the principal medium through which intelligence collected by the Commercial Intelligence Branch is published. It is issued weekly at the price of 1*d.* All applications respecting purchase should be addressed to Messrs. Wyman & Sons, Ltd., Fetter Lane, E.C., or to Messrs. G. Street & Co., Ltd., 30, Cornhill, E.C.

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BULLETIN

OF THE

IMPERIAL INSTITUTE

1906. Vol. IV. No. 4.

SCIENTIFIC AND TECHNICAL DEPARTMENT.

RECENT INVESTIGATIONS.

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

COTTON CULTIVATION IN BRITISH EAST AFRICA.

Large areas of land in British East Africa possess a soil and climate well adapted to cotton cultivation. In the southern portions of the Protectorate cotton can be grown on non-irrigated land, but in the dry northern districts irrigation is necessary. During the year ending March 31, 1905, the area under cotton was estimated at 300 acres. A large increase is contemplated in the immediate future, but the extension of the industry is hampered by lack of transport facilities, there being no direct service from Mombasa to England. A ginning plant has been sent recently to the Protectorate by the British Cotton Growing Association. Cotton is being grown at present principally in the Seyidie Province, but experiments are being made at various localities in other provinces. The Tana Valley and the Gosha District of Jubaland are stated to offer particularly good prospects. A seed farm has been established at Malindi.

Numerous samples of cotton from British East Africa, including "native," "Egyptian," "American upland" and "Sea Island" varieties, have been examined at the Imperial Institute, and it appears probable that, although the native cottons are of fair quality, the Egyptian varieties will give the best return. A description of some of these samples has been published in this *Bulletin*, 1905, **3**. 139. A consignment of eighteen bales of brown Egyptian cotton, received at the Imperial Institute in 1905, was of promising quality, but was somewhat inferior to the brown cotton of Egypt, owing chiefly to irregularity in colour. The product was sold at 6⅛*d.* per lb., when "fully good fair" brown Egyptian was quoted at 8*d.* per lb. The crop from the Government farm at Malindi for the season 1904–5, consisting of 36 cwt. of brown Egyptian cotton, was sold in this country at prices ranging from 5¼*d.* to 7½*d.* per lb.

The amount of cotton exported in the year ending March 31, 1905, was 88,236 lb., valued at £1,460.

During the present year several samples of cotton have been forwarded for examination by the Director of Agriculture and Forestry, Nairobi, and an account of the quality and value of these products is given below.

COTTON FROM MALINDI.

These samples were received in the form of seed cotton, and were ginned in the Department by means of a Platt's Macarthy gin. On examination they gave the results recorded in the first table on p. 293.

It is evident from the tabulated results that the Sea Island cotton was of fair quality but of irregular length. The presence of short fibres in long-stapled cottons causes a considerable diminution in their commercial value. Further experiments will be necessary before it can be definitely established that Sea Island cotton can be grown satisfactorily in British East Africa, as this crop readily suffers deterioration under changed conditions.

The four samples of Egyptian cotton were generally of fair quality, but were not equal to the standard sample of "Mitafifi" cotton with which they were compared. The colour was uneven

	1. From Malindi.	2. From Malindi.	3. From Malindi.	4. From Sala Maneru, West.	5. From Malindi.
Number or mark of sample	"Sea Island cotton. Sown May 1–19, 1905. Picked October."	"Afifi cotton. Sown March 24, 1905. Picked September and October."	"Afifi cotton. Sown April 20–30, 1905. Picked November 28."	"Afifi cotton from May 1904 sowing. Plants cut down to one foot from ground in March 1905. Picked December 8."	"Afifi cotton from 1904 sowing. Sown May 1905. Picked December 4."
Description	Unginned, clean.	Unginned, clean.	Unginned, slightly "leafy."	Unginned, fairly clean.	Unginned, fairly clean.
Lint	Soft and silky, lustrous, pale cream to white, generally free from stains. Yield on ginning, 28 per cent. Easily detachable from seed.	Soft, lustrous, pale reddish brown to white. Yield on ginning, 35 per cent. Easily detachable from seed.	Soft, fairly lustrous, pale reddish brown to white. Yield on ginning, 35 per cent. Easily detachable from seed.	Soft, lustrous, uneven light reddish-brown colour, small portion white. Yield on ginning, 37 per cent. Easily detachable from seed.	Soft, fairly lustrous, uneven colour, reddish-brown to white, occasional dark brown stains. Yield on ginning, 35 per cent. Easily detachable from seed.
Seed	Small, smooth, dark brown to black with greyish-brown tufts.	Small, smooth, dark brown with brown or green tufts.	Small, smooth, dark brown with greenish-brown tufts.	Small, smooth, dark brown with small greenish-brown tufts.	Small, smooth, brown usually with greenish-brown tufts, sometimes not tufted but spiked.
Strength	Good.	Normal.	Normal.	Normal.	Fairly good.
Length of fibres . . .	Mostly 1·5–2·1 inches. Some about 1 inch.	Generally 1·0–1·5 inches.	1·1–1·4 inches.	1·0–1·5 inches.	0·9–1·4 inches.
Diameter of fibres . .	Average, 0·0006 inch. Variation, 0·0004–0·0011 inch.	Average, 0·0007 inch. Variation, 0·0004–0·0010 inch.	Average, 0·0007 inch. Variation, 0·0004–0·0010 inch.	Average, 0·0007 inch. Variation, 0·0004–0·0008 inch.	Average, 0·0007 inch. Variation, 0·0004–0·0008 inch.
Microscopical characters	Fine and fairly regular, but a small proportion of immature fibres present.	Regular and generally mature.	Regular and generally mature.	Regular and generally mature.	Regular and fully mature.
Commercial value* . .	About 9*d.* per lb.	About 6*d.* per lb.	About $5\frac{3}{4}$*d.* per lb.	About $5\frac{1}{4}$*d.* per lb.	About 5*d.* per lb.

* On the date of these valuations, "fancy" Georgia Sea Island cotton was quoted at $10\frac{1}{2}$*d.* per lb., and "fully good fair" brown Egyptian at $8\frac{7}{16}$*d.* per lb.

in every case, and the fibre showed a tendency to become white. Many of the seeds were withered, and showed signs of the attack of insect pests. A number of insects bearing a strong resemblance to the "cotton stainer" (*Oxycarenus hyalinipennis*) were found dead in the samples. Several small reddish grubs, about 0·25 inch long, were present alive in the seeds, upon which they were apparently feeding. The presence of the empty husks caused the samples to give a larger percentage yield of cotton on ginning than would otherwise have been obtained. Samples Nos. 4 and 5 were somewhat inferior to Nos. 2 and 3 in lustre and colour, but resembled them in other respects. It is interesting to note that these cottons, although of the second year's growth, were nevertheless of fair quality and but little inferior to those of the first season. If, however, the yields are much smaller, the plan of collecting a second year's crop is, of course, inadvisable. In order that Egyptian cotton may be grown in British East Africa, of a quality equal to that of the cotton grown in Egypt, great care will be required in the purchase and selection of seed for sowing, and in the general cultivation and harvesting.

COTTON FROM GOLBANTI.

Results of Examination.

	1.	2.	3.
Number or mark of sample	"American cotton grown on the Tana alluvial soil."	"Afifi cotton grown on the Tana alluvial soil."	"Afifi cotton grown on the high red soil of the Tana Valley."
Description . . .	Ginned, fairly clean, but contained some leaf fragments and crushed seed. Soft, fairly lustrous, cream to white with occasional yellow or brown stains.	Ginned, clean, soft, fairly lustrous, pale reddish-brown with some dark brown stains.	Ginned, fairly clean, but contained some leaf fragments and crushed seed. Soft, fairly lustrous, uneven pale reddish-brown colour with some yellow stains.
Strength	Poor.	Normal.	Normal.
Length of fibres . .	0·9–1·2 inches.	1·0–1·5 inches.	1·0–1·5 inches.
Diameter of fibres .	Average, 0·0008 inch. Variation, 0·0005–0·0012 inch.	Average, 0·0007 inch. Variation, 0·0004–0·0011 inch.	Average, 0·0007 inch. Variation, 0·0004–0·0010 inch.
Microscopical characters	Fairly regular, but a small proportion of immature fibres present.	Regular and generally mature.	Mostly regular and mature.
Commercial value * .	About 5½*d.* per lb.	About 6*d.* per lb.	5½*d.* per lb.

* On the date of these valuations, "middling" American cotton was quoted at 6·07*d.* per lb., and "fully good fair" brown Egyptian at 8$\frac{7}{16}$*d.* per lb.

COTTON FROM MAZERAS FARM, MAKINDU AND NGAO.

Results of Examination.

	From Mazeras Farm.	From Makindu. 1.	From Makindu. 2.	From Ngao, Tana river.
Number or mark of sample	"No. M. 1, Sea Island cotton from Mazeras Farm."	"No. M. 2, Egyptian cotton from Makindu, first year crop."	"No. M. 3, Egyptian cotton from Makindu, from second year's growth."	"No. M. 4, Excelsior, American. Sown in April 1905, picked in November."
Description . . .	Ginned; contained a considerable quantity of leaf fragments and crushed seed. Soft, fairly lustrous, cream coloured, with some brown and yellow stains.	Ginned; contained leaf fragments and crushed seed. Fairly soft, of rather poor lustre. Colour uneven, light brown to white, with dark brown and yellow stains.	Ginned; fairly clean, but contained some crushed seeds. Soft, fairly lustrous, light reddish-brown, with many stains.	Ginned; clean, but contained some leaf fragments. Soft, lustrous, of uneven pale cream colour, with some brown or yellow stains.
Strength	Very poor.	Poor.	Fairly good.	Fairly good.
Length of fibres . .	1·2–2·1 inches.	Mostly 0·9–1·3 inches.	Mostly 1·1–1·4 inches.	0·9–1·4 inches, but mostly about 1·1 inches.
Diameter of fibres .	Average, 0·0006 inch. Variation, 0·0004–0·0009 inch.	Average, 0·0008 inch. Variation, 0·0005–0·0011 inch.	Average, 0·0007 inch. Variation, 0·0005–0·0010 inch.	Average, 0·0008 inch. Variation, 0·0006–0·0010 inch.
Microscopical characters	Fine, somewhat irregular, and not fully mature.	Partly immature.	Regular and generally mature.	Regular and fully mature.
Commercial value * .	About 9*d.* per lb.	About 6*d.* per lb.	About 6¼*d.* per lb.	6⅛*d.* per lb.
Remarks	The presence of broken, withered seed indicated the attack of some insect pest. The low value of the cotton was due to its weakness and poor colour. The immature cotton present would lead to an abnormal amount of waste in manufacture.	These cottons were both of poor quality, but the second year's growth was superior to that of the first year. The presence of crushed, hollow, withered seeds indicated the attack of some insect pest.		This cotton was of very good quality and would be readily saleable.

* On the date of these valuations, "fancy" Florida Sea Island was quoted at 12·5*d.* per lb., "fully good fair" brown Egyptian at 9⅝*d.* per lb., and "middling" American at 6·16*d.* per lb.

The sample (No. 1) of American cotton was deficient in strength, and would consequently prove somewhat wasteful in manufacture. The commercial value of the cotton was also diminished by the presence of stains. The Egyptian cottons (Samples Nos. 2 and 3) were of fair quality, and although somewhat lacking in lustre, were fine and generally mature. Both samples were inferior to the standard "Mitafifi" cotton, with which they were compared. Sample No. 2 was superior to sample No. 3 in being more lustrous, of better colour, and less stained. It is evident, therefore, that the plants grown on the better soil gave the most satisfactory results.

It should be pointed out that insufficient care had been taken in ginning these samples, many crushed seeds being present which would tend to stain the cotton.

ORIGANUM OIL FROM CYPRUS.

TWO samples of origanum oil have been forwarded recently to the Imperial Institute by the Acting Director of Agriculture for Cyprus. The first was received in January 1905, and represented the main stock of the distillate for the season 1904–05. The second sample was received in July of the present year, and represented the oil distilled during the season 1905–06.

The main supply was in each case forwarded to the Crown Agents for the Colonies for sale, on the basis of the results of analyses made at the Imperial Institute.

Description of Samples.

The sample of oil received in 1905 weighed about 2·5 lb., and was contained in two small tins. When received it was pale yellow in colour, but rapidly darkened on exposure to light, developing a dark brownish-red colour. It had a pleasant odour, resembling that of thyme, and a somewhat pungent thyme-like flavour.

The sample received in the present year closely resembled the product forwarded in 1905, and may be described in the same terms.

Chemical Examination.

The oil was examined, and gave the following results:—

	Sample received in 1905.	*Sample received in* 1906.
Specific gravity at 15·5° . .	0·966	0·9645
Refractive index at 23° . .	1·5144	1·51
Rotation in a 100 mm. tube . .	0°	0°
Solubility in 70 per cent. alcohol	1 in 1·6 parts	1 in 1·4 parts
"Phenol" content . . .	82·5 per cent. (*by volume*)	82·5 per cent. (*by volume*)

The "phenol" was extracted from the oil by the usual methods, and, after careful examination, was identified as carvacrol, which is a liquid isomeride of the better-known solid, crystalline substance thymol, generally present in French "white oil of thyme" obtained from *Thymus vulgaris.* Carvacrol resembles thymol in odour, and is somewhat closely related to it chemically. Thymol is extracted on a considerable scale from such materials as ajowan oil, obtained from an Indian plant *Carum ajowan*, and is used as an ingredient in perfumes, or as an antiseptic. It is probable that carvacrol could be used in the same manner, though as an antiseptic it seems to have received but little attention up to the present. The Cyprus origanum oil would be an excellent raw material for the preparation of carvacrol.

Identity of the Plant Furnishing the Oil.

No information was supplied with the sample as to the botanical name of the plant yielding the Cyprus origanum oil, but in composition and characters the latter agrees very closely with that yielded by *Origanum hirtum*, which is known in commerce as Trieste or Cretan origanum oil. The oil was, however, also precisely similar in character to a small sample of the oil, said to be derived from *Origanum onites*, which Professor Dunstan obtained during his recent visit to Cyprus (this *Bulletin*, 1905, **3**. 327). It would be of interest to have the botanical name of the plant producing the Cyprus origanum oil definitely determined, and a herbarium specimen of the plant has been asked for in order that its botanical identity may be established.

Commercial Value of the Oil.

Samples of the oil were submitted to soap manufacturers, manufacturing druggists, makers of perfumery, and brokers dealing in essential oils. These firms were informed of the results of the chemical examination, and they were asked to make offers for the whole or a portion of the consignment. The following is a selection of the opinions expressed by these firms as to the quality and value of the oil :—

Soap manufacturers.—It was obvious that the dark colour of the oil would prevent its use for perfuming white or delicately-coloured soaps, and consequently only a limited number of soap-makers were prepared to buy the material. It was ascertained in the course of these inquiries that most of the oil of this type now used by these firms is obtained from France or Spain, and the Cyprus oil was new to most of them. The French oil, it should be pointed out, is derived from *Thymus vulgaris*, and usually contains thymol, though this may be replaced by carvacrol. The source of the Spanish oil, which contains carvacrol but no thymol, is not definitely known, but is probably a species of origanum. From both these oils "white thyme oils" are prepared by special processes of rectification.

Manufacturing druggists.—One of these firms stated that they could not use this oil in place of white thyme oil, as the phenol it contains is carvacrol and not thymol, and it was not certain how the bactericidal properties of these two phenols compared.

The results obtained by Cadeac and Meunier, and by Chamberland, who made a careful comparison of the bactericidal values of a large number of essential oils, show that oil of Cretan origanum, which contains carvacrol, possesses strongly antiseptic properties. As the result of their being made acquainted with this work, the firm in question revised their opinion of the oil and expressed willingness to buy a quantity at the current price for red thyme oil.

Perfumery makers.—No offers were received from firms of this class.

Essential oil dealers.—A number of offers were received from these firms. It is noteworthy that a German firm, to whose notice the oil was brought, stated that they did not consider it likely that so large a consignment of this oil could be sold at remunerative rates, and that the demand for origanum oil had fallen off somewhat in recent years.

The best of the offers received were communicated by the Imperial Institute to the Crown Agents for the Colonies, by whom the two consignments were finally sold as follows:—

Oil of Season 1904–05.	*Oil of Season* 1905–06.
1,224 lb. at 3*s*. per lb.	1,450 lb. at 3*s*. per lb.
1,050 lb. at 3*s*. 2*d*. per lb.	

Conclusions.

The foregoing results show that this oil sells readily in this country at prices which should be fairly remunerative to producers in Cyprus. It should, however, be borne in mind that the demand for this oil is somewhat limited, and that it competes with the thyme oil produced in France and Spain, and with the "origanum oil" produced in Smyrna, and that consequently a sudden increase in production in Cyprus might lead to a considerable fall in price. The Cyprus oil has, however, the advantage that it is very rich in the odorous and antiseptic constituent carvacrol, and it is probably due to its richness in this constituent, as revealed by the analyses made at the Imperial Institute, that the comparatively high prices realised for these consignments were obtained at a time when "red thyme oils" were selling at lower rates. It would be advantageous if a refined white oil could be prepared by some simple method from this material, as this would probably fetch an enhanced price, and be applicable to other purposes for which the "red oil" is unsuitable.

CAPE BERRY WAX FROM CAPE COLONY.

SAMPLES of this wax were shown recently at an exhibition held by the Royal Horticultural Society in London, and at the Colonial Exhibition at the Crystal Palace. The attention of the Director of the Imperial Institute was directed to the material by Mr. A. J. Chiappini of Cape Town, who stated that although it was obtainable in quantity in the Colony no considerable use for it had yet been found. A sample of the wax was supplied to the Imperial Institute, at the suggestion of the Director, by the Agent-General for Cape Colony, in order that it might be examined and its exact commercial value ascertained.

Description of Sample.

The sample consisted of a moulded cake of wax weighing 5½ lb. In its general characters the wax was similar to the material usually known as Myrtle wax, which is derived from *Myrica cerifera*. The Cape berry wax is probably derived from one or other of the several species of Myrica growing in South Africa, which include *M. quercifolia*, *M. cordifolia*, *M. laciniata*, and *M. serrata*.

Results of Examination.

The following table gives the constants of this wax as ascertained in the Scientific and Technical Department of the Imperial Institute, with the figures previously recorded for myrtle wax for comparison. It will be seen that the figures correspond very closely.

	Cape berry wax.	Myrtle wax.
Saponification value	211·1 (mgr.)	205–217 (mgr.)
Iodine value	1·06 per cent.	1·95–3·9 per cent.
Acid value	4·09 (mgr.)	—
Mean molecular weight of fatty acids	236·1	243
Melting-point of wax	40·5° C.	40·8° C.
Melting-point of fatty acids	47·5° C.	47·5° C.
Specific gravity at at 99° C.	0·8741	0·875–0·878

These results indicated that the wax might be found useful by soap-makers, and possibly for the manufacture of candles, although it appeared that the comparatively low melting-point of the fatty acids might render the material unsuitable for the latter purpose.

Commercial Valuation.

Samples of the wax were submitted to two firms of manufacturers for valuations.

One of these reported that the wax was not suitable for candle-making, but that it yielded a hard white soap. They wished to have a few hundredweights for trial, and estimated its value at two-thirds to three-quarters the price of ordinary beef tallow, *i. e.* from 22*s.* to 24*s.* a cwt. at that time.

The second firm, after inspecting the sample and having been informed of the results of its examination at the Imperial Institute, requested that a trial consignment of 10 tons of the wax might be obtained at a price not to exceed £29 per ton net, c. i. f. Liverpool. This offer was at once communicated to the Agent-General for Cape Colony, who transmitted it to the Secretary of Agriculture at Cape Town, asking that the shipment might be made as early as possible.

In the result, however, it proved impossible to obtain the quantity required for the trial consignment owing to the absence of any organisation for collecting the wax at the proper season. From information subsequently received there is no doubt that large quantities of the wax will be available, provided that the collection of the material is carried on continuously during the season, and an attempt will be made to arrange this next year.

OCCURRENCE OF MONAZITE IN THE TIN-BEARING ALLUVIUM OF THE MALAY PENINSULA.

THE deposits of cassiterite or tinstone in the alluvium of the Malay Peninsula are the most important at present known. The mineral appears to be derived from metalliferous veins of varying character, which penetrate both the intrusive granite that occupies so much of the country, and the superincumbent crystalline schists and limestones.

Until now tinstone was the only constituent of the alluvium considered of importance; indeed, the presence of other heavy minerals such as wolfram and zircon depreciated its value on account of the difficulty of separating the tinstone from these minerals, which in themselves were of no value. Recently there has been some demand for wolfram, and it is now being separated in some places by electro-magnetic classifiers.

In June 1904, Mr. Alma Baker of Batu Gajal in the Federated Malay States sent to the Imperial Institute a sample (FmB 2) of heavy sand obtained by concentration from the alluvial tin workings of the Dindings Settlement on the west coast. He stated that the sand, which he described as zircon, could be obtained in considerable quantities, and asked for information as to whether there was any commercial demand for such material, and if so what its value might be, and through what channels it could be disposed of.

The sand was therefore systematically investigated in the Scientific and Technical Department of the Imperial Institute. It consisted of fine grains varying from 0·1 to 0·3 mm. in diameter. The mineral most largely represented was zircon, in colourless or brownish prisms, and flat plates, with a monoclinic aspect. Cassiterite or tinstone appeared in brownish prisms, ilmenite (titanate of iron) in opaque grains, violet by reflected light, and monazite in rounded honey (or greenish) yellow crystals. Monazite is essentially a phosphate of cerium, lanthanum, and didymium, with a varying percentage of thorium, perhaps in the form of silicate (see this *Bulletin*, 1905, **3**. 153). Monazite is probably accompanied in this sand by a little xenotime, a phosphate of yttrium, which usually contains a smaller percentage of thorium. These two minerals were no doubt derived from the disintegration of decomposed granitic rocks similar to those which have yielded the monazite-bearing sand of Brazil, which is the principal source of the thoria so extensively employed in the manufacture of incandescent gas mantles. A partial analysis of the sand furnished the results given in the first column in the accompanying table (p. 309).

The silica and zirconia are present in almost exactly the correct proportions to form zircon. The titanium oxide appears to be combined with the greater part of the iron oxide forming ilmenite. The tin oxide is no doubt present as cassiterite, and the remaining constituents of the sand, including nearly 2 per cent. of thorium oxide (thoria), represent the monazite and xenotime.

Calculating on this basis the mineral composition of the sand was found to be the following:—

		Per cent.
Zircon	$ZrSiO_4$	25
Ilmenite	$FeTiO_3$	21
Cassiterite	SnO_2	17·6
Monazite and xenotime		23

The calculated composition of the monazite (including xenotime) is given in the second column of the table of analyses (p. 309), whilst in the last two columns of the same table the average composition of monazite and xenotime is shown for comparison. The amount of xenotime present in the sands examined is so small that it may for all practical purposes be disregarded.

It will be seen that the calculated composition agrees very well with that of monazite, though the phosphoric acid is rather low and thoria unusually high, the latter, however, has been found to vary greatly in specimens of monazite from different localities.

The presence of nearly 2 per cent. of thoria in the sand was of considerable interest from the economic standpoint, but, as pointed out in a report made on this material, the market value of sand containing thoria is seriously diminished when it forms such a small percentage of the total as in the present case. It was, therefore, recommended that the sand should be separated on the spot with the help of electro-magnetic separators. The ilmenite would be first separated in a magnetic field of moderate strength, and afterwards by increasing the strength of the magnet the monazite itself could be removed in a comparatively pure state, so that a product would be obtained containing about 8 per cent. of thoria. The residue, consisting of zircon and tinstone, could be separated by jigs, shaking tables, or other hydraulic gravitational classifiers, since the specific gravity of tinstone is 7, while that of zircon varies from 4 to 4·7. Fairly pure tinstone, containing about 75 per cent. of metallic tin, could thus be obtained. Xenotime is less magnetic than monazite, the magnetic character of which depends on the presence of cerium, so that if in any case an appreciable amount of xenotime were present, the monazite could be easily separated from it.

In March 1905 another sample (FmS 1) of heavy sand was received at the Imperial Institute from Mr. Scrivenor, the geologist to the Federated Malay States, who had detected monazite in it. The locality from which it was obtained appears to have been the Kemaman river, Tringganu, near Pahang. On examination under the microscope it was found to consist of the following minerals in grains not exceeding 0·2 millimetre in diameter:—Quartz in irregular colourless fragments, zircon, andalusite (a silicate of alumina usually associated with metamorphic rocks) in rectangular colourless grains, a considerable amount of monazite, tourmaline (a silicate and borate of aluminium, iron, and other elements, often associated with tinstone), ilmenite, and the three forms of titanium oxide, viz. anatase in minute square dark blue plates, brookite in small brownish plates, and rutile in deep red grains; no cassiterite was noticed, so that this mineral can only occur in small amount.

A chemical analysis gave the percentage composition shown in the third column of the table of analyses (p. 309).

From the analytical results the mineral composition of the sand appears to be roughly the following:—

		Per cent.
Quartz	SiO_2	6·0
Zircon	$ZrSiO_4$	22·7
Andalusite	Al_2SiO_5	10·2
Anatase, Brookite, Rutile	TiO_2	4·7
Ilmenite	$FeTiO_3$	14·1
Cassiterite	SnO_2	1·0
Monazite		41·6

The calculated percentage composition of the monazite is shown in the third column of the table of analyses (p. 309). It resembles that of a typical monazite, but the phosphoric acid is rather lower, and the rare earths rather higher than usual; similar results have, however, been furnished by analyses of monazitic sands from Alexander County, North Carolina, U.S.A., and from Gough Country, New South Wales. The considerable amount of yttria may be due to the presence of a certain proportion of xenotime, and the fact that the percentage of thorium is lower than in the monazite from the Dindings Settlement may, perhaps, be accounted for in the same way.

The presence of the comparatively light minerals, quartz, and andalusite shows that the sand had not been so carefully washed as in the case of the sand from the Dindings Settlement. In spite of this it contains a higher percentage both of monazite and thoria.

It was suggested that the further concentration of the thorium-bearing constituents should be conducted on the same lines as in the case of the sand from Dindings. The ilmenite can be separated as before in a weak field, but the titanium oxides will not be lifted by it. When the monazite has been removed, a mixture of quartz, andalusite, zircon, titanium oxides, and a little cassiterite (tinstone) will be left. By hydraulic gravitational processes these could be separated into three groups, the lightest, consisting of quartz (specific gravity 2·66) and andalusite (specific gravity 3·2), is of no value, the second would include 17 per cent. of the titanium oxides (specific gravity 3·82 to 4·25) and 83 per cent. of zircon (specific gravity 4 to 4·86), which are too close in specific gravity for separation in this way. The third group would consist of tinstone.

In September 1905 a sample (FmS 2) of concentrated sand containing monazite from the alluvial workings of the Sempan Tin Company, Pahang, was forwarded by Mr. Scrivenor.

The monazite in this case was often white and opaque on the surface, presumably the result of incipient decomposition. The sand was analysed, with the results shown in the fifth column of the table of analyses.

The following percentage mineral composition was calculated from the analysis :—

	Per cent.
Cassiterite	65
Monazite	13
Ilmenite, Rutile, Magnetite	16
Columbite (niobate and tantalate of iron)	3

Some of the monazite was separated by electro-magnetic means, and subsequently hand-picked. It was analysed, and the percentage composition is shown in the sixth column of the table (p. 309).

The low percentage of phosphoric acid in the monazite of this and other sands, and the presence of more than 1 per cent. of water, may be accounted for by the slight decomposition of the mineral. The percentage of thoria is higher than the average for monazite.

This sand also is eminently suited for electro-magnetic separation, which would much increase its commercial value, as if it were smelted for tin in its present condition the thoria would be lost in the slag.

In October of the same year a sample of monazite sand (FmS 3) from a small alluvial tin mine at Baias Tujoh, near Kampar Perak, was received from Mr. Scrivenor. This was described as "Amang," the local term applied to the heavy minerals, supposed to be useless, separated from the tin ore of the Chinese alluvial mines in the last washing. The material is sifted, the finer particles being collected and re-washed.

The result of a partial analysis of the sand in the state in which it was received is given in the seventh column of the table of analyses. The mineral percentage composition was inferred from mineralogical and analytical data to be the following :—

	Per cent.
Cassiterite	18
Monazite	1·5
Ilmenite	28·5
Zircon, with some rutile	52

This sand could be separated in the manner already indicated, an operation that is carried out both in Brazil and in North and

South Carolina in the United States. In Brazil, sand containing only 2 per cent. of monazite has been successfully worked, although it was not associated with other constituents of much value. Here the tin ore would be made available by concentration, so that, although the monazite amounts to only 1½ per cent., the separation should be commercially successful.

No analysis was made of the monazite itself, but it appears from the bulk analysis of the sand to contain rather more than 5 per cent. of thoria.

In June 1906 another sample of washed sand from the Kemaman river was received. In a letter from Mr. Warnford Lock, forwarded at the same time, it was stated that the exact source of the sand had not been ascertained, but there was practically no doubt that it was found in hills of biotite granite from which the alluvium had been derived. He added that the workmen were unable to separate the monazite and cassiterite by mechanical means, but arrangements were being made for the installation of electro-magnetic classifiers.

A preliminary examination of the material, with the help of the electro-magnet, gave the following approximate composition :—

	Per cent.
Cassiterite and zircon . .	60
Monazite (mainly) . . .	32
Ilmenite (mainly) . . .	8

When the sand was sifted on a sieve with thirty meshes to the inch, it was found that the finer material which passed through contained nearly all the monazite, and had the following composition :—

	Per cent.
Cassiterite and zircon .	26
Monazite	58
Ilmenite	15

while the coarser sand consisted mainly of cassiterite and zircon.

The ilmenite and monazite were then successively removed from the siftings by electro-magnetic means, leaving the tinstone and zircon, which were now added to the coarser material of the same composition that failed to pass the sieve. In this way the ilmenite was eliminated, the tinstone concentrated, and the monazite obtained in a fairly pure state.

There can, therefore, be no question that the separation of the different constituents of the alluvial tin deposits can be effected by a combination of hydraulic, mechanical, and electro-magnetic processes, though the details of these operations must be modified to suit the composition and grain of each sand. Some of the constituents thus recovered, such as tinstone, monazite, and wolfram, already command a market. For others, such as zircon and rutile, there is a small and uncertain demand. The ilmenite is, in fact, the only one of these heavy minerals which is not in any commercial demand at the present time.

The results of the investigations conducted at the Imperial Institute clearly indicate that the alluvium of the Malay Peninsula often contains, besides tinstone, other constituents of commercial value, of which monazite is the most important, and that by a comparatively simple process these may be separated. By the same operation the tinstone, which is seriously depreciated or even rendered useless by their presence, will be concentrated and enhanced in value.

It may be added that until recently monazite sand containing about 5 per cent. of thoria had a market value of £7 to £10 per ton for each unit per cent. of thoria present. The price has since declined, and it is probable that little more than £5 per ton for each unit per cent. of thoria would be obtained at the present time.

TABLE OF ANALYSES.

		1. Sand from Dindings Settlement.	2. Calculated composition of monazite from Dindings Settlement.	3. Sand from the Kemaman river, Tringgannu, near Pahang.	4. Calculated composition of monazite from Kemaman river, Tringgannu, near Pahang.	5. Sand from Sempang Tin Co., Pahang.	6. Concentrated monazite from the Sempang Tin Co., Pahang.	7. "Amang" from Baias Tujoh.	8. Average composition of Monazite.	8. Average composition of Xenotime.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Thoria	ThO_2	1·99	8·7	2·20	5·30	1·51	8·38	0·08	8·28	2·03
Stannic oxide . .	SnO_2	17·60	...	1·06	...	64·53	...	17·94	0·06	0·13
Titanic ,, . .	TiO_2	9·62	...	12·14	...	6·49	...	21·63	...	...
Zirconia	ZrO_2	17·56	...	15·23	...	0·48	...	In considerable amount but not estimated.	...	0·62
Silica	SiO_2	8·78	...	17·13	...	2·44	0·92		2·08	1·46
Uranic oxide . .	UO_3	...	...	0·19	0·46	...	...	...	...	1·16
Cerium ,, . .	Ce_2O_3	14·61	63·8	12·18	29·34	3·41	25·46	1·02	30·32	0·83
Lanthanum oxide / Didymium ,,	La_2O_3 / Di_2O_3			14·32	34·49	4·38	32·72	...	26·86	...
Yttrium oxide . .	Y_2O_3	...	...	1·88	4·53	...	2·80	...	2·13	57·86
Alumina	Al_2O_3	...	...	6·42	...	0·24	0·84	...	0·08	0·21
Ferric oxide . . .	Fe_2O_3	...	...	...	...	3·09	2·78	...	1·29	1·42
Ferrous ,, . . .	FeO	11·43	...	5·94	...	2·36	...	12·22 (Including ferric iron calculated as ferrous).	...	...
Manganous oxide .	MnO	...	...	0·67	...	0·36	...	...	0·06	0·04
Copper oxide . .	CuO	...	...	0·16	0·39	...	...	...	...	...
Lead ,, . .	PbO	...	...			...	...	...	0·12	0·30
Lime	CaO	...	...	trace	...	0·31	0·61	...	0·89	0·59
Magnesia . . .	MgO	...	...	0·05	0·12	...	...	...	0·02	0·09
Potash	K_2O	..	...	...	...	...	...	...	...	...
Soda	Na_2O	...	...	...	...	...	...	...	...	...
Niobic oxide . .	Nb_2O_5	...	...	...	...	2·86	...	...	...	...
Tantalic ,, . .	Ta_2O_5	...	...	...	...					
Phosphoric anhydride	P_2O_5	6·14	26·7	10·54	25·39	3·54	23·92	0·49	27·53	32·45
Water or loss on ignition . . .	H_2O	...	...	...	...	0·81	1·14	...	0·53	1·01
Moisture		...	...	...	...	...	0·14	...	...	...

GENERAL NOTICES RESPECTING ECONOMIC PRODUCTS, THEIR PRODUCTION AND DEVELOPMENT.

BRITISH ASSOCIATION, 1906.

PRESIDENTIAL ADDRESS TO THE SECTION OF CHEMISTRY AND AGRICULTURAL SCIENCE.

"*Some Imperial Aspects of Applied Chemistry.*"

THE following is the text of the presidential address delivered during the recent meeting at York by Professor Wyndham R. Dunstan, M.A., LL.D., F.R.S., F.C.S., Director of the Imperial Institute.

"The President of the chemical section of the British Association must always have a large choice of subjects for his address. He may attempt to review the chemical progress of the year, or to give an account of researches in that division of the science in which he is most interested. He may deal with the ever-recurring problems of education; or, again, he may draw attention to the importance of our science in one or other of its many relations to National and Imperial affairs. I have decided to adopt the last course, and to invite your attention at York, where several tropical products furnish the basis of important industries, to the intimate association of our science with the problems that await solution in connection with the utilisation of the raw materials and economic products of our colonies, and especially those of our tropical possessions. There is a pressing need that the Imperial Government should recognise much more fully than it has hitherto done, and at least as fully as foreign Governments are already doing, the claims of scientific investigation to be regarded as the pioneer instrument of this work, and as the essential first step in the material and commercial development of our possessions.

Although my remarks will be chiefly directed to the importance of chemistry in this connection, my plea will be more general. It is that the scientific method of experimental research should be systematically applied in each division of the sciences concerned. In the case of raw materials, however, whether vegetable or mineral, their commercial value must depend chiefly, if not entirely, upon their composition, and sooner or later the method of chemistry must therefore be applied.

In determining the value of the mineral resources of a country other specialists are also concerned, and the assistance of the geologist, the mineralogist, and eventually of the metallurgist may be required. Similarly with vegetable and agricultural products the services of the economic botanist and of the entomologist will be needed. It will therefore be necessary for me in dealing with the subject as a whole to touch upon several aspects in which other sciences are concerned, and with which the science of chemistry must co-operate in attaining a practical end—namely, the material development of the countries concerned. I need make no apology for many allusions to scientific agriculture, for this subject is this year attached to this section, and indeed the science of chemistry is of fundamental importance to agricultural practice both at home and in the Tropics.

In the first place I must ask you to allow me to say a few words as to the very wide interests that are involved in the proper solution of the problem of colonial development.

It is all-important that the wage-earning community of this country should have an adequate supply of tea, coffee, cocoa, rice, tobacco, and other commodities, and that our manufacturers should be able to count upon a regular supply of cotton, jute, rubber, and other raw materials as far as possible under their own control. All these products are derived almost exclusively from the Tropics, and experience shows that it is a great disadvantage to the manufacturer not to be able to exercise control in the direction of securing the regular production of these materials, and especially not to be able to avoid the great and sudden fluctuations in their price, which are often the result of financial speculation on the part of a foreign capitalist who has secured the control of the output of a foreign country.

The almost entire dependence of the great textile industries of Lancashire upon the cotton crop of the Southern States of America has placed this industry at the mercy of American speculators, whose tactics may lead, as in 1903, to such a rise in the price of the raw material as to render it imperative for the manufacturer to close his mills, and by throwing large numbers out of employment to bring poverty and misery to many thousands of people.

The great principle which must now necessarily guide our system of administration and expenditure in our tropical Colonies and Protectorates has as its purpose the utilisation of natural resources and the creation and development of native industries with the aid of European supervision and advice. Adequate supplies of produce, natural and agricultural, will thus be ensured to British manufacturers and consumers from territories within the administration of the British Crown. This principle of employing our 'undeveloped estates' for the advantage of our manufacturers and consumers, and at the same time for the benefit of the natives who inhabit these countries, was put into action by Mr. Chamberlain during his long tenure of office as Secretary of State for the Colonies, and this recognition of a vitally important principle must always be associated with his name.

Excepting India and the self-governing Colonies, the Crown Colonies and Protectorates, for which alone the Imperial Government is directly responsible, include an area of about two and a half million square miles and a population of about forty millions. The value of these possessions to us at the present time may be judged from the value of their import and export trade with the United Kingdom. The value of the exports of these countries in 1904 was estimated at about four and a half million pounds sterling, and the imports from the United Kingdom at about twelve and a half million pounds sterling. In gauging the importance to this country of the development of these possessions, the export trade of which is only in its infancy, it should be remembered that the profits arising from the export as well as from the import trade are chiefly domiciled in this country; since practically the whole of this trade is in the hands of British merchants, and the entire profits, including those of shipping, etc., are therefore subject to our national system of taxation, and represent a very substantial annual contribution to the British Exchequer.

It is therefore only reasonable that a certain sum should be expended from British funds to aid the applications of science to the commercial development of these possessions. Such an expenditure in the light of the facts to which I have drawn attention may be regarded as an investment with the certainty of a profitable return.

I have thought it necessary to give this brief account of the position of our still undeveloped Crown Colonies and Protectorates and the national importance to us of their systematic development before proceeding to the principal subject of this address, which is to emphasise the aid which science in several of its branches can render to this work of development, and especially the science of chemistry, the capacities of which in this connection have so far not been sufficiently recognised.

The importance of utilising our own tropical possessions as sources of the raw material required by the manufacturer is now generally recognised, and very considerable progress has been made in recent years. The tea produced in India and Ceylon has largely superseded the China tea formerly used in this country. Similarly, coffee is extensively grown in India, in the West Indies, and in several of our African possessions. The jute cultivation in India has been very successful, and the demand for this fibre is so great that the question of its cultivation in our West African colonies is now under consideration. India-rubber, hitherto chiefly obtained from South America, is of increasing importance as a commercial article, and the South American tree has been introduced with success in Ceylon, the Straits Settlements, and the Federated Malay States, which are rapidly becoming important rubber-producing countries whose produce is competing successfully with that of South America. The cultivation of cotton, hitherto principally carried on in the United States, is being vigorously proceeded with in India, the West Indies, and in West Africa, as well as in Egypt and the Sudan, and we may look forward in the future to these countries supplying the British manufacturer with a large proportion, if not the whole, of the cotton he requires.

There are, however, vast resources, both mineral and vegetable, in our Colonies and Protectorates which are awaiting development for an exact knowledge of their composition and properties, which can only be ascertained by scientific means and chiefly through chemical investigation, whilst the British manufacturer is in need of increased and better supplies of the raw materials on which his industrial activity depends. This demand for increased supplies now affects nearly every industry in this country. Rubber and fibres are well-known examples; fats and oils for the manufacture of soap and perfumes; and tanning materials, as well as numerous minerals, are other instances in which our manufacturers are at present anxious to discover new sources of supply. These sources can only be discovered and their value ascertained by properly directed scientific investigations.

We have heard much recently respecting the assistance which science can bring to the maintenance and development of the industrial efficiency of this country, and the Imperial Government is being urged to give its help, especially by providing increased facilities for the education of scientific men, competent to aid the manufacturers of this country in improving their methods and processes. In this work the science of chemistry is one of the most important. There is scarcely an industry to which it is not able to render immense service. Within recent years this fact has slowly gained recognition, and the principle of State assistance to industry is virtually admitted, both in respect of education and of research. The most conspicuous examples of a recognition of the principle are the grants made from the National Treasury to the new Technological College at South Kensington and to the National Physical Laboratory.

Not less important than the service which science can render to existing industries and their extension is that which it can contribute to the Imperial problem of ascertaining and rendering available for the manufacturer the vast undeveloped resources of our own possessions. Our own experience and the example of other countries have shown that such work cannot be systematically carried on by private enterprise. Upon its successful accomplishment depends, not only the unrestricted supply of the necessary raw materials for which the manufacturer looks in increasing quantity, but also the prosperity of the country which produces these materials. This success can only be brought about by a combined effort on the part of the manufacturer and of the Government. The manufacturer can provide information as to the materials he needs. The preliminary work of discovering suitable material by scientific means, as several foreign

Governments have already recognised, must be endowed, directed, and carried on with Imperial funds. It cannot be expected that private enterprise will take steps to explore the resources of little-known countries on the chance of a particular material being discovered, nor can the work, as a rule, be successfully done by this means. Experience shows that the most effective manner of promoting the commercial development of a new country is for the Government to carry out systematically with its own officers the preliminary work of exploration and examination of the natural resources, with the aid of such technical advice as may be necessary from manufacturers and users, and then, having established the fact that particular products of value can be found or cultivated in a given country, to leave commercial enterprise to do the rest. By action on these lines immense progress is being made in French, German, and Dutch possessions, whilst the United States Government has taken similar action with the Philippines. In our own case, where this work exists it is in most cases in a more or less embryonic condition, and lacks the organisation which is necessary for success.

In many of our Crown Colonies and Protectorates there already exist, or are in the process of organisation, agricultural and other scientific departments, many of which include officers who are engaged in the work of exploring and developing the vegetable resources of these countries, especially by experimental planting. Chemists are attached to some, but not to all of these departments. In the West Indies the valuable work accomplished by Professor Harrison, Mr. Francis Watts, Professor Albuquerque, Professor Carmody, and Mr. Cousins is well known, and illustrates the great services which the science of chemistry may render, not only to tropical agriculture, but to every branch of economic development. It is clearly desirable that at least one scientific department should be attached to the Government of each of the principal Crown Colonies and Protectorates. As a rule, it is convenient that this should be an agricultural department with the services of a scientific chemist at its disposal. In a tropical climate, and with limited appliances at his command, it must be admitted that a chemist is severely handicapped, and, as a rule, he cannot be expected at first to be able to do much beyond the comparatively simple and preliminary work, chiefly analytical, which, however, in a little-known country is of the greatest importance to an agricultural department. In addition, he would have to deal with the composition of natural products of all kinds, both vegetable and mineral, as well as with the improvement of native industries. If the chemist is able to refer complicated or special investigations to a central department at home, and is provided with assistance in the routine work, he would be in a position to undertake the scientific investigation of a selection from the numerous problems with which a chemist will be confronted.

A chemist working in the spirit of an investigator will be able to render special services to the cause of tropical agriculture, and it is therefore of importance that in future the men appointed to these posts should be chosen as far as possible on account of the promise they have shown as investigators. The determination of the constituents of little-known indigenous plants as the first step towards ascertaining their economic value is another department of work which cannot be carried out without a chemist, and the same applies to the examination of poisonous plants, and also of minerals, in addition to the determination of the composition of foods and feeding stuffs.

Tropical agriculture is a subject which is now of the first importance, especially in those countries in which our policy is to depend on a native population for the actual cultivation of the soil. We have two functions to perform in our position as supervisors: the one is to ascertain the nature and capabilities of the soil by actual experiment, for which well-organised experimental stations are a necessary part of every agricultural department; the other duty is to convey to the natives, chiefly by means of demonstration, the results of this experimental work, so that they may be persuaded to make it a part of their agricultural practice.

Work on these lines is being done under Government auspices in the French and German colonies, and I may allude to the French successes in Algeria, in Senegal, and in the Sudan, and to the advances made by Germany in East Africa. These achievements are mainly due to a policy of continuous scientific work on agricultural lines. We shall have the privilege of hearing from Dr. Greshoff, the eminent director of the Colonial Museum at Haarlem, an account of the chemical investigations which are being carried out in connection with Java and the Dutch Indies (see page 344).

In many of our own Colonies and Protectorates active agricultural departments, equipped with the means of experimental working, are only now in process of organisation. One of the most recently organised of these is that of the Transvaal, which, at Lord Milner's initiation, has been completely equipped on the lines of that model for all such effort, the agricultural department of the United States. This department has as its chief chemist Mr. Herbert Ingle, of the Yorkshire College, now the University of Leeds.

If we are to compete successfully with foreign countries it is necessary that the position of science in relation to tropical agriculture should be definitely recognised. The days when a botanical garden served the purpose of an entire scientific establishment in a colony have passed away, and we now require, in order that a proper return should be obtained, and the natives assisted in their agricultural practice, a scientific department with a proper complement of specially trained officers, including a consulting chemist, other specialists being added to the staff as the requirements arise. These officers should be remunerated on a scale likely to attract some of the best-educated men from this country, which is at present far from being the case.

It would be out of place to discuss here the detailed organisations of these scientific departments. I merely desire to urge the necessity of their functions being extended, and of their receiving adequate financial support.

It is important that the scientific work which is being accomplished by these various departments should be brought to a focus, and that the results obtained in one colony should be available for the information of the departments in other colonies. The work of all such establishments requires to be unified by co-operation with a central department which can extend the investigations conducted in the colonies, carry out investigations and inquiries which cannot be undertaken on the spot, maintain the necessary touch with the manufacturers, and co-ordinate the work undertaken and the results obtained in each of the separate colonial establishments and systematically collate it, so that each may be aware of the results that are being obtained in other countries. In our African possessions at present the same investigations and inquiries have to be conducted independently, and often without the knowledge that the problem in question has been already solved.

Another increasingly urgent duty of the Central Department is to inform the colonial establishments of the results of the work which is being conducted in foreign countries, and of the progress which is being made in the utilisation of raw materials all over the world, and to bring to their notice the constantly changing requirements of the manufacturers and users of raw materials.

So far as botany is concerned, this co-ordination has been to a large extent effected through the agency of the Royal Gardens, Kew, which is in touch, through the Colonial Office, with all the botanical gardens in the Crown Colonies and Protectorates. In chemistry, as well as in certain other subjects, these duties have been performed in recent years by the Scientific and Technical Department of the Imperial Institute, which is now working in co-operation, not only with the Governments of the Crown Colonies and Protectorates, but also with those of several of the self-governing colonies, and also with the scientific departments which have been brought into existence in India, where at last the importance of scientific agriculture is receiving due recognition from the Government.

So little has hitherto been done in this direction that the number of problems requiring attention is exceedingly large; and even with a specially trained staff of workers and extensive laboratories, such as now exist at the Imperial Institute, it becomes necessary to select, as the principal subjects for investigation, those which are regarded by the Governments of the countries concerned as of the most practical importance, and in which the British manufacturer is at the moment most concerned. There must therefore remain a large number of materials of unknown composition and of problems of purely scientific interest which offer an attractive field for the chemical investigator. Already steps have been taken to provide for the investigation of these subjects by scientific men who are willing to undertake them in communication with the Institute. For example, Mr. A. G. Perkin, F.R.S., has been furnished with material which has led to the identification and determination of the constitution of the colouring matters of a number of plants which are employed as dyes in India and the Colonies. Professor A. H. Church, F.R.S., has determined the composition of many new or little-known food grains. Dr. Crossley, Dr. Le Sueur, and Dr. Lewkowitsch have examined the constituents of a large number of fats and oils furnished by seeds of Indian and African origin. Dr. W. J. Russell, F.R.S., has been furnished with selected materials for examination in connection with his interesting investigations of those substances which affect the photographic plate in the dark, whilst the Hon. R. J. Strutt, F.R.S., has investigated the radioactivity of a number of new or little-known minerals containing rare earths. Last year over 500 different materials and problems were submitted from the Colonies and India for investigation to the Scientific Department of the Imperial Institute, and each year there must remain an increasing number of interesting subjects which cannot be included in the Department's annual programme of work. Many of these would furnish excellent subjects for chemical research by advanced students in connection with the universities and technical colleges throughout the country. It is nearly always possible to arrange to furnish the necessary material for any competent worker to deal with. Next year a list of such subjects awaiting investigation will be available at the Imperial Institute for those in search of subjects for chemical research.

Whilst the investigation of some of these subjects may at once produce results of scientific value, many of them present difficulties in their investigation which are far more serious than those which attend the usual synthetical work in organic chemistry. I do not know of any more profitable experience for the advanced student, who is already familiar with the principles of organic chemistry and of laboratory practice, than the separation in the pure state of the constituents of a plant and the determination of their chemical constitution. In inorganic chemistry the examination of a new mineral furnishes similar experience.

In carrying out research of the kind I am advocating, the chemical investigator will have the additional advantage of knowing that the scientific results he obtains will contribute to the knowledge of the resources of the British Empire, and possibly be the means of laying the foundations of new industries.

I need hardly remind chemists that some of the most important discoveries in our science, and many of those which have had the most profound influence on the development of chemical theory, have arisen from the examination of the constituents of raw materials. The discovery of morphia in opium led to the recognition of the new class of alkaloids; the discovery of amygdalin in the bitter almond of the new group of glucosides; the investigation by Liebig and Wöhler of the chemical properties and composition of the essential oil of the bitter almond was largely instrumental in laying the foundations of modern organic chemistry; whilst it was during the examination of the constituents of bran that Fownes was led to the discovery of furfurol and the subsequent recognition of a new type of organic compound. In more recent times the examination of the constituents of oil of turpentine and various essential oils yielded by different plants has been the means of elucidating the chemical theory of the great group of terpenes, and latterly Harries' investigation of caoutchouc has led to the discovery of the ozonides which seem likely to be of much importance as a new means of determining the constitution of certain classes of organic compounds. Lastly, I may remind you that the discovery of helium might have been long delayed had not Professor Miers drawn Sir William Ramsay's attention to the so-called nitrogen furnished by the mineral cleveite.

I have thought that it would be of interest on the present occasion if some account were given in the Section of the chemistry of certain of the raw materials employed in the principal manufacturing industries of the city of York. These industries are vitally concerned with an adequate supply of certain raw products of tropical origin, especially cocoa and gums. In connection with the first of these, the better qualities of which have hitherto been obtained largely from the West Indies, a new industry of cocoa production has sprung up in West Africa, notably in the Gold Coast and in Lagos. This West African cocoa presents some peculiarities which have rendered it desirable to examine the nature of its constituents. Gums of the nature of gum arabic are at present chiefly derived from the Anglo-Egyptian Sudan and the French colony of Senegal. It is, however, clear from the examination of gums collected in West Africa that that country, and especially Northern Nigeria, will be able in the future to contribute to the needs of the British manufacturer, in addition to India and Australia, which will also be able to make important contributions. In connection with the investigation of these gums derived from new sources at the Imperial Institute, the very remarkable observation has been made that certain gums from India and the Colonies possess the property of evolving acetic acid when exposed to the air. The chemical constitution of one of these gums has been fully investigated at the Imperial Institute by Mr. H. H. Robinson, who will contribute a paper on the subject to the Section, in which he will show that the production of acetic acid is due to the elimination of an acetyl group by hydrolysis through the moisture of the air. He has also succeeded in elucidating to a large extent the chemical nature of the gum. Mr. Robinson will also make a report on the present position of the chemistry of gums, a class of substances whose constitution is exceptionally difficult to unravel. Little, if any, advance has been made in recent years on the well-known researches of O'Sullivan.

There is no more important group of questions demanding attention from the chemist at the present time than those connected with the production of india-rubber or caoutchouc. An enormous increase in the demand for india-rubber has taken place in the last few years, and last year the production was not less than 60,000 tons. Until recently the supply of rubber came chiefly from two sources—the forests of Brazil, which contain the tree known as *Hevea brasiliensis*, furnishing the Para rubber of commerce, which commands the highest price, and the forests of Africa, where climbing plants, generally of the Landolphia class, also furnish rubber. The increased demand for caoutchouc has led to the extensive planting of the Para rubber tree, especially in Ceylon and in the Federated Malay States. Systematic cultivation and improved methods of preparation are responsible for the fact that the product of the cultivated tree, which begins to furnish satisfactory rubber when six or seven years old, is now commanding a higher price than the product of the wild tree in Brazil. It is estimated that within the next seven years the exports of cultivated india-rubber from Ceylon and the Federated Malay States will reach between ten and fifteen million pounds annually, and that after fifteen years they may exceed the exports of the so-called wild rubber of Brazil.

The services which chemistry can render to the elucidation of the problems of rubber production and utilisation are very numerous. Methods of treatment depending on a knowledge of the other constituents of the latex have led to the production of rubber in a purer condition. Much still remains to be elucidated by chemical means as to the nature of the remarkable coagulation of the latex. As is well known, the latex is a watery fluid resembling milk in appearance which contains the rubber, or, as I think more probable, the immediate precursor of rubber, together with proteids and other minor constituents. The constituent furnishing rubber is in suspension, and rises like cream when the latex is at rest. On the addition of an acid, or sometimes of alkali, or even on mere exposure, coagulation takes place and the rubber separates as a solid, the other constituents for the most part remaining dissolved in the aqueous liquid or 'serum.' The first view taken of the nature of the coagulation process was that, like the coagulation of milk by acids, it is dependent upon a process of proteid coagulation, the separated proteids carrying down the rubber during precipitation.

This explanation cannot, however, be considered complete by the chemist, and there are peculiarities connected with the coagulation of the latex which are opposed to the view that it is wholly explained by the coagulation of the associated proteids. The experimental investigation of the question on the chemical side is beset with many difficulties, which are increased if access cannot be had to fresh latex. A number of experiments were made at the Imperial Institute with latex forwarded from India.

The difficulties contended with in preventing coagulation during transit were great, but in the case of the latex derived from certain plants these were to some extent surmounted, and the results obtained, especially with reference to the behaviour of certain solvents towards the latex, led to the conclusion that 'coagulation' can take place after removal of the proteids, and that in all probability it is the result of the polymerisation of a liquid which is held in suspension in the latex and on polymerisation changes into the solid colloid which we know as caoutchouc. Weber, by experiments conducted in South America with fresh latex, arrived at a similar conclusion, which later workers have confirmed. Although the nature of the process is not yet completely elucidated, there is little room for doubt that the coagulation is due to the 'condensation' or polymerisation of a liquid contained in the latex. For the chemist the important question remains as to the nature of this liquid from which caoutchouc is formed.

The chemical nature of caoutchouc is a subject which has attracted the attention of distinguished chemists from the middle of the eighteenth century, among them being Faraday, Liebig, and Dalton. Faraday was the first to examine the constituents of the latex of *Hevea brasiliensis*. It is only in recent years that our knowledge of the constitution of organic compounds, and especially of the terpene group, has rendered it possible to make any great advance. It is interesting to record that Greville Williams, in 1860, made most important contributions to this subject. He identified a new hydrocarbon, isoprene, as a decomposition product of caoutchouc, and recognised its polymeric relation to caoutchouc.

The results obtained from the analytical side, and especially the formation of dipentene and isoprene by pyrogenic decomposition of caoutchouc, had pointed to the fact that caoutchouc was essentially a terpenoid polymer of the formula $(C_{10}H_{16})_x$. Harries finds, however, that the ozonide of caoutchouc, when distilled with steam, breaks up into lævulinic aldehyde, lævulinic acid, and hydrogen peroxide, and he concludes from this that caoutchouc is a polymer of a 1 : 5 dimethyl*cyclo*octadiene. Whilst Harries' work has brought us much nearer the goal, and has led to the discovery of a new method of investigation through the ozonides, which is obviously of wide application, it cannot yet be said that the constitution of caoutchouc has been settled or its relation to the parent liquid substance of the latex definitely established. It has still to be shown how a closed-chain hydrocarbon such as Harries' octadiene can undergo polymerisation forming the colloid caoutchouc.

There are strong arguments for the view that the constitution of the parent substance present in the latex is nearly related to that of isoprene. This remarkable hydrocarbon of the formula C_5H_8, first obtained by Greville Williams from the dry distillation of rubber, is an olefinic (unsaturated) hydrocarbon which is found among the products, resulting from heating caoutchouc. It readily polymerises, forming dipentene. Bouchardat noticed that this hydrocarbon obtained from the pyrogenic decomposition of caoutchouc furnished a substance identical with rubber when acted on by hydrochloric acid and under other conditions. To Wallach and also to Tilden is due the further important observation, that when isoprene prepared from oil of turpentine is kept for some time it gradually passes into a substance having all the characteristic properties of caoutchouc.

I have very briefly drawn attention to the present position of our knowledge of the chemistry of caoutchouc in illustration of the interest which attaches to the examination of vegetable products, and also because of the immense importance of the problem from the practical and commercial standpoint. Chemistry in this case holds the premier position in reference to this subject, and to a large extent may be said to hold the key to the future of the rubber industry in all its phases. The discovery of better methods of coagulation, preparation, and purification will be effected through chemical investigation, as will also the determination of the manner of utilising the various other plants which furnish rubber-like latices. That the physical properties of raw rubber, on which its technical value depends, are to be correlated with the chemical composition of the material there can be no doubt. The chemical analysis of raw rubber, as at present conducted, is, however, not always to be taken by itself as a trustworthy criterion of quality, and more refined processes of analysis are now needed. Although the finest caoutchouc for technical purposes is only yielded by some half-dozen plants, under whose name these varieties of caoutchouc pass, there can scarcely be a doubt that the elastic substance in each case possesses a very similar, if not identical, chemical structure. Nearly all the latices and similar fluids furnished by plants contain more or less caoutchouc. Even opium, which is the dried juice of the capsule of the poppy, contains caoutchouc, whilst the opium yielded by certain Indian species contains a notable proportion. Chemistry must determine the means by which caoutchouc can best be separated from these relatively poor latices. In view of the increasing production of the nearly pure caoutchouc which is furnished by *Hevea brasiliensis*, *Funtumia elastica*, *Castilloa elastica*, *Ficus elastica*, and a few other plants which occur or can be cultivated in several of our tropical possessions, the question is not a pressing one at the moment.

Moreover, it cannot be doubted that chemical science will sooner or later be able to take a definite step towards the production of rubber by artificial means.

The production of caoutchouc by chemical means has, indeed, virtually been accomplished in its formation from isoprene.

The exact nature of this change has still to be determined. When this has been done it will only remain to cheapen the cost of production to make the manufacture of synthetic rubber a purely practical problem. I should be the last to discourage the great extension of rubber planting which is now taking place. It is warranted by the present demand for the material. It has also to be remembered that the actual cost of producing cultivated raw rubber, which is at present about one shilling per pound, will probably be reduced, and the market price of rubber may eventually be so considerably lowered that, as with quinine, the synthetic production could not be profitably carried on. That is a question which involves many factors at present unknown, and only time can decide. Chemists may, however, confidently predict that before the British Association again meets at York the chemical synthesis of rubber will be a fully accomplished fact.

As I have said, our science is concerned with nearly every problem connected with the great rubber industry, and in concluding these few remarks I may allude to the production of vulcanised rubber depending on the formation of additive compounds of the hydrocarbon with sulphur. In this connection I should mention the recent experiments of Mr. Bamber in Ceylon, which appear to show that vulcanisation may be accomplished by acting on the uncoagulated latex with sulphur. If this proves to be practicable, it may mean the transference to the tropics of the subsidiary industry of vulcanisation, which is at present carried on in Europe.

Owing to the importance and interest which attach to the chemistry of rubber, it is to form an important feature in the work of this Section at the York Meeting. Papers will be contributed by some of the best-known workers in this field, by Professor Tilden, and by Professor Harries, of Kiel, who will give an account of his recent work; whilst Mr. Pickles, of the Imperial Institute, will present a report summarising the whole of our chemical knowledge of the subject (*see page* 362).

The chemical investigation of raw materials often raises, unexpectedly, problems of great scientific interest. The examination at the Imperial Institute of the seeds of the Para rubber tree (*Hevea brasiliensis*) has shown that they contain what proves to be a valuable drying oil, and in the course of the investigation it was ascertained that there is also present in the seeds an enzyme closely allied to, if not identical with, lipase, which is capable of splitting the oil by hydrolysis into glycerin and the free fatty acid. Subsequently, during the examination of other oil seeds similar enzymes have been detected, and it would appear probable that most oil seeds may prove to contain an enzyme capable of decomposing the fatty constituent.

Another subject of great chemical interest and botanical importance which has come into prominence in connection with the Indian and Colonial work of the Imperial Institute is to be included in a joint discussion which has been arranged with the Section of Botany. I refer to the production of prussic acid by plants which, as I have elsewhere suggested, it is convenient to refer to as 'cyanogenesis.' In this discussion we shall have the advantage of the co-operation of Professor Van Romburgh of Utrecht and Dr. Greshoff of Haarlem, whose work with Dr. Treub of Java on this subject is known to chemists and botanists alike. The history of the origin of the several investigations in which Dr. Henry has been associated with me is not without interest in connection with the principal subject of this address. During the first British expedition to the Sudan against the Mahdi a number of transport animals were poisoned through eating a small vetch which springs up in the Nile Valley during the fall of the river. The plant (*Lotus arabicus*) is well known to the Arabs, by whom it is cut when fully grown, and used as fodder for animals.

The results of the investigation of this matter, which were communicated to the Royal Society, proved that the young plant generated prussic acid when crushed with water. It was found to contain a new glucoside lotusin, together with an enzyme capable of decomposing it into prussic acid, dextrose, and a yellow colouring matter, lotoflavin.

The glucoside is of special chemical interest, as being the only one known which contains the cyanogen group attached in the molecule to the sugar residue. Further investigation has shown that other fodder plants which are occasionally poisonous owe this character to the existence of other cyanogenetic glucosides. In a series of papers communicated to the Royal Society, Dr. Henry and I have described the properties and constitution of dhurrin from *Sorghum vulgare*, and of phaseolunatin, which we have shown to be responsible for the production of prussic acid by *Phaseolus lunatus* (Lima beans), *Manihot utilissima* (cassava or tapioca), and by linseed (the flax plant). Phaseolunatin is remarkable in furnishing acetone as one of its products of hydrolysis. This investigation, besides fulfilling the primary purpose for which it was carried out, has raised a host of problems ;—as to the constitution of glucosides, the nature of the enzymes which accompany them in the plants, and also in relation to the fundamental question of plant metabolism.

Another subject of Imperial as well as National importance is to be the subject of a joint discussion with the Section of Physiology. I refer to the problem of diet. As chemists we are interested in this subject chiefly from the point of view of the composition of foods, and of the molecular structure which is associated with dietetic value. The first attempt to deal with the matter from the scientific side was made by a great chemist, Liebig. We are now in a position to investigate the problem more minutely, and the work of American physiologists has already led to important results. We have still to learn how materials such as rice and potatoes, which are nearly free from proteids, continue nevertheless to serve as the main diet of large numbers of people. It would seem that the best plan of operations will be for physiologists to settle by the accurate methods now available the precise value of typical foodstuffs, and for the chemist to deal with these in relation to their composition, and finally with reference to the constitution of their constituents. The time has come when an advance must be made from the chemical side in the analytical methods employed for gauging the value of food materials.

I feel that I have said much, but that I have left still more unsaid on many topics. I must leave almost untouched the entire subject of mineral chemistry, which is not only important in connection with the determination of the resources of India and the Colonies, but is also a subject somewhat neglected on its chemical side, which has been recently brought into prominence through the discovery of radio-activity.

The new radio-active mineral thorianite, from Ceylon, of which Mr. Blake and I have given an account to the Royal Society, brings me at once to a subject which raises the most fundamental of chemical questions, the nature of the elements and of the atom. The recent discussions of this subject have become so purely speculative that, whilst chemistry is bound to follow the lead of physics in this matter, chemists are inclined to consider that more well-ascertained facts are needed for any further discussion to be profitable from the purely chemical side.

In this address I have ventured to urge the fuller recognition by Government of the scientific method as a powerful instrument in promoting the commercial development of the Colonies, and I have drawn attention to the important part the science of chemistry can play in the Imperial work of developing the resources of our possessions.

No apology is needed in this place for directing attention to a subject which involves a most important practical application of our science, since one of the principal functions of the British Association is to bring science into close touch with the problems of our national life, and to interest the general public in the application of science to their solution.

I have, however, also shown that many problems of the highest scientific interest arise in connection with the investigation of these economic problems.

The meeting of the British Association coincides this year with the celebration of the Jubilee of the Coal-Tar Colour Industry, and we welcome among us a number of distinguished foreign chemists who have come to join in honouring the great chemist Sir William Perkin, to whom the inception of this industry is due. It is fitting that, as President of the Chemical Section, I should refer to this great occasion in my address, and express for myself, as well as for the chemists here present, the admiration we feel for Sir William Perkin's genius and for the splendid example he has set in his life-long devotion to experimental research, an example from which all of us have profited who have had the good fortune to come into relation with him."

CYANOGENESIS IN PLANTS.

THE term cyanogenesis has been suggested by Dunstan and Henry to describe the production of prussic acid by plants. Reference has already been made in this *Bulletin* on several occasions to the occurrence of cyanogenesis in plants of economic importance to India and the Colonies, which have been investigated in the Scientific and Technical Department of the Imperial Institute. In several cases the examination of these plants has been undertaken at the suggestion of Agricultural or other Departments concerned, owing to the fact that they had proved poisonous to animals (*Bulletin of the Imperial Institute*, 1903, **1**. 12 and 112; 1905, **3**. 373). Whilst the subject is of great importance from this point of view, it is of no less interest from the scientific side, since it has been suggested by various authorities that prussic acid, or the derivatives of the acid, which occur in plants may be regarded as primary materials from which plants form some of the constituents necessary to their existence. It is obvious that if this view can be upheld the study of cyanogenesis may ultimately become of practical importance to the agriculturist. At present, nothing definite can be said on this side of the question, owing to the fact that very little systematic investigation into the matter has been made from the botanical side; and though much is now known as to the chemistry of cyanogenesis, in particular as regards the nature of the compounds in which prussic acid appears to be stored up in those plants by which it is secreted, and as to the methods by which this acid is liberated from these compounds, much remains to be done in ascertaining the nature of the primary material from which the acid is first produced by plants, and the process by which this is accomplished. The botanical side of the subject is less developed, though two notable contributions to it have been made by Dr. Treub, Director of the Botanical Gardens at Buitenzorg, Java, who has investigated in detail the external conditions governing the occurrence of cyanogenesis in the two tropical plants *Pangium edule* and *Phaseolus lunatus*.

The foregoing considerations are perhaps sufficient to indicate that the subject is one of considerable importance, and it has been considered advisable to publish in this *Bulletin* the following account of our present knowledge of the subject. A full report on cyanogenesis was presented by Prof. W. R. Dunstan, F.R.S., and Dr. T. A. Henry to the chemical section of the British Association during its recent meeting at York, which gives fuller technical details than is possible in the present article. Those interested in the scientific side of the subject may be referred to that report (*British Association Reports*, 1906).

The production of prussic acid by a plant was recorded for the first time in 1800 by a pharmacist named Bohm, of Berlin, who obtained it by distilling water which had been in contact with crushed bitter almonds. Though prussic acid was discovered by a Swedish chemist named Scheele in 1782, its poisonous nature was not recognised until 1803, when Schräder explained the toxicity of bitter almonds as being due to the production of prussic acid when the almonds are bruised in contact with water. Even before this time instances of the poisonous nature of certain plants, which we now know to be due to their power of producing prussic acid, had been recorded, thus in the *Liber Exoticorum* of Clusius, published at Leyden in 1605, reference is made to the poisonous nature of cassava, and the remarkable observation is recorded that the roots of this plant are more poisonous when the plant is grown under the dry conditions prevailing in many parts of the mainland of South America than when it is cultivated under the moist conditions of certain of the West India Islands. Again Madden, in a paper communicated to the Royal Society of London in 1731, drew attention to the fact that cherry-laurel water, prepared by distilling water in which bruised cherry-laurel leaves had been macerated, was poisonous. The latter case was also explained by Schräder in 1803 as being due to the production of prussic acid. The cases of bitter almonds and cherry-laurel leaves remained until about 1851 practically the only known instances of the production of prussic acid by plants, but since that year the formation of this acid has been detected in a very large number of plants, and in an incomplete list of such plants recently compiled by Dr. Greshoff of the Colonial Museum at Haarlem, about 150 species are enumerated. In most of these cases, investigators have been content to record the fact that prussic acid is produced, and the method of its production has been definitely ascertained in comparatively few instances.

In all the plants in which the chemistry of cyanogenesis has been thoroughly investigated it has been found that the prussic acid is liberated when the plant is ground up either in its fresh moist condition or, if it has been previously dried, when the dried ground plant is placed in water: in every case the presence of water is essential. It has also been found that from all such plants, by appropriate methods, a definite crystalline compound can be isolated, which is quite stable, and can be kept for indefinite periods, but which when dissolved in water and boiled with dilute acids decomposes and evolves prussic acid. This same decomposition, with the production of prussic acid, can also be brought about by various ferments. This may perhaps be conveniently illustrated by an example. By extracting bitter almonds with alcohol, a colourless crystalline substance can be obtained, which has been named amygdalin. When a solution of the latter in water is boiled with diluted hydrochloric acid (spirit of salt), the mixture acquires the well-known odour of essence of bitter almonds owing to the fact that prussic acid and benzaldehyde (oil of bitter almonds) are simultaneously produced. The same decomposition is brought about if ordinary yeast is added to a solution of amygdalin in water. It may be assumed therefore that this crystalline substance, amygdalin, is the source of the prussic acid and the oil of bitter almonds, which are formed when ground bitter almonds are mixed with water. The agent contained in the bitter almonds which effects this natural decomposition of amygdalin has been found to be a special ferment. The latter, like amygdalin, can be isolated from bitter almonds, and is prepared and sold under the name emulsin. The proof that the production of prussic acid in the bitter almond is due to the decomposition of amygdalin by emulsin is found in the fact that the addition of emulsin to amygdalin, dissolved in water, results in the almost immediate production of prussic acid and oil of bitter almonds.

Amygdalin belongs to a well-defined class of substances known to chemists as glucosides; the latter name indicating that when they are decomposed in the way already indicated by acids or ferments they invariably yield glucose or a similar saccharine substance, in addition to certain more specific products such as the prussic acid and oil of bitter almonds produced in the case of amygdalin. These glucosides may be divided into two classes, according as they do or do not yield prussic acid on decomposition, and it is convenient to describe the former class as cyanogenetic glucosides. The fermentive agents which accompany these glucosides in plants, and which serve to decompose them, are termed enzymes or unorganised ferments, the latter name serving to distinguish them from the organised ferments such as yeast, mould, etc. Recent researches have shown that enzymes are widely distributed in plants and animals, and that many of the functions necessary to life are discharged by them. A general article on unorganised ferments and their industrial application has already been published in this *Bulletin* (1905, **3**. 185), to which reference may be made for fuller information. As already indicated, cyanogenetic glucosides and enzymes capable of decomposing these have been isolated from all the plants in which cyanogenesis has been thoroughly investigated on the chemical side, and it may be convenient here to give a short account of what has been done in this direction since the isolation of the first cyanogenetic glucoside —amygdalin—from bitter almonds in 1830.

LOTUSIN.

This glucoside was isolated at the Imperial Institute in 1901 from the Egyptian plant *Lotus arabicus*, which grows along the banks of the Nile. A general account of this work has already been given (*Bulletin of the Imperial Institute*, 1903, **1**. 13), so that no extended reference need be made to it here except to say that on decomposition, by acids or ferments, lotusin yields prussic acid, glucose, and a yellow dye, lotoflavin, which possesses tinctorial properties similar to those of quercetin, the constituent to which the well-known dyestuff "quercitron bark," still largely used by calico printers, owes its dyeing powers. The enzyme or unorganised ferment, which occurs with lotusin in *Lotus arabicus*, was also isolated and studied and was named lotase. A full account of the chemistry of lotusin and lotase is given in a paper contributed by Professor Dunstan and Dr. T. A. Henry to the Royal Society (see *Phil. Trans.*, 1901, B. **194**. 515).

DHURRIN.

This glucoside was also prepared for the first time at the Imperial Institute from the well-known plant *Sorghum vulgare*, widely grown in tropical and sub-tropical countries for the sake of its edible grain, which forms one of the principal foodstuffs of the natives of India, Egypt, East and West Africa, and elsewhere. The glucoside occurs only in the young green plant, so that *Sorghum* like *Lotus arabicus* is only temporarily poisonous, and the conditions under which the glucoside is gradually eliminated as the plant matures have already been described in detail (*Bulletin of the Imperial Institute*, 1903, **1**. 147). When dhurrin is decomposed by acids it yields prussic acid, glucose and *para*hydroxybenzaldehyde, the latter being an inodorous substance closely related to benzaldehyde (oil of bitter almonds).

The enzyme which occurs in *Sorghum* along with dhurrin, is probably identical with the emulsin found in almonds. (Dunstan and Henry, *Proc. Roy. Soc.*, 1902 **70**. 153.)

PHASEOLUNATIN.

This substance, there is reason to believe, is one of the most widely distributed cyanogenetic glucosides in nature, it having been already isolated at the Imperial Institute from three different sources, the beans of *Phaseolus lunatus*, the roots of the cassava plant, and the stems, leaves and seed of common flax. It also probably occurs in the leaves of the Para rubber-tree *Hevea brasiliensis*, and in several other plants from which, though the glucoside itself has not been isolated, its characteristic decomposition products have been obtained.

When decomposed by the general methods already described phaseolunatin yields prussic acid, glucose, and acetone. The three plants named contain in addition to the glucoside two enzymes, one either identical with or very similar to the emulsin of almonds, and the other closely resembling the maltase, which occurs in yeast, and it is to the action of this maltase-like enzyme that the natural decomposition of phaseolunatin, which takes place when the ground plants are moistened with water, is due. The chemistry of phaseolunatin and the enzymes associated with it have been dealt with in a paper communicated to the Royal Society (Dunstan and Henry, *Proc. Roy. Soc.*, 1903, **72**. 285), and a fuller account of the enzymes will be given in a paper to be read before the same society shortly.

Beans of Phaseolus Lunatus.—Phaseolunatin was first prepared from the beans of this plant obtained from Mauritius, where it is grown in an almost wild state for use as a green manure. The same plant is also grown under practically wild conditions in Java, and it is from this source that the poisonous "Java beans," which have been imported recently into this and other European countries for use as a feeding material for cattle, are derived (see *Bulletin of the Imperial Institute*, 1905, **3**. 373).

The beans obtained from *Phaseolus lunatus* as grown in Mauritius and Java possess a very characteristic shape, are somewhat shrivelled, and vary in colour from pale fawn with purple spots to deep almost purple black, though in the case of the "Java beans," but not in those obtained from Mauritius, a few pale cream-coloured beans are also present. Varieties of the same plant are grown in many tropical countries, especially in Burma. The beans produced by the varieties cultivated in the latter country differ markedly from the Java and Mauritius beans; in particular they are less angular in shape, smaller, more plump, and much lighter in colour, being almost white ("white Rangoon beans"), or pale pink or fawn with a few purple markings ("red Rangoon beans"). There exists yet a third variety of the beans of *Phaseolus lunatus* obtained from South America, Madagascar, and other tropical countries, and also produced to a small extent in the South of France. These beans are larger and plumper than the varieties already mentioned and are white, or nearly so. The last variety is generally known in commerce as "Lima beans."

Cordemoy has stated (*Flore de la Réunion*, 1895) that the beans of *Phaseolus lunatus* are purple in the wild state, light brown when semi-cultivated and white when carefully cultivated. These three stages are roughly represented in the commercial products by the "Java" or "Mauritius beans," "Rangoon beans" and "Lima beans" respectively.

Owing to the recent large importation of "Java" beans into Europe, and the numerous cases of poisoning, which have resulted from the use of this material as a feeding-stuff, great interest has been aroused in this product, and the beans have been examined by many chemists in this country, Germany, France, Holland and Belgium. Some reference has already been made in this *Bulletin* (1905, **3.** 373) to the results which have been obtained in this way, but since the date of that article further facts have been recorded. In a paper entitled "On the Presence and Detection of Cyanogen in Java, Burma and Haricot Beans," published in the *Analyst* (August 1906), Messrs. Tatlock and Thomson give the results of a series of experiments they have made on the estimation of the prussic acid yielded by these various beans, and as the experience gained at the Imperial Institute with these products differs in some repects from that recorded by Messrs. Tatlock and Thomson, and also throws some light on points raised by those who took part in the discussion on their paper, it has been thought desirable to place these differences on record. In the first place it should be stated that the beans contain no amygdalin as Messrs. Tatlock and Thomson seem to suppose, but only the glucoside phaseolunatin already referred to. In the course of the discussion on Messrs. Tatlock and Thomson's paper, Dr. J. W. Leather, Agricultural Chemist to the Government of India, stated that it is uncertain what the botanical nature of these beans is and that they seem to be derived from a mixture of species. Cordemoy's opinion, quoted above, seems to leave no doubt that these differently coloured beans are the product of a single species, and the French botanist Guignard has stated (*Comptes rendus*, 1906, **147**. 545), that careful examination of "Java," "Rangoon," and "Lima" beans show that they all possess certain characters in common by means of which they may be distinguished from the beans yielded by other species of Phaseolus, and notably from common haricot beans derived from *Phaseolus vulgaris*. Guignard used for comparison with the commercial products an authentic sample of the beans of *Phaseolus lunatus* obtained from the Botanical Gardens at Buitenzorg. The Imperial Institute has received through the Government of India a sample of the beans of *Phaseolus lunatus* as grown in Burma, and comparison of these with the Burma, Rangoon or Paigya beans of commerce, leaves little doubt that they are identical. Finally the white "Lima beans" have long been a commercial article and are commonly cultivated in the South of France, and no doubt has been expressed as to their being the product of *Phaseolus lunatus*. There does not seem to be much ground for doubt as to the botanical origin of these beans. In this connection it is worth mentioning that several of the samples of Java beans examined at the Imperial Institute were found to contain a few seeds of *Dolichos lablab*, but the number of these present was always very small. No production of prussic acid could be detected in the admixed *Dolichos lablab* beans.

It is most desirable that confusion between the cultivated white beans of *Phaseolus lunatus* and ordinary haricot beans should not occur. The name haricot should be reserved for the beans derived from the well-known European species of *Phaseolus* furnishing this product. This unfortunate confusion of the white beans of *Phaseolus lunatus* with ordinary haricot beans is noticeable in Messrs. Tatlock and Thomson's paper, where the term haricot is apparently applied indiscriminately to white beans derived from *Phaseolus lunatus* or *Phaseolus vulgaris*.

It has been shown in the papers already referred to (*Proc. Roy. Soc.*, 1903, **72**. 285 ; *Bulletin of the Imperial Institute*, 1903, **1**. 15, 122, and 1905, **3**. 373), that the beans produced by *Phaseolus lunatus* grown under the practically wild conditions which obtain in Mauritius and in Java, yield much larger quantities of prussic acid than the semi-cultivated reddish beans produced in Burma, whilst the white Lima beans examined at the Imperial Institute yielded none. Correlating this with Cordemoy's statement quoted above, it has been suggested (*loc. cit.*) that the cyanogenetic principle appears to be more or less completely eliminated from the beans of *Phaseolus lunatus* by careful cultivation of the plant, since in the experiments made at the Imperial Institute, neither the white Rangoon nor the white Lima beans yielded any prussic acid.

The results of more recent investigators in general confirm these observations, and indicate clearly that phaseolunatin is gradually eliminated from the beans by cultivation, Java beans being found to yield most prussic acid, the buff-coloured Rangoon beans a small quantity, and white Rangoon or Lima beans least or none at all. All the white cultivated beans of *Phaseolus lunatus* examined by Guignard (*loc. cit.*) yielded very small quantities of the acid, whilst Messrs. Tatlock and Thomson's "small haricot beans, Rangoon," yielded 0·009 per cent., and the "small haricot beans, Chili," none ; it may probably be assumed that these two latter products originated from *Phaseolus lunatus*.

The mixed Java beans of commerce, as already stated, usually contain a small proportion of white beans. These need to be carefully distinguished from the *white cultivated* beans of *Phaseolus lunatus*, since unlike the latter they yield considerable quantities of prussic acid. The fact that the wild plant occasionally furnishes white beans, does not affect the validity of the advice that the users of the beans of *Phaseolus lunatus* as a feeding-stuff for cattle should for safety employ only the cultivated white beans, since, so far as is at present known, the white beans of the wild variety are not likely to be a commercial product. In commerce, white beans will doubtless be the cultivated non-poisonous form (cf. *Journal of the Board of Agriculture*, 1906, March and April).

It was observed at the Imperial Institute that in the case of the wild Mauritius product, the deep purple-coloured beans yielded nearly twice as much prussic acid as the pale brown ones, and a similar relationship had previously been observed by Bonamé for the Mauritius beans (*Rapp. Ann. de la Station Agronomique de l'Isle Maurice*, 1900, 94).

Guignard (*loc. cit.*), Kohn-Abrest (*Comptes rendus*, 1906, **3**. 586), and Tatlock and Thomson (*loc. cit.*), have all found that this is not the case with the "Java beans," and the results of the examination of various samples of "Java beans" at the Imperial Institute confirm this view, as the following table of results shows:—

Origin and colours of beans.	Dunstan and Henry.	Guignard.	Kohn-Abrest.	Tatlock and Thomson.
	Prussic acid.	*Prussic acid.*	*Prussic acid.*	*Prussic acid.*
Java.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Mixed beans, all colours .	0·038–0·0116	0·052–0·102	...	0·027–0·137
Black beans	0·107	0·046	...	0·042
Purplish-black beans . .	0·116	...	0·052	0·031
Wine red beans	...	...	0·058	...
Reddish-brown beans . .	...	...	0·037	0·038
Bright maroon beans . .	...	...	0·050	...
Light brown beans with dark spots	0·103	...	0·041	0·038
Pale brown with dark spots	0·104	...	0·126	...
Cream white	0·105–0·110	0·052	0·037	0·027
Black with white stripes .	0·062	...	0·058	...
Mauritius.				
Mixed, all colours . . .	...	...	...	...
Purplish black	0·088	...	...	...
Brown	0·087	...	...	..
Light brown	0·041	...	...	..
Burma.				
Pale brown with purple spots	0·004–0·008	0·011	...	...
Cream white	*nil*	0·006	...	..
Provence.				
Large cream white	*nil*	traces 0·004–0·008	...	..
Madagascar.				
White	...	0·008	...	..

There is finally the question as to whether any simple process can be devised for rendering Java beans innocuous and suitable for use as fodder. It has been stated that the beans are rendered harmless by boiling, and that treated in this way they are commonly used in Java as food.

It has been found at the Imperial Institute that by soaking the beans in cold water overnight, and then boiling them in water until they are soft, practically no change in the amount of phaseolunatin takes place, but the cooked beans when broken up in water do not yield prussic acid, since the enzyme has been destroyed in the cooking process, and is no longer available to decompose the glucoside. Messrs. Tatlock and Thomson found, on the contrary, that in a sample of Java beans treated as described above the percentage of glucoside (measured by the amount of prussic acid produced) was reduced by about one-half.

It must be remembered that though such cooked beans no longer yield prussic acid when mixed with water, it does not follow that they are not poisonous, especially to herbivorous animals, since there is always the risk of the cooked beans being fed to the animals along with other vegetable material containing an enzyme capable of decomposing the phaseolunatin present in the cooked beans, even if there should be no intestinal enzyme capable of decomposing the glucoside.

It seems probable, however, that the whole of the prussic acid could be eliminated by grinding the beans to a fine powder, mixing this with cold water, and exposing it in thin layers, frequently stirred, to the air, but this scarcely seems to be a practicable process of treating the beans except on a very small scale.

Cassava.—The same glucoside phaseolunatin also occurs in the cassava or manioc, widely cultivated in the Tropics for the sake of its starchy roots, which are used as food, and also as a source of starch. Two varieties of cassava are known, viz. the "sweet" and "bitter" kinds. The presence of prussic acid in bitter cassava was first recorded by Boutron-Charlard in 1836, though the fact that the toxicity of this material was due to a volatile constituent was first established by Henry and Boutron-Charlard in 1833. Since that time it has generally been assumed that prussic acid is only obtainable from the "bitter" variety, but in

1870 Francis showed that both varieties as grown in the West Indies yield prussic acid in about the same proportions, and the production of the acid by both varieties has more recently been confirmed by Carmody and by Harrison. It was noticed in 1899 by Van Romburgh in Java that when the bruised leaves of the cassava plant are macerated in water, and the latter distilled, acetone and prussic acid are obtained. With a view to ascertaining the origin of the prussic acid in cassava, an examination of the tubers was undertaken at the Imperial Institute in 1905, and it was found possible to isolate from bitter cassava a glucoside, which was eventually proved to be identical with phaseolunatin obtained from *Phaseolus lunatus* (Dunstan, Henry, and Auld, *Proc. Roy. Soc.*, 1906, B. **78.** 152). Further, it has also been shown that cassava contains the same mixture of enzymes as is present in the beans of *Phaseolus lunatus*.

Flax (Linseed).—The occurrence of cyanogenesis in flax was first observed by Jorissen in 1883, who stated that when linseed meal (ground flax seed) is allowed to stand with warm water at 25° C. prussic acid is produced. Subsequently the same author, in association with Hairs, succeeded in obtaining from flax seed a cyanogenetic glucoside, which was named linamarin. The quantity of this glucoside present in flax seed is exceedingly small, as is shown by the fact that the amount of prussic acid obtained from the seed is not more than 0·008 per cent. It seemed probable from a consideration of the results obtained by Jorissen and Hairs that linamarin might prove to be identical with phaseolunatin, and consequently the investigation of this material was undertaken at the Imperial Institute, with the result that it has been shown that the two glucosides are identical (Dunstan, Henry, and Auld, *Proc. Roy. Soc.*, 1906, B., **78.** 145) and that further the same mixture of two enzymes, the one resembling emulsin and the other similar to maltase, as occurs in cassava and *Phaseolus lunatus*, is also present in flax.

SAMBUNIGRIN.

This glucoside was isolated from the leaves of the common elder by Bourquelot and Danjou in 1905, though Guignard had almost simultaneously recorded the presence in elder leaves of a cyanogenetic glucoside, which underwent decomposition by an enzyme also present in the leaves yielding prussic acid and benzaldehyde.

PRULAURASIN.

This substance was obtained for the first time in a pure state trom the leaves of the common cherry-laurel by Herissey, although various investigators had previously recorded the existence of a cyanogenetic glucoside in these leaves, and had obtained impure preparations of it, and, as already mentioned, the production of prussic acid when cherry-laurel leaves are crushed and moistened with water had been recorded as early as 1803. Prulaurasin is decomposed by dilute acids, and by the emulsin-like enzyme which occurs with it in cherry-laurel leaves yielding benzaldehyde (oil of bitter almonds), prussic acid, and glucose. It is of interest to note that amygdalin, sambunigrin, and prulaurasin all yield the same products when decomposed, but in the case of the first glucoside twice as much glucose is produced on hydrolysis as in the cases of the two latter substances. Sambunigrin has the same composition as prulaurasin, and in this connection it is worth mentioning that amygdalin is decomposed by the enzyme maltase, which occurs in yeast yielding a third glucoside, which has been named mandelic nitrile glucoside, and this also has the same empirical composition as prulaurasin and sambunigrin. At present the reason of the differences between these three glucosides of the same composition is unknown, and it is possible that two or perhaps all of them may prove to be identical.

GYNOCARDIN.

This cyanogenetic compound was isolated by Power and Gornall in 1904 from the oily seeds of *Gynocardia odorata*, and was subsequently examined in greater detail by Power and Lees. The raw material from which gynocardin was isolated is of special interest, since it was long supposed to be the source of chaulmugra oil, a material which has been used in the East for the treatment of leprosy, and has also acquired some reputation in European medicine as a remedy for some forms of skin disease. Investigations recently conducted in India have, however, shown that the real source of chaulmugra oil is the seed of *Taraktogenos Kurzii*, a material which curiously enough also contains a cyanogenetic compound, though this is of so unstable a character that it has not yet been possible to isolate it. When gynocardin is decomposed by acids or by an enzyme occurring with it in gynocardia seeds it furnishes glucose, prussic acid, and a third product, which is very unstable, and is immediately converted into an amorphous resin. The enzyme which occurs with gynocardin has been named gynocardase. It closely resembles the emulsin of almonds.

KARAKIN.

This substance was obtained by Easterfield and Aston in 1903 from the karaka fruit (*Corynocarpus lævigata*) of New Zealand. The production of prussic acid, which takes place n this fruit, has been traced to this glucoside, but practically nothing is known regarding the chemistry of the latter.

The cyanogenetic glucosides mentioned above are all that have been definitely isolated, though indications of the existence of such compounds in many other plants have been obtained, and it may with tolerable certainty be asserted that such compounds occur in all the plants in which cyanogenesis is known to take place.

It is, perhaps, of interest to mention that among the plants in which the production of prussic acid has been observed are included many which are of great economic importance. Reference has already been made in this connection to cassava, flax, bitter almonds, sorghum, and chaulmugra seeds, and in addition to these the acid has been obtained from the seeds and leaves of the Para rubber plant (*Hevea brasiliensis*), the leaves of *Hevea spruceana*, which also yields a marketable rubber, the seeds of two other Hevea species, the roots of the Ceara rubber plant (*Manihot Glaziovii*), a near relative of the cassava plant, the seeds, leaves, and flowers of numerous Rosaceous plants cultivated either for the sake of their fruits or flowers, the seeds of several species of Vicia used as feeding-stuffs, the seeds of *Schleichera trijuga*, from which "macassar oil" is obtained, alder-bark, employed to some extent in medicine, and recently Brünnich has observed its occurrence in small quantities in maize and other grasses grown in Queensland.

THE SIGNIFICANCE OF CYANOGENESIS.

In the literature relating to this subject three main ideas as to the significance of the production of prussic acid in plants may be traced. At first it was regarded as merely a waste product of no physiological importance; later the view that it was possibly a means of protection to the plant was suggested, and quite recently a small number of botanists and chemists have brought forward the idea that the acid is an intermediate product formed during the elaboration of proteids by plants. Evidence in favour of this last-mentioned view has been accumulated in several ways. In the first place Dr. Treub has investigated the distribution of cyanogenetic compounds in the two tropical plants *Pangium edule* and *Phaseolus lunatus*, and has determined the conditions which influence the production of the acids in these plants, and his results go to show that the acid must play some important part in their life processes.

Further, the number of plants in which cyanogenesis is known to occur is now comparatively large, and it is scarcely conceivable that there should be so many cases of the production of this acid unless this phenomenon was of some physiological significance.

Finally, the course of cyanogenesis has been investigated in several plants, and the results seem to indicate that the production of prussic acid is particularly active during that part of the life of a plant in which the vital processes are proceeding most actively. Thus in *Lotus arabicus*, *Sorghum vulgare*, and flax it has been shown that the seed either contains no cyanogenetic glucoside or mere traces, and that on germination there is a sudden large development of cyanogenetic glucoside, which reaches a maximum usually before the plant is full grown, and then, as the period of ripening or complete maturation sets in, the amount of cyanogenetic glucoside declines, and finally disappears.

While it seems probable, therefore, that cyanogenesis may play some important part in plant metabolism, it is not yet possible to say anything definite as to the method of the initial production of prussic acid, though various suggestions have been put forward to account for its formation in plants.

Since most plants derive their supply of nitrogen from soluble nitrates contained in the soil, it has of course been assumed that these nitrates form the primary source of the prussic acid. If it may be supposed that from the nitrates occurring in cell-sap, small quantities of free nitric acid may be generated by the action on the nitrates of vegetable acids, it seems likely that by the interaction of this free nitric acid, either with formaldehyde or sugar, prussic acid might be generated, and this might then combine on the one hand with a plant sugar and on the other with an aldehyde or a ketone occurring in the plant, forming a cyanogenetic glucoside of the usual type. It seems clear, however, that these cyanogenetic glucosides are merely temporary reserves of prussic acid, and it may be that the object of their formation in the plant is to store up the toxic acid in a harmless form. Only one investigator, M. Gautier, has put forward definite suggestions as to the steps by which prussic acid may be eventually elaborated into proteid-like material by the plant, and as these are at once highly technical and purely speculative, it is scarcely worth while to do more than call attention to them in the present connection.

CHEMICAL RESEARCH IN THE DUTCH INDIES.

THE following statement regarding the organisations existing in the Dutch East and West Indies for the chemical investigation of natural products, has been communicated by Dr. Greshoff, who was formerly in charge of the chemical laboratory attached to the well-known botanical garden at Buitenzorg, in Java, and since 1890 has been Director of the Colonial Museum at Haarlem, in Holland.

Chemistry is studied almost entirely as an applied science in the Dutch East Indian Colonies. In Java there are three secondary schools, similar in character to the German Realschulen, which are provided with laboratories for teaching elementary chemistry. There is not, as yet, a native University, though the island is inhabited by a very intelligent race, anxious to obtain European instruction. The nearest approach to a University is found in the native School of Medicine at Batavia, which was founded in 1851 and has 150 pupils. It has a medical journal of its own, though this is of course not of the same importance as the Dutch Indian medical journal and the Dutch Indian journal of science, which occasionally contain chemical contributions; the former was started in 1853, the latter in 1850.

Chemistry has never been an intellectual luxury in Java, but has always been encouraged as a means of supplying the practical needs of life, especially on the agricultural side.

Through the influence of Prof. G. Mulder (1802–1880) when scientific adviser to the Dutch Colonial Office, laboratories for the examination of minerals, and for the study of agricultural chemistry were founded. The latter was under the direction of Dr. Fromberg, at one time Assistant to Prof. Johnston at Edinburgh. This laboratory was closed when Fromberg died in 1858.

Mulder was of opinion that the prosecution of chemical research in Java might be made part of the duties of pharmacists attached to the army of occupation, and this led to the establishment of the Army Medical Service Laboratory at Batavia, which is now chiefly used for the preparation of drugs. Though Mulder's high expectations were not realised, useful contributions to chemical science were not infrequently made by the military pharmacists appointed under this scheme, thus van Gorkom, Moens, van Leersum, all of whom were pharmacists in the Army Medical Service, brought chemistry to the aid of cinchona cultivation, and it is exclusively owing to chemical control of the Java cinchona plantations, that the methods of selection and cultivation have been greatly improved, so that Java now has practically a monopoly of the trade in cinchona bark. The production of cinchona bark in Java is about 7,000 tons per annum, equivalent to seven-eighths of the world's consumption. In 1903, a large new laboratory for the investigation of problems connected with the cinchona plantations was established by the Dutch East Indian Government in the Preanger.

Whilst the Government took the first step in applying science to cinchona cultivation in Java, to private initiative was due its introduction into most of the other colonial agricultural industries. In 1886, when there was great distress in Java among sugar planters in consequence of the great fall in prices, and of the "tereti" disease of the cane, the more energetic planters saw that the aid of science must be sought. Almost simultaneously, three Institutes for sugar chemistry and sugar agriculture were founded, each in a centre of the industry, and each fitted up and maintained by the Planters' Association. Numerous Dutch scientists have worked in these institutes, and the practical results obtained have exceeded the most sanguine expectations. From year to year the yield of sugar per acre has been increased, disease has been warded off, the manufacturing methods have been improved, and now Java is in the forefront of cane-sugar producing countries, the production of cane-sugar having risen from half-a-million to one and a tenth million tons per annum during the last ten years.

The literature which has been issued for these sugar laboratories in Java is too voluminous to be mentioned here, though reference may be made to the Journal for the Sugar Industry, which has been published since 1893, and is considered one of the best technical journals of its kind. In the chemical study of the sugar cane the foremost worker in Java is Prinsen-Geerligs, Director of the Laboratory for Sugar Analysis at Kagok-Pehalongan. It is owing to him that there has been introduced into Java a system of "mutual control" in manufacture, by means of which every factory can compare its own results with those of other factories—a system of working which would probably also be useful to European laboratories engaged in agricultural and food analysis.

Following the example of the sugar planters, other branches of agriculture in Java have started their own laboratories. Since 1892, a laboratory for the investigation of problems connected with indigo cultivation has been at work in Klaten, and to its efforts is due the Javanese method of extracting indigo from the Natal indigo plant (*Indigofera arrecta*). In the case of indigo, however, chemistry has the difficult task of fighting against one of its own triumphs, viz. artificial indigotin. It is certain that, owing to scientific advice, the Java indigo planters will be able to compete more advantageously than planters in many other countries with the German works, and if prices remain moderately good, they may perhaps even be able to hold their own. Investigations on indican and indigotin of benefit to the Java indigo industry have also been carried out during recent years in Holland, partly in the Haarlem Laboratory, but especially in the laboratories of the technical high school at Delft.

A laboratory for cocoa investigation was started in Java under the directorship of Dr. Lehntner, who subsequently took charge of a similar institution in Brazil.

Perhaps the most important aids to planting progress in Java have, however, been furnished by the Chemical Laboratory attached to the Government Botanic Garden (Lands Plantentuin) at Buitenzorg. Since 1880 these gardens have been under the influential direction of Prof. Treub. Last year they were reorganised, and became the Government Department of Agriculture.

The agricultural chemical investigations carried on at Buitenzorg, with the support of the planters concerned, have been more especially those connected with tea in Java and with tobacco in Sumatra (Deli). The tea investigations have been in progress since 1893, and have greatly increased our knowledge of this important plant. The reports published on the subject in Java in the Dutch language have remained almost unknown in other countries.

There are two general chemical laboratories at Buitenzorg, one for pharmacological chemistry opened in 1887, and since 1892 under the direction of Boorsma, and the other a laboratory for agricultural chemistry which was from 1890–1903, under the able direction of van Romburgh, now Professor of Organic Chemistry at Utrecht University.

It is to be regretted that the Buitenzorg researches have been limited to the flora of Java itself, and even to those plants which can be grown in the abnormally damp climate of Buitenzorg, for unfortunately, none of the other Dutch East Indian Islands has a botanical garden. Mention may be made in passing of the analysis of tropical fruits now being made under Boorsma's direction, which is complementary to the detailed investigation of East Indian foodstuffs, now being carried on in my own laboratory at Haarlem, where already 400 different East Indian food products have been analysed.

Close scientific relationships are maintained between Holland and its East Indian Colonies, and most Dutch botanists and some chemists make a point of working for a period at Buitenzorg. Java has provided Holland not infrequently with University professors, who have made a name in the Colonies. In this way the scientific ties between the mother country and the Colonies are strengthened, but the continuity of the work in Java is often broken thereby.

In spite of what has been done in applying chemistry to agriculture in Java, much yet remains to be done. The existing agricultural laboratories are insufficient to supply information for new branches of tropical agriculture, and there is an almost complete absence of provision for commercial and technological work. The examination of imported foods for adulterants, and of drugs, and artificial manures, is practically unknown in Java. Provided that the imported articles have not been damaged by sea water, nobody is concerned about their purity. Similarly no special provision is made for physiological and toxicological investigations.

In conclusion, a few words must be said about the Dutch West Indian Colonies.

From several causes, such as the want of cheap labour, the migration of the sugar industry, the diseases of the cocoa plant, Dutch Guiana for many years has not been in a flourishing condition. That there is now an earnest desire in the mother country to improve the condition of things, is shown by the fact that twice in succession a Dutch cabinet minister has left his office to become Governor of this small colony. It is also this desire for improvement which has brought about the foundation at Paramarito of experimental gardens, a laboratory for agricultural chemistry, and a department of agriculture.

It is proposed that, as soon as the new agricultural department in the Dutch West Indies is in working order, botanists and chemists from Holland shall regularly visit this colony in order to carry out their scientific investigations, and to collect material for study. A beginning has been made already by Professor Wend of Utrecht, formerly director of an agricultural laboratory in Java, who, with his pupils, is preparing a preliminary flora of Dutch Guiana and the Dutch West Indian Islands.

IMPROVEMENT OF WEST AFRICAN COTTON.

THIS description of a simple, systematic process to be followed in selecting cotton seed for sowing, with a view to improving the type of cotton grown in British West Africa has been prepared by Mr. G. C. Dudgeon, Superintendent of Agriculture for the West African Colonies and Protectorates.

Having selected a good "native" variety to start from, there should be little difficulty in improving it. In several parts of West Africa good types of native cotton occur, but in all cases these have been found wanting in one or more particulars, which render them not altogether satisfactory, and the elimination of these unsatisfactory characteristics is one of the most important ends of the selection process to be described.

Assuming that a small area has been planted with seed from one of these good "native" cottons, and that it is desired to establish a better quality of cotton by improving this, the officer in charge of the experiment should in the first instance go through the plants when they are half-grown and pull up all which show signs of disease or imperfection. These should be burned. Next, all plants showing vigorous growth and a tendency to fruit early should be marked with stakes. Earliness in fruiting is desirable where the cotton plant is to be treated as an annual, but is less important where two seasons' crops are taken from the same plant. By raising an early-fruiting annual cotton, it is possible to break the continuity in the generations of many insect pests, and so render the cotton plants less liable to attack by such pests. Further, early ripening of the fruit gives the planter the opportunity of more thoroughly cultivating his land.

About a week after the stakes have been put in, the officer should make a second inspection and eliminate from the marked plants all which show improper branching, insufficient buds to the branch, or any indications of disease.

After these preliminary selections have been completed, strong healthy plants only will remain marked by stakes, and in these the more important characteristics must be looked for. At this time from 10 to 20 per cent. of the plants in the field may bear stakes, and an examination of the first ripe bolls produced by these should be made for *fineness* and *strength* of lint. If in the same inspection those which are most satisfactory in *whiteness*, *length*, and *regularity*, of staple can be determined, so much the better. If not, the bolls must be inspected later for these qualities. At this stage the plants still remaining should have labels tied to them, with the following italicised words printed on them, against which the officer can make his note :—

Quality of stalk (thick, thin, or medium). *Branches* (number, high or low, bushy or straggly). *Earliness* (date of opening of first bolls). *Colour of lint. Fineness. Strength. Length and regularity of staple* (a cotton of uniform length is more valuable than an uneven cotton of greater maximum length). *Silkiness or lustre. Relative weight of lint to seed.*

The last point can be decided upon as a final test, and will reduce the selection to plants which are to be used as mother plants for the following season's further selection. The seed from the whole of these selected plants can be used, although it is sometimes desirable to leave out that taken from the bolls which ripen last.

A complete description of the mother-plant selected as above should be recorded for reference. The order of importance of the qualities mentioned above having been decided upon, marks should be assigned to the different plants in the field, and in this way it should be easily determined which is the most desirable form of cotton to establish. Without such directions to follow, the choice between two or three plants might be difficult. For instance, one plant might give the largest yield, yet fail in some quality of lint, or it might be best in everything, with the exception of relative weight of lint to seed. It seems best to recommend that the seed from each of the selected plants should be sown in separate plots, and the values worked out later. In no circumstance should seed from plants showing variation from one another be mixed, or the object of the selection will be defeated.

It is fair to take the production of seed from a selected plant in West Africa, after allowing for dead seeds, and late bolls, as 400, from which 300 plants will be produced under ordinary conditions. From these 300 plants selection must be made in the second year in the same way as before, the seed for replanting being taken only from that plant best approximating to requirements. The remaining seed of the second year's crop, which will be, at any rate, an improvement on the original stock, can be distributed to the more careful native farmers, but should not be used for sowing at the experiment station. Later, when a good type has been established in the experimental plantations, selection of parent forms will be reduced to the elimination of those plants which show an undesirable variation from the established form, as well as those which show liability to disease or weakness. The work at this time will be so much simplified that the experimental plantation can then become a seed-producing area capable of distributing improved seed.

The work of selection for each season should be done by the same officer on the plantation throughout that season.

THE IMPORTANCE OF HUMUS IN TROPICAL AGRICULTURE, WITH SPECIAL REFERENCE TO COCOA CULTIVATION.

THE recently-issued report for 1905–06 on the Botanic Station of Dominica (Imperial Department of Agriculture for the West Indies) contains (p. 4) a summary by Dr. Francis Watts, C.M.G., the Superintendent of Agriculture for the Leeward Islands, of the results obtained on a series of plots devoted to manurial experiments with cocoa. These particular experiments, inasmuch as their results indicate a remunerative method of manuring cocoa trees, are naturally of great local value. They also have a wider interest as throwing light on one of the fundamental problems of tropical agriculture—namely, the preservation of humus.

In the scheme of experiments, some $1\frac{3}{4}$ acres, bearing cocoa trees about 10 years old, were divided up into five plots, which were treated as follows from 1900 onwards:—

A. No manure.

B. Basic phosphate, 4 cwt. per acre. Sulphate of potash, $1\frac{1}{2}$ cwt. per acre.

C. Dried blood, 4 cwt. per acre.

D. Basic phosphate, 4 cwt. per acre. Sulphate of potash, $1\frac{1}{2}$ cwt. per acre. Dried blood, 4 cwt. per acre.

E. Mulched with grass and leaves.

The individual trees were thus manured year after year in exactly the same way, and the cumulative results are comparable to those which would be obtained in actual estate practice. The first point established was that the treatment with nitrogenous manures was remunerative. Thus, to take the last year, the net financial result with plot B, which received phosphate and potash and no nitrogen, was a loss at the rate of £4 4*s.* 3*d.* per acre; on the other hand, on both plots to which nitrogen was added there was a gain, that is to say, the increased value of the crops more than compensated for the cost of the manure; plot C gave a net gain on manuring of £4 8*s.* per acre, and plot D of £8 0*s.* 4*d.* per acre.

Still more striking, however, was the result obtained on the fifth plot, E, manured with grass and leaves, the gain on manuring being at the rate of not less than £20 16*s.* 6*d.* per acre. That this was no accidental result is well brought out in the diagrammatic summary of the experiments accompanying the report, in which the yields of "wet" cocoa are plotted by means of lines on a uniform scale for the years 1903–06. From this diagram it can clearly be seen that the mulch of grass and leaves, whilst of slower action than more readily available manures, is more lasting in its effects. The mulched plot, E, was beaten by C and D in 1903, tied with C in 1904, beat both in 1905, and altogether outdistanced them in 1906.

The material employed for mulching consisted chiefly of lawn mowings and the fallen leaves of neighbouring trees, particularly *Pithecolobium Saman*, the well-known "Guango" or "Rain" tree. The general suggestion is made that grass, etc., from uncultivated lands might commonly be used for mulching cocoa, or if no waste land is to hand, that certain areas should be set aside and used for the production of material for mulching.

These results are worthy of serious consideration in many parts of the tropics where the provision of chemical manures is often expensive, and where also the humus of the soil rapidly disappears and needs replenishing. The beneficial nature of such manuring will probably be apparent not only with cocoa, but also other crops, especially those which owing to their casting a deep shade or for other reasons do not allow a mulch to be grown under them.

GRAPHITE AND ITS USES.

Physical and Chemical Characters.

CARBON occurs in the uncombined state in three forms—diamond, graphite, and amorphous carbon—which differ considerably in their physical and chemical characters.

While the diamond crystallises in octahedra or other forms characteristic of the cubic system, graphite belongs to one of the rhombohedral classes of the hexagonal system. The crystals have a six-sided tabular form, but are only exceptionally well developed, the mineral as a rule being either quite compact or occurring in flakes, irregular prisms, or fibres. Compact graphite is sometimes, especially in North America, referred to as amorphous, and the other forms as crystalline, but this is not correct, as all graphite is crystalline, and must be carefully distinguished from amorphous carbon. It is better to refer collectively to the non-compact varieties as flake graphite. The colour of graphite varies from a steel-grey resembling that of molybdenite to iron-black, and the streak is similar, being grey to greyish-black in colour. The lustre may be metallic or dull, but the streak is nearly always shining and metallic in appearance. The specific gravity of graphite when pure is over 2·25; its hardness is less than 2, that is to say, it is softer than gypsum and rock-salt and scarcely harder than talc (French chalk). The forms of graphite, however, that resemble anthracite have approximately the same hardness (2 to 2·5) as that substance.

Graphite is a much better conductor of heat and electricity than the other forms of carbon. If heated out of contact with the air or other oxidising medium, it suffers no change except at the very highest temperatures of the electric arc, by which it may be volatilised. Even if heated in the air it does not burn except at a white heat, when it is slowly converted into carbonic acid.

Graphite may be distinguished from bort and carbonado, which are black forms of diamond, by its specific gravity and hardness.

The variety of compact graphite that resembles anthracite can be distinguished from that mineral by its higher conductivity for heat, which causes it to feel cold to the touch.

Molybdenite, sulphide of molybdenum, is very similar in colour, lustre, and hardness to some graphite; it may, however, be distinguished by its higher specific gravity (4·7 to 4·8) and its streak, which is bluish-grey on paper and greenish-grey on unglazed porcelain. Molybdenite gives the typical blowpipe reactions for molybdenum and sulphur.

Some other minerals, for instance tetradymite (a telluride and sulphide of bismuth), closely resemble graphite, but may be distinguished in like manner by their specific gravity and blowpipe reactions.

Graphite may be formed artificially in a number of different ways. The only method, however, which has been commercially successful is the heating of amorphous carbon out of contact with the air in the electric arc. The change is facilitated if certain oxides be present; ferric oxide appears to be most effective, but silica, alumina, clay, lime, or manganese oxide may be substituted. The material employed is usually anthracite coal. Most of the ash is eliminated in the process and a product of great purity is obtained. Carbon electrodes are graphitised in a similar manner in order to increase their conductivity.

Mode of Occurrence.

In nature, graphite appears to originate in two entirely different ways.

In some cases it is formed by the action of intense heat on coal or other carbonaceous material, such heat being the result of the presence in the immediate neighbourhood of intrusive igneous rocks. As examples of graphite deposits formed in this way by contact metamorphism may be mentioned those in the Noric Alps of Styria, in the Pennine, Cottian and Maritime Alps in Northern Italy, at Craigman in Ayrshire, in the Caucasus, at Darjiling in India, near Maryborough in Queensland, in Buller County, New South Wales, in the Eastern Townships of Quebec, in Rhode Island in the United States, Sonora in Mexico, and Barreiros near Minas Novas in Brazil. Graphite formed in this way is compact, the so-called amorphous graphite. It includes dull and earthy varieties, and the special type already referred to as presenting a close resemblance to anthracite.

The more usual mode of occurrence of graphite is, however, as a secondary mineral, deposited in pre-existent rocks by gaseous emanations from the interior of the earth, usually following on the intrusion of igneous dykes or masses. It may occur as a local impregnation of the rock or as "stockwerks," veins, beds, or pockets. Typical deposits formed in this way are those of Cumberland, Bavaria, Bohemia, Ceylon, and Southern India.

These secondary deposits have been ascribed to the alteration *in situ* of veins or other infillings of solid or semi-solid hydrocarbons such as albertite or asphalt, or to the decomposition of the vapour of acetylene or other volatile hydrocarbons, but Weinschenk, who has made a careful study of Bavarian and Bohemian deposits, and has examined numerous specimens from Ceylon, believes that the carbon forming the graphite was deposited from emanations containing carbonic oxide or the metallic carbonyls, especially those of iron and manganese, the oxides of which are often found in decomposed rock associated with deposits of graphite. He thinks, however, that cyanogen compounds may also have played a part, and refers to the frequent presence of nitrogen in graphite, and suggests that the association of graphite with titanium minerals points to the former existence of a cyanogen-titanium compound such as that which is met with in slags from titaniferous iron ores.

The graphite of secondary origin may either be flaky, prismatic, fibrous, or compact in structure. It is sometimes classified commercially, according to size, into lump, chip, dust, and sweepings. The coarser material occurs where the deposits have not been disturbed by earth movements. Although the secondary graphite deposits are usually of better quality, yet the irregularity of their mode of occurrence renders systematic mining almost impossible. When the immediate supply is exhausted much money may be spent in unsuccessful endeavours to discover further ore masses.

Uses.

The uses of graphite depend on its resistance to the action of heat and corrosive agents, its conductivity of heat and electricity, the softness and smoothness of the finer or compact varieties, which spread out under pressure to form a uniform and almost frictionless surface, its opaque black colour and streak, the ease with which the latter can be produced and its permanent character. The absence of occluded gases, which are present in all forms of amorphous carbon, is a recommendation for some purposes.

The earliest use of graphite appears to have been in the manufacture of crucibles and furnaces. For this purpose coarsely flaky graphite, which breaks up easily into thin plates along the cleavage planes, is best. When these plates are well mixed with a good fire-clay the product possesses a considerable amount of elasticity, as well as conductivity for heat. It therefore has the power of suffering great variations in temperature without ill effects.

An analysis of a typical Passau crucible, probably of the same composition as those used by the alchemists in the Middle Ages, showed it to contain 56 per cent. of fire-clay, 34 per cent. of carbon, 8 per cent. of iron oxide, and 2 per cent. of magnesia. The iron oxide and magnesia represent the impurities in the fire-clay and graphite employed. Other crucibles contain 50 per cent. of carbon, 33 per cent. of refractory clay, and 14 per cent of sand.

The graphite used for making crucibles is stated to be sifted through screens containing from 40 to 100 meshes to the inch, while the sand passes through one with 40 meshes. The clay is made into a thin paste with water, and sand and graphite are mixed in. After being passed several times through a "pug mill," it is tempered for some weeks in a damp place. It is then kneaded and moulded, on a wheel, so as to arrange the graphite flakes tangentially. The crucibles are placed in plaster moulds and left for three hours, during which time part of the moisture is absorbed by the plaster.. They are then dried for a week at a temperature of from 70° to 80° F., and burned at about 1,350° C. in a common pottery kiln, which is first fired with anthracite coal and afterwards with long-flaming wood.

Compact graphite is used for crucibles of inferior quality, being finely powdered for the purpose. In this case, however, the high conductivity for heat of the graphite is its most important quality, for the powdered compact material does not give the product the same elasticity as does the flaky graphite. There is accordingly a tendency for fine cracks to form when the crucible is subjected to great heat; they are not sufficiently extensive to allow the contents to escape, but prevent the crucible being used a second time. These crucibles are, however, preferred on account of their lower cost for use at especially high temperatures, such as that required for steel casting, for under these conditions even the best crucibles manufactured of fire-clay and flaky graphite are so much injured that they cannot be used again.

Another important use of graphite is in "lead" pencils. These date from as early as the middle of the sixteenth century. The "leads" were formerly carefully sawn out of a very fine-grained graphite found at Borrowdale in Cumberland. When greater hardness was required they were heated in molten sulphur. This deposit was exhausted early in the nineteenth century, but similar material was met with at Batougol near Irkutsk in Siberia, and this likewise has now long since been worked out. At present powdered graphite is employed, being moulded to the required shape. For this purpose graphite that is neither too coarsely flaky nor too compact is required. In the former case it is practically impossible to powder it sufficiently fine, while in the latter the streak on paper is too dull. Different shades can be obtained by mixing the graphite with sulphur, sulphide of antimony, or lamp-black. The product is given the necessary cohesion either by pressure *in vacuo* or mixing with clay and baking.

Compact graphite and inferior flake graphite are widely employed for polishing stoves and other iron objects and preserving them from rust. They are also used as a facing for moulds in foundries so that the casting may separate easily. In some cases the mould itself is constructed of graphite.

Graphite of inferior quality is also used in the manufacture of black paints. These may contain about 50 per cent. of graphite mixed with oil and other ingredients.

Its conductivity for electricity causes graphite to be used in facing the moulds used in electroplating, and for the same reason graphitised carbons are now much used in electro-chemical processes at high temperatures, and for this purpose the difficulty with which it is oxidised is an additional recommendation. Graphite is also used in dry batteries. The grains of high explosives have been coated with graphite of great purity (especially that obtained artificially) to prevent the formation of static charges of electricity and consequent sparking.

Graphite is of the greatest value as a lubricant for machinery, especially in cases where the pressure on the bearings is very great and the movement slow, so that lubricating oils are soon pressed out. It is not destroyed at a high temperature or by corrosive materials, and does not attack metals. At the same time, by permanently filling the irregularities of the metal it creates a smooth surface, which gives rise to but little friction. Its conductivity for heat is an additional advantage, as it assists in keeping the bearings cool. The purest varieties should be used. The feeding has been a difficulty, and various methods have been tried for dry feeding. It is also mixed with grease or oil, and some combinations can, it is said, be fed in the ordinary way. It has also been proposed to saturate oil with finely-powdered graphite, and suspend it in another oil with which the first will not mix.

Graphite is used instead of asbestos for steam packing. It is also employed as a cement for pipe joints, and in other ways as a substitute for red- and white-lead.

A recent patent describes a process in which graphite, after being crushed and passed through a sieve of from 120 to 150 meshes to the inch, is stirred into a saturated solution of alum or aluminium sulphate at the temperature of boiling water. Steatite is subsequently added, and the whole is well mixed, with the addition of water if it be required. The product is dried and ground up in a chilled-steel mortar. More graphite may, if desired, be added before grinding. The powder obtained may be compressed into cakes for use as stove polish, or employed for the manufacture of pencils or crucibles. The proportions of the ingredients vary, according to the purpose for which the product is required. The following represents an average composition: Graphite, 80 parts; steatite, 14 parts; alum, 6 parts.

Artificial graphite is employed in the form of grains and powder in the manufacture of black paint, dry batteries, and accumulator brushes. A considerable amount is used in the manufacture of lubricants, in electroplating, and in chemical work that requires carbon of especial purity. The graphitisation of carbon poles has already been alluded to.

Concentration.

Graphite usually contains a certain amount of foreign material, which may include quartz, various silicates especially mica, pyrites (iron disulphide), and the carbonates of lime and iron. In the crude graphite these impurities may amount to as much as 90 per cent. Excess of iron, lime, or magnesia renders the material unsuitable for crucibles, as it makes the clay that is mixed with the graphite more fusible. Pyrites is still more objectionable, as the sulphur combines with the metals melted in the crucible and renders them brittle, and in other ways inferior in quality. Any admixture of quartz and the harder silicates seriously interferes with the use of the mineral for pencils or lubricating purposes.

Flake graphite can be easily cleaned or concentrated. Frequently the pyrites is coarse enough to be removed by hand. In other cases the whole may be crushed so that the pyrites and the harder material is ground to a fine powder, while most of the graphite retains its flaky character so that it can be separated, and in this way material containing over 90 per cent. of carbon can be obtained. A large amount of fine graphite, however, passes through the sieve with the impurities. The separation may also be effected by exposing the crushed material to currents of air, which carry out most of the graphite and allow the impurities to fall.

Compact graphite is ground very fine and then separated either by a "slime" or a "float" process. In the former case the powder is mixed with water, which is then allowed to pass through a succession of settling tanks, which may be as many as eighteen in number. The earlier tanks receive the sulphides and other heavy minerals, as well as a proportion of the silicates, not unmixed with graphite; the latter tanks contain the graphite in gradually increasing purity. The material is finally passed into a filter press and compressed into cakes, which are then dried and crushed. The separation is by no means perfect. Part of the graphite is lost, and the concentrated product is not free from silicates, especially those of a micaceous structure. These last, however, are comparatively innocuous.

In the float process the powdered graphite is thrown on the surface of water, which is slowly moving forward. The lighter material floats on the surface, where it is collected, while the heavier constituents sink. If the graphite be first dried and then exposed to the vapour of volatile petroleum, which it easily absorbs, it floats more easily, and better results are obtained.

In the next number of the *Bulletin* (1907, **5**. No. 1) an account of the geographical distribution of graphite will be given.

GENERAL NOTES.

Chemistry and Agricultural Science at the British Association Meeting at York, 1906.—The section of Chemistry and Agricultural Science at the recent meeting of the British Association at York was presided over by Professor W. R. Dunstan, F.R.S., Director of the Imperial Institute, whose presidential address, dealing with the applications of science, and more especially chemistry, to the discovery of the best methods of utilising colonial resources, is published in full in this *Bulletin* (p. 310). Many of the papers read before the section this year also dealt with products and matters of colonial interest, and therefore merit brief mention here.

Messrs. Leetham and Cramp gave an account of researches they had conducted in perfecting an apparatus for the production, from atmospheric air by electrical means, of an active gas containing small quantities of ozone and oxides of nitrogen, which is being applied on an industrial scale for bleaching and sterilising flour. It was mentioned incidentally in the course of the paper that flour after treatment by this active gas can be kept in fair condition for a much longer period than untreated flour, even in such hot, damp climates as prevail in the West African Colonies.

A discussion also took place on the significance of cyanogenesis in plants, to which the President, Dr. T. A. Henry and Professor van Romburgh of Utrecht and Dr. Greshoff of Haarlem contributed. A *résumé* of the present position of this subject is given in this *Bulletin* (p. 329).

A paper on the utilisation of atmospheric nitrogen was read by Mr. T. Jamieson, who described what he regarded as special organs developed on leaves by plants for the direct absorption and assimilation of nitrogen from the air. This view, which is not in accordance with the results of modern work, was criticised by several agricultural and botanical authorities present, who considered that the case had not been made out.

Papers on the chemistry of rubber were read by Mr. S. S. Pickles, Assistant in the Scientific and Technical Department of the Imperial Institute, Professor Harries of Kiel, and Professor W. A. Tilden. The first of these papers is summarised in the succeeding note. The second paper gave a *résumé* of Professor Harries' work on the action of ozone on rubber and the products obtained when the caoutchouc ozonide is decomposed by steam. Professor Tilden gave a historical summary of his observations on the formation of rubber from isoprene by polymerisation, and an account of the constituents of the coagulated latex of *Dyera costulata*, a product which comes on the market under the name of "pontianac" (*Bulletin of the Imperial Institute*, 1903, **1**. 65, and 1904, **2**. 162).

Mr. H. H. Robinson, Assistant in the Scientific and Technical Department of the Imperial Institute, presented a report on the position of the chemistry of gums, a *résumé* of which will be given in the course of an article dealing with the production, properties, and uses of gums to be published shortly in this *Bulletin*. The same author gave an account of the gum of *Cochlospermum Gossypium* from India, which has the curious property of liberating acetic acid when exposed to air. A full account of the chemistry of this gum is given in the *Journal of the Chemical Society*, 1906, **89**. 1496.

On the last day of the meeting a joint discussion was held with the section of Physiology on the subject of food and diet, in which Professor Dunstan, Dr. Hopkins, and Professor Armstrong took part. The trend of the discussion indicated that the subject was considered of great importance, that it should be attacked jointly by chemists and physiologists, and that the present methods of investigation both on the chemical and physiological sides required improvement in order to give trustworthy data.

Messrs. A. D. Hall and C. T. Gimingham contributed a paper on the action of ammonium salts on clay and similar substances, with special reference to the changes thus induced in soils, and Dr. F. Darbishire and E. Russell described an apparatus they have devised for measuring the rate of absorption of oxygen by soils, by the application of which they have ascertained that in a similar group of soils whose cropping powers are known the most productive are those which absorb most oxygen.

Mr. W. P. Bloxam gave an account of a new method of estimating indigotin, the blue colouring matter of natural indigo, which is suitable for use in indigo factories as a method of controlling quality of the indigo produced.

In addition to the foregoing a number of papers of purely scientific interest were contributed, to which detailed reference need not be made here.

Chemistry of Rubber.—A report on "Our Present Knowledge of the Chemistry of Rubber" was read before the section of Chemistry and Agricultural Science of the British Association during the recent meeting at York, by Mr. S. S. Pickles, M.Sc., Assistant in the Scientific and Technical Department of the Imperial Institute. The report gave an historical account of the scientific work which has been done on caoutchouc. Commencing with a statement of the nature, chemical composition and source of rubber, its method of occurrence in the latex, and the distribution of the laticiferous system in rubber plants, the report went on to deal with the older statements regarding the occurrence and applications of rubber.

From a scientific standpoint the nature of the decomposition products of indiarubber are of considerable importance, as bearing on the chemical constitution of the rubber hydrocarbon, and therefore a considerable portion of the report was devoted to a survey of the results of investigations of the products obtained when rubber is destructively distilled.

Amongst these products is the interesting hydrocarbon "isoprene," which has the chemical formula C_5H_8 and boils at 37° C. It was first isolated in a fairly pure state by Greville Williams in 1860, and was further investigated by Bouchardat in 1875, who stated that on treatment with hydrochloric acid it was converted into an elastic substance having all the properties of indiarubber. Tilden in 1882 confirmed these observations, and also obtained isoprene from turpentine oil by decomposition with heat. The isoprene obtained from turpentine oil also passed into an elastic rubber-like body on treatment with certain chemicals, and subsequently (1892) the same chemist observed that, even without the addition of other substances, but simply on standing for a long time, isoprene passes into an elastic substance, having apparently all the properties of natural indiarubber.

The report further dealt with the researches which ultimately led to the discovery of the constitution of isoprene, and also with the investigation of other products of rubber distillation, *e.g.* the hydrocarbons dipentene, $C_{10}H_{16}$, and heveene, $C_{15}H_{24}$, or $C_{20}H_{32}$.

The chemical derivatives of indiarubber itself were then considered. Allusion was made to the work of Weber and others on the chemical compounds produced when rubber is vulcanised, which led to the conclusion that the process of vulcanisation consists in the addition of sulphur or sulphur chloride at the ethylenic linkings in the rubber molecule. The compound obtained when rubber is treated with bromine, $C_{10}H_{16}Br_4$, prepared first by Gladstone and Hibbert in 1888, and afterwards more fully investigated by Weber, was referred to.

An account was given of the study of the action of nitric acid on rubber, and the recent work of Ditmar in this field was considered. The results of the investigation of the effect of nitrous fumes on solutions of rubber, and of the similar effect of nitrogen dioxide, obtained by Harries and Weber respectively, also find a place in the report.

The recent work of Harries on the action of ozone on rubber was also dealt with in detail. These results, which have a most important bearing on the question of the ultimate structure of the molecule of rubber, are too technical to be discussed fully here, but it may be mentioned that as the result of these investigations Harries concludes that the molecule of caoutchouc contains as a nucleus a carbon ring, consisting of eight carbon atoms, arranged probably in the following order :—

$$\begin{array}{l} CH_3—\overset{}{C}—CH_2—CH_2—CH \\ \quad\;\;\, \| \qquad\qquad\qquad\quad\;\; \| \\ \quad\;\; CH—CH_2—CH_2—C—CH_3 \end{array}$$

and that by some simple means this nucleus is capable of polymerising into the substance we know as indiarubber.

The paper is printed *in extenso* in the *Report of the British Association*, 1906.

Cotton from Bermuda.—A small consignment of Sea Island seed-cotton received from Bermuda, was examined in the Scientific and Technical Department of the Imperial Institute.

The product consisted of fairly clean, unginned cotton. A few small portions of the fibre were stained deep yellow, and the seed was withered, indicating the occurrence of an insect pest in the crop. The yield of ginned cotton amounted to about 28 per cent.

The ginned cotton was soft to the touch, fine, wavy, of an even pale cream colour and of good lustre. The length of the fibre varied from 1·6 to 2·3 inches, and the average diameter was 0·0006 inch. On microscopical examination, the cotton was found to be somewhat irregular in structure, probably owing to the presence of unripe fibres.

The seeds were of medium size, dark brown to black in colour, and were either quite smooth or bore small greenish-brown tufts at the pointed ends.

The commercial experts reported that the cotton was fine and long, but would suffer some waste in manufacture, and that it was worth from 13*d.* to 14*d.* per lb., "fine" Sea Island being quoted at 14*d.* and "extra fine" Sea Island at 21*d.* per lb. on the same date. Attention was drawn to the small quantity of stained cotton in the sample, and it was stated that if much of this was present in a consignment it would considerably reduce the commercial value of the material.

Oil from the Seed of the Ceara Rubber-tree.—In a previous number of the *Bulletin of the Imperial Institute* (1903, **1.** 156) an account was given of the properties of the fixed oil from the seeds of the Para rubber-tree (*Hevea brasiliensis*) which had been examined in the Scientific and Technical Department. It is interesting to note that a somewhat similar oil is yielded by the seeds of the Ceara rubber-tree (*Manihot Glaziovii*), and has been examined recently by Fendler and Kuhn (*Ber. deut. Pharm. Ges.*, 1906, **15.** 426).

This oil is described as of a greenish-yellow colour, with an odour resembling that of olive oil, and a somewhat harsh and bitter taste. The constants of the oil are given below, and for the sake of comparison the corresponding constants of Para rubber seed oil are also quoted:—

	Ceara rubber seed oil.	*Para rubber seed oil.*
Specific gravity	0·9258	0·9302
Acid value	2·18	10·7
Saponification value	188·6	206·1
Reichert-Meisel value	0·7	—
Iodine value	137·0 *per cent.*	128·3 *per cent.*
Unsaponifiable matter	0·9 " "	—

The mixed fatty acids of Ceara rubber seed oil consist of 10·97 per cent. "solid acids" (melting-point, 54° C.) and 89·03 per cent. "liquid acids."

The oil "dries" in about ten hours when kept at 55° C. in the air, but only after several weeks if exposed to the air at the ordinary temperature.

Production of Cocoanuts in Cuba.—During the year ending in June 1906, 18·5 millions of cocoanuts were exported from Cuba, this being an increase of 4·5 millions on the preceding twelve months. The general method of culture of cocoanut palms in the island is as follows:—Cheap sandy ground unsuitable for other purposes is used, and in fact the trees grow best on the sea-shore, where they get plenty of water, the salt causing no ill effects. It is also found advantageous to plant bananas and cocoa trees in the cocoanut palm plantations, the bananas providing shade for the young cocoa trees. The time necessary to bring a cocoanut palm to the fruit-bearing period varies from about five years on the sea-coast to seven or eight years in the interior, each tree giving on the average 60 nuts annually. The nuts are plucked twice a month.

Cocoanuts smaller than 3½ inches in diameter fetch only $4 per 1000, but first-class nuts are worth $10–18 per 1000. Nearly 30 per cent. of the nuts are small or bad, and these are generally used for feeding pigs or are pressed locally for the production of cocoanut oil. The cocoanut fibre does not appear to be utilised in Cuba.

International Agricultural Institute.—Reference is made in a recent number of the *Journal of the Board of Agriculture* (1906, xii. 3) to the proposal to establish an International Agricultural Institute.

The Institute owes its inception to the initiative of H.M. the King of Italy, who in 1905 invited the different Governments of the world to take part in a conference to be held in Rome for the purpose of considering the constitution and organisation of the proposed Institute. The United Kingdom was represented at this conference by Sir E. Egerton, the Earl of Jersey, the Earl of Minto, Sir Thomas Elliott, and Mr. T. P. Gill. The conclusions arrived at by the delegates were embodied in an "Acte Finale" which, it was arranged, should be submitted by the Italian Government for the consideration of the various Powers. According to this document the International Agricultural Institute is to be an official institution on the governing body of which each country adhering shall be represented by delegates of its own selection. It is to be the duty of the Institute—

(*a*) To collect, elaborate, and publish with as little delay as possible statistical, technical, and economic information regarding the treatment of the soil, the cultivation of vegetable products, the breeding, etc., of animals, the trade in agricultural products, and the prices obtainable for these on the various markets.

(*b*) To send to interested parties, in a similarly rapid manner, full information of the nature above mentioned.

(*c*) To maintain a record of the cost of rural labour.

(*d*) To notify all new plant diseases which may appear in any part of the world, indicating the districts affected, the spread of the disease, and, if possible, efficacious means of prevention or remedial treatment.

(*e*) To consider questions relating to agricultural co-operation, insurance, and credit in all their forms, to collect and publish information which may be useful in the various countries for the organisation of undertakings relating to agricultural co-operation, insurance, and credit.

(*f*) To present, if expedient, to Governments for their approval measures for the protection of the common interests of agriculturists and for the improvement of their condition, after having previously taken means of obtaining the necessary information.

In order to help towards the foundation and maintenance of the

Institute, H.M. the King of Italy has presented to the Institute the control and revenues of two domains near Pisa, estimated to produce £12,000 per annum. The new buildings of the Institute, to be located in Rome, will probably be completed towards the end of 1907.

The British Treasury has agreed to the adherence of this country to the Convention for the establishment of the Institute.

Leather from Lagos.—A small consignment of tanned goat-skins was received recently at the Imperial Institute from Lagos, for examination and valuation in connection with a general inquiry into the native leather industry of West Africa and the possibilities of its improvement. The consignment consisted of six tanned goat-skins, four of which were dyed and two undyed. An examination of the skins showed that several of them exhibited the harsh and damaged condition which is frequently noticed in consignments of these skins, which come on the market as "Niger leather." The harshness appears to be due mainly to improper tanning of the skins, and the damage consists principally of cuts on the under surface, brought about by the use of primitive tools or lack of care in removing the skins from the dead animals.

The skins were submitted to commercial experts for valuation, who reported that they were suitable for this market, and that the dyed skins would fetch from 1*s.* 6*d.* to 2*s.* per lb., whereas the undyed skins, which were harsh and badly flayed, would probably be worth from 1*s.* 3*d.* to 1*s.* 4*d.* per lb.

The Marble Deposits of New South Wales.—These deposits have recently been examined for the Commonwealth Government by Mr. C. F. Summers, who states in his report on the subject that they are both varied and extensive. The only white marble deposit now being worked is the Caloola quarry, situated near Newbridge in the Bathurst district. The marble produced, which is of fair quality and promises to improve with further working of the deposit, is suitable for architectural and monumental purposes.

About seventeen miles from Bathurst are situated the Rosedale and Fernbrook quarries, which produce a variegated marble of rich and vivid colouring. The Borenore quarry in the Orange district yields large blocks of marble without the necessity of using special mechanical tools. This marble is suitable for cabinet-making. The Caleula quarry, also in the Orange district, yields two varieties, one being of a light body-colour streaked with green and red, and the other dark in colour and rather dull and heavy in tone.

Extensive deposits of variegated marbles of several types also occur in the Molong district.

A large deposit of useful variegated marble is found between Cudgegong and Rylstone on Carwell Creek. The marble is of two kinds, grey with a white streak or grey with pink streaks.

At Bucharoo is situated what is described as the finest deposit of variegated marble in the Mudger district.

Petroleum in New Zealand.—Indications of the existence of reservoirs of petroleum at a considerable distance below the surface have been noticed at New Plymouth on the west coast of North Island, and near Greytown on the west coast of South Island. Boring experiments were made for the first time in the former district about 1865, but until quite recently no success has been achieved. At the instance of a syndicate formed in New Zealand the boring operations were some years ago renewed, and oil was struck at 905 feet, but the presence of water, which rose and fell with the tide, caused this bore to be abandoned.

A fresh bore to a similar depth yielded 10 barrels of oil per day, but this soon stopped owing to falls of soft rock into the bore. In 1896, a fresh bore was made to a depth of 1,976 feet, but again water interfered, and later the works were destroyed by an explosion and a subsequent outbreak of fire.

Recently this bore has been continued to a depth of 2,331 feet, and a good flow of oil quite free from water has been obtained. The yield of oil, at first, was 30 barrels per day, but it was then accompanied by sand and mud. Later, the rate of flow and the quality of the oil increased considerably, and according to recent reports it amounts to 400 barrels per day, and is accompanied by a considerable quantity of gas.

It is proposed to proceed with the erection of a refinery and the sinking of more bore-holes.

Utilisation of Quartz.—A demand has arisen for nearly clear, crystalline and colourless quartz. The size of the crystals is unimportant. Suitable material can be sold at about £20 per ton. Small representative samples, if sent to the Imperial Institute, will be tested and, if necessary, referred to manufacturers for trial with a view to the purchase of consignments.

NOTICES OF RECENT LITERATURE.

NEW BOOKS.

HISTORICAL GEOGRAPHY OF THE BRITISH COLONIES. Vol. i. *The Mediterranean and Eastern Colonies.* By C. P. Lucas, C.B., second edition revised and brought up to date by R. E. Stubbs, B.A. Pp. vii + 304. (Clarendon Press, Oxford, 1906.)

Mr. Lucas's *Historical Geography of the British Colonies* is well known as affording a concise and comprehensive summary of the principal events in the history of the "British Dominions beyond the Seas," and it is welcome evidence of the esteem in which the work is held that a new edition has been called for. A second edition of vol. iii (West Africa) appeared in 1898, and of vol. ii (the West Indies) in 1905. The present volume is devoted to those Dependencies of Great Britain which lie on, or near to, the great trade routes to India and the Far East, although no one of them is a colony in the true sense of the word they show examples of every type of the dependencies of the Empire from a Protectorate to a complete Crown Colony.

As indicating the scheme of the book we may instance section V, "On the British Dependencies in the Malay Indies." The history of European intervention is broadly sketched, with a discussion on the origin and affinities of the Malays and aboriginal tribes such as the Semangs and Sakais. Successive chapters are devoted to the Straits Settlements, the Federated Malay States and Borneo; the mode of government and administrative machinery, area, religion, currency, products, trade and climate of each constituent state is described, the whole forming a most interesting and authoritative account of this region. In a similar manner are treated Gibraltar, Malta, Cyprus, Aden, British Somaliland, Ceylon, Mauritius, the Seychelles, and the British Dependencies in China. Thirteen maps greatly increase the usefulness of the volume.

PETROLEUM. *A Treatise on the geographical distribution and geological occurrence of Petroleum and Natural Gas; The physical and chemical properties, production, and refining of Petroleum and Ozokerite; The characters and uses, testing, transport and storage of Petroleum Products; and the legislative enactments relating thereto; together with a description of the Shale Oil and Allied Industries; and a full bibliography.* By Sir Boverton Redwood, D.Sc., F.R.S.E., Assoc. Inst. C.E., F.I.C. In two volumes, with numerous maps, plates and illustrations in the text. Pp. 1064. (London: Charles Griffin & Co., Ltd., 1906.)

This is a second and enlarged edition of a well-known book, and is an invaluable storehouse of information of every description relating to petroleum.

The detailed account of the distribution and character of petroleum deposits of the world is divided between the first two sections of the book, the former giving the historical and commercial aspects of the subject, and the latter the geological relations of the petroliferous beds. It would have facilitated reference had all the information about each locality been given together.

The third section contains a summary of the results of most of the work that has been done on the physical characters and chemical properties of the mineral, and the fourth section gives a brief account of the theories which have been advanced as to its origin. The author does not refer to the fact that a large number of geologists, rightly or wrongly, still believe in the inorganic origin of some at least of the deposits.

The succeeding sections deal with the production, refining, storage, testing and uses of petroleum and allied substances. The laws and regulations in force in all parts of the world relating to these matters are also given in some detail, as are the importation dues in force in different localities.

Valuable features of the book are the statistics which, though they occupy forty-seven pages, one could have wished even more exhaustive. No information is given, for instance, as to the Indian imports, which are of considerable interest as showing the struggle between the American and Russian oils for the Indian market, and finally, the reduction of the amount of the Indian imports due to the rapid increase of the internal production.

The importance of the petroleum industry can perhaps best be realised by the list of tank steamers engaged in transporting this commodity, which extends over twenty-two pages in an appendix. The work concludes with a remarkably complete and comprehensive bibliography, consisting of nearly six thousand entries.

CEMENTS, LIMES AND PLASTERS. *Their materials, manufacture and properties*. By Edwin C. Eckel, C.E. Pp. xlv + 689. (New York: John Wiley & Sons. London: Chapman & Hall, Ltd., 1905.)

This work gives a comprehensive account of the distribution and mining of raw materials used in the manufacture of cements. No adequate summary of the literature of this subject was available previously in America, and the author not only supplies this need but lays European readers under obligation by giving a complete account of the deposits available, and methods of manufacture used in America. The plan of the book is briefly that each variety of cementing material is dealt with in a separate part, complete in itself, and therefore particularly easy of reference.

Part I consists of five chapters dealing with the distribution and excavation of gypsum and of the preparation of plaster of Paris therefrom. Chapter IV, on "flooring plasters," contains an account of Van't Hoff's recent investigations on this subject.

Part II deals with lime and lime-sand bricks. The latter are but little known in this country, but have been manufactured on a large scale in Germany and the United States.

Part III contains a description of the chief sources of magnesia and of the manufacture of magnesia bricks. Some account is also given of "oxychloride cements" and "sorel-stone."

Parts IV, V, and VI deal with hydraulic lime, natural cement, and Portland cement respectively. In each the source, preparation, and properties of the final products are separately treated, and detailed and illustrated descriptions of the machinery employed are given. One noteworthy feature of the work is the proposal to introduce a "cementation index" to express the "hydraulicity" of a cementing material. This is essentially a compounded ratio of acid to base in both the cement under examination and in an ideal cement.

In part VII, under the title of "puzzolan" cements, are described the nature and uses of pozzuolana sand and artificial preparations such as ground slag of suitable composition, which when mixed with slaked lime give a material having the properties of ordinary cements.

This book should be of great service to those engaged in working raw materials for cement, or in the manufacture or use of the latter material, and its value is greatly enhanced by the copious references to original literature supplied at the end of each chapter.

MINING LAW OF THE BRITISH EMPIRE. By Charles J. Alford, F.G.S., M. Inst. M.M. Pp. xii + 300. (London: Charles Griffin & Co., Ltd., 1906.)

The author has collected a considerable amount of valuable information on the mining law in force in different portions of the Empire, and in many cases the laws or regulations are printed *verbatim*.

The subject naturally falls into two divisions: (1) the law relating to concessions and (2) that regulating the work in the mines, in the interests of the safety and well-being of the employees. In the United Kingdom the greater part of the minerals are vested in private persons, and the author accordingly gives *in extenso* a typical preliminary mining agreement or "take-note" (really "tack-note," viz. note of a tack or lease) and a mining lease such as are granted by private owners in the West of England. He also gives abstracts of the British Metalliferous Mining and Coal Mines Regulation Acts, which belong entirely to the second category. He discusses the question of their extension to the Colonies or foreign countries, without apparently being aware that similar regulations are already in force in India and many of the Colonies.

In the case of India he gives in detail the Law on Mining Concessions in force in Mysore, but not that of British India, though the present Mysore law, like that which preceded it, differs in important respects from that of British India; and valuable as are the gold mines of Mysore, it is probable that the mining development in British India will be in the future far more important. The unqualified statement that in the Madras Presidency the property in minerals is vested in the owners of the surface is inaccurate. It is true that this is the case in many localities where mining has been carried on, but these are exceptions to the general law.

The author is curiously misinformed with regard to Ceylon. He states that "gemming" is the principal industry, but adds that "some deposits of coal, iron and graphite are worked in the interior." As a matter of fact coal does not occur. The mining of graphite on the other hand is not only by far the most important mineral industry of the island, but the output of the mineral is second in amount only to that of Bohemia, and the first in the world in value.

Nothing is said as to the mining regulations of Northern and Southern Nigeria, and British East and Central Africa, though in some at least of these countries mining operations have commenced and are likely to assume considerable proportions.

These and other omissions and inaccuracies will no doubt be set right in a new edition, and meantime this volume should find a place in the libraries of those interested in the mineral development of our Colonies and Dependencies.

THE MINING MANUAL FOR 1906. By Walter R. Skinner. Pp. lxiv + 1506. (London: 11–12, Clements Lane, Lombard Street, E.C. 1906.)

This is an annual publication which has now reached its twentieth number. It is invaluable as a work of reference for those interested in mining. Its title is, however, somewhat misleading. It is not a "Manual of Mining" but a directory of mining companies, their directors, mining and consulting engineers and managers. A brief history is given of each mine from the financial standpoint. In so comprehensive a work some slips are inevitable—for instance in the table of the annual yields of Indian mines on p. 1167 the Champion Reef Mine is given as commencing to yield in 1899, whereas a reference to p. 800 is sufficient to show that it was producing well long before that date.

REPORT OF THE BUREAU OF MINES (ONTARIO), 1905. Part ii. Second edition. *The Cobalt-Nickel Arsenides and Silver Deposits of Temiskaming.* By Willet G. Miller, Provincial Geologist, Toronto. 1906. Pp. 97 with maps and illustrations. (Toronto: Government Printer. 1905.)

The author describes in detail the geology of this new mining region, and the character and contents of the veins which intersect lower Huronian strata.

He gives a short description, for the purpose of comparison, of other cobalt-nickel deposits in different parts of the world, including the silver mines of Lake Superior, the cobaltiferous ores of the Joachimsthal and Annaberg mines in Bohemia and Saxony and of the Chalanches in France, which present great resemblance to the Temiskaming deposits, and the well-known ores of New Caledonia.

An appendix contains a translation of Bruchmueller's *Early History of the Cobalt Mining Industry in Saxony.*

REPORT OF THE BUREAU OF MINES (ONTARIO) 1905. Vol. xiv. Part iii. *The Sudbury Nickel Field.* By A. P. Coleman. Pp. iv + 188 with large map and numerous illustrations. (Toronto: Government Printer. 1905.)

This is a detailed and readable account of the Sudbury deposits. The geological relations of the ores and associated rocks are fully described. The author supports the usual view that they were originally segregation products of an enormous intrusive sheet, the upper surface of which is acidic and the lower basic. It now forms a synclinal basin, and the nickel ores occur on the lower margin of basic rock—a hypersthene gabbro or norite—or are associated with apophyses from the norite into the surrounding rock.

The petrology and mineralogy of the district are carefully described, and considerable space is given to an account of different mines, the workings being illustrated by plans and sections.

Among other subjects dealt with are the commercial development of the field, the occurrence of nickel in other parts of the world, the statistics of nickel production, the uses of nickel with especial reference to the nickel steel industry and the expenses of mining and smelting nickel ores.

REPORT ON THE MINERAL STATISTICS OF NEWFOUNDLAND FOR THE CALENDAR YEAR 1905; also REPORT ON THE CONTINUATION OF THE COAL-BORING OPERATIONS IN THE CENTRAL CARBONIFEROUS AREA NEAR GOOSE BROOK, HUMBER VALLEY. By James P. Howley, F.G.S., Geological Survey of Newfoundland. Pp. 30. (St. John's, N.F.: "The Evening Telegram," Printers, 1906.)

The mineral production of Newfoundland in 1905 is shown in the following table:—

	Amount. *Tons.*	Value. *Dollars.*
Copper Ore	78,720	358,880
Iron Ore	689,970	689,970
Pyrites	50,720	229,530
Slate	12,072 squares	45,000
Talc	6,000	24,000
Miscellaneous (chiefly building and road-making materials)		20,913
		1,368,293

The production of copper ore fell off by 29,119 tons and the value by $107,859 as compared with the previous year. The Union Mine at Tilt Cove is beginning to give signs of exhaustion after 42 years of mining, but other copper mines show promise of taking its place. The output of iron ore was increased by 100,231 tons and the same number of dollars in value. The amount of ore is considerable, but at the present rate of production the deposits on the dry land must soon become greatly reduced. It is proposed to exploit the submarine deposits on the north of the island. There are numerous deposits of lower grade ore in Newfoundland and Labrador, which must one day be worked. The output of pyrites was less by 91,480 tons, but there was an increase in value of $18,830. The principal mines show signs of giving out, but it is believed that the abundant pyrrhotite deposits can be worked at a profit, though they are not so rich in sulphur. The output of slate increased by 1,250 tons and the value by 7,200 dollars. It is hoped to export it to Europe. The talc industry is a new one and operations have for the present been suspended.

There are other minerals which may one day prove to be of commercial importance, including barytes, gold, platinum and coal. The boring operations for coal have not, however, up to the present led to the discovery of payable seams.

NEW SOUTH WALES: DEPARTMENT OF MINES AND AGRICULTURE. *Geological Survey* (*Mineral Resources*). No. 11. *Molybdenum.* By E. C. Andrews, B.A. Pp. 17, with plate and diagram. (Sydney: Government Printer, 1906.)

The author gives a brief account of the character and modes of occurrence of molybdenite. He describes the principal deposits of New England, New South Wales, and their probable mode of origin in simple language, which could be understood by a miner without knowledge of geology. The mineral usually occurs in quartz "pipes" traversing granite masses near their contact with older rocks. The "pipes" are mainly formed by replacement of the granite.

In the case of the important deposit worked in Sach's molybdenite mine, Kingsgate, twenty-two miles east of Glen Innes, the pneumatolytic action is stated to have altered the mica and felspar first to sericite and then to quartz.

ORANGE RIVER COLONY: MINES DEPARTMENT. *Annual Reports for the years ending* 30*th June*, 1904, *and* 30*th June*, 1905, *respectively, with map illustrating the mineral development of the Colony.* (Bloemfontein: Argus Printing and Publishing Co., Ltd.)

The output of coal, diamonds and salt, the only mineral products mined on a commercial scale in the colony, are shown in the following table:—

Coal.			Diamonds.		Salt.		Total.
Year.	Tons.	Value. £	Carats.	Value. £	lb.	Value. £	Value. £
1903–4.	108,989	53,865	219,900	779,972	No statistics.		833,657
1904–5.	118,636	55,293	320,548	938,617	12,386,035	8,928	1,002,839

Coal.—The greater part of the colony is covered by the Karoo beds, which have yielded excellent coal in Natal and the Transvaal. Coal outcrops in many localities and is probably still more widely extended below the surface. At present mining operations are confined to the neighbourhood of Vereeniging, Vierfontein and Kronstadt.

Diamonds.—Good results continue to be obtained at Jagersfontein, where underground mining is being substituted for open workings. Operations are also carried on at Koffyfontein and other localities in different parts of the colony. Much prospecting was carried out and numerous "indications" were found. Some of these were attributed to "denuded overflows" from a pipe, or to "fissures," containing typical "yellow" and "blue" ground and also supposed to be connected with the diamond pipes.

Gold occurs in the "banket reefs" round the intrusive granite mass which has its centre near Parys, and a gold field has recently been proclaimed at Vredefort. The reefs are highly inclined, dipping at about 65 %.

Copper has been found in the Heilbron and Bethulie districts.

Petroleum.—There are numerous indications of the occurrence of mineral oil in the north-east part of the colony. It is stated chiefly to occur in "oil veins" traversing intrusive sheets of dolomite.

Iron.—Valuable deposits of iron ore are met with in the north. It is stated that at Rietvallei, south-east of Vredefort, there are several reefs of "clean ironstone" varying in width from 8 to 20 feet and dipping at an angle of 50–55°.

Gypsum of considerable purity occurs in the north of the colony.

Salt is obtained from Brine Springs at Zoutpan, in the Jacobsdal district and Haagenstad in the Bloemfontein district.

THE PHYSIOGRAPHY OF THE RIVER NILE AND ITS BASIN. By Captain H. G. Lyons, Director-General of the Survey Department, Cairo. 1906. Pp. 411, with numerous illustrations and maps.

The author discusses the difficult problems that present themselves in connection with the great river. He describes in turn different portions of its basin, their geology, orography and climate, with especial reference to the rainfall and evaporation, the latter being an element of the greatest importance. He shows that only a small fraction of the rainfall of the plateau of the great lakes and the region of the Bahr-el-Ghazal reaches the lower Nile, the remainder being lost by evaporation in lakes and swamps, so that all trace of seasonal variations in the discharge disappears, till the confluence of the Sobat is reached, which brings the flood water from the summer rains on the southern uplands of Abyssinia. Its high-water period lasts from May or June to January, while that of the Blue Nile, flowing from northern Abyssinia, only continues from June or July to October. During these months it dams up the lower course of the White Nile, which assumes the character of a temporary reservoir, the contents of which become available when the Blue Nile falls.

The important subject of the variation in the Abyssinian rainfall and the Nile flood from year to year, and their relation to the rainfall of India, is discussed at some length, and the book concludes with a full bibliography and index. Special mention must be made of the maps, sections and diagrams, which add considerably to the value of the work.

ÉNUMÉRATION DES PLANTES RÉCOLTÉES PAR ÉMILE LAURENT PENDANT SA DERNIÈRE MISSION AU CONGO. By É. de Wildeman. Fasicule iii. Pp. 193–354. Plates xlvii–cvi. (Brussels, 1906.)

The nature and scope of this work have already been described in the course of the review of the first two instalments (*Bulletin of the Imperial Institute*, 1906, **4**. 73). The present volume maintains the high standard set in its predecessors, and its wealth of plates affords a good opportunity to any one to become acquainted with the botanical characteristics, and in many instances the habit, of a large series of plants from this interesting region.

Amongst economic plants treated of in this part, the coffees are the most important, and no less than twenty-eight plates are devoted to members of this group, in addition to numerous illustrations in the text pourtraying the cultivation and curing of coffee and some of the pests which attack it. The species figured comprise *Coffea affinis*, De Wild.; *C. arabica*, L.; *C. aruwimiensis*, De Wild., *nov. sp.*; *C. Arnoldiana*, De Wild.; *C. Royauxii*, De Wild., *nov. sp.*; *C. canephora*, Pierre and Froehner, four varieties and forms; *C. congensis*, Froehner, three varieties; *C. liberica*, Bull; *C. stenophylla*, Don.; *C. Dewevrei*, De Wild.; *C. Dybowski*, Pierre; *C. Klainii*, Pierre. There is an interesting discussion on the great variability of the coffees, and the difficulties encountered in attempting to define exactly the various species, as for instance in the case of *Coffea stenophylla*, the "wild bush" or "native coffee" of Sierra Leone, which does not occur wild in the Congo, but is cultivated at Eala.

VITICULTURE IN NEW ZEALAND. By Romeo Bragato. Pp. 60, with 35 illustrations. (New Zealand Department of Agriculture, Viticultural Division. Wellington, 1906.)

The author, who is the Superintendent of Viticultural Stations and Viticulturist to the Government of New Zealand, brings together in this book useful information, with special reference to the open-air cultivation of American vines in the colony. The advisability of planting American vines is insisted upon because of their comparatively high resistance to phylloxera, and as an illustration of the extent to which American vines are appreciated in other parts of the world, it is pointed out that in France alone some 3,000,000 acres have been planted with these vines.

The scheme of the publication is that of a general practical manual; climate, soils, the characteristics and mode of cultivation of American vines, grafting, pruning, training, manuring, and drainage are the chief subjects discussed, and the illustrations, mostly apparently reproduced from actual photographs, greatly enhance the value of the book to the planter. In the author's opinion the North Island of New Zealand has a climate "well suited to the production of high-class light wines."

THE TIMBER TRADES DIRECTORY. Fifth edition. Pp. xx + 349. (London: William Rider & Son, Ltd., 1906.)

This directory, which is published every four years, contains lists of firms in the United Kingdom engaged in the foreign, colonial, and home timber, mahogany and hardwood trades, as well as of the exporters of timber in the various timber-producing countries, and the continental and colonial importers of this commodity.

A special feature of the new edition is the inclusion of fifteen plans of the principal docks and harbours of the chief timber-importing centres of the United Kingdom.

The work is divided into five sections dealing with (1) London and suburbs, (2) England and Wales (Provincial), (3) Scotland, (4) Ireland, and (5) Foreign Countries. It will doubtless be invaluable to all branches of the timber trade and wood-working industry, and will also prove useful to the export timber trade supplying the markets of the United Kingdom.

WATTLES AND WATTLE BARKS: *Hints on the Conservation and Cultivation of Wattles, together with particulars of their values (with a botanical appendix concerning New South Wales species).* By J. H. Maiden, F.L.S. (Sydney: Government Printer, 1906.)

Reference has already been made in this *Bulletin* (1906, **4**. 66) to the experimental cultivation of wattles for the production of the valuable tanning material, wattle bark, recently undertaken in British and German East Africa. In this connection special interest attaches to the issue of a third edition of Mr. Maiden's well-known pamphlet on the wattles, which has now been out of print for some years. The pamphlet deals in an exhaustive fashion with the nature of the soil suited to wattle cultivation, the best methods of sowing the seed, the care of the trees, the stripping of the bark, its preparation for the market, and the cost of production.

In the second part of the pamphlet descriptions of the best indigenous wattles of New South Wales are given.

This publication may be recommended to all interested in the cultivation of wattle bark or in the use of this material as a tanning agent.

NEW JOURNALS.

ANNALES DE L'INSTITUT COLONIAL DE MARSEILLE. Published under the direction of Dr. Edward Heckel. Volume iii. Second series. 1905.

This publication is issued annually and contains the results of investigations conducted under the auspices of the Institute on the natural products of the French Colonies. The present number contains seven articles, several of which are of special interest.

An account of the condition of Madagascar, written in the year 1756 by a M. Bernard, then a surgeon in the service of the French "Compagnie des Indes," is now printed for the first time, from a manuscript discovered recently by M. Rey, consulting physician to the Foreign Hospital at Marseilles. M. Lefenose contributes a detailed chemical study of the "wood oils" obtained in French Indo-China from a number of species of *Dipterocarpus*.

Dr. Heckel gives a long and detailed morphological study of the "sand box" (*Hura crepitans*) largely cultivated in the Tropics as an ornamental tree. The fruit, after being boiled in oil and pierced with small holes, is frequently employed as a "sand-box" in the French Colonies, where, it may be explained, that as in France itself, fine sand is still largely employed for drying, or, rather, absorbing ink as a substitute for blotting paper. The seeds are used in Mexico as a purgative, and the latex is employed as a fish poison.

Professor Courchet gives the results of a morphological and anatomical study of *Eperua falcata*, a tree which grows in French Guiana, and is the source of the oily wood known as "Walaba," specimens of which were shown at the Paris Exhibition in 1878, and from which the "Balsamam antarthriticum indicum" used in medicine in the eighteenth century was derived. This "balsam" has been examined by Professor Tschirch, who shows that it consists essentially of a mixture of proteids. The gum obtained from the bark of the tree is the subject of a brief note by Professor Ribaut, who states that it is not, as previously supposed, of the nature of a kino. Both the so-called "balsam" and the gum contain traces of butyric acid. A similar botanical study of the "kernels" of *Perriera madagascariensis* is supplied by M. Courchet.

The pericarp of the fruit of *Raphia pedunculata*, which is employed by the natives in Madagascar as the source of a yellow dye, is dealt with botanically by M. Decrock, and chemically by M. Schlagdenhauffen, but the actual colouring matter to which the tinctorial properties of the pericarp are due does not seem to have been isolated. The last paper gives the results of an elaborate investigation of the larva of "io irene," a silk-worm indigenous to French Guiana.

The Bulletin is well printed, and is provided with a number of good illustrations.

THE PHILIPPINE JOURNAL OF SCIENCE, 1906. Nos. 1–7 with four supplements. (Manila: Bureau of Science of the Government of the Philippine Islands, 1906).

The Bureau of the Government Laboratories of the Philippine Islands is now amalgamated with the Bureau of Mines, and, under the title of the Bureau of Science, carries on the work previously executed by the two departments.

Accounts of the work, formerly made public in occasional Bulletins, are now published in the *Philippine Journal of Science*, which is to be issued in about ten numbers a year, of which seven numbers and four supplements have appeared during the period January to September of the present year. The numbers of the journal already issued contain several communications relating to the bacteriology, pathology, and treatment of various tropical diseases, the botany, geology, and natural history, etc., with some articles on the various economic products of the Islands. Of special interest to the cultivator of economic products is the series of papers on the coconut palm. The first of these, "On the water relations of the coconut palm," contains an account of results obtained during eight months' work on the physiology of the tree and the various conditions affecting it.

A second article on "The coconut and its relation to the production of coconut oil" discusses many points of interest, such as the influence of soil and locality on the quantity and quality of the coprah produced, the ripeness of the nut, and its influence on the yield of coprah and oil.

A third article on "The keeping qualities of coconut oil and the causes of its rancidity," suggests that the rancidity usually characteristic of this oil is mainly due to the use of partially decomposed nuts for its preparation, an important secondary factor being the action of the air on the oil.

In the last article of the series, "The principal insects attacking the coconut palm," the various pests of this type and the effects produced by them, as well as remedial and preventive measures, are described. These articles are all well illustrated by reproductions of photographs and by diagrams.

A paper on "The vegetation of the Lamao Forest reserve" illustrates and describes the nature of the vegetation of that district. Reference may also be made to the paper entitled "Philippine fibres and fibrous substances," in which the suitability of these products for paper-making, and brief descriptions of the methods of testing their suitability for this purpose are given, special importance being attached to the waste materials obtained from "Abaca" (Manila hemp), "Maguey" (*Agave cantula*), and to the "Cogon" grass (*Imperata exaltata*), and "Taláhib" grass (*Saccharum spontaneum*), which occur in the Philippine Islands. Specimens of paper made from "Abaca" waste and "Cogon" grass are issued with the number of the journal containing this article.

COLONIAL PUBLICATIONS.

Copies of the following publications descriptive of the resources of British Colonies and Dependencies have recently been received. They are available for distribution at the Central Stand in the Exhibition Galleries, free of charge, so long as numbers permit, excepting any to which a price is affixed.

Canada.

NEW BRUNSWICK, CANADA. Pp. 1–8. A brief, illustrated account of New Brunswick. The climate, matters of practical interest to English farmers thinking of settling there, and the timber and wood-pulp industries are the principal topics discussed.

VANCOUVER, BRITISH COLUMBIA. Issued by the Tourists' Association, Vancouver. By means of illustrations and descriptive notes an effort is made to interest tourists and commercial men in Vancouver—"the Liverpool of the Pacific."

VANCOUVER BOARD OF TRADE. Eighteenth Annual Report. 1904–5. Pp. 1–128. The report contains summarised information relating principally to the trade of Vancouver. Owing to the construction of the Grand Trunk Pacific Railway now being decided upon, and the numerous inquiries received regarding the Great Northern interior of British Columbia, information of service to would-be settlers has been brought together in the form of descriptive accounts of the various districts. The mining industry is reviewed as a whole and also in detail for each principal product. The legislation affecting the manufacture of paper pulp is reprinted from an official bulletin.

Sudan.

SALE BY TENDER OF LEASEHOLD BUILDING SITES AT PORT SUDAN. Particulars and Conditions of Tender and Sale. Issued by the Sudan Government. 1906. The pamphlet contains a plan of the proposed general arrangement of Port Sudan, including the sites of the various Government buildings, quays, customs enclosures, bonded warehouses, bridge, railway, etc. The approximate dimensions, annual rent, and other particulars are given for the sites shown on the plan. There are also copies of forms of tender, certificate of deposit, and a specimen form of lease.

Uganda.

UGANDA RAILWAY. GOODS TARIFF. Pp. 1–108. Official. A collection of the rules and rates relating to conveyance of goods, live stock, carriages, etc., on the Uganda Railway.

British East Africa.

THE IMPERIAL INSTITUTE. THE BRITISH EAST AFRICAN COURT. Price 2*d.* A brief account of the physical features, climate, and resources of British East Africa prefaces a detailed descriptive catalogue of the products of the Protectorate on exhibition in the British East African Court at the Imperial Institute. Most of the chief products of the country are represented in the collection, and the pamphlet provides a summary of the resources of this interesting region.

South Australia.

THE NILE OF AUSTRALIA. By David J. Gordon. Pp. 1–74. Adelaide, 1906. The author is one of the Vice-presidents of the River Murray League of South Australia, by whom the publication is issued. The policy of the League is "a complete system of locks and storage basins such as will provide permanent navigation of the Murray, Darling, and Murrumbidgee Rivers, and ensure an ample supply of water to meet all requirements of irrigation."

There is a detailed description of the history of the Murray River, and its actual and potential uses for transport, irrigation, and pleasure-seeking. The navigable length of the three rivers is given as 3,212 miles. The pamphlet is illustrated.

New South Wales.

TROUT FISHING IN NEW SOUTH WALES. Published by the Railway Commissioners. Pp. 1–53. The chief centres for the sport are fully described, and there are notes on equipment, cost, and similar practical matters. November to April are the best months. The pamphlet is accompanied by numerous illustrations and maps.

NEW SOUTH WALES FOR THE IMMIGRANT. Bulletin No. 9. of the Intelligence Department. Pp. 1–28. 1906. The attractions of the country are well set out, and practical information afforded as to assisted passages, fares, route, regulations for immigrants, and other matters.

Queensland.

QUEENSLAND. THE LAND ACTS AND AGRICULTURAL LANDS PURCHASE ACTS—Amendment Act of 1905. Pp. 1–31. This contains the regulations regarding land selections.

QUEENSLAND. THE WINTER PARADISE OF AUSTRALIA. Pp. 1–34. A popular handbook of general information regarding the scenery, natural resources, and conditions of life in the State. The account of Brisbane is accompanied by a street plan. The book is well illustrated.

QUEENSLAND. THE WONDERS OF THE NOR' EAST. By Randolph Bedford. Issued by Authority, Government Printer, Brisbane. Pp. 1–16. A well-illustrated pamphlet devoted principally to a popular account of the scenery of the Great Barrier Reef. There are brief notes on Bêche-de-mer, turtle, dugong, and other inhabitants of the neighbouring waters.

New Zealand.

STATISTICAL VIEW OF FIFTY YEARS' PROGRESS IN NEW ZEALAND (1856–1905.) Compiled by the Registrar-General. Pp. 1–10. 1906. Statistics are given relating to population, land and stock, trade, transport, and banking.

NEW ZEALAND INTERNATIONAL EXHIBITION. Pp. 1–14. An illustrated handbook summarising briefly the principal features of the exhibition to be held between November 1, 1906, and April 1907, with some notes on New Zealand scenery.

SOME FACTS ABOUT NEW ZEALAND MEAT. Issued by the High Commissioner for New Zealand. Pp. 1–8. An illustrated pamphlet setting forth the precautions taken to ensure the good quality of New Zealand meat, which is exported with a Government guarantee.

NEW ZEALAND MEAT. By the Hon. W. Pember Reeves, High Commissioner for New Zealand. Pp. 1–12. An article reprinted from the *Daily Chronicle* (London) of July 16, 1906, dealing with the same topics as the preceding publication.

INDIAN AND COLONIAL COLLECTIONS.

THE BRITISH CENTRAL AFRICAN COURT.

THE British Central Africa Protectorate consists of a narrow strip of territory, about five hundred and twenty miles long and from fifty to one hundred miles wide, lying approximately between latitude S. 9° 45′ and S. 17° 15′ and longitude E. 33° and E. 36°.

On the south and east the Protectorate is bounded by Portuguese East Africa, on the north by German East Africa, and on the west by the territory of the British South Africa Company, known as North-Eastern Rhodesia. The country, which has an area of about 41,000 square miles, falls naturally into two divisions—the first consisting of the western shore of Lake Nyasa with the high tablelands separating it from the basin of the Loangwa River, and the second, comprising that portion of the Protectorate to the south of Lake Nyasa and bounded by the Kirk Mountains on the west, and by the Ruo River, the Luasi Hills, and Lake Chiuta on the east.

Much of the country is mountainous, consisting generally of lofty plateaux rising more or less abruptly from the lower ground. One of the principal ranges is the famous Mlanje Mountain, consisting of a great tableland of an area of about two hundred square miles, from which arise several granite peaks, the highest of which is over 9,800 feet. The Shiré Highlands are in the lower half of the Protectorate, and from north to south extend for over ninety miles, with an average width of about twenty-five miles; the highest point is the plateau of Mount Zomba, which rises to an altitude of 7,000 feet. Other important ranges are the Kirk Range, Nkonde Mountains, and the Angoniland Plateau.

The only important river in the Protectorate is the Shiré, which, issuing from the southern end of Lake Nyasa, takes a southerly course for eighty-five miles, when it skirts the Shiré Highlands for about fifty miles in a series of falls and rapids. Nearly one hundred and thirty miles lower down the river joins the Zambesi, at a point one hundred miles from the sea. At the mouth of the Zambesi is the port of

Chinde, leased by the Administration from the Portuguese Government for trade and mail purposes. The Upper Shiré is navigable for seventy miles below the Lake, but much depends upon the rainfall for the year; the Lower Shiré is used by the river steamers up to a point within twenty-eight miles by road from Blantyre.

The largest settlement in British Central Africa is Blantyre, which is the business centre of the Shiré Highlands; Zomba, Port Herald, Chiromo, Matope, and Liwonde are other important settlements. The principal ports on Lake Nyasa are Fort Johnston (the head-quarters of the Marine Transport Department), Kota Kota (the trade port for North-Eastern Rhodesia), and Karonga, Bandawe, and Nkata.

The climate of the elevated districts, especially the Shiré Highlands, is much more pleasant than that of the hot river valleys and the shore of Lake Nyasa. In the Highlands the maximum temperature is 97°, with an average rainfall of from fifty to one hundred inches; but in the Lake district the shade temperature often rises to as much as 120°, with a rainfall not exceeding thirty-five inches. The Protectorate cannot be said to be a healthy country for Europeans on account of the prevalence of various forms of malaria.

VEGETABLE PRODUCTS.

Coffee (*Coffea arabica*).—Coffee planting is one of the most important industries of the Protectorate, but, owing to the varying climatic conditions, the output shows considerable fluctuation from year to year.

Nearly all the estates are situated at altitudes varying from 1,900 feet to 3,000 feet, and the best land is a red clay found in the Shiré Highlands and several other districts. The crop can rarely be cultivated with success in British Central Africa without resorting to irrigation. Arabian coffee (*Coffea arabica*) has proved to be the variety most suited to local conditions, but from time to time experiments have been made with other varieties, viz., Liberian coffee (*Coffea liberica*), *C. stenophylla*, and Abeokuta coffee; the results, however, have not been satisfactory. An experimental plantation of seven acres is conducted by the Forestry and Botanical Department at Zomba.

Samples exhibited:—

1. Coffee dried in the "cherry."
2. Coffee in the "parchment"; hand-pulped and sun-dried.
3. Coffee in the "parchment."
4. Cleaned coffee (Longberry). First quality.
5. Cleaned coffee (Longberry). Second quality.
6. Cleaned coffee (Peaberry).
7. Cleaned coffee.

All the samples were received from the Scientific Department, Zomba, 1902.

Tea (*Camellia Thea*).—Tea planting on a small scale has been carried on for some years past in British Central Africa, but very little progress has been made. There are about four hundred acres under tea on the south-western slopes of Mlanje Mountain, the only district in the Protectorate suitable for the crop. There is a small export, but a considerable part of the crop is consumed locally.

Samples of the tea examined in the Scientific and Technical Department of the Imperial Institute were found to be of good quality, but the percentages of ash and soluble extract were somewhat lower than those yielded by the best Indian and Chinese teas. (*Bulletin of the Imperial Institute*, 1904, **2**. 80.)

Samples exhibited:—

1. "Orange Pekoe." Grown at Mlanje, and manufactured without machinery.
2. "Broken Mixed." Grown at Mlanje, and manufactured without machinery.
3. "Dust Fannings." Grown at Mlanje, and manufactured without machinery.

These samples of tea were received from H. Brown, Esq., Mlanje, through the Scientific Department, Zomba.

Rice (*Oryza sativa*).—An excellent quality of white rice has been raised for many years past in the neighbourhood of Kota Kota on the western shore of Lake Nyasa by the descendants of Arab traders.

In order to provide the local Indian troops with rice, which hitherto had been imported at considerable expense from India, the Administration in 1895 commenced a policy of encouraging rice cultivation, and imported seed for free distribution to the natives. The cultivation extended rapidly on the shores of the Lake, and, in 1902, the Government imported from India further supplies of seed rice suitable for hill cultivation as well as for the ordinary method by irrigation. The natives are encouraged to pay the hut tax in rice.

There are large tracts of land on the shores of the Lake suitable for rice cultivation, the most important districts being in Central Angoniland, West and North Nyasa, and Marimba. Upwards of five hundred tons are used annually by the Government for the troops and men employed on public works, and large quantities are also taken by private employers of labour. The amount brought in by natives and merchants in 1904–05 amounted to upwards of one thousand tons, and, with the provision of improved transport facilities, an export trade in rice might reasonably be expected to arise.

Wheat (*Triticum vulgare*) has been cultivated in several parts of the Protectorate, and a considerable quantity is annually grown for conversion into flour for local consumption. The milling is chiefly done by the Missions in the country, who have imported milling machinery.

In many districts the crop is subject to "rust," a disease due to the attacks of a fungoid parasite (*Puccinia graminis*). A native bearded wheat from Ujiji is much less susceptible to the disease than varieties imported from Europe, South Africa, and Australia.

Maize (*Zea Mays*) is largely grown as a native food-stuff.

Ground Nuts (*Arachis hypogea*).—The seeds of these nuts yield a valuable oil for soap-making and for culinary purposes. The nuts are largely grown by the natives, and are brought in by Indian traders, who ship them to Marseilles and Hamburg *viâ* Chinde. The industry is now being taken up by the European planters.

Gum.—The material is collected by the natives from trees the botanical identity of which has not yet been ascertained.

An analysis in the Scientific and Technical Department of the Imperial Institute showed that the gum was partly soluble in water, and resembled the gums of the Indian tree *Cochlospermum Gossypium* and the Australian plant *Sterculia acerifolia.* At present such gums are of little commercial value. (*Bulletin of the Imperial Institute*, 1904, **2**. 86.)

Ginger.—Ginger is prepared from the rhizomes or underground stems of *Zingiber officinale.* Small quantities are grown on several estates in British Central Africa. A valuation by brokers of a sample forwarded to the Imperial Institute was 32*s.* or 33*s.* per cwt., provided that the spice was thoroughly dried before shipment.

Chillies (*Capsicum minimum, C. frutescens*).—Chillies are an important secondary crop, and formerly were grown by nearly every planter in the country. Several varieties are cultivated, but the most important is that known as the "Nyasaland chillie," which is very similar to the Zanzibar chillie. The crop is often raised between the lines on a coffee plantation without detriment to the latter product.

There has recently been a falling off in the production, since many planters have turned their attention to the cultivation of tobacco and cotton, for which better prices are obtained. Further, the raising of cereals and other food-stuffs for sale to the railway and other employers of labour has diverted a good deal of attention from this crop.

Sample exhibited:—

Chillies. Grown at Cholo, Blantyre district. Received from Messrs. Cox Bros.

Tobacco (*Nicotiana Tabacum*).—The natives of British Central Africa have long been known to cultivate tobacco successfully, but it is only within recent years that any attempt has been made by the European settlers to grow the crop. At the present time the industry appears to be well established, and to be making satisfactory progress; the export for 1905–06 was valued at no less than £3,307.

The climate of many parts of the country is eminently suited to tobacco, and an article said to be equal to good-class Virginian tobacco is now being placed on the market. Great attention is being paid to the more careful "curing" of the leaf in flue-curing barns similar to those used in America. The principal market for the tobacco is the Transvaal, where the product is admitted duty free; smaller quantities are exported to other parts of British South Africa, notably Rhodesia.

Samples of tobacco grown in the Protectorate have been received at the Imperial Institute for examination and report. Chemical analysis showed that the leaf was very similar in composition to American tobaccos, and the reports of technical experts to whom the samples were submitted indicated that, with improved methods of preparation, tobacco suited for the English market could be produced in British Central Africa. (*Bulletin of the Imperial Institute*, 1904, **2**. 80.)

Samples exhibited:—

1. Tobacco (Songani Brand). Long cut, guaranteed pure. Grown and manufactured by the African Lakes Corporation, Ltd.
2. Cigarette tobacco. Grown and manufactured by the Blantyre and East Africa Company, Ltd.
3. Pipe tobacco. Grown and manufactured by the Blantyre and East Africa Company, Ltd.

Strophanthus Seed.—Strophanthus seeds are now largely employed in medicine as a source of the glucoside strophanthin, which is a powerful heart stimulant. An extract of the seed has long been used by the natives of British Central Africa for poisoning arrows.

The seeds used in medicine are derived from *Strophanthus Kombé*, a large climbing plant belonging to the Periwinkle family (*Apocynaceæ*), and seeds of other species also come into commerce. When complete the seeds of the several species are terminated by a slender awn and a feathery tuft of hairs about two inches long. A considerable quantity of the seeds is annually exported from British Central Africa.

Samples exhibited:—

1. Strophanthus seeds.
2. Genuine seeds of *Strophanthus Kombé*. Collected by the African Lakes Corporation, Ltd., and presented by Messrs. Oppenheimer & Co., Ltd., 1905.

Rubber.—A small quantity of rubber, obtained principally from *Landolphia Kirkii*, is exported from British Central Africa, but the quantity is less than in former years. Practically all the rubber exported is collected, chiefly by natives, in the Bangweolu, Tanganyika, and Luapula districts to the north-west of the Protectorate, and also from the Congo Free State; very little is now obtained from the Protectorate itself, since the rubber-producing areas were small and quickly exhausted. The rubber is well known on the European market, its price varying from 2*s.* 6*d.* to 3*s.* 3*d.* per lb. An analysis of a typical specimen is given in the *Bulletin of the Imperial Institute*, 1904, **2.** 83.

Increased attention is being paid to the cultivation of several varieties of rubber plants, and at the present time there are upwards of nine hundred acres of planted rubber. The climatic conditions are reported to be unsuited to the Para rubber-tree (*Hevea brasiliensis*), but extensive experiments with Ceara rubber (*Manihot Glaziovii*) and with the indigenous Landolphia vine are being carried out. A small shipment of rubber from cultivated plants has already been made.

Samples exhibited:—

1. Landolphia rubber. Balls as prepared by the natives and brought in for sale. Received from the African Lakes Corporation, Ltd.
2. Portion of stem of rubber vine (*Landolphia Kirkii*). From Kafue district, North-Eastern Rhodesia.

Cotton.—Cotton planting by Europeans in British Central Africa was first seriously started in 1901–02, and the export for the following year was valued at £3. During the past financial year (1905–06) cotton headed the list of exports from the Protectorate, the crop being valued at over £16,000; the average price for the American varieties was 7*d.* per lb., and as much as 9*d.* has been obtained for some of the Egyptian types.

The soil and climatic conditions of a large area of British Central Africa are suitable for cotton cultivation, and it is estimated that nearly 100,000 acres might be cropped annually, or about ten times the area now devoted to cotton. Labour is reported to be both abundant and willing, but, up to the present, somewhat inefficient chiefly owing to lack of experience. The cotton-growing country may be divided into two regions, viz. the river levels and the Highlands. In the former, where rich alluvial soils are found, the cottons which have proved to be the most successful are the Egyptian varieties, Abassi thriving well and giving the highest yield. Kidney cotton (*Gossypium peruvianum*) is also grown, and Sea Island cotton (*G. barbadense*) is being experimented with.

In the Highlands, where there are often large patches of cotton soils, Upland (*G. hirsutum*) and other American varieties are the most suitable. The cotton is ginned by both hand and power gins and baled by hydraulic and other presses. The African Lakes Corporation, Ltd., possess an oil-extracting mill for dealing with the cleaned seeds.

Much attention has been given by the authorities to the establishment of a native cotton-growing industry, and many tons of seed, chiefly Egyptian, have been distributed, free of charge, to the native cultivators. In some parts of the country, especially in the Upper

Shiré district, good results have been obtained, but, on the whole, cotton growing does not appeal to the natives whose simple and few wants can be readily supplied by growing other crops, the cultivation of which involves the expenditure of comparatively little labour.

A large number of samples of cotton grown in the Protectorate have been examined in the Scientific and Technical Department of the Imperial Institute, and about twenty of the specimens are now on exhibition in the British Central African Court. (See also *Bulletin of the Imperial Institute*, 1904, **2**. 87.)

Samples exhibited :—

1. Abassi cotton. Grown in West Shiré district; length of staple, 1·1 in.–1·6 in.
2. Abassi cotton. Grown in Midima district between Mlanje and Blantyre; length of staple, 1·2 in.–1·7 in.
3. Yannovitch cotton. Grown at Matope, Upper Shiré River; length of staple, 1·1 in.–1·5 in.
4. Yannovitch cotton. Grown on Lukulesi Estate, Mlanje; length of staple, 0·8 in.–1·3 in.
5. Yannovitch cotton. Grown in West Shiré district; length of staple, 1·0 in.–1.7 in.
6. Yannovitch cotton. Grown at Matope, Upper Shiré River; length of staple, 1·1 in.–1·4 in.
7. Mitafifi cotton. Grown in Blantyre district; length of staple, 1·0 in.–1·4 in.
8. Egyptian cotton. Grown on Lukulesi Estate, Mlanje; length of staple, 0·9 in.–1·4 in.
9. Egyptian (probably). Grown at Chipande, near Blantyre; length of staple, maximum, 1·5 in.
10. American Upland cotton. Grown on Lukulesi Estate, Mlanje; length of staple, 0·9 in.–1·5 in.
11. American Upland cotton. Grown in Blantyre district; length of staple, 0·9 in.–1·4 in.
12. American Upland cotton. Grown in Blantyre district; length of staple, 1·0 in.–1·4 in.
13. American cotton. Grown at Magomero, Namadzi, between Blantyre and Zomba; length of staple, 0·8 in.–1·2 in.
14. American cotton (probably). Grown at Chiole; length of staple, 1·0 in.–1·4 in.
15. Native cotton (probably Egyptian). Grown in Liwonde district; length of staple, 1·0 in.–1·4 in.
16. Native cotton (probably Egyptian). Grown in Liwonde district; length of staple, irregular, maximum 1·4 in.
17. Native cotton (probably Egyptian). Grown in Liwonde district; length of staple irregular, maximum 1·6 in.

18. Native cotton (probably Egyptian). Grown in Liwonde district; length of staple irregular, maximum 1·4 in.
19. Native cotton (probably Egyptian). Grown in Liwonde district; length of staple irregular, maximum 1·3 in.

Ribbons.—These ribbons were hand-woven by the natives of Kota Kota, a port on the western shore of Lake Nyasa, from imported dyed cotton yarn.

The people of this district are descendants of Arab traders from the coast and exhibit considerable taste in ivory and wood carving, weaving and other industries.

Sample exhibited:—

Five Ribbons. Received from the Colonial Office, 1906.

Fibres.—Several important fibre plants grow well in British Central Africa, and were it not for the relatively high cost of production and freight it is probable that the cultivation of fibre-yielding plants would constitute a profitable industry.

The most important of the indigenous fibre plants are *Sansevieria cylindrica*, the leaves of which yield a "Bowstring hemp," and *Securidaca longipedunculata*, the source of a bast fibre known under the name of "Buaze." The former is abundant in most parts of the Protectorate, especially at Mlanje, and a sample of fibre examined at the Imperial Institute was found to be of a superior quality in many respects, and, subject to improved methods of preparation, was declared by brokers to be worth about £25 per ton. (*Bulletin of the Imperial Institute*, 1904, **2**. 84.)

Buaze fibre is of fine quality and much resembles flax, and the possibility of utilising the properly prepared fibre as a substitute for flax is now being investigated at the Imperial Institute. The fibre is principally derived from the young annual shoots, two or three feet long, which are sent up from the roots or stools of trees which have been cut down. It is largely used by the native fishermen on the shores of Lake Nyasa for making their nets.

"Mauritius hemp," prepared from the leaves of *Fourcroya* [*Furcræa*] *gigantea*, has been introduced into the country and thrives well. A sample of the fibre forwarded to the Imperial Institute for examination proved to be of excellent quality, and, although somewhat short, was valued at from £26 to £30 per ton.

Large numbers of young plants of Fourcroya (Furcræa) and of *Agave rigida*, var. *sisalana*, from the leaves of which sisal hemp is prepared, were supplied to the planters by the Forestry and Botanical Department of British Central Africa during 1905.

Two interesting fibres of the jute class have recently been received and examined at the Imperial Institute under the the native names of "Denji" and "Nzonogwi" fibre. Both are bast fibres, derived from

Sida rhombifolia and *Triumfetta rhomboidea* respectively. The plants are stated to grow abundantly in the Shiré Highlands, especially in marshy places. "Denji" is the more important, and the yield is said to be from 1,800 to 2,000 lb. of cleaned fibre per acre. The fibres were found to closely resemble Indian jute in chemical characteristics and composition, but were probably inferior to that fibre in spinning qualities. The approximate value of the fibres was reported by brokers to be about £12 per ton. (*Bulletin of the Imperial Institute*, 1905, **3.** 25.)

Samples exhibited:—

1. Mauritius hemp (*Fourcroya* [*Furcræa*] *gigantea*).
2. Bowstring hemp (*Sansevieria cylindrica*).
3. Rope. Made from Bowstring hemp.

The above samples were received from the Scientific Department Zomba, 1902.

4. Buaze fibre (*Securidaca longipedunculata*). Received from the Botanical and Forestry Department.
5. Denji ribbons (*Sida rhombifolia*). Bark containing the fibre stripped from the stems.
6. Denji fibre (*Sida rhombifolia*). Received from the Botanical and Forestry Department.
7. Nzonogwi ribbons (*Triumfetta rhomboidea*). Bark containing the fibre stripped from the stems.
8. Nzonogwi fibre (*Triumfetta rhomboidea*). Received from Botanical and Forestry Department.
9. Yarn spun from Denji and Nzonogwi fibres.

Timbers.—Many varieties of hardwoods are found in the Protectorate and several are largely used for local purposes. In the present state of transport facilities, however, it is not probable that an export trade in timber could be developed.

The most important of the native timbers are:—Mpingu or ebony (*Diospyros* sp.), Mbawa or African mahogany (*Khaya senegalensis*), Mzuku, and the famous "Mlanje cedar" (*Widdringtonia Whytei*). The latter tree belongs to the Conifer family and is found in considerable quantities on the slopes of the Mlanje Mountain.

Efforts to conserve the forests and to establish regular plantations of the most promising timbers are being carried out in the Mlanje, Zomba and Blantyre districts. Seedlings of Mlanje cedar have been planted out on the Tuchila plateau of Mlanje Mountain, but it has been decided to discontinue planting in this locality on account of the difficulty of transporting the timber. The tree, however, together with Eucalyptus and African mahogany, is being planted on the Zomba plateau.

The working qualities of several of the timbers of the Protectorate have been examined at the Imperial Institute, and an account of the results is given in the *Bulletin of the Imperial Institute*, 1905 **3.** 18.

Samples exhibited:—

1. MPINGU, native ebony (*Diospyros* sp.).—Met with frequently on the plains at an elevation of about 2,000 feet.
2. MBAWA, African mahogany (*Khaya senegalensis*).—The tree belongs to the Mahogany Order (*Meliaceæ*), and is found throughout tropical Africa from Mozambique to the West Coast. The wood is suitable for carpentery, joinery, and turnery.
3. NGOSA.—From North-Eastern Rhodesia.
4. MLOMBWA.—From North-Eastern Rhodesia.
5. MZUKU.—Occurs in the Mangoche district up to an altitude of 5,000 feet. A fine-grained, compact wood of medium weight, resembling American birch in appearance but of a deeper reddish colour. The timber is reported to resist the attacks of white ants.
6. MLOMBWA or MTUMBATI (Natural Order *Leguminosæ*).—Found in the Mangoche district up to 3,500 feet. A hard, brittle timber bearing a superficial resemblance to walnut. Weight, 51 lb. per cubic foot.
7. MBAWA, (*Cedrela* sp.).—A soft, fissile timber, closely resembling Mexican cedar, which might be used as a substitute for the cheaper qualities of mahogany. It is not attacked by the white ant. Weight, 36½ lb. per cubic foot.
8. MKALATI.—From the Mangoche district. Found as solitary trees in the open plains up to 3,500 feet. A hard, handsome timber closely resembling the Cape Beech or Beukenhout (*Myrsine melanophleos*). It is somewhat difficult to work, but takes an excellent polish. Weight, 48¾ lb. per cubic foot.
9. MLANJE CEDAR, Mkuguza (*Widdringtonia Whytei*).—From Mlanje Mountain. A very light, firm timber of a uniform reddish colour, with a good figure in radial section. It works easily, and is said to be proof against white ants. Weight, 58¼ lb. per cubic foot.
10. MLUPATI.—From the Mangoche Mountain. A fine-grained compact timber working easily and well. Weight, 44 lb. per cubic foot.
11. NAKAWALIKA.—From the Mangoche Mountain. An inferior timber of no value for export purposes, since it lacks durability and is difficult to work.

Most of the above samples were collected by Captain Claude Percival and forwarded by him to the Imperial Institute for examination.

ANIMAL PRODUCTS.

Ivory.—The export of ivory is much less than in former years. At the present time it is doubtful whether there are any elephants in British Central Africa outside the game preserves, and practically all the ivory exported from the Protectorate is brought in by natives from the adjoining territories of Rhodesia and Portuguese East Africa.

There is also a small trade in hippopotamus teeth.

Samples exhibited:—

1. Two elephant tusks.
2. Two photographs illustrating the transport of ivory.

Beeswax.—A considerable quantity of beeswax is collected by the natives from the nests of wild bees, which are very abundant in the country. A small quantity is exported.

A sample of clarified beeswax examined in the Scientific and Technical Department of the Imperial Institute was valued by brokers at from £6 17*s.* 6*d.* to £7 per cwt. (*Bulletin of the Imperial Institute*, 1904, **2**. 80.)

Samples exhibited:—

1. Clarified beeswax. Prepared from balls brought in by natives. Received from Mrs. Brown, Mlanje.
2. Beeswax. Balls as brought in by the natives for sale. Received from the Scientific Department, Zomba, 1902.
3. Beeswax.

MINERAL PRODUCTS.

There would appear to be little doubt that British Central Africa possesses a valuable asset in its mineral wealth. Iron ore is reported to occur throughout the country, and some of the deposits are of excellent quality. The ore is found in two forms: a bog-iron ore of inferior quality, largely smelted in former times by native smiths, especially in Angoniland, the iron being used in making spear-heads and agricultural implements; and a rich haematite ore which is plentiful in many localities.

Coal is found in the North Nyasa district, not far from the shores of Lake Nyasa. The beds belong, geologically speaking, to the Gondwana formation of India, and chemical examination at the Imperial Institute has shown that the coal has a composition similar to that of samples from the Gondwana rocks. (See *Imperial Institute Technical Reports and Scientific Papers*, 1903, p. 3.)

Gold exists in various parts of the Protectorate, but, up to the present, has not been found in payable quantities. The most promising fields for prospecting would appear to be Central Angoniland Marimba, West Nyasa, and North Nyasa.

Limestone is found in large quantities in the Upper Shiré district.

A considerable number of samples of rocks and minerals from the Protectorate have been forwarded from time to time to the Imperial Institute for chemical examination, and detailed information regarding them will be found in the *Imperial Institute Technical Reports and Scientific Papers*, 1903, p. 39, and in the *Bulletin of the Imperial Institute*, 1904, **2.** 69, and 1905, **3.** 133. Among the more important may be mentioned (1) a sample of argentiferous galena, constituting a valuable ore of lead containing a fair amount of silver; (2) a nickeliferous pyrrhotite containing copper pyrites and somewhat resembling the ore worked for nickel and copper at Sudbury, Ontario, Canada.

A mineral survey of British Central Africa is now being carried out in connection with the Imperial Institute.

LIBRARY.—RECENT ADDITIONS.

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Mauritius Almanac for 1906 . . .	Compiled by D. P. Garrioch. (*Imprimerie Nouvelle.*)
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The Singapore and Straits Directory, 1906	(*Messrs. Fraser & Neave, Ltd.*)
Annual Calendar of McGill College and University, Montreal, for the session 1906–1907	(*The Secretary.*)
McGill University Examination Papers, 1905–1906	(*The Registrar.*)
Report of the Adelaide Chamber of Commerce, 1906	(*The Secretary.*)
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Our Empire, past and present. Vol. i. Great Britain in Europe. Second edition	By the Earl of Meath, M. H. Cornwall Legh, LL.A., and Edith Jackson. (*The Earl of Meath.*)
Rand Pioneers: Third Annual Report with Appendices, 1906 . . .	(*The Secretary.*)
The Incorporated Accountants' Year-Book, 1906–1907	(*The Secretary.*)
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Immigration and its Effect upon the United States	By Prescott F. Hall, A.B., LL.B. (*Messrs. George Bell & Sons.*)
Pickings from Pro-Vaccinist Polemics .	*W. J. Furnival, Esq.*
Transactions of the Institution of Naval Architects. Vol. xlviii., 1906 . .	(*The Secretary.*)
India	By Pierre Loti. (*Ben Walmsley, Esq.*)

Transactions of the Institution of Mining and Metallurgy. Vol. xv., 1906 . .	(*The Secretary.*)
The Calendar of King's College, London (University of London), for 1906–1907	(*The Principal.*)
Documentary History of Education in Upper Canada. Vols. xiv., 1858–1860; xv., 1860	By J. George Hodgkins, I.S.O., M.A., LL.D. (*Minister of Instruction, Ontario.*)
Annual Report of the Perth Chamber of Commerce, Western Australia, 1906 .	(*The Secretary.*)
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Report of the South African Colonisation Society, 1904	(*The Secretary.*)
"*Verb. Sap.*" on Going to East Africa, British Central Africa, Uganda, and Zanzibar, and Big-Game Shooting in East Africa. With Swahili Vocabulary	(*The Mombasa Trading Syndicate.*)
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