"Baluchar," from the name of a village where it is supposed to have been originally procured. The *ganja* of Upper India, such as that of Gwalior and the Central Provinces, is called "Pathar." The refuse from the manufacture of *ganja* is often sold as *bhang*.

Insanity.

Medicinal and Chemical Properties.—The action of the drug in causing insanity has, by the Report of the Hemp Drugs Commission, been viewed as a greatly overstated belief. The moderate use of the drug is attended with no evil physical effects. If pure and taken in moderation it has little or no tendency to originate insanity. But when mixed with the poisonous substances sometimes employed it becomes most pernicious. Excessive use of hemp in any form, however, indicates and intensifies mental instability. It tends to weaken the mind, and may even lead to insanity. But in the year of the Hemp Drugs Commission only 7·3 per cent. of lunatics admitted to all the Asylums in India were said to be those in which hemp could reasonably be regarded as having been a factor of importance. [*Cf.* Gibbon, *Med. Jurisprudence for Ind.*; Walsh, in *Journ. Mental Science*, 1894.] Moreover, the insanity produced, as a rule readily gives way to treatment, and since the drug creates no craving its discontinuance is possible, and the restoration of the mental faculties almost instant. So much has, however, been written on these subjects that it is impossible to do more than refer the reader to some of the standard works that may with advantage be consulted.

Mental Instability.

Creates no Craving.

[Pereira, *Mat. Med.*, 1850, ii., 1237–44; Hamilton, *Fl. Homœop.*, 1852, i., 134–42; Honigberger, *Thirty-five Years in the East*, 1852, i., 153–7; ii., 248–56; Hem Chunder Kerr, *Rept. of Cult. and Trade in Ganja*, 1877; Fluckiger and Hanbury, *Pharmacog.*, 1879, 546; Dunstan and Henry, *Exam. of Active Principle of Hemp*, in *Journ. Soc. Chem. Indust.*, 1898, xvii., 269; *Derivatives of Cannabinol*, in *Yearbook of Pharmacy*, 1899, 73; 1900, 133; Dutt, *Mat. Med. Hind.*, 1900, 235–41; *Pharm. Journ.*, 1902, lxviii., Holmes, 342; Marshall, 362; Humphrey, 392; Greenish, 492; lxix., Holmes, 129; Mahen, 131; 1903, lxxi., 431, 548; *Ind. Med. Gaz.*, Nov. 1904, 401–15, 421.]

Trade and Revenue.

Trade and Fiscal Administration.—In India the cultivation of this plant, where intended for the production of *ganja*, can alone be undertaken under license; moreover, the cultivation is periodically inspected, and the yield approximately ascertained. While no restrictions are placed on the sales to the trade, the produce when disposed of by the cultivator is stored either in Government warehouses for the purpose, or in approved godowns under double keys, one retained by the owner, the other by a Government official. Removals pay the fixed duty, and are recorded in such a way as to show the relation to the cultivator's estimated production and deed of sale. Both wholesale and retail traders have to obtain licenses. The traffic in *ganja* is thus under complete control through every stage. With regard to *charas*, a minimum duty of Rs. 80 per maund is levied on all imports. The drug is stored in approved warehouses and a further duty paid on removal, while inter-provincial adjustments are conducted on permits to carry from one province to another. *Bhang*, where found possible, is also taxed, but, the plant being wild in many localities, no interference is made with the domestic supplies of the people, the regulations having effect only on actual sales and regular trade. The sale of the narcotic in any form by persons not licensed to cultivate or sell these drugs, is a criminal offence.

License.

Stored.

Duty.

Criminal Offence.

Separate licenses have to be taken out for the traffic in each of the three kinds of the drug, and the retail vendor is prohibited from supplying

children or insane persons with any. A limit is at the same time fixed on the amount that may be either sold to, or possessed by, a private person at one time. It is universally believed by both traders and consumers that all forms of the drug deteriorate with age. This is just the opposite opinion to that held with regard to opium. It accordingly follows that every effort is made to dispose of the produce year by year, and not to store it. It is perhaps on this account that such indifferent results have been obtained with Indian hemp as a medicine in Europe as compared with India. Long years ago Honigberger (*l.c.* 157) deplored this fact. To ensure fresh stuff it has accordingly been recommended by Prain that all purchases by the European dealers should be made direct through the Government official in joint charge of the warehouses.

Deterioration with Age.

Direct Purchase Recommended.

Area and Revenue.—In 1895, when the Government of India published their Resolution on the Report of the H.D. Commission, the total area in all India under regular cultivation of the plant was estimated at under 6,000 acres. In 1900–1 the *Agricultural Statistics of India* show the extent of cultivation to have been only 4,096 acres; in 1901–2 it would appear to have stood at 2,496 acres; in 1902–3 at 1,940 acres; in 1903–4 at 2,637 acres; and in 1905–6 at 2,645 acres, with, over and above, 419 acres in the Native States. If these figures denote an actual curtailment of area, not merely more accurate returns, they have curiously enough been coincident with increasing revenue. In the *Excise Administration Reports*, the Hemp Drugs are shown to have realised a total revenue of £201,344 in 1900–1, of £213,224 in 1901–2, and of £225,352 in 1902–3—later figures are not available. It would therefore seem that official returns may be accepted as exemplifying the continued careful control and restriction pursued by the Government.

Area.

Reduction in Area but Expansion of Revenue.

Prices and Duty.—The prices of the various forms of Indian hemp vary so greatly that it seems hardly worth while to give a quotation of the figures usually recorded. The price depends upon a multitude of circumstances, such as the quality, method of preparation, degree of taxation, and the like. The Government of India, in their Resolution on the H.D. Commissioners' Report, placed before the various Indian Administrations a table of retail prices per seer (2 lb.), which was commended to their attention with a view to gradually securing a greater uniformity. To manifest the extremes exhibited in that table the following may be abstracted:—GANJA in Assam sells at Rs. 15 lowest price and Rs. 40 highest price; while in Bombay it is sold, lowest price 6 annas and highest Rs. 5. CHARAS in Panjáb, lowest price Rs. 4, highest Rs. 15; while in Bengal its lowest price is Rs. 35 and its highest Rs. 40. BHANG in Panjáb sells at lowest price 2 annas and highest 8 annas, while in Bengal its lowest price is Rs. 1 and the highest Rs. 6 per seer. These variations to a large extent are the direct expression of the varying incidence of taxation, but there can be little or no doubt that there is a considerable variability in intrinsic merit, not only between the produce of one province and another but even between the different districts of the same province.

Prices: Duty.

Highest and Lowest.

Intrinsic Merit.

For the rates of duty and all other particulars regarding the traffic in hemp narcotics, the reader should consult the provincial Reports of Excise Administration in India. Some of these annual volumes (especially those published by the Government of Bengal) will be found to contain the fullest possible details.

D.E.P., ii., 133. Caper.

CAPPARIS SPINOSA, *Linn.; Fl. Br. Ind.*, i., 173; Cooke, *Fl. Pres. Bomb.*, i., 44; *Pharmacog. Ind.*, i., 135; CAPPARIDEÆ. The Edible Caper of Europe and the *kabarra, kaur, kiari*, etc., of India.

A small prostrate shrub found on hilly and rocky ground in Upper India. It is distributed to Afghanistan, West Asia, Europe, N. Africa, Australia and the Sandwich Islands. There are a considerable number of species of ***Capparis***, no less than 30 being mentioned in the *Flora of British India*, but only two or three besides ***C. spinosa*** are of any great importance. These are ***C. aphylla***, *Roth.*, the *karél, nepti*, etc.—a dense much-branched shrub found abundantly in the drier parts of the Panjáb, Gujarat, Rajputana, Deccan and S. Karnátak, and ***C. horrida***, *Linn., f.*, the *ardanda, karvíla*, etc., found in the Gangetic valley, etc., as far north as Saharanpur, in the Western Peninsula, also in Chittagong, Pegu and Ceylon. It is also distributed to Java and the Philippines. Besides these ***C. grandis***, the *pachunda, guli*, etc., is found in the Deccan, Karnátak and Ceylon.

Oils. Several species are known to yield OILS. ***C. grandis*** affords an oil used in medicine and for burning, while ***C. spinosa*** yields a volatile oil which has the properties of garlic oil (*Pharmacog. Ind.*, *l.c.*).

Medicine. The caper is mentioned by Greek and Latin writers, and through them doubtless the MEDICINAL properties of the root were made known to the Arabs. It was very generally employed in affections of the liver and spleen, and also in amenorrhœa. In India all parts of the plant are regarded as stimulating and astringent, when externally applied.

Food. The young flower-buds and fruits of ***C. aphylla***, as also of ***C. spinosa***, are eaten in India. The former species is the more important; the buds are pickled and the fruits eaten both when green and when fully ripe. ***C. spinosa*** is met with in the Panjáb, but it has never assumed the position of importance assigned to it in Europe, where the pickled buds form the "Capers" of commerce. Gerarde (1596) and Miller (1748) mention that the caper had been successfully grown in England in the open air, but it is usually regarded as requiring protection

Timber. in winter. The WOOD of ***C. aphylla*** is employed in India for making combs, small beams and rafters, for the knees of boats, etc., and is valuable because of its not being attacked by white ants. [*Cf. Taleef Shereef* (Playfair, transl.), 1833, 120.]

D.E.P., ii., 134–40. Red Pepper.

CAPSICUM, *Linn.; Fl. Br. Ind.*, iv., 238; Steph. and Church., *Med. Bot.*, 1834, i., pl. 44; Bentley and Trimen, *Med. Pl.*, t. 189; Duthie and Fuller, *Field and Garden Crops*, iii., 36–7, pl. 72, 74; Sturtevant, *Hist. Gard. Veg.*, in *Amer. Nat.*, 1890, xxiv., 151–7; Irish, *Rev. Genus Capsicum*, in *Missouri Bot. Gard.*, 1898, ix., 53–110, tt. 8–28; SOLANACEÆ. The Guinea Pepper, Red Pepper, Pod Pepper, Chilli, Cayenne, Tabasco, etc.

History. **History.**—There would seem to be little doubt that the entire series of plants constituting the genus ***Capsicum*** are natives of tropical America. Peter Martyr was perhaps the first person who described this kind of pepper. In an epistle dated

Columbus. 1493 (the year following the discovery of the West Indies), he says that Columbus had brought to Spain "pepper more pungent than that from the Caucasus." In 1494 Chanca, the physician who accompanied Columbus on his second voyage, addressed a letter to the Chapter of Seville on the same subject. In that he calls this pepper by its West Indian name, *axi*—a word that has since been rendered as *achi* or *agi*, and has survived in Spanish to this day. Although some of the 16th century authors maintain that the *siliquastrum* of Pliny is the Pod Pepper (***Capsicum***) of modern trade, the more strictly botanical writers are very nearly unanimous in the opinion that capsicum was not known in Europe

Cardamom confused with Capsicum. prior to the discovery of America. In passing it may further be observed that all the older authors speak of *siliquastrum* as coming from Calicut, from which circumstance it may be inferred to have been the cardamom—a spice which to this day is almost exclusively derived from that port and which has been associated with the Malabar Coast of India from the remotest antiquity. At all events Amatus on Dioscorides (pub. 1554) distinctly confuses capsicum with cardamom. Fuchs (*Comment. de l'Hist. des Pl.*, 1542–9, ch. 281; also *Hist. Stirp.*, 1555, 797) gives an account of "Siliquastro or Piperitis," which by some is called "Indian or Chalechut Pepper," "Cardamom," "Spanish Pepper," etc., and which Avicenna speaks of under the name of "Zingiber caninum."

Matthiolus (*New Kreüterb.*, 1563, 216) gives a good plate of ***Capsicum*** and calls it "Calicut pepper." He says it is a foreign plant lately introduced into gardens in Germany, and subsequently (*Med. Compend.*, 1571, 322) he remarks that it is an obvious mistake to confuse ***Capsicum*** with ***Cardamomum***. Lobel (*Stirp. Adv. Nova*, 1570, 134) observes that within his memory this plant (of which he gives a good plate) has been brought from Goa and the shores of Calicut. There can be no doubt, therefore, that the Portuguese had very early introduced Capsicum into Goa, and very possibly commenced to export it, in competition with the true pepper, hence Lobel as an after-thought may have associated Calicut with the new emporium Goa. Clusius (review of Garcia de Orta) in the *Aromaticum*, published in 1574, makes no mention of ***Capsicum***, so that it may be inferred the plant had not been seen by Garcia de Orta in India. A little later, however, Clusius (*Hist. Exot. Pl.*, 1605, 340) under *Capsicum brazilianum* or wild pepper, observes that Spanish or American pepper was brought from the Spanish West Indies and carried to India by the Portuguese under the name of Pernambuco Pepper. Jacobus Bontius (*Hist. Nat. et Med. Ind. Or.*, in Piso, *Ind. Utri re Nat. et Med.*, 1658, 130–1), who wrote in 1629, describes this pepper under the names of *Lada Chili* and Brazilian *Ricinus*, a fact that led some authors to confuse it with ***Ricinus communis***—the Castor Oil. [*Cf. Paulus Ægineta* (Adams, transl.), iii., 171.] Rheede (*Hort. Mal.*, 1679, ii., 109, pl. 56, in a note by John Commelin) remarks that the *capo-molago* or Indian pepper described by him was in reality Brazilian pepper, the prefix *capo* or *capro* denoting its introduction by the Arab traders; his plate is a typical example of ***Capsicum frutescens***. It is practically the same plant which Rochefort calls *axi* or *carive*; which Recchius (*Nat. Hist. New Spain*) describes as *chilli* or Mexican pepper; possibly also that which Piso calls by its Brazilian name *quiya*; which Elizabeth Blackwell figures and describes in her *Curious Herbal* (1739, i., pl. 161); and which Hernandius (*Hist. Pl. Nov. Hisp.*, 1790, i., 277–82) discusses and illustrates most fully as one of the forms of ***Capsicum***. In a further passage Rheede gives a plate of the *vallai-capo-molago*, which is doubtless *var.* ***grossa***, and was thus apparently a more recent introduction into India than the *capo-molago*. [*Cf.* Labat, *Nouv. Voy. aux Isles de l'Amerique*, 1724, ii., 68; Milburn, *Or. Comm.*, ii., 208; Bentham, *Notes on Targioni-Tozzetti, Cult. Pl.*, in *Journ. Hort. Soc.*, 1855, ix., 141; Henry, *Econ. Bot. China*, 39; Semler, *Trop. Agrik.*, 1900, ii., 284–5; *Pharm. Soc. Mus. Repts.*, 1895–1902, 58.]

Brought from Goa.

Pernambuco Pepper.

Early Indian Pictures.

With a history so full and so pertinent (many other authors might be cited), it is indeed surprising that one of the greatest of Eastern botanical authors, nearly a hundred years after the appearance of Rheede's *Hortus Malabaricus*, should have affirmed in the most emphatic manner possible his belief that at least certain forms of ***Capsicum*** had not only been cultivated in India from the most ancient times, but that it was the *siliquastrum* of Pliny and *Capsicum orientale* of Actuarius. Rumphius (*Herb. Amb.*, 1750, v., 247–52, pl. 88, ff. 1–4) advanced those opinions without observing that many of the passages in his own most admirable and detailed account contradicted his main contention. For example, while commenting on Rheede's Malabar name *molago*, he deprecatingly observes that no mention is made of its daily and well-known use as a condiment. It never seems to have occurred to Rumphius that Rheede's silence on that point, as also the fact that Marco Polo (1286–96) and Garcia de Orta (1563) made no reference at all to capsicum (though they discuss ordinary pepper and the cardamom), might be accounted for by the belief that the capsicums were unknown to the Natives of India in the time of Marco Polo, and even so late as that of Garcia de Orta, while they were but imperfectly understood in Rheede's time. Rumphius describes three main forms of ***Capsicum***, which he calls (*a*) the great red capsicum, the *ritsje* of the Dutch and *recche* of the Portuguese in India, the *tschili besar* or *tschili-ayer* of the Natives; (*b*) the lesser red capsicum—a fruticose plant called *tschili-mera*; and (*c*) the yellow ***Capsicum*** known as *tschili-cuning*. Rumphius then adds that the Portuguese write the West Indian name *axi* as *achi*, hence comes the Indian name *achar*, which the Dutch render *atsjar*—a word which has the same meaning as *reccheado*, namely pickles. It will thus be seen that practically the entire series of vernacular names mentioned by Rumphius, far from their establishing an ancient knowledge in India, would seem to prove that the introduction of the plant may have taken place somewhere about the middle of the 17th century. The names in use in India to-day are clearly of foreign or modern origin, such as *chillies*, *lal-marcha* (= red pepper), *goa-mircha* and the like. There are, in fact, no ancient

Rheede *versus* Rumphius.

Gracia de Orta and Marco Polo.

Modern Names.

names for the capsicums in Chinese, Sanskrit, Arabic, Persian, Hebrew, Greek, or Latin. No Indian botanist has ever recorded having found a species of ***Capsicum*** in a wild condition. But the rapidity with which the species and races of this pepper became disseminated throughout the tropical and warm temperate tracts of the globe, following closely on the discovery of the West Indies and America, is one of the many examples of the marvellous powers of adaptability and endurance possessed by the plant-cohorts from the New World on their invading the Old.

Varieties and Cultivated Forms.

C. annuum, *Linn.; C. grossum, Willd.*, in *Fl. Br. Ind.*, iv., 239; Irish, *l.c.* 65-97, tt. 10-28.

The following statement is derived mainly from Mr. H. C. Irish's admirable review of the varieties and cultivated races of this species :—

(*a*) **Var. abbreviatum,** *Fingerh.* : the Celestial, Etna, Kaleidoscope, Red Wrinkled Princess of Wales, etc.

Nepal Chilli.

(*b*) **Var. acuminatum,** *Fingerh.* : the best examples are the erect-fruited Chilli and the pendent-fruited Long Cayenne, Long Yellow Cayenne, Nepal Chilli and the Yellow Nepal Chilli. It includes, in fact, most if not all the long, pointed, pendent forms common as field crops. Recently Mr. H. M. Leake performed some interesting experiments with capsicums at Dalsing Sarai. He selected seed carefully and sowed them in order to watch the tendencies to variation. Nearly half the erect podded stock had pendent pods. Every plant was, however, consistent, either having all its pods erect or all suspended. He further found that chillies will grow on *usar* land if sown early. Very possibly most of Leake's plants belonged to this variety, but as I have not seen any of his specimens I cannot say for certain.

Influence of Soil.

This would appear to be the *Capsicum minus flavum* of Rumphius (*l.c.* 248). Mr. Irish remarks that the seed of the Nepal Chilli had been supplied by the Superintendent of Saharanpur Botanic Gardens, and on being cultivated proved different from other plants seen by him. In the *Report of the Saharanpur Botanic Gardens* (1894–5, 10) it is stated that the Superintendent had received seed direct from Col. H. Wylie, British Resident in Nepal. The plants grew freely, but the pods produced possessed none of the peculiar flavour and pungency of the pods imported from Nepal. The Superintendent then adds, "In the letter which accompanied the seeds Col. Wylie informed me that that would prove to be the case, as the variety so much in request is the product of a peculiar kind of soil, only found in certain localities, and that in Nepal itself the true Nepal chilli when not grown on the right soil, scarcely differs from the common long red chilli of Indian bazars."

Cherry Pepper.

(*c*) **Var. cerasiforme,** *Miller: Roxb., Fl. Ind.*, i., 574.—Cherry-pepper is often alluded to by the early authors, such as Miller, Gerarde, Parkinson, Tournefort, etc. This includes the Little Gem, Prince of Wales, Cherry, Yellow Cherry Oxheart, Yellow Oxheart, etc.

Cayenne.

(*d*) **Var. conoides,** *Miller:* the best-known races are the Coral Gem, Tobasco, Cayenne, Orange-Red Cluster, etc.

(*e*) **Var. fasciculatum,** *Sturt.* : the better known races are Red Cluster, Yellow Cluster, etc.

(*f*) **Var. grossum,** *Sendt.: Roxb., l.c.*—This is the *kaffree-murich*; is often alluded to and figured by the early European writers such as Miller, Parkinson, Fousch, Gregorius, Bauhin, Morison, Rheede, etc. Under this form have to be placed —The Emperor, Monstrous, Sweet Spanish, Bell, Ruby King, Golden King, Brazilian Upright, Squash, Yellow Squash. In India the races of this variety may be said to exist mainly as garden plants, though large inflated yellow fruits of this form have recently begun to appear in the markets as a regular article of trade.

Black Nubian.

(*g*) **Var. longum,** *Sendt.: C. annuum* and *purpureum, Roxb., Fl. Ind.*, i., 573; *C. bicolor, Bot. Mag.*, 43, n. 1835.—This is the plant most frequently described by the early European authors. The best-known races are Black Nubian, Long Red, Country Fair, Cardinal, Long Yellow, Elephant's Trunk, Ivory Trunk, etc. Roxburgh tells us that he found a single plant of ***C. purpureum*** in the Botanic Gardens, Calcutta, in 1796 but could not learn whence it came, though he adds, "most likely from the Malacca Islands." Irish assorts all these together as forms in which the calyx rarely embraces the base of the fruit. It seems probable that most of the plants hitherto regarded by writers on Indian garden plants as forms of ***C. frutescens*** should be relegated to this position

C. frutescens, *Linn.; C. fastigiatum, Bl.;* Wight, *Illust. Ind. Bot.*, ii., 198; Dunal, in DC., *Prod.*, xiii., pt. i., 416; *C. minimum, Miller, Gard. Dict.*, 1768 (ed. viii.); Roxb., *Fl. Ind.*, i., 574; *Capo-Molago, Rheede, l.c.* Bird Pepper.

This is often called "Bird Pepper." According to the *Pharmacographia Indica* (ii., 563), *C. minimum* exists as a weed of cultivation in most parts of India. This I personally have never observed, and hesitate to accept. Owing to the large size of the plant it is the *gach-marich* of most Indian writers.

Var. baccatum, *Linn.: C. minus rubrum, Rumph., l.c.* 248, t. 88, f. 2; *C. Brasilianum, Clusius, Hist. Exot. Pl.*, 340, etc.

Rheede and Rumphius figure and describe forms of ***C. frutescens,*** but say remarkably little about the capsicums most prevalently cultivated at the present day. And a thoughtful perusal of the passages used by Roxburgh, in his *Flora of India,* leaves the impression that, even in his day, the cultivation of no capsicum assumed the magnitude of a regular field crop, such as may be seen to-day in almost every province of India, especially in Bengal, Orissa, Madras and the Deccan. But ***C. frutescens,*** far from having become the most abundant form, is usually met with as solitary plants in the grounds around temples and in the flower gardens of the well-to-do classes, but is hardly if ever a regular crop. It is nearly always distinguished as the *gach-marich* or "*long ka morich,*" as it is called by Buchanan-Hamilton (*Stat. Acc. Dinaj.*, 187–8). In India the most extensively cultivated are the following forms of ***C. annuum :—var. acuminata*** followed by ***longa,*** and next ***cerasiformis.*** Evidences of Modern Origins. Field Crop.

Cultivation.—It is impossible to furnish any statistics of the areas under these plants since they are most frequently raised as borders to fields, or as lines through fields. In Eastern and Northern Bengal, however, capsicum becomes a regular field crop, thriving best on a light sandy loam. The form most frequently seen is a long, narrow, pointed, pendulous red fruit. The seed is sown broadcast, and in Bogra, for example, capsicum assumes the condition of an exceedingly important cold-season crop. In the *Settlement Report for Nagpur, Central Provinces,* some useful particulars are afforded regarding chillies. The seed is sown about June and the seedlings are transplanted about August. In September the earth has to be banked up against the stems. Irrigation is necessary during the cold weather, and the crop comes into season from January to March. Its value is from Rs. 120 to Rs. 150 per acre. Dry chillies are only about one quarter the weight when green. Very little information exists regarding the red pepper of Assam or of Burma. Of the Kyaukse district of the latter province we read that the lowest estimated yield would be 365 lb. (=100 viss), valued at Rs. 15 an acre, the highest about Rs. 350. Of Sagaing it is said the seed is sown in August, planted out in September and October and the crop ripens from January to March, the green fruit a month earlier. A long and highly instructive account will be found in the *Settlement Report for Meiktila* (1896–8, 8, 23, 69), which shows the high-class cultivation pursued, the labour entailed, and the risks through failure of rains. The crop usually comes into bearing by the middle of December. The trade is entirely in the hands of the Chinese, who rule the market and export all they can purchase. In Myingyan the sowings are not made till September, and the plants come into season about March. Chillies have been recommended as a catch crop among young tea for Assam. Cultivation. Bengal. C. Prov. Burma.

TRADE IN CAPSICUM

Bombay. In the Bombay Presidency chillies are rotated with ordinary market-garden produce. On the black soil of the Deccan (Krishna Valley) is produced a fairly large proportion of the red pepper conveyed to Bombay. But the most important areas of production in Western India are Dharwar, Belgaum, Khandesh, Satara, Poona and Sholapur. Capsicums are usually sown in the rains, but if the land be irrigated they become a *rabi* crop. Usually they are raised in a nursery and transplanted, and in about three months the first crop may be gathered. [*Cf.* Mollison, *Textbook Ind. Agri.*, 1901, iii., 206–9.] Speaking of the **Panjáb.**, Dr. Stewart tells us that when grown on the hills, chillies become more pungent, hence no doubt the special merit of the so-called Nepal Cayenne. In the *Lahore Gazetteer* (1893–4, 164) will be found useful particulars of this crop. It is planted out in June and begins to come into season by October. Thirty maunds an acre for wet and 8 for dry are considered a fair outturn. The cultivators sell it wet at 30 seers or one maund the rupee. In the *Gazetteer for Montgomery District* (1898–9, 142) it is stated that the crop is sown in January–February; the ground dug about the roots in February–March; watered every fifteen days; and the pods collected May, June and July. White ants and parrots prey on it.

Food. ***Uses.***—It is needless to mention the varied uses of capsicum. The dried fruit reduced to powder forms the Red Pepper or Cayenne of com-
Cayenne Pepper. merce. But cayenne is, as a rule, prepared from the small, very pungent fruited forms only. It is an ingredient in all curries and many other food preparations, and is used throughout India and by every class of the community, so that while of comparatively modern introduction, the consumption of red pepper has now become all but universal. There are various brands of pepper sauce, which are produced as decoctions of the
Vinegar. fruits in salt water or vinegar (see p. 1110). Tabasco and Paprika are special European sauces. In Bengal an extract of the consistence of treacle is regularly prepared and sold. The green fruits are pickled or cooked fresh
Medicine. with special dishes or even eaten raw. As a MEDICINE capsicum is stomachic, stimulant and astringent; cayenne pepper is a valued adjunct to gargles, and an ingredient in most medicines that are intended to alleviate toothache. As a rubefacient and counter-irritant, the bruised fruits, in the form of a poultice, act energetically, and added to mustard are often highly beneficial. For the medicinal uses and chemical properties the reader should consult the *Pharmacographia Indica* and other such works.

Trade. ***Trade in Capsicum.***—During the five years ending 1900–1 the foreign exports rose from 8,126,175 lb. valued at Rs. 7,20,925, to 9,485,820 lb. valued at Rs. 12,47,349. These figures represent an increase of 16·7 per cent. on the quantity, and as much as 73·0 per cent. on the value. In 1906–7 the corresponding figures were 11,007,929 lb. and Rs. 14,37,635. During that year Madras contributed 7,677,763 lb., Burma 1,386,739 lb., Bengal 1,567,162 lb., and Bombay 363,060 lb. The most important receiving countries were Ceylon, which took 8,419,713 lb., the Straits Settlements 1,872,738 lb., Mauritius 287,027 lb., Aden 104,356 lb., the United Kingdom 85,428 lb., and other countries the balance of the total.

These figures are, therefore, representative of the normal and present condition of the traffic, and they also denote its thriving condition. This is confirmed by the account of the *Trade carried by Rail and River in India* during 1906–7. During the five years previous the recorded transactions under the statement of imports were 832,648 cwt. in 1902–3; 760,611

cwt. in 1903–4; 763,106 cwt. in 1904–5; 977,801 cwt. in 1905–6; and 883,059 cwt. in 1906–7. But of these very large amounts only about one-third was received by the port towns as the supplies to meet local demands and foreign exports. Turning to the corresponding returns for exports, it is seen that Madras is by far the largest producing province of India proper (that is, excluding Burma, not shown in the returns of rail and river traffic), followed ordinarily by Bengal and the Panjáb. All the rest of India (including the Native States) exports usually about the same amount as Bengal, which is commonly only about half that of Madras.

CAREYA ARBOREA, *Roxb.*; *Fl. Br. Ind.*, ii., 511; Gamble, *Man. Ind. Timbs.*, 364; Cooke, *Fl. Pres. Bomb.*, i., 497; Duthie, *Fl. Upper Gang. Plain*, 344–5; Brandis, *Ind. Trees*, 332; MYRTACEÆ. The *kumbi, ayma, arjama, putai-tanni-maram, kumbir, buda-durmi, kaval, gavuldu, banbwe*, etc. D.E.P., ii., 157.

A large deciduous tree of rapid growth, frequent in the Sub-Himalayan tracts from the Jumna eastward and in Bengal, Burma, Central, South and West India, ascending to 5,000 feet, also met with in the moist regions of Ceylon. Robinson (*Desc. Acc. Assam*, 1841, 43) described it as a "tree of immense size. The wood . . . well adapted for the stocks of match-locks." It is much subject to the defoliating *lymantriid* moth, ***Dasychira thwaitesii***, *Moore*. The leaves turn red in the cold season.

It appears to yield a GUM, and a good FIBRE for coarse cordage and sacks is made from the bark, the latter part being also employed in TANNING and as a DYE. Tasar silkworms feed on the leaves. The bark is also used as an astringent MEDICINE; when moistened it gives out much mucilage and is utilised in the preparation of emollient embrocations. The flowers are given as a tonic after child-birth, and the dried calyces (*vákumbhá*) of the flowers are sold in the market as a demulcent in coughs and colds. The fruit, known as *khúni*, is eaten in the Panjáb and is also given to cattle. According to Innes (*Jungle Products*, 1898, 10) the bark is ground into a kind of flour in Oudh during famine. The seeds are said to be more or less poisonous. The TIMBER, which is very durable and fairly hard, is used for agricultural implements, gunstocks, houseposts, cabinet-work, etc., but Kurz says it is too heavy for such purposes (43 to 60 lb. per cubic ft.). It stands well under water, and is much admired for axles. "This is an important tree with a fine wood, which is too much neglected" (Gamble). The fibrous bark is used as a slow-match in Mysore, and has been successfully tried by the Ordnance Department as a substitute for English beech in fuses. In Ganjam it serves for the scanty clothing of Hindus affecting sanctity. Rheede (*Hort. Mal.*, iii., 36) says that wild pigs are very fond of the bark, and that it is used by hunters to attract them.

Gum and Fibre. Tan and Dye. Medicine. Food and Fodder. Timber.

CARICA PAPAYA, *Linn.*; *Fl. Br. Ind.*, ii., 599; Cooke, *Fl. Pres. Bomb.*, i., 524; PASSIFLOREÆ. Most of the vernacular names, *papeya, papaya, papia, bappayi, popai*, etc., are obviously derived from the Carib *ababai*, which is still further corrupted into the English Papaw. The Burmese name *himbawthi* means fruit brought by sea-going vessels, and the Panjábi name *kharbuza* is Castor-oil-Melon. D.E.P., ii., 158. Castor-oil-Melon.

History.—A subherbaceous almost branchless tree, commonly cultivated in gardens throughout India and in various localities more or less naturalised. The fruit is not mentioned in the *Ain-i-Akbari* as having been known to Akbar. It was sent to Clusius from Brazil in 1611 (*Hist. Exot. Pl.*, app. 42), who gives good drawings of the male and female plants. George Marcgraf (*Hist. Pl.*, in Piso, *De Med. Bras.*, 1648, 103) furnishes an account of the plant, and a short description, with a figure, is given by Jacobus Bontius (*Hist. Nat. et Med. Ind. Or.*, in Piso, *Ind. Utri. re Nat. et Med.*, 1658, 96). It was figured and described admirably by Boym in 1656 as an Indian plant introduced into China (*Fl. Sin.*, pl. A), so that it must be regarded as another instance of the rapid dispersion of new plants after the discovery of America. Rheede (*Hort. Mal.*, i., 21, f. 15), 1686, and Rumphius (*Herb. Amb.*, i., t. 50), 1750, also figure and describe both male and female plants, the former observing that the Malabar History.

Pharmacopœia did not include the drug. Hughes (*Hist. Barbados*, 1750, 181, tt. 14, 15) gives a couple of splendid plates prepared by Ehret, while Labat (*Nouv. Voy. aux Isles de l'Ameriq.*, 1724, ii., 308) contributes a useful account of the plant.

Medicine. Dr. Dymock believes that a fibre from the stem is utilised in America and Africa, but the principal value of the tree lies in the fruit, which is both eaten and employed as a MEDICINE. An account of its medicinal properties may here be summarised from *The Agricultural Ledger* (1896, No. 31). The digestive action of the juice upon meat was probably known in the West Indies at a very early date, and appears to have been communicated to the inhabitants of this country upon the introduction of the tree by the Portuguese. It has long been the custom in India to render meat tender by rubbing it with the juice of the fruit or by wrapping it in papaw leaves. In 1877 the milky juice began to attract attention in Europe as a digestive ferment, and Herr Wittmack of Berlin in 1878 made a careful examination of its properties (*Pharm. Journ.*, Nov. 30, 1878).

Active Principle. On the evidence of medical, physiological and chemical experiments made with *papaya*, the active principle has been separated and given the name of *papain* or *papayotin*. It was first separated by Peckolt. This may now be considered almost an article of medical commerce in Europe, and has in fact been extensively used in France and Germany, as well as in England, being given with good results even to children. Notwithstanding all the experiments made with this vegetable pepsin, it has not as yet been introduced into the British Pharmacopœia, though four preparations of it are given in the "*Extra-Pharmacopœia*." *Papain* is even held by some to compare very unfavourably with pepsin when tested with egg albumen. Mr. J. C. Umney, reporting on a sample of 12 oz. of dried *Carica* powder, wrote :—"There is no doubt that by repeated precipitation by alcohol a highly active digestive product might be obtained from this crude concentrated *papaw* juice, valuable for use under those circumstances where pepsin is unavailable." [*Cf. Agri. Ledg., l.c.* 310; Bouchut and Wurtz, *Comptes Rendus*, 1889, 425; 1890, 1379; Bouchut, 617; Wurtz, 1891, 787; also *Dict. de Chem.*, suppl., ii; *Pharm. Journ.*, ser. 3, x., 343, 383; *Chem. and Drugg.*, 1904, 185.]

Collection. A question of importance to be settled is the most serviceable form of commercial *papain*. And since prolonged moisture is deleterious, the juice should be dried as soon as possible; but heat is said to destroy its activity, hence it should be dried at a low temperature. A preparation of this kind is sold in commerce under the name of "Finkler's Papain." The best method to prepare *papain* is to collect the juice of the unripe fruit, mix it with twice its own volume of rectified spirit, let the mixture stand for a few hours, and then filter off the insoluble matter and dry *in vacuo* or over calcium chloride at the ordinary temperature of the atmosphere. After being powdered it should be kept in well-stoppered bottles ready for use. In view of a possible trade either in India or in Europe, manufacturers are recommended to observe carefully the precautions just enumerated. On account of caste difficulties, it might not prove

Animal Pepsin. possible to introduce animal pepsin very largely into use in India, but a good vegetable substitute might be of much value and find a ready sale.

Food. The ripe FRUIT is eaten by all classes and esteemed innocent and wholesome. A wonderful range in quality is observable. In some localities, such as Hazaribagh in Chota Nagpur and Gauhatti in Assam, the fruit is large and very sweet; in others it is small, coarse and hardly edible. The opinion generally prevails that to obtain good fruit it is necessary to remove the majority of the male trees. The better qualities of the ripe fruit are eaten with a little sugar and fresh lemon juice, and by some people with pepper and salt. The use of *papaw* juice

Industrial Use. in softening tasar cocoons and thus facilitating their being reeled, has recently received some attention.

[*Cf.* Buchanan-Hamilton, *Stat. Acc. Dinaj.*, 166, 196; Fleming, *Ind. Med. Pl. and Drugs*, in *As. Res.*, 1810, xi., 161–2; Ball, *Comment. Garcia de Orta, Coll.*, xxxvi., in *Roy. Ir. Acad.*, ser. 3, i., 653; *Pharmacog. Ind.*, ii., 53; Wiesner, *Die Rohst. des Pflanzenr.*, ii., 790; *Der Tropenpflanzer*, 1901, v., 27, 288; viii., 94–5; Sly, *Papain or Veget. Pepsin*, in *Agri. Journ. Ind.*, 1907, ii., pt. 2, 212–3.]

D.E.P., ii., 165. Bengal Currant.

CARISSA CARANDAS, *Linn.*; *Fl. Br. Ind.*, iii., 630; Buch.-Ham., *Stat. Acc. Dinaj.*, 169; Gamble, *Man. Ind. Timbs.*, 479; Cooke, *Fl. Pres. Bomb.*, ii., 124; APOCYNACEÆ. Bengal Currants (Mason), *karaundá, timukhia, kurumia, kalaka, kalivi, karekai, kan*, etc.

A dichotomously branched bush cultivated for its fruit in most parts of India and said to be wild in Oudh, Bengal, S. India, the Konkan and Kanara; distributed to Burma and Ceylon. The tree yields LAC in the Panjáb (*Agri. Ledg.*, 1901, No. 9, 211). Lac. The fruit is ripe in July to August. Seasons. It is mentioned in the *Ain-i-Akbari* (Blochmann, transl., 1590, i., 67) as sub-acid, and as sold at 1 *dám* per seer, *i.e.* 40 seers for Rs.1. It is said to be used as an AUXILIARY in DYEING and TANNING; an adhesive fluid exudes from wounds on the stem. Dyeing and Tanning. When unripe the fruit is astringent, and when ripe cooling, acid and useful in bilious complaints and as an antiscorbutic. Medicine. The root is acrid and is made up as a paste with lime-juice and camphor, and used to keep off flies and relieve itch. Just before it ripens the fruit is made into pickles and also employed in tarts and puddings. When fully ripe it makes a jelly equal to red currant, for which purpose it is grown in European gardens. Food. The Natives universally eat it fresh and do not cook it, except as a preserve in curry or chutney. The TIMBER is hard, smooth and close-grained, and is used both as fuel and for Timber. making spoons and combs, especially at Udayagiri in Nellore. The shrub makes exceedingly strong fences, and its number of sharp spreading thorns render such hedges almost impassable.

C. spinarum, *A. DC.*; a small thorny evergreen shrub, wild in most parts of India, especially in the drier zones. The small fruit is eaten and the timber used for much the same purposes as that of ***C. Carandas.*** It is an important element in reafforestation, since it persists on the poorest and rockiest soils in spite of being greedily eaten by sheep and goats. Rumphius (*Herb. Amb.* (*Auctuar.*), 1755, vii., 57) describes ***C. Carandas,*** the cultivated plant, whose fruits he says are made into pickles when half ripe. His plate (t. xxv.) is, however, such that its determination is impossible.

[*Cf.* Baber, *Memoirs*, 1519 (Engl. transl.), 326; J. Bauhin, *Hist. Pl.*, 1651, i., 88; Garcia de Orta, 1563, *Coll.*, xiii.; also in Clusius, *Arom. Hist.*, 1567, 214; and Ball, Comment. in *Proc. Roy. Ir. Acad.*, ser. 3, i., 400; Jones, *As. Res.*, iv., 263–5; *Pharmacog. Ind.*, ii., 419.]

CARPETS AND RUGS.—Birdwood, *Indust. Arts Ind.*, 370–86; Baden-Powell, *Handbook, Manuf. and Arts Pb.*, 1872, 10–2, 26–7, 51; W. P. Dickson, *Notes on Carpet Manuf. in Lahore Jail*, Dec. 1885; T. N. Mukharji, *Art Manuf. Ind.*, 388–98; *Monographs, Woollen Industries*:—N. Banerjei, *Bengal*, 1899, 15; A. W. Pim, *N.W. Prov.*, 1898, 9–12; D. C. Johnstone, *Panjáb*, 1886, 7–8; B. A. Brendon, *Bombay*, 1899, 7–12; J. T. Marten, *Cent. Prov.*, 1899, 8; E. Thurston, *Madras*, 1898, 1–11; *Journ. Ind. Art*, 1905, ix.; C. Latimer, *Monog. Carpet Making in Pb.*, 1907; Watt, *Ind. Art at Delhi*, 1903, 425–47. For MATS of vegetable fibres see under **Mats and Matting**, p. 775. **D.E.P., ii., 176–82. Carpets.**

History.—Considerations of space forbid any attempt to discuss the Carpet Industry of India in detail. As pointing possibly to their essentially foreign nature, carpets are in India often designated as *alcatifs* (*katif* = a carpet with long pile, in Arabic). They are mentioned by Pinto (1540 A.D.); Tenreiro (1560); by Linschoten (1598); and by Pyrard (1608)—the last author gives details of the luxurious habits of the Portuguese ladies of Goa, sitting on costly *alcatifs*. There may be said to be two chief kinds of carpets in India:—(*a*) PILE STITCH (the *kalins* or *galichas*), and (*b*) the PLAIN STITCH (the *daris* and *shatranjis*). The reader will find a fairly comprehensive sketch of Pile Carpets in *Indian Art at Delhi*, 1903, and with much advantage might consult the special monographs mentioned above as also the article in the *Dictionary*, while the series of admirable plates given in the *Journal of Indian Art* (1905) will fully elucidate the subject. Pile Stitch and Plain Stitch. In passing it may be said that there is no certain knowledge that Origin. the manufacture in India of high-class pile carpets dates farther back than the reign of the Emperor Akbar, of whom we read that in the year 1590 he "extensively encouraged" carpet weaving in Agra, Fatehpúr and Lahore, and again that "all kinds of carpet-weavers have settled here (? Agra) and drive a flourishing trade." [*Cf. Ain-i-Akbari* (Blochmann, transl.), i., 55; (Gladwin, transl.) ii., 30, 41–2; also (Jarrett, transl.) iii., 9.] One of the earliest and best-known carpets from the Imperial factory at Lahore is that presented in 1634 by Mr. R. Bell to the Girdlers' Company of London, and which may be seen in the Com-

pany's hall. It bears the Company's arms and is Persian in design. It is quite probable, however, that India possessed a carpet industry of its own, though very possibly not in pile carpets, long anterior to the advent of Persian influence (see under Multan, also Ellore). But it would be difficult if not impossible to prove either that India possessed an indigenous art of pile-carpet weaving before the date named, or that the introduced industry made much progress for many years subsequently. It, however, survived and in time absorbed so many local conceptions as to justify the description "Indian Carpets." It has been said that the modern jail-made pile carpets have debased and degraded a system of manufacture that had been "literally and figuratively interwoven with the life of the people." But if the pile-carpet industry was only introduced and fostered by Akbar and practised by his co-religionists, and if it be the fact that it has not to the present day been taken up by any recognised Indian caste, it is difficult to see how it could be described as having become "interwoven with the life of the people." It is much more likely that the modern jail-manufacture preserved from extinction the foreign art, than that it debased and degraded it. Milburn (*Or. Comm.*, 1813, i., 136) says that carpets were formerly an article of trade, but through "the improved state of our own manufactures and the heavy duty on Persian carpets, they are now seldom imported." It would thus seem fairly certain that by the beginning of the 19th century the Indian carpet trade (such as it had been previously), like that of Persia, had suffered greatly through the rise of British manufacturing enterprise. The craftsmen in all countries produce the standard of goods demanded of them; it would therefore be most interesting to obtain any sort of indication of the class of goods in demand immediately prior to the modern jail-made article. So far as Indian records are concerned there is nothing to show that the Natives of India to any material extent ever used, and certainly to-day they do not use, Indian pile carpets. Pyrard (*Voy. E. Ind.*, 1601–10 (Engl. transl.), ii., 248) observes that "They make carpets of the fashion of those of Persia and Ormus, but not so fine or so dear, for they use the rougher and longer wool; the patterns are however the same; they also make cotton carpets with bands of many colours." So long ago as 1655, Terry in his *Voyage to East India* (ed. 1777, 129) pointed out that the Eastern artists were essentially imitative. He speaks of their cotton and silk carpets, but makes no reference to woollen carpets. Thus, then, for the degradation of Indian art not the Government nor the Natives are responsible, but the people of Europe and America, who ask for and therefore get cheap inartistic productions. And this has possibly been confirmed definitely by an invention recently announced that will enable Oriental carpets to be produced by new and special machinery at a price far below that of the hand-loom weaver.

Persian Influence.

Indian Influence.

Jail Influence.

Native Demand.

Machine-made.

For the purpose of easy reference the classification employed in *Indian Art at Delhi* may be pursued in this review :—

Pile Carpets.

I. Pile Carpets :—

Panjáb.

1. ***Panjáb.***—The chief centres of the carpet industry in this province are Amritsar, Kashmir, Lahore, Multan, Hoshiarpur, Batala, Bahawalpur, Kohat and Bannu, and they have been named in their order of importance. But Peshawar has also to be added, since it is the great emporium of the Trans-frontier traffic in carpets brought from Afghanistan, Turkestan and Persia.

Lahore.

Lahore.—It has already been suggested that the manufacture of carpets at Lahore, established very possibly by the Emperor Akbar, soon decayed, and in support of that view it may be pointed out that in Honigberger's *Thirty-five Years in the East* (a work that deals specially with Lahore prior to 1852) there is no mention of an indigenous carpet industry. In this connection also it may be observed that the *Ain-i-Akbari* makes frequent reference to the Persian carpets as regularly imported into India (Blochmann, transl., 55). And it would seem probable that most of the Lahore carpets mentioned in the Records of the East India Co., and elsewhere, refer to that Trans-frontier trade and not to Indian woven carpets. A letter to the East India Co., for example, of the year 1617 (Foster, *E.I.C. Letters*, vi., 250) mentions that "carpets to be well chosen would require a long time: those which are true Lahore carpets are not suddenly to be gotten." It is possible that this may point to the survival of the Muhammadan carpet-weaving industry (introduced by the Emperor some 30 or 40 years previously), or it may simply denote the uncertain Trans-frontier supply, the carpets being picked up in the bazárs, not ordered from the weavers. At the present day, at any rate, the most prized carpets in Lahore Museum are

those discovered at Peshawar, and, with the exception of a few looms in the jails, there is no local industry. A beautiful carpet, the property of Mr. G. Salting, is figured in the *Journal of Indian Art* for April 1905, and said to have come from a Lahore factory in the 17th century.

Amritsar—This is probably the most important carpet-weaving centre in India, although the industry would appear to be quite modern. I have not been able to find any references to it, either in the *East India Co.'s Letters* or in the older books of travel. It may be said to be mainly in the hands of Hindus who employ European supervision, and Muhammadan weavers who work (for the most part) on the contract system. It is affirmed that the utmost care is taken in securing the oldest and choicest patterns and in selecting the wool and the vegetable dyes. Pashm (the fine shawl-wool) and camel's hair are used for the best descriptions, and, as with all Indian carpets, the work is done entirely by hand. There are several factories, some of which possess as many äs 300 looms, others not more than eight or ten. The industries of *Hoshiarpur* and *Batala* may be taken as off-shoots of the carpet-weaving of Amritsar. Amritsar. Pashm. Hoshiarpur and Batala.

In *Kashmir* there are several factories which turn out extremely beautiful work. The trade is in Srinagar, and the factories are practically all owned by Europeans, and were originated to find labour for the shawl-weavers who were thrown out of employment through the decline in the demand for their hereditary craft manufactures. The plates in the *Journal of Indian Art* (1905), July and October (six in number), fully exemplify this style. The fine old carpets preserved in the Asar Mahal of Bijapur are believed to date from 1657 and to have come from Kashmir. If this be correct the Delhi Emperors may have established a factory in the "Happy Valley" 250 years ago. The carpets in question are fully representative of the styles usually designated Mughal. [*Cf. Journ. Ind. Art., l.c.* Jan.] Kashmir.

Multan is often spoken of as having an indigenous carpet industry, or at all events one which dates prior to the introduction of the Persian craft. It thus seems probable that the so-called Multan conceptions were modelled on rugs brought long ago from Turkestan, in consequence of the Pawindah trade. The narrow shape, bold yet not clear detail, and vivid colouring are characteristics of both Multan and Turkestan carpets. On the other hand, Mr. Latimer speaks of the household industry of Multan as characterised by names of tools, designs, and methods of weaving that are clearly of Persian origin. Examples of Multan and Dera Ismail Khan carpets are to be seen in the *Journal of Indian Art* (1905), July and October numbers. *Bahawalpur* carpets differ but little from those of Multan. In passing, mention may be made of a recent attempt to utilise in the local carpet industry the vast supplies of the floss of ***Calotropis gigantea*** (p. 207). Multan. Bahawalpur.

Peshawar is, as has been already observed, the emporium for Trans-frontier rugs, notably Turkoman or Tekke (commonly called Bokhara) rugs and the expensive Herat and Yarkand carpets. In *Kohat* and *Bannu* and a few other places along the North-West Frontier a peculiar form of rug is produced called *nakhai*, in which loops of the weft threads are made to protrude an inch or so between each pair of the warp strands. The designs are usually in purple or crimson with black, yellow, and sometimes green. The result is crude but not inartistic. Peshawar. Kohat and Bannu.

2. ***Rajputana and Central India.***—From the jail-looms of *Jaipur* excellent rugs and carpets are produced. Some of the most historic of pile carpets are, it is said, in the possession of His Highness the Maharaja. In the *Journal of Indian Art* is given a coloured illustration of one of the gems of that series. *Bikanir* produces the best carpet-wool in India, and is thus eminently suited to become a great weaving centre. The Central Jail has for some years taken a high place for the quality and artistic merit of its carpets. The patterns followed are mostly those of the famous book on Oriental Carpets published by the Imperial and Royal Austrian Commercial Museum, and the carpets produced have attained a position of great merit, through the enlightened interest taken in the subject by His Highness the Maharaja. *Ajmir* jail also produces many excellent carpets and beautiful rugs. Rajputana and C. India. Jaipur. Bikanir. Ajmir.

3. ***Sind and Baluchistan.***—The carpets manufactured in Sind closely resemble those made in Multan. They are said to be the cheapest, coarsest, and least durable of all Indian carpets. The Baluchistan rugs are in design Turkoman, not Persian. They arrive by camel-caravan at Quetta (and Peshawar also) from Afghanistan, mainly Seistan. They are made mostly of goat's hair, which gives Sind and Baluchistan.

them their singularly beautiful lustre. But the Baluchistan carpets and rugs have deteriorated sadly from their pristine beauty and excellence.

U. Prov. Agra.

4. ***United Provinces.***—Several centres are noted for their carpets, such as *Agra, Mirzapore, Jhansi, Jabbalpur* and *Allahabad. Agra* is one of the three centres at which the Emperor Akbar endeavoured to establish a carpet industry. In the *Journal of Indian Art* (Oct. 1905) two plates are given of carpets turned out at this centre. To this day the superior designs of its jail-made carpets are a striking refutation of the charge brought against the jails of having degraded the carpet industry. Recently a factory has been established under European management, to utilise the skilled labour outside the Central Jail. It appears from the E.I.Co.'s letters that Agra was an important distributing centre for other than locally made carpets. Thus the Company's servants of Surat purchased Lahore carpets at Agra (*E.I.C. Letters, l.c.* 250), and the Portuguese merchants of Goa took various carpets from Agra in exchange for jewellery.

Mirzapore.

Mirzapore may perhaps be described as the headquarters of the cheap commercial modern carpets of India. In the *Journal of Indian Art* (July 1905) will be found a highly typical representation of 90 per cent. of the carpets of this centre. There are numerous private factories (both Native and European) engaged in the industry, but the patterns have of late years been supplied mainly by firms in Europe and America, so that the deterioration in quality noticeable for many years past may be spoken of as a direct consequence of this dictation.

South India.

5. ***South India.***—The carpets exported from Masulipatam and Cocanada were those that first attracted attention in Europe as being specifically Indian, and doubtless a century ago they were made at much the same centres as to-day.

Ellore.

At *Ellore,* where the weavers are Muhammadans but very poor, the business is done by advances.

Three Classes of Carpets.

Three classes of carpets were shown to me during a visit made in connection with the Delhi Exhibition :—(*a*) carpets of foreign design, mostly Persian, and defective in every direction : (*b*) carpets collectively known as of Ram Chandra design. In the *Journal of Indian Art* will be seen (July and October numbers) examples of these carpets, especially those from *Vellore.* The same journal (viii., pl. 50) shows a *Coromandel* carpet which doubtless belongs also to the Ram Chandra group. These, as a rule, were good, the colours being well chosen but the quality very low, not more than 5 or 8 threads to the inch : (*c*) the third type represented by an old rug which was so woven (by what the weavers call the "velvet method") as to simulate the fine texture of the old grass-mats. This was probably the original style of Rajamundry and Ellore.

Ram Chandra Carpets.

Masulipatam.

Masulipatam once turned out some of the finest carpets in India, but foreign exporters are said to have degraded the industry by supplying cheap and bad material. At the writer's suggestion the Madras School of Arts reproduced for the Delhi Exhibition two fine Ram Chandra carpets, the originals of which are preserved in the Madras Central Museum. The prevailing features are the rich deep brown-red of the field and the quaint border of rosettes of flowers.

Malabar.

Malabar is said to have formerly produced the only pile carpets of pure Hindu design made in India. They are apparently not now manufactured. In the account of Sir George Birdwood—his Life and Work—as given in the *Journal of Indian Art* (viii., pl. 50), a corner of a beautiful Malabar carpet is shown.

Bangalore.

The jail in *Bangalore* in Mysore State has for long been noted for the good quality of its carpets. One shown at Delhi was distinctly a Hindu design with a Ram Chandra border.

Deccan.

6. ***The Deccan.***—*Hyderabad* formerly produced the wonderfully fine silk rugs known as WARANGALS. The *Journal of Indian Art* (Jan. and July, 1905) shows three carpets of this school. This charming textile has the property of changing colour according to the point of view. The carpets at present produced, while possessing certain features of their own, are far inferior to the old work. The scheme of colour is scarlet, yellow and white. In the work just quoted will also be found highly characteristic examples of Hyderabad carpets.

Warangal Rugs of Hyderabad.

Western India.

7. ***Western India.***—It is probable that the Persian traders very early established themselves along the western coast of India, and there produced carpets under the patronage of the Emperors, Princes, and Nobles of India, very possibly long before they were made in Agra and Lahore. Certainly *Cambay* was one of the earliest seats of the craft, for according to Linschoten (*Voy. E. Ind.* (ed. Hakl. Soc.), i., 47, 60), who travelled in India about 1584, the people of that

city made "*alcatiffas*" (that is, long-pile carpets), "but they are neyther so fine nor so good as those that are brought to Ormus out of Persia." *Alcatif*, according to Crooke (*Hobson-Jobson*, 11), was a name much used in India for carpets during the 16th century. Bombay, except in the School of Art, does not produce carpets. *Ahmedabad* is mentioned very frequently in the E.I.Co.'s letters and records as a centre in the carpet industry. At present there are only one or two very small factories, and the carpets turned out are sent chiefly to America. In *Poona*, the Yeroda Jail has produced some excellent work, mostly copies of the old carpets in the possession of the Asar Mahal and Jamai Musjid of Bijapur. Thus it may safely be affirmed that the Poona jail, instead of exercising a debasing influence on the carpet industry, has conserved what might otherwise have been lost.

Ahmedabad.

Poona.

II. Cotton and Woollen Carpets in other than Pile Stitch.—The *daris*, *shatranjis*, etc. Just as the pile carpets referred to above (the *kalins*, *kalichas* or *galichas*) are usually in wool but sometimes in cotton, so the *daris* and *shatranjis* are mostly in cotton though sometimes in wool.

Cotton and Woollen Carpets.

As already suggested, it is probable that the Indian carpets, prior to the Muhammadan invasion, belonged almost exclusively to the description here indicated. Stein (*Ancient Khotan*, 1907, xxiv., 337, 398) describes and illustrates a fragment of a woollen carpet found by him in the ruins of the Niya site, which were engulfed by sand about the 3rd century. This appears to be in plain stitch, and recalls in design the embroidered rugs of Hissar and Sirsa. So also another rug found at the Niya site is described as of the regular Indian *dari* type, and seems a brocaded cotton textile much closer to the woollen fabrics of Tibet than to anything made in India (*l.c.* 333–4, 397, pl. lxxv.). Terry, in his *Voyage to E. India*, about 1615 (ed. 1777, 127, 186), mentions the cotton carpets in "fine mingled colours," but makes no mention of the woollen or pile carpets. Mandelslo (*Travels*, 1683, in Olearius, *Hist. Muscovy, etc.*, 1662, 39) speaks of the floor of the house in which he resided in Ahmedabad as being covered with tapestry and the pillars draped in silk stuffs. Plain stitch carpets and rugs are universally used by the poorer Muhammadans as praying-carpets (*jainamaz*), and in consequence have often more art shown in their composition than might be anticipated. Some of the more noteworthy centres of production are Rangpur in Bengal; Agra, Aligarh, Bareilly and Bulandshahr in the United Provinces; Jaipur and Bikanir in Rajputana; Bahawalpur, Multan, Gujarat, Sialkot, and Peshawar in the Panjáb; Dharwar, Belgaum, Ahmednagar, Kaladgi and Cambay in Bombay; and Vadavedi and Adoni in Madras. Many modern and ancient *daris* of great beauty were shown at the Delhi Exhibition. One of the most interesting and artistic was the *shatranji* said to have been presented by the Emperor Auranzeb in 1626 to the Jamai Mosque of Bijapur. This has a rich Indian red field with, suspended from the top of each *jainamaz* section, a lamp symbolical of the faith. It would appear to have been woven more like tapestry than an ordinary *dari*, and to have had the patterns separately made and interwoven in their places on the loom. These and such-like give a lesson that might well be learned by the manufacturers of cotton carpets throughout India, namely, that if they would abandon the striped forms and produce richer and more varied designs, such as those of the Poona Jail *daris*, a larger market might be found in India itself, and in foreign countries as well, than has as yet been secured. There can be little doubt that neatly and substantially woven cotton carpets would be more acceptable to the inhabitants of tropical countries than woollen ones, because cheaper, cooler, cleaner and (under a tropical climate) more durable. Further, cotton plain carpets would doubtless be preferable to cotton pile carpets. Much, therefore, remains to be done in the direction of developing the Indian trade in cotton carpets and rugs. [*Cf. Monographs, Cotton Industries*:—Banerjei, *Bengal*, 1898, 33–4; Silberrad, *N.W. Prov.*, 1898, 24–6, f. 36; Enthoven, *Bombay*, 1897–9, 11, 33, etc.; Thurston, *Madras*, 1897, 7–11; Latimer, *Monog. Carpet-making Pb.*, 1907, 1–3.]

Tapestry.

Possible Future Trade.

Woollen Daris and Shatranjis, though not met with very abundantly in India, are still made and much admired. The Bhutias of Darjeeling and the people of Nepal and Eastern Tibet weave strips of woollen thick cloth in various designs, which, when sewn together into sheets, closely resemble Kurdish *khilims*. Mention has already been made of a fragment of a rug found by Stein in the ruins of Niya, Khotan, as recalling the Bhutia woollen rugs. The people of Darjeeling proper also weave thick *chadars* of white and blue

Woollen Daris and Shatranjis.

that are very beautiful and find a distinct place among the art treasures of the residents in the eastern side of India, but are only rarely seen elsewhere.

Bikanir. In *Bikanir*, plain-stitch rugs are regularly woven in wool, but in the same form as the cotton *daris*. The pattern most often employed recalls the barbaric cross-stitch embroideries of Hissar and Sirsa. In Quetta, rugs and camel saddle-cloths are largely woven in wool and richly ornamented with shells. They are in stripes with patterns worked within, and to all intents and purposes should be classed as *khilims*.

Trade ***Trade in Carpets and Rugs.***—The only available details concerning the export trade in Indian-made carpets and rugs refer to (*a*) Mats and Matting of vegetable fibre : (*b*) Carpets and Rugs of wool. A summary of available statistics on the former subject will be found on page 778, so that it is only necessary to give here such particulars as are available regarding the woollen carpets. The quantities are always estimated by

Exports. pound weight, not number. The total weight exported from India to foreign countries in 1899–1900 was 1,691,577 lb., valued at Rs. 23,73,289 ; in 1903–4, 1,878,202 lb., Rs. 26,04,576 ; and in 1906–7, 1,603,330 lb., Rs. 20,89,516. In the last year, goods to the value of 11 lakhs of rupees went from Bengal, 6 lakhs from Bombay, and 2 lakhs from Madras. The increase in the total quantity and value of carpets, etc., exported in 1903–4 was due to an improvement in the trade in these articles with the United Kingdom. The latter took in 1899–1900, 1,180,779 lb., Rs. 17,21,987 ; and in 1903–4, 1,549,658 lb., Rs. 19,54,560 ; but in 1906–7 the quantity fell again to 1,346,144 lb., Rs. 15,66,113. The exports to Ceylon fell from 235,070 lb. in 1899–1900 to 2,980 lb. in 1903–4 ; and in 1906–7 rose to 4,303 lb. The United States took quantities varying from 223,551 lb. in 1899–1900 to 401,340 lb. in 1901–2 ; 266,526 lb.

Imports. in 1903–4 ; and 174,727 lb. in 1906–7. There is also a fairly extensive import trade in Carpets and Rugs, chiefly to Burma and Bombay, from the United Kingdom and Germany. It amounted in 1899–1900 to 842,716 lb., Rs. 8,46,013 ; in 1903–4 to 887,192 lb., Rs. 8,96,738 ; and in 1906–7 to 1,016,055 lb., Rs. 10,56,679.

D.E.P., ii., 183. Wild Safflower. **CARTHAMUS OXYACANTHA,** *Bieb. ; Fl. Br. Ind.*, iii., 386 ; *Ann. Rept. Indust. Mus. Calc.*, 1899–1900, 7–8 ; Watt, *Agri. Ledg.*, 1901, No. 12 ; *Ind. Art at Delhi*, 1903, 231–3 ; COMPOSITÆ.

Wild Safflower (the *kuzburai, kháreza,* of the Trans-Indus and *karar, políyan, poli, kantiári, kandiara, mian kalai,* etc., of the Panjáb) is a native of the drier arid tracts of North India. In Peshawar district it is peculiarly prevalent, the spinose clumps constituting an objectionable feature of the grassy tracts. Where met with in fair abundance the seeds (or to be more correct, fruits) are collected on account of the large quantity of oil which they contain. This oil is the chief ingredient in the Afridi wax-cloth presently to be described, and may also

Cement. be used as a glass cement.

D.E.P., ii., 183–95. Cultivated Safflower. **C. tinctorius,** *Linn. ; Cnicus Indicus,* Rumph., *Herb. Amb.*, 1750, v., 215–20, pl. 79 (2) ; Mukerji, *Handbook Ind. Agri.*, 1901, 292–5 ; Mollison, *Textbook Ind. Agri.*, 1901, iii., 98–101 ; Abbey-Yates, *Agri. Ledg.*, 1904, No. 11. The Cultivated Safflower, Bastard Saffron, Carthamine Dye, the *kusum, kásumba, kusúmbo, kusubi, kardi, kábri, ma, sufir, kar* or *karar, sendurgam, agnisikha, hebu, su, subán,* etc. The Arabic *usfúr* (Ibn Baithar, 1200 A.D., ii., 196) assumed various forms and gave us the English name :—thus *affiore* (Pegolotti, *Pratica di Mercat.*, 1343, 372), *asfiore, asfrole, astifore, asfiori, zaffrole* or *zaffrone, saffiore* and finally *safflower*. Another Arabic name, *kurtum* (used in the Makhzan), may

have originated the botanical name ***Carthamus.*** The most prevalent Indian vernacular name *kusum* comes direct from the Sanskrit *kusumbha.*

History.—" This plant is the *kusumbha* of Sanskrit writers, who describe the seeds as purgative, and mention a medicated oil " (*Pharmacog. Ind.*, ii., 308). That is the commonly accepted opinion, but on the other hand Dutt (*Mat. Med. Hind.*, 307) makes no mention of the special knowledge possessed by the Sanskrit medical writers, and it may be added the medical treatise which constitutes *The Bower Manuscript* (Hoernle, transl.) is silent both as to the *kusumbha* plant and its oil. The Greek *cnicus* (*Paulus Ægineta* (Adams, transl.), iii., 178) by most authors is identified with the Bastard Saffron. The early Greek authors speak of *cnicus* as a spinose plant, but Dioscorides (iv., 187 (ed. Sprengel), 1829, i., 680) mentions that it was a pot-herb and purgative medicine. Galen, Avicenna, Serapion, Rhases, etc., follow Dioscorides, but most Arab writers add the additional property that it is alexipharmic. Mesua, who lived at Bagdad in the 10th century, wrote a great work on the Medicine of the Greeks and Arabs. He opens his account of *cnicus* (Marinus, transl., 1562, 74) by observing that the plant is both wild and cultivated, but that the so-called Indian *cnicus* is not *cnicus* at all. He then observes that the seed is the most valuable, especially the large white kind. The figure given by Marinus is an excellent representation of ***C. tinctorius.*** Carthamus was retained in European pharmacy down to comparatively recent times. De Candolle (*Orig. Cult. Plants* (Engl. transl.), 164), following Targioni-Tozzetti (*Cenni Storici, Intro. di Varie Piante*, 1853, 88), thinks the determination of the Greek *cnicus* with Carthamus very doubtful. Pliny distinctly says the oil was used in Egypt in place of castor-oil, but he adds the plant was not known to the Romans. It may be added that Pliny writes it *cnicus* and Columella *cnecus.*

Cnicus versus *Carthamus.*

Purgative Oil.

The grave-cloths of the ancient Egyptian mummies are dyed with safflower, and fragments of the plant and the seeds have been found in tombs. [*Cf.* Rawlinson, *Hist. Egypt*, 1881, i., 62–3; Hehn, *Kulturpfl. und Haust.* (ed. 6), 261; Wiesner, *Die Rohst. des Pflanzenr.*, ii., 678–84.] The Sanskrit authors describe the *kusumbha* oil as purgative, so that identical properties were assigned to it in Egypt, Africa and India. An Abyssinian so-called wild species (***C. lanatus,*** in Schweinfurth, *Fl. Æth.*, 1867, 143) has by some writers been accepted as the original stock of the cultivated plant; so also, and with equal if not greater force, ***C. Oxyacantha,*** the Indian wild species, has been advanced as the source of the cultivated plant. De Candolle accordingly came to the opinion that since an undoubted ancient cultivation had been established for both India and Africa it was probable the true ***Carthamus tinctorius*** might be found wild in the intermediate country Arabia. He accordingly cites in part support of that suggestion the circumstance that an author quoted by Ibn Baithar (the Arab, Abu Anifa) mentions both a wild and cultivated form as met with in that very country. In China there would seem little doubt safflower (*hung-hua* or red-flower) was introduced about the 2nd century B.C. [*Cf.* Breitschneider, *Europ. Bot. Disc. in China*, 1898, 4; also *Value Chinese Botanical Works*, 1870, 15.] Japan received it from China, but according to Rein (*Indust. Japan*, 176–7) it can hardly be regarded as more than a botanical curiosity in that country—the cosmetic *beni* being manufactured from foreign (mostly Indian) supplies of safflower. [*Cf.* Milburn, *Or. Comm.*, 1813, ii., 238–9; Buchanan-Hamilton, *Stat. Acc. Dinaj.*, 208; Lacaita, in Maw, *Genus Crocus*, app. v.; *Der Tropenflanzer*, viii., 511; Joret, *Les Pl. dans L'Antiq.*, 1904, ii., 272.]

Abyssinian Wild Plant.

Indian Wild Plant.

Chinese Plant.

Cultivated Indian Races.—There are two main conditions, one grown purely and simply for its flowers—the safflower dye of commerce, the other for its oil-yielding seeds, the *kusum* or *carthamus* oil of trade. The former is fairly extensively produced in Bengal, the United Provinces and the Panjáb, while the latter is chiefly met with in the Central Provinces and Bombay. But while these two conditions or properties seem well understood agriculturally, dried specimens of the plant grown for the one or the other purpose are indistinguishable. Moreover several races occur under each of these states, such as with small, very hard spinose leaves (much as in *C. Oxyacantha*) or with large, soft, almost non-spinose edible leaves. Some have narrow, hard and sharply spinose bracts, others broad almost entire bracts. Still, however, most of these

Two Crops.

Dye

Oil-yielding Forms.

conditions recur again and again with the oil-yielding and the dye-yielding races, so that no set of characters can be given, to separate the groups that belong to the one or the other. Speaking broadly, however, the

Dye-yielding Forms.

oil-yielding forms are more spinose than the dye-yielding, and have usually yellow-coloured flowers, the dye forms being orange or even yellow tinged with scarlet. The dye-yielding plants require a rich soil and

Spiny and Spineless Forms.

humid atmosphere, hence the loss of spines may be due to high cultivation and protection. In the young state the smooth-leaved spineless forms

Grown as a Pot-herb.

are edible, and in some parts of the country, notably Burma, they are mainly, if not exclusively, grown as pot-herbs. But within each of the great centres of production there may be both smooth and spinose forms. Thus in Bengal a spinose dye-plant is known as *kuthi* or *kutela* and a spineless dye-state called *murdi*, *murilla* (= shaved), *bhuili*. In the United Provinces the spineless *kusum* affords both dye and oil, while the spinose form distinguished as *kasar*, *kasur*, is grown for its oil-seeds only. In Berar (Sule, *Monog. Dyes and Dyeing*, 1895–6, 1) the spiny

The Dye and the Oil Crops.

kati kardi yields an inferior dye and good oil, while spineless *bodki* gives a superior dye. In Bombay two great centres of production exist, viz. on the rich alluvial loams of Kaira and Ahmedabad, in Gujarat, where the spineless red-flowered dye-yielding *kusumbyachi* or *kusumba* prevails, and the Deccan, with its spiny *sadhi* or *kardai*, an oil-yielding crop. [*Cf.* Fawcett, *Monog. Dyes and Dyeing, Bomb.*, 1896, 25–9.] Briefly Bengal is (or rather was) the source of *kusum* dye, and the Deccan of the safflower oil. These products may therefore be dealt with separately :—

Safflower Dye.

Safflower or Carthamine.

I. THE DYE—Safflower or Carthamine.—So much has been written regarding the cultivation and utilisation of safflower that a brief review of the modern results seems all that is called for. But it may be explained that the various provincial Governments of India issued, in 1896, monographs on "Dyes and Dyeing," and that these will be found to have special chapters on safflower. So also *The Agricultural Ledger* (1904, No. 11) may be described as a compilation of the more important passages from modern writers, and it thus amplifies the particulars recorded in the *Dictionary*. The remarks that follow will accordingly be restricted as far as possible to facts calculated to assist the merchant or cultivator, but will abstain from republishing technical details, especially methods of dyeing. But in this connection it may be observed that safflower has preserved its position in spite of foreign dyes, mainly

Wedding Garments.

through the colour being viewed as more or less sacred for wedding garments.

Cultivation.

Cultivation.—Safflower, though by no means so important a crop as in former years, is still grown to a fair extent in the Dacca Division of

Bengal.

Bengal, and here and there throughout the Province. Taylor (*Topog. and Stat. Dacca*, 1840, 133–5) gives an interesting account of the production during the prosperity of the industry. The best quality was grown in the

Assam.

vicinity of Pattergotta. Safflower is also met with in the Surma Valley

C. Prov.

and in Manipur, but not in the Assam Valley proper. In the Central Provinces it used to be extensively produced in Raipur and Chhindwara, but the

U. Prov.

area in recent years has been greatly curtailed. In the United Provinces of Agra and Oudh, though met with now and again, it assumes importance

Panjáb.

in Meerut only. In the Panjáb it is to be seen in most districts, but Hoshiarpur and Amballa are perhaps most spoken of, and the safflower of the hills, especially that of Kabul, has the best reputation. The wild

safflower is also a product of considerable value. In Berar safflower is regularly cultivated, though by no means to the extent formerly witnessed. In Madras it may be seen here and there, and in Burma it is more grown as a vegetable than as a dye. But in Bombay there are two centres of production. The cultivation for dye is not extensive, and is confined to Gujarat and the Karnátak, Kaira being perhaps the most important district. Dr. Hove (1787) refers to the dye of *Carthamus* being then used in Gujarat to dye *pagris*. But the Bombay dye is regarded as much inferior to that of Dacca in Bengal.

Berar. Madras. Burma. Bombay.

Methods.—The systems of cultivation pursued are so very similar throughout India that the subject may be treated collectively, the remark being made that it differs province by province, according to the amount of attention given and the local value of the crop. It is sown along with other *rabi* crops such as gram, wheat, barley, tobacco, opium, chillies, carrots, etc., from about the middle of October to the end of November, or in Chittagong as late as January. It requires a light sandy soil, and one which possesses a fair amount of moisture. In the better cultivation the land is lightly manured and ploughed repeatedly from May or June till sowing time. It is either sown broadcast or drilled, the latter in Bombay, 3 drills 18 to 22 inches apart of safflower alternating with the subsidiary crop. In the less important cultivation it forms single drills or surrounds other crops, its spiny character serving the purpose of a protecting hedge. On the central flowering head appearing, this is nipped off in order to cause lateral shoots and a more copious flowering. The prunings and thinnings are eaten as a pot-herb. The crop comes into season in January to April, or even May, and is plucked every second or third day. Delay in collecting the flushings of florets causes loss in dye. Rain during the flowering is also very injurious. The florets being picked after fecundation, the seed ripens and yields a supplementary crop. The average yield of dried florets is in Bengal about 80 lb. (according to Mollison (*l.c.* 100) from 100 to 120 lb. in Bombay), per acre, and of oil-yielding seeds (fruits) 400 to 600 lb. The first and the last pickings of florets are by most writers considered inferior in dye merit to those in mid-season.

Methods. Seasons of Sowing. Thinnings Eaten. Seasons of Crops. Yield.

Manufacture.—The day's collection is carried to the homestead and partially dried in the shade. It is then rubbed between the hands, placed on an arrangement of basket filters, and pure stream (or slightly acidulated) water poured over. This removes the most soluble of the useless yellow dye, but care must be taken that the water is not alkaline, or the red dye also may be washed out and the florets rendered useless. When the water passes through clear the washings are regarded as complete. The florets are then partially dried and pressed into the small characteristic cakes met with in trade; then the drying is completed. According to Taylor the florets in his time were saturated with water in the evening and next morning trodden underfoot, and this was repeated for four or five days until the water ran off clear.

Manufacture. Florets Washed. Dried and Caked.

In centres where little attention is given to the crop the florets are not washed, and instead of being made into cakes, are formed into balls or sold as loose powder. The presence of the yellow dye lowers the value and increases the weight. In Bombay a curious sytem prevails which consists in rubbing into the florets a certain amount of *til* oil (a *tola* weight to a pound of the florets). Mollison observes that this is the practice in Gujarat, but it is known to produce loss of colour. This very possibly

Oil rubbed into Florets.

accounts for the lower price of Gujarat safflower as compared with that of Dacca. Apparently also the yellow dye is not removed until a later stage, and the oil would thus seem to serve no useful purpose. It recalls, however, the practice described by Rumphius (*l.c.* 217), where the people of the Malay are spoken of as adding the bruised oil-yielding seeds of ***Aleurites triloba*** to prevent the florets from crumbling to dust.

Price. Safflower-dye cakes (Gujarat) are sold in Bombay at 2 to 2½ lb. per rupee. The value is estimated according to the colour that a given weight will impart to a pound of cotton.

Trade in the Dye. ***Trade in Safflower Dye.***—Madder in Europe and Safflower in India are the dyes that felt immediately the effect of the discovery of chemical colours. This, in the case of the Indian product, may be exemplified very briefly. Half a century or so ago, safflower became a fairly important commodity. It is curious, however, that none of the early travellers in India mention the dye. The first botanist who describes its cultivation in the East would appear to be Rumphius. Milburn records the

Early Statistics. Record. exports in 1804 as having been 247 cwt., valued at £1,460, or £5 18*s.* 5*d.* a cwt. Four years later the exports were 1,070 cwt., valued at £4,532, or £4 4*s.* 8*d.* a cwt. An import duty at British ports was levied of 7*s.* 4*d.* a cwt. In 1824–5 the exports from India appear to have been 6,185 cwt., and in 1837 they stood at 7,962 cwt. Passing over a period of close on forty years, we next learn that the Indian traffic had become (in 1874–5) 10,157 cwt., valued at Rs. 6,50,827 (or expressed at the rate of exchange that then prevailed, approximately £60,000); but a sudden change took place, for the very next year the traffic fell to 2,914 cwt., valued at Rs. 1,63,528, and ten years still later (1884–5) had become 1,459 cwt.,

Recent Returns. valued at Rs. 83,083. Within the past six years a revival in quantity seems to have set in, since the exports were in 1899–1900, 1,993 cwt., valued at Rs. 34,572, and in 1903–4 the corresponding figures were 4,313 cwt. and Rs. 67,506. They have since fallen, however, to 3,670 cwt., Rs. 50,389, in 1906–7. A remarkable feature of the traffic thus briefly outlined may be said to be the decline in the prices realised—viz. from £5 18*s.* 5*d.* a cwt. to the price in 1901–2, viz. Rs. 20 or £1 6*s.* 8*d.* a cwt. Even twenty years previously (1881–2) the price realised was nearly double the rates that rule to-day. It is not, therefore, to be wondered at that safflower has ceased to be an important crop, and that but for the local markets the dye might by now have disappeared from India as completely as has the madder from Europe.

Japanese Demands. The exports from India go mainly to Hongkong, but a recent demand from Japan has been viewed as a favourable prognostication for the future. The local market continues fairly large in spite of foreign mineral dyes, owing to the fact that safflower is associated with the social customs and religious feelings of the people. The varying quality would seem to depend first of all upon the climate and soil of the locality where produced; next, the care pursued in collection, and the method of preparation followed. With all the finer samples the yellow dye has been washed out and the florets purified. This has naturally the effect of lowering the weight and concentrating the dye. Washed safflower must

Price. accordingly fetch a higher price than the impure and adulterated dye. In further purification of the dye a second yellow colour is precipitated

Carthamin. and removed by means of acetate of lead. *Carthamin*, the valuable red colour, may then be extracted in a pure form by making use of its

solubility in alkaline solutions, and insolubility in pure or acidulated water. In India the alkali used is almost invariably that prepared by incinerating *bajra* (*Pennisetum*) stems or *chir chira* (*Achyranthes*, see p. 49), but crude natural carbonate of soda known as *sajji-mátti* is also employed. It would seem probable that the isolation and utilisation of carthamin is in India a comparatively recent discovery.

Alkali Used.

II. THE OIL.—The seeds from the dye-yielding plant are collected and form a supplementary return, but, as already stated, in some parts of the country, notably Bombay, an oil-yielding crop is specially grown. Mollison (*l.c.* 98) says, "Safflower is the most important oil-seed crop in the Bombay Presidency. The area is usually from 500,000 to 600,000 acres annually. The chief centres of cultivation are in the black-soil *rabi* lands of Ahmednagar, Poona, Sátára, Bijápur, Dhárwár, and Belgaum." It is subordinate to the crops with which it is associated such as *juár*, wheat or gram. "It therefore participates in the general cultivation given to these crops." "Usually three consecutive rows of safflower alternate with 9 or 15 or 21 consecutive rows of the principal crop." In the Central Provinces the area of special oil cultivation has recently been greatly curtailed, so that the Deccan production may be accepted as alone of importance, though of course the oil of the dye crop must not be entirely ignored.

Oil.

Bombay.

Ahmednagar, Poona, Sátára, Bijápur, Dhárwár, and Belgaum.

C. Prov.

Manufacture.—It has been customary to find Baden-Powell's statement (*Pb. Prod.*, 421) that two oil-yielding forms of this plant exist —the wild and the cultivated—repeated by Indian writers without its being observed that an admission was being thereby made to which only the most cursory attention had been subsequently paid. But in addition to there being two distinct sources of the oil there are also two widely different methods of preparation. In the one the seeds (fruits) are simply subjected to cold-dry pressure either before or after they have been husked. The yield is said to range from 20 to 30 per cent., but both the quality of the oil and the value of the cake depends upon the seed being husked. The second process is a hot-dry extraction, or rather a crude downward distillation. The seeds are placed within an earthen pot, and this is inverted over the mouth of a similar pot placed within the ground, the two pots being separated by a perforated plate. Over and around the inverted pot is piled some fuel, and on this being ignited, the seeds are partly roasted; the oil in consequence drains from them and accumulates in the lower or submerged pot.

Two Oil Plants.

Extraction of the Oil.

Two Methods.

The cold-drawn oil has a clear straw colour, with a sp. gr. of ·9224 at 15° C. According to Hooper (*Agri. Ledg.*, 1904, No. 11, 160), it "possesses pronounced drying properties. It readily saponifies with alkalis, forming a fairly good soap, and the free fatty acids have some of the characteristics of the linoleic acid obtained from lineseed. The oilcake retains 11·55 per cent. of the natural oil, and is not contaminated with earthy impurity. The nitrogen amounts to 3·19 per cent., which is equivalent to 19·94 per cent. of albuminoids." It is an oil extensively used for culinary purposes, and to adulterate *ghi* or *til*. Moreover, safflower, earthnut, and *til* are often mixed together and the oil expressed; this constitutes the sweet-oil of Bombay. Safflower oil is also said to be an ingredient in Macassar hair-oil. Inferior qualities are used for illumination. The hot-extraction oil is about one-fourth larger than the cold, but is useless both for burning purposes or for food. It has, in fact, acquired a

Description.

Culinary Oil.

Sweet-oil.

new property, and been converted into a substance very serviceable for greasing well-ropes, leather well-buckets, etc., purposes for which the cold-drawn oil is quite unsuited. In other words, the oil has been converted into what is known as *roghan*—a substance employed to prevent leather from hardening on its being exposed to the action of water or of a damp atmosphere.

Roghan.

Oil.

Oil of Wild Safflower.—In the Northern Panjáb, more especially Peshawar, a very different process is adopted from that just detailed for the manufacture of *roghan*. The *polli* oil (the oil of ***C. Oxyacantha***) expressed by the cold process is placed in earthen vessels and boiled continuously for twelve hours. The vessels are so placed that it is not possible for a flame to reach the boiling liquid, and the temperature is kept low and uniform. In time it emits volumes of white pungent vapour, so exceedingly disagreeable that the manufacturers are compelled to conduct their industry under special license and in a place assigned to them remote from human dwellings. On the oil being cooked to the required extent, and while still boiling hot, it is thrown into large shallow trays containing cold water. It swells up into a jelly-like substance, the *roghan* of Northern India. This is stored in tin cans and sold to the manufacturers of the so-called Afridi wax-cloth.

Afridi Wax-cloth.

Wax-cloth.—It would occupy too much space to repeat the accounts published in *The Agricultural Ledger* (1901, No. 12, 393-414) and *Indian Art at Delhi*, 1903 (229-34), regarding this curious little industry. The facts made known in these publications prove that we have been incorrect in affirming that the Natives of India were unaware of the drying property of certain oils in the manufacture of paint with mineral pigments. But in the Afridi wax-cloth the paint is not applied by a brush but by means of an iron style. The rapidity and accuracy with which the pattern is elaborated by threads of plastic and coloured *roghan* has to be seen to be appreciated or understood. The skilled artist can work from right to left or left to right with equal ease, and, just as in penmanship, the thick downward strokes and the fine upward hair-lines are each made to occur in their proper places in the elaboration of the pattern with which the fabric is being covered. Where two or more colours have to be given, the operator usually applies all the patches or lines of one colour before he proceeds to use the second or the third shade. The half-finished table-cloth or fire-screen may in consequence often appear a bewildering production, since it may be impossible to discover the actual pattern in the operator's mind.

Oil Paint.

Application to Cloth.

Castor-oil *Roghan.*

In passing it may here be added that in Baroda, castor-oil, and in Kach, linseed-oil, are similarly made into the *roghan* used in the fabrication of the wax-cloths of these localities. Experiments conducted in the Industrial Museum, Calcutta, have revealed the fact that the oil of the wild safflower possesses no special properties over those of the cultivated plant. It would further seem that in the Afridi wax-cloth India possesses the nucleus of a possible large new craft, that of producing wax-cloth, water-proofing materials and linoleum, from local materials and possibly by means of the expert craftsmen who from time immemorial have turned out the goods here indicated. The jute mills of Calcutta prepare and export the cloth required by the wax-cloth and linoleum manufacturers of Europe and America. India, moreover, will be seen to import a by no means insignificant amount of the specially prepared wax-cloth and linoleum (oil-cloth and floor-cloth) made on the jute textiles exported from India

Linoleum.

Cloth for Linoleum made in India.

for that purpose. In 1876–7 these imports were valued at only Rs. 17,620; in 1901–2 they came to Rs. 5,74,306; in 1903–4 to Rs. 4,17,788; and in 1906–7 to Rs. 6,20,305. Surely the effort to participate in so prosperous a traffic is worthy of attention.

Edible Seed. ***Edible Seed and Cake.—Carthamus*** seeds, especially after being roasted, are eaten, but are most valued as a food for poultry, though, as already observed, the tender shoots are prized as a pot-herb or salad. Mollison makes the remark that cattle have to be educated to eat the cake, but that it has the advantage of keeping well and does not get mouldy. It is highly valued as a manure.

Cake.

[*Cf.* Leather, *Agri. Ledg.*, 1897, No. 8, 159; Duthie and Fuller, *Field and Garden Crops*, i., 51–4, pl. xiii.; *Monographs, Dyes and Dyeing*:—Banerjei, *Bengal*, 73; Duncan, *Assam*, 17–8; Russell, *Cent. Prov.*, 10–11; Hadi, *United Prov.*, 76–7; Fawcett, *Bombay*, 25–9; Holder, *Madras*, 3; Fraser, *Burma*, 10; *Agri. Ledg.*, 1899, No. 12; *Journ. Chem. Soc.*, 1900, 362–3; 1902, 864; *Imp. Inst. Tech. Repts.*, 1903, 128, 131–2; Rawson, Gardner and Laycock, *Dict. Dyes, etc.*, 276; Blount and Bloxam, *Chem. for Engin. and Manuf.*, 326.]

D.E.P., ii., 200. Black Caraway. **CARUM BULBOCASTANUM,** ***Koch.***; *Fl. Br. Ind.*, ii., 681; *Bunium Bulbocastanum, Linn.*; *Carum nigrum, Royle, Illust. Him. Bot.*, 229; *Rec. Bot. Surv. Ind.*, i., 154; *Paulus Ægineta* (Adams, transl.), iii., 74; UMBELLIFERÆ. Black Caraway, *siyah, shia, sájíra, shah-zerah, shiyah zirah, kala jerah* (*zerah*), *zirdu siah*, etc., also called *guniyun* in Kashmir and *umbhu* in Ladakh. These names seem for the most part to be modern adaptations, since the true *kálajíra* is the Black Cumin (***Nigella sativa***, see pp. 442, 811).

Habitat. Black Caraway is a native of Baluchistan, Afghanistan, Kashmir, Lahaul, Chumba, etc., eastward to Garhwal and Kumaon, and westward to Quetta. It is mainly a weed of cultivated land, but is liable to prove dangerous in fields owing to the fondness of pigs for the root. It also exists truly wild on grassy slopes (at alt. 6,000 to 11,000 feet), whence the shepherds collect it as a valuable source of income; but it is nowhere cultivated. It is probably the *krishna-jiraka*, which Royle maintained was well known to the Hindus before the introduction of the European Caraway (***C. Carui***). [*Cf.* Lawrence, *Valley of Kashmir*, 67; Aitchison, *Bot. Afghan. Delimit. Comm.*, in *Trans. Linn. Soc.*, iii., 1.]

An inquiry instituted by the Reporter on Economic Products in response to a question put by the Indian Chambers of Commerce, resulted in the collection of specimens of *zerah* (*zíra*) from the chief towns of India as well as of the fruits (seeds) and plants from all known areas of supply. The fruits in every instance were found to be ***C. Bulbocastanum*** and not ***C. Carui*** (except when stated to be a foreign or imported drug). The examination showed, however, that other seeds are often used as adulterants or substitutes for black caraway. The adulterants were similar in shape, size and markings, but quite destitute of the characteristic aroma. For example, Mr. L. G. Smith, Forest Divisional Officer of Sambulpur, sent four samples from the local bazárs which were subsequently identified as (1) the true Caraway (*mita zerah*), most probably imported; (2) ***C. Bulbocastanum, sa-*** or *shah-zerah*; (3) ***Vernonia anthelmintica, parbat-zerah***; and (4) ***Nigella sativa, kala-zerah***. The sample of black caraway was, however, not pure. Pure parcels were received from Yasin in Gilgit and from Hazara. From Kullu and Bashahr were furnished two qualities called "*zira*" and "*singhu*." The latter was stated to be an adulterant. "*Zira*" proved to be ***C. Bulbocastanum***, and ultimately, through the assistance of Mr. J. H. Lace, then Assistant Inspector-General of Forests, the adulterant was recognised as ***Bupleurum falcatum***. Mr. Lace found the people gathering the seeds in Chamba; he secured a sample and corresponding botanical specimen, so that his material became an authentic type with which to compare the adulterants of commerical parcels. It was in consequence found that the ***Bupleurum*** was identical with the adulterant sent from most parts of India. Is this the *pseudo-bunium* alluded to by Paulus Ægineta which Adams suggested might be ***Pimpinella tenuis***? Mr. Lace says that ***Bupleurum*** is known locally as

Grades of *Zerah*.

Adulteran *Singhu*.

banchak or *bankok*, and that before it is mixed with the carum the fruits are coloured with a decoction of walnut bark. It is sold at 9 seers to the rupee, the true article being very much more expensive—say 3 seers to the rupee. Usually 5 seers of *banchak* are mixed with one seer of *zira*. The black caraway and its adulterant are therefore respectively the "*zira*" and "*singhu*" mentioned in the *Panjâb Forest Administration Reports* from 1894–1900 as obtained from the Kullu forests and sold, the former at Rs. 15 to Rs. 27½ per maund, the latter at Rs. 8. Sir Walter Lawrence says that the seeds of ***Daucus Carota*** are also used as an adulterant, but this cannot be done to any great extent since carrot-seed is not abundant and is also easily distinguishable from caraway, while the dyed ***Bupleurum*** can with difficulty be separated.

Uses. The uses of this caraway, so far as can be ascertained, seem identical with those of ***C. Carui***. From Bashahr large quantities of black caraway are conveyed annually to Rampur and thence distributed *viâ* Amritsar all over India. Amritsar also receives the Kashmir, Afghanistan and N. Himalayan supplies. Other emporia are Karachi and Cawnpore; the former obtains its supplies from Hazara and Baluchistan, the latter from Garhwal and Kumaon. The price at Cawnpore varies according to quality from Rs. 25 to Rs. 44 per maund of 52½ seers, but the consumption is very limited and the sales are usually in small parcels of ½ to 2 maunds. In addition to an Indian supply, Bombay

Price. imports from Persia. The wholesale price is said to be Rs. 8 per 37½ lb. (= Surat maund), and the retail price for cleaned fruit 8 annas per lb. [*Cf. Pharmacog. Ind.*, ii., 120; Kaye, *Settl. Rept. Baltistan Dist., Kashmir*, 1889, 16; Rivett, *Assess. Rept. Muzaffarabad, Kashmir*, 1899, 10, 12, 50, app. xxv.; *For. Admin. Repts. Pb.*, 1894–5 to 1901–2; *Rev. Working Plans, Pangi For., Chamba*, 1901, 2; *Rept. Cent. Indig. Drugs Comm.*, 1901, i., 119; etc., etc.]

D.E.P., ii., 196–8. European Caraway.

C. Carui, *Linn.; Fl. Br. Ind.*, ii., 680. The European Caraway, Carve, Kümmel, *zirah, karoya, karawya*. The vernacular names are in the main, of course, those given under the foregoing species, though sometimes to the name *zerah* is prefixed a description, as *mitha* (sweet), *vilayati* (foreign), or *safed* (white).

As met with in India the fruits are mainly imported, but the plant is probably occasionally cultivated in gardens on the plains as a cold-season crop. The repeated though vague statements of its existence in India "wild and cultivated" seem likely to be due mainly to confusion with ***C. Bulbocastanum***. There is, however, a fairly large import trade in the spice and it may be well to epitomise here a few of the chief uses of caraway, always premising that when such uses can be attributed to the Indian-grown caraway, the reference is in all proba-

Uses. bility to ***C. Bulbocastanum***. The seed is employed both powdered and entire. In the former condition it is an important ingredient in curry powders; in

Medicine. the latter it is put into cakes, biscuits, etc. As a MEDICINE it is stimulant, carminative and astringent. But it is frequently used in flavouring cordials and

Oil. certain preparations of Indian hemp (*bhang*). A valuable essential OIL, obtained from the fruits, is employed in medicine and as a perfume for soaps. The distilled oil is first mentioned in the price ordinances of Berlin for 1574 and in the *Dispensatorium Noricum* (1589). The two valuable constituents in the oil are *carvone* (formerly, *carvol*), which is the essential and odour-bearing body and possesses all the qualities of the drug in a pure form; and *carvene* or *limonene*, a by-product, not suitable for liqueurs but "can be satisfactorily employed instead of caraway oil in medium and cheap soaps" (Schimmel & Co., *Semi-Ann. Rept.*, April 1892, 12). The percentage of oil varies apparently according to cultivation and country of origin. Of the European sorts the Bavarian wild plant yields the highest percentage, 6·5 to 7, whilst the Russian stock yields only 3·2 per cent. The sp. gr. lies between 0·907 and 0·915; oils of lower sp. gr. rarely occur, and are less valuable as they contain less carvone. [*Cf.* Gildemeister and Hoffmann, *Volatile Oils*, 550–8.] A case of poisoning by caraway-seed presented symptoms similar to those induced by other essential oils. [*Cf. Ind. Med. Gaz.*, 1896, 145.] It may be added that caraway from which the oil has

Fodder. been expressed is dried in special apparatus and used as a CATTLE FOOD, being prized for its high percentage of crude protein (20 to 23·5 per cent.) and fat (14 to 16 per cent.). [*Cf. Paulus Ægineta* (Adams, transl.), iii., 158; *E.I.C. First Letter Book*, 201, 480; Bentham, *Comment. on Targioni-Tozzetti*, in *Journ. Hort. Soc.*, ix., 145; Wiesner, *Die Rohst. des Pflanzenr.*, ii., 794.]

C. copticum, *Benth.; Fl. Br. Ind.*, ii., 682; Cooke, *Fl. Pres. Bomb.*, i., 564; Prain, *Beng. Plants*, i., 536; Duthie, *Fl. Upper Gang. Plain*, i., 394. The Bishop's Weed, Lovage (of Indian writers), *ajowan, ajwain, ajwan, juvani* (*jurani*), *ajamo, chochara, owa, amam, omámi, omu*, etc., a herbaceous plant cultivated throughout India, especially in Bengal. It also grows in Egypt, Persia, and Afghanistan, and more recently was introduced into Europe. D.E.P., ii., 198-200. Habitat.

This is certainly not the "*ami*" or "*ammi*" of Dioscorides (as exemplified in the *Codex Vindob.*, 60, which is *Ammi Visnaga*), though that opinion has often been upheld. [*Cf. Pharmacog. Ind.*, ii., 116.] It would appear, however, to be *Ammi perpusillum*, of Lobel (*Stirp. Hist.*, 1576, 414). The fruits are certainly the *ajave* of Percival (1773). Pomet, physician to Louis XIV. of France (*Hist. Drugs* (Engl. ed.), 1712, 3, f. 5), observed that by far the best quality came from Alexandria and Crete. In India it is sown in October to November on ridges, the seed being dibbled every 6 inches; strong manures are deleterious but a liberal supply of water is necessary. The aromatic fruits are much in request for admixture in curries, etc., and in *pan supari*. The plant is referred to in the *Taleef Shereef* (Playfair, transl., 1833, 9) as astringent, aphrodisiac, vermifuge and diuretic. By distillation a WATER and an OIL are obtained, the percentage of the latter being about 3–4. The oil is given medicinally in cholera, colic, etc., being considered, like the fruits, antispasmodic, stimulant, tonic and carminative. History. Cultivation. Medicine Oil.

Omum-water is prepared and sold in most Indian bazárs. A crystalline substance or stearoptine separates from the oil and forms on the surface during distillation. This is sold as *ajwain-ka-phul* ("flowers of *ajowan*"), and is identical with *thymol*, which is the principal constituent (45 to 55 per cent.) of *ajowan*-oil and for which alone the fruits are distilled in Europe. It is prepared on a fairly extensive scale in Ujjain and other towns of Central India and was first made known to Europe by Dr. Stocks. The price is from Rs. 6 to Rs. 12 per lb. [*Cf. Rept. Cent. Indig. Drugs Comm.*, i., 125.] The value of *thymol* is mainly as an antiseptic, and very large orders have recently been received from Japan. The price in Europe varies with the character of the Indian season: during cholera and plague years it has been high (*e.g.* 22*s.* per kilo in 1901), but over-production has tended to keep prices low (*e.g.* 13*s.* 6*d.* in 1897, 13*s.* in 1903). Besides *thymol* certain hydrocarbons called *thymene* are obtained from *ajowan*-oil and used as a soap-perfume. A sample of the fresh plant itself cultivated at Miltitz (Saxony) yielded 0·12 per cent. oil, but the oil had only 1 per cent. of *thymol*. Of 8,641 cwt. of the fruit exported from Bombay in 1903, 8,443 cwt. went to Germany and the rest to America and Egypt. [*Cf.* Schimmel & Co., *Semi-Ann. Rept.*, Oct.–Nov., 1903, 104; Apr.–May, 1904, 130.] The distilled dried fruit contains 15 to 17 per cent. protein and 25 to 32 per cent. fat, thus making an excellent food for cattle. [*Cf.* Gildemeister and Hoffmann, *l.c.* 557; Craddock, *Rept. Land Rev. Settl., Nagpur*, 1890–5; Lawrence, *Valley of Kashmir*, 1895, 346; *Brit. Pharmacop.*, 1898, 335; White and Humphrey, *Pharmacop.*, 1901, 496, 553, etc.] *Omum*-water: *Thymol*. Fodder.

C. Roxburghianum, *Benth.;* Prain, *Beng. Plants*, i., 536; *ajmud, ajmot, randhuni, chanu, rajani*, etc. D.E.P., ii., 201–2. Ajmud.

This is extensively cultivated throughout India for the sake of its seeds, which are used in curries and to some extent for its leaves as a substitute for parsley. As a drug *ajmud* is regarded as carminative and stimulant and has the reputation of being specially useful in vomiting, dyspepsia, etc. (*Taleef Shereef* (Playfair, transl.), 1833, 8). It is probably only a cultivated form of ***C. stictocarpum,*** *var.* ***hebecarpa,*** *C. B. Clarke* (*Fl. Br. Ind.*, ii., 681–2). [*Cf.* Buchanan-Hamilton, *Stat. Acc. Dinaj.*, 188; Fleming, *Ind. Med. Pl. and Drugs*, in *As. Res.*, 1810, xi., 157.] Food. Medicine.

CARYOTA URENS, *Linn.; Fl. Br. Ind.*, vi., 422; Gamble, *Man. Ind. Timbs.*, 729; Prain, *Beng. Plants*, ii., 1093; Brandis, *Ind. Trees*, 654; Cooke, *Fl. Pres. Bomb.*, ii., 805–6; PALMEÆ. The Indian Sago-palm, Bastard-sago, *mari, bherawa, birlimhad, mhár-mardi, conda-panna, bhyni, shunda-pana, minbaw*, etc. A beautiful palm met with throughout the hotter parts of India from the Sikkim Himalaya and Assam to Ceylon and Singapore, distributed throughout tropical Asia and Malaya. D.E.P., ii., 206–8. Sago-palm. Habitat.

The Fibre.—The plant is mentioned by almost all the pre-Linnæan Fibre.

authors from Varro (116 B.C.) downwards. The chief commercial value of the palm lies in the fibrous cords or fibro-vascular bundles found naked at the base of the leaf-sheath and within the petioles, flowering stalks and even the stems as well. These constitute the strong *kittul* fibre of Ceylon and the *salopa* of Orissa, a fibre which also comes from Burma and Bombay.

Kittul or *Salopa* Fibre.

Brushes and Brooms.

It is made into ropes, brushes, brooms, baskets, etc. As a brush fibre it was described in the *Treasury of Botany* (1866) and has been shipped from Ceylon to England since about 1860. Five or more strands, fastened together by special machinery, have moreover been found to make an excellent substitute for whalebone in corsets. Since the discovery that *kittul* fibre was not only equal but even superior to, because less brittle than, the Bahia *piassava* (the fibre of ***Attalea funifera***), several brush factories in India, it is believed, have begun to use it instead of bristles in hair-brushes, clothes-brushes, horse-brushes, etc. [*Cf.* Hooper, *Rept. Labor. Ind. Mus.*, 1903–4, 29.] In this they are following the lead of European makers : Hannan (*Text. Fibres Comm.*, 1902, 155), for example, says that *kittul* is now in much request in Europe for brush-making and that some of the finest qualities have been adopted as substitutes for bristles. Jackson (*Comm. Bot. XIXth Cent.*, 1890, 142) observes that as much as forty (now fifty) years ago *kittul* fibre was exported to England for admixture with horse-hair (may it not have been ***Chamærops humilis?***). In the brush trade it is steeped in linseed-oil and thus made so pliable that it can be used either with or without bristles in making soft, long-handled brooms which are extremely durable and can be sold at about a third the price of ordinary hair-brooms. Dodge (*Useful Fibre Plants of the World*, 112–3) says it is also made up into machine brushes for polishing linen and cotton yarns, for cleaning scutched flax, brushing velvets, etc. Both in India and Ceylon fishing-lines are made from *kittul* fibre (Drury, *U. Prov. Ind.*) and strong wiry ropes capable of holding wild elephants are constructed of the fibre, while in Australia the leaves apparently are regarded as a good paper material. Lastly, the woolly substance or scurf scraped from the leaf-stalks is used in Burma for caulking boats. The quotations in London on April 20, 1901, were for *long quality*, 8½*d.* to 9*d.* per lb.; for No. 1, 6½*d.* to 7*d.*; No. 2, 2¾*d.* to 3¼*d.*; and No. 3, 1*d*; Ide & Christie (*Monthly Circ.*, Oct. 15, 1907) give the following returns of present date :—*Long*, 8*d.* to 9¾*d.*; No. 1, 6*d.* to 7¾*d.*; No. 2, 2*d.* to 3½*d.*; No. 3, 1*d.* to 1½*d.* Mr. J. C. Willis tells us (*Admin. Repts. Bot. Gard.*) that the exports from Ceylon have never exceeded those returned for the year 1898, viz. 3,794 cwt. The exports from India are unimportant.

Fishing Lines and Ropes.

Price.

Sago : Sugar.

The Sago and Sugar.—Besides its fibres, ***Caryota*** yields from the interior of the stem a sago which is mentioned by Roxburgh (1832), by Robinson (*Desc. Acc. Assam*, 1841, 56) and by other writers as almost equal in quality to the best sago of commerce. As a matter of fact it would seem to be an inferior article, though quite wholesome (*Yearbook of Pharmacy*, 1903, 328). On the Malabar Coast and elsewhere it is made into bread or gruel and thus constitutes an important article of food with the poorer classes. The "cabbage" or terminal bud is edible, like that of most palms. Commelinus (Rheede, *Hort. Mal.*, i., 16, n.) remarks that, according to authors, the pulp of the fruit is bitter and irritates the tongue —a circumstance which doubtless suggested the specific name ***urens.*** The fruit is certainly very pungent and insipid, but I cannot recollect

Food.

Cabbage.

having observed the tingling property just mentioned, though I have eaten it. Finally a toddy or juice is collected by "training" and "tapping" the spathes. This juice is either fermented and distilled into an alcoholic liquor or boiled down into a dark syrup which solidifies into jaggery or palm-sugar—an important product, especially in Bombay and Ceylon. Mr. A. M. Sawyer, writing of the "training" and "tapping" processes in North Travancore (*Ind. For.*, 1896, xxi., 134–8), says that at the end of the first five days of tapping the yield is about 4 quarts per day, increasing by degrees to 6, 8, and 12 quarts. In strong, healthy individuals even 18 or 20 quarts may be obtained at the end of the course. Sometimes, in an unusually prolific palm, three or even four spathes may be seen tapped at the same time, while others, in spite of the most careful training, yield no toddy whatever. An average-sized spathe is tapped in about four months, and all the spathes of one palm are exhausted in about two years. According to Roxburgh the best trees give as much as 100 pints in twenty-four hours. Further details may be found by reference to **Borassus** (pp. 170–1).

Toddy. Sugar. Yield. Varying Yield.

The TIMBER is strong and durable, being much used for agricultural purposes, water-conduits, and for beams and rafters. Not infrequently it is cut into walking-sticks. The seeds are used as beads by the Muhammadans. [*Cf.* Rheede, *Hort. Mal.*, i., t. 11; Buchanan-Hamilton, *Stat. Acc. Dinaj.*, 150; Morris, *Comm. Fibres, Cantor Lect.*, 1895, 34; Lushington, in *Ind. For.*, 1899, xxv., 54–6; Sadebeck, *Kulturgew. der Deut. Kolon.*, 1899, 313; Jumelle, *Les Cult. Colon.* (*Aliment.*), 1901, 25–7; Wiesner, *Die Rohst. des Pflanzenr.*, 1903, ii., 208, 411–2.]

Timber. Beads.

CASSIA, *Linn.; Fl. Br. Ind.*, ii., 261–6; Gamble, *Man. Ind. Timbs.*, 1902, 271–5; Prain, *Beng. Plants*, 1903, i., 435–9; Duthie, *Fl. Upper Gang. Plain*, 1903, i., 290–6; Cooke, *Fl. Pres. Bomb.*, 1903, i., 417–27; Brandis, *Ind. Trees*, 253–5; LEGUMINOSÆ. **D.E.P., ii., 210–26.**

A genus of herbs, shrubs or trees that contains in all about 380 species, mostly tropical, a few only being extra-tropical. India possesses some 18 indigenous species with three or four fairly plentiful introduced forms. They have all showy flowers but are mainly of value as medicines or as tans:—

C. Absus, *Linn.*; *cháksú, chimar* or *chinól, banar*, etc., a herb found fairly plentifully throughout India. The seeds are used in the treatment of ophthalmia and as a cathartic. Species.

C. alata, *Linn.*; the *dádmardan* (=ringworm-killer), or *vilayati-* (or *shinnai*) *-agati* (the foreign ***Sesbania grandiflora***), is a small shrub found in gardens throughout India and supposed to have been introduced from the West Indies. The leaves rubbed up into a thin paste and mixed with vaseline constitute an effectual remedy for ringworm. [*Cf.* Fleming, *Ind. Med. Pl. and Drugs, As. Res.*, 1870, xi., 163; Bennett, *Wanderings N.-S. Wales*, 1834, i., 123.] Ringworm.

C. Fistula, *Linn.*; the Indian Laburnam, the Purging Fistula, or *amaltás, alash, sundáli, sonali, báhavá, gurmála, konraik-kai*, etc. A moderate-sized tree of the Sub-Himalayan tracts ascending to 3,000 feet and common throughout the plains of India and Burma. Indian Laburnam.

The bark is to some extent used both as a tanning material and a drug. The pulp of the fruit is regarded as a safe and useful purgative—one of the commonest of domestic medicines in India—but has the objection of not keeping well. Adams (Comment. in *Paulus Ægineta*, iii., 429–31) mentions that it was known to Serapion, Rhases, Mesua, Ebn Baithar, etc.—in fact to most of the early Arab writers, who speak of it as a purgative drug procured from India, Arabia and Egypt. It is also largely used in smoking mixtures to flavour the tobacco used by the Natives, especially in Bengal. [*Cf.* Mesua, *Op.* (ed. Marinus), 1562, 52; Garcia de Orta, *Coll.*, xiv.; also Clusius, *Hist. Arom.*, 1567, 136; also Comment. by Ball, in *Proc. Roy. Ir. Acad.*, 3rd ser., i., 400; Linschoten, *Voy. E.* Medicine: Pulp of Fruit. Smoking Mixtures.

Ind., 1598 (ed. Hakl. Soc.), ii., 121–2; Prosper Alpinus, *De Pl. Ægypti*, 1592, 3; Pyrard, *Voy. E. Ind.*, 1601 (ed. Hakl. Soc.), ii., 361; Jacobus Bontius, *Hist. Nat. et Med. Ind. Or.*, 1629, in Piso, *Ind. Utri. re Nat. et Med.*, 1658, 101–2; Ligon, *Hist. Barbados*, 1657, 68; Tavernier, *Travels*, 1676 (ed. Ball), i., 174, n.; ii., 20; *E.I.C. First Letter Book*, 200, 480; Buchanan-Hamilton, *Stat. Acc. Dinaj.*, 158.]

Jamaica Senna.

C. obovata, *Collad.*; sometimes called Country Senna, Jamaica Senna, Italian Senna. This is the *bhui-tarwar*, a plant common in many parts of India and occasionally to be seen in the bazárs as an inferior quality of Senna. [*Cf.* Greenish, *Pharm. Journ.*, 4th ser., ix., 470–1.]

Negro Coffee.

C. occidentalis, *Linn.*; the Negro Coffee or *kásóndi, kásundá, hikal, kálkashundá*, etc. An under-shrub abundant on waste land and roadsides throughout India, though probably originally introduced from America. The

Medicine.

leaves, roots and seeds are medicinal. The seeds dried, then ground to powder,

Coffee Substitute.

are used as a good substitute for coffee, and since they are antibilious are said to be often beneficial. [*Cf. Kew Bull.*, 1881, 34–5; *Yearbook of Pharmacy*, 1887, 175–6; *Pharmaceut. Journ.*, 1900, lxv., 439; Ridley, *Mal. Pl. Names*, 116; *Rev. des Cult. Colon.*, 1902, x., 63.]

C. Sophera, *Linn.*; the *káli-kasonda, jangli-takla, kál-kasondá, banar*—(the *kásamarda* or cough-destroyer)—a closely allied and often much confused plant with *C. occidentalis*. It is cosmopolitan in the tropics and common throughout India. The bark, leaves and seeds are cathartic and the juice of the leaves

Ringworm.

viewed as a specific for ringworm. [*Cf.* Prosper Alpinus, *l.c.* 35.]

Fœtid Cassia.

C. Tora, *Linn.*; the Fœtid Cassia or *chakundá, panevár, panwár, tarotá, kovaria, kowaria*, a gregarious annual under-shrub found everywhere in Bengal and throughout tropical India. This is in Sanskrit called *chakramarda* (= ring-

Ringworm.

worm-destroyer), once more confirming the all but universal reputation of the

Adjunct to Indigo.

species of Sennas. But in this particular plant a more or less new property has been attributed to the seeds, in that they are largely used along with indigo. For this purpose they are regularly sold to the dyers. They are also roasted, ground to a powder, and used in place of coffee. Mr. William Elborne of Owens College chemically investigated these seeds and came to the conclusion that their activity was due to "emodin, a substance closely allied to chrysophanic acid, in chemical characteristics, and considering the purpose for which the Natives of India use the plant, evidently in medicinal properties." Adams (Comment. in *Paulus Ægineta*, iii., 466) identifies this plant with the *kelkel* of the Arabs —a drug mentioned by Avicenna, Serapion, Rhases, etc. etc.

D.E.P., ii., 212–5. Tinnevelly Senna.

C. angustifolia, *Vahl.*; the Tinnevelly Senna of Indian commerce, perhaps best known by the following names:—*sanna-mukki, senά-makhi, Hindi-sanna, nilavirai*, etc.

Adams (Comment. in *Paulus Ægineta*, iii., 431–3) gives a most interesting sketch of the early knowledge in Senna. He says Serapion was undoubtedly the first author who describes the drug as an article of the Materia Medica. He, however, quotes still other writers, such as Isaac Ebn Amram and Abix. All the Arab physicians, in fact, extol the merits of senna in purging black or yellow bile and in acting as a cordial when mixed with suitable drugs, such as violets. The present species, as also the Alexandrian (*C. acutifolia, Delile*), were introduced to both Indian and European pharmacy through the Arabs. The former species (the only one grown in India) is fairly extensively produced in Tinnevelly, and recently its cultiva-

Cultivation.

tion has been extended to Madura and Trichinopoly, districts of South India, and to Poona in Bombay. It is sown on red or black clay loams, fairly liberally ploughed and manured, the sowing being in May. Weeding has to be attended to, but irrigation is hardly if ever necessary. The season for collecting the leaves is June to December. The yield is said to be 1,000 lb. (2 *candies*) an acre, which allows a handsome margin for profit.

Indian senna is either exported coastwise to Bombay and thence to foreign countries, or is consigned direct from Tuticorn. The drug is also imported by India from Arabia, where it is collected from the wild plant and

accordingly often much adulterated. It would appear that about 5,000 cwt. are usually taken by India and again re-exported under the name of East Indian Senna or Moka or Aden Senna, and is thus no doubt the true *sanna* (*sona*) *-kokki* (*maki*) or *sanna hajazi*. For many years past, however, the imports from Arabia have been declining and the exports of Tinnevelly *senna* improving. The purity, high quality and low price of the Indian article place it in the front rank. In 1887–8 the total exports from India of locally grown senna came to 21,376 cwt., valued at Rs. 3,18,869. More recent figures are given by some writers, such as 5,000 candies annually from Tuticorin, but the data for an exact and detailed statement of the total trade are not available. Quite recently a new form of senna has appeared in the London markets from India. This has been shown by Barber to be ***C. montana,*** but as a drug it has been found inferior to ***C. angustifolia,*** and should therefore be discouraged. [*Cf.* Hooper, *Rept. Labor. Ind. Mus.* (Indust. Sec.), 1903–4, 30; Gibson, *Journ. Agri.-Hort. Soc. Ind.*, ii., 193; vi. (Select.), 128; *Pharmacog. Ind.*, 1890, i., 526–30; *Agri. Ledg.*, 1896, No. 29, 290; *Capital*, May 1902; *Pharm. Journ.*, 1901, 397.]

Aden Senna.

Exports.

C. auriculata, *Linn.;* the Tanner's Cassia, *tarwar, tarota, tangedu, tanghedi, tangadi, avala, avari,* etc. A tall shrub found plentifully in Central and South India as far north as Rajputana and also in some parts of Burma. It is common on dry stony hills and on black soils.

D.E.P., ii., 215-6. Tanner's Cassia.

The bark is largely used in tanning and gives a buff-coloured leather. It has been remarked that Madras is favoured in the possession of this tanning material. But it is feared the discovery of the method of chrome tanning has even already given a totally new turn to the subject of Madras tanned or dressed skins and rendered the special advantage mentioned of comparatively little avail. (See **Hides**—Chrome Process, p. 637.) It has always, however, been contended that the raw skins of Madras are naturally well fitted for a high-class tannage. They possess some special properties much liked by the curriers into whose hands they eventually pass to be transformed into the morocco leather used for book-binding, furniture, carriage lining, and many other such purposes. Experts have, moreover, reported that the colour of leather prepared with this bark alone changes into murky brown, further that compared to its merits the price is too high (Rs. 20 a candy of 500 lb.). With a view to ascertaining more precise particulars as to supply, price, and property of this tanning bark, the Reporter on Economic Products to the Government of India issued a circular letter to Forest and other officers of India in which samples of the bark and full particulars were called for. The result was rather disappointing, and has been reviewed in *The Agricultural Ledger* (1896, No. 9). The Scientific Staff of the Imperial Institute also published some of their investigations with the bark (reprinted by Dunstan, *Imp. Inst. Tech. Repts.*, 1903, 184–5), from which it would appear that the samples examined gave extreme variations in amount of astringent principle and therefore of commercial value. Some time subsequently Hooper (*Agri. Ledg.*, 1902, No. 1, 27) pointed out that one source of diversity was in the age of the plant from which the bark had been collected. In young plants he found the bark to contain only 11·92 of tannin and 22·35 extract, while in old plants the corresponding figures were 20·12 of the former and 29·0 of the latter. In another part of his report (*l.c.* 3) he places

Merits.

Price.

Recent Investigations.

cassia bark as the fourth most valuable in a series exhibited by him, the cassia having 23 per cent. of tanning matter. Prof. Hummel, Yorkshire College, Leeds, found the tannin to be 20·5 per cent. On the other hand, Leather mentions only 15·5 per cent. of tannin, but a high accompaniment of soluble non-tannings. So also Prof. Procter (*Rept. Soc. Arts*, 1904), who places this bark as one of the Catechols, speaks of the "thoroughly unsatisfactory character of the *turwar* tannage, for the use of book-binding and upholstery," and asks whether there may not be other more desirable materials. These modern results and opinions would thus seem to assign a much lower position to the Tanner's Cassia than seems to be the belief in South India. By way of conclusion it may be mentioned that in the Northern Division of Madras the bark (*tanghedi*) or some *babul* gum is added to sesamum seed when it is to be pressed for its oil. It is said that this practice enhances the value of the cake (see p. 986).

Unsatisfactory Tannage.

Medicinal Uses.

The seeds, like those of *C. Absus*, are valued as a local application in purulent ophthalmia. An infusion of the leaves is esteemed as a cooling medicine and as a substitute for tea. The leaves are also eaten as a green vegetable in times of famine. The shoots are largely utilised as Native tooth-brushes, and the root is spoken of as of great value in tempering iron metal (see **Acacia**, p. 5; and *cf.* Wiesner, *Die Rohst. des Pflanzenr.*, i., 716).

Tooth-brushes.

D.E.P., ii., 233–4. Toon or Indian Mahogany.

CEDRELA TOONA, *Roxb.*; *Fl. Br. Ind.*, i., 568–9; Gamble, *Man. Ind. Timbs.*, 157–9; Cooke, *Fl. Pres. Bomb.*, i., 217; Duthie, *Fl. Upper Gang. Plain*, i., 153; Brandis, *Ind. Trees*, 145; MELIACEÆ. The Toon or Indian Mahogany, Moulmein Cedar, *tún*, *lím*, *lúd*, *drawí*, *poma*, *tundú*, *thit-kado*, etc. A large, rapidly growing, deciduous tree, 50 to 60 or even 80 feet high and sometimes as much as 20 feet in girth It is met with chiefly near streams in the tropical Sub-Himalayan tracts, from the Indus eastwards to Sikkim and Assam; also at low elevations throughout Western and Southern India: less common in Eastern Bengal and Burma.

Timber.

This important Indian timber tree is extensively cultivated and often self-sown. It would appear to have been first described, so far as India is concerned, by Jones (*As. Res.*, 1795, iv., 281; also Fleming, *As. Res.*, 1810, xi., 163). The roots are surface-feeders, so that it ought not to be grown on the borders of fields. In the plains of the Panjáb the young plant must be protected against frost. The TIMBER is durable, not eaten by white ants, and not liable to warp. It is therefore much in demand for furniture and carvings, especially in Saharanpur (*Indian Art at Delhi*, 1903, 111), and in Bengal and Assam is constantly used for tea-boxes, hence its having become scarce. In Assam it was formerly much employed for boats and canoes, and in South India is very largely converted into cigar-boxes. It is exported from Burma as "Moulmein Cedar," and known under that name on the English market. Col. Seaton gives the cost of cutting and delivery as Rs. 44 per ton. Specimens sent to London from Dehra Dun in 1883 realised 4½*d.* per superficial foot, and in Malabar in 1902, ½-inch planking fetched Rs. 2 per cubic foot, ¾-inch planking was sold at Rs. 1–14–0, and 1-inch at Rs. 1–12–0. [*Cf. Ind. For.*, 1883, ix., 427; *Capital*, July 24, 1902, 118.]

Cigar-boxes.

"Moulmein Cedar."

Trade.

Medicine.

The bark is used, especially along with a powder of the nuts (seeds) of ***Cæsalpinia Bonducella***, as a tonic and antiperiodic in Native MEDICINE. The flowers afford a red and yellow DYE. [*Cf. Taleef Shereef* (Playfair, transl.), 1833, 61.]

Dye.

Fodder.

The seeds, young shoots, and leaves are given as FODDER to cattle.

There are several other Indian forms, the properties of which are similar to those just detailed. The most important are ***C. microcarpa***, *C. DC.*, and ***C. serrata***, *Royle* (the *dál*, *dauri*, *soni*, etc.). The latter is particularly abundant below Simla and elsewhere in the N.W. Himalaya, where the timber is in considerable local demand, being employed for beams and sleepers, on

N.W. Himalayan Form.

sledge-roads, for wet-slides, bridges, hoops of sieves, etc. [*Cf.* Buchanan-Hamilton, *Stat. Acc. Dinaj.*, 154; *Ind. For.*, ii., 87–8; vii., 49–50; x., 246, etc.; Robinson, *Desc. Acc. Assam*, 1841, 41; *Pharmacog. Ind.*, i., 339; Greshoff, *Extra Bull., Kolon. Mus. Amsterdam*, 1896; Wiesner, *Die Rohst. des Pflanzenr.*, i., 79; ii., 94, 957.]

CEDRUS LIBANI, *Barrel., var.* **Deodara**, *Hook., f.; Fl. Br. Ind.*, v., 653; Ribbentrop, *Deodar*, in *Ind. For.*, 1899, xxv., app.; Gamble, *Man. Ind. Timbs.*, 710–6; Collett, *Fl. Sim.*, 487; Brandis, *Ind. Trees*, 1906, 691; CONIFERÆ. The Himalayan Cedar, *deodár*, *dedwár*, *diár*, *kelu*, *keori*, *kelon*, *kilar*, *giam*, *paludar*, *nakhtar*, etc. Dutt (*Mat. Med. Hind.*, 1900, 247, 296) gives it the Sanskrit name of *devadáru*. D.E.P., i., 235–7. Himalayan Cedar.

A very large evergreen tree (often 250 feet) of the Western Himalaya, extending westwards to the mountains of Afghanistan and eastwards to the Dauli river in Kumaon; most common at 6,000 to 8,000 feet, but in the more eastern section of its area it ascends to 10,000 feet in altitude. Said to have been introduced into Great Britain about 1831, and is now cultivated to a considerable extent both in Europe and America. The closely allied species, the Cedar of Lebanon proper, was introduced, so Miller says (*Gard. Dict.*, 1731), into the Physic Garden of Chelsea about 1683, but it is now believed that it was actually being grown in England a few years before that date (1662–70). According to Bentham (*Notes on Targioni-Tozzetti, Journ. Hort. Soc.*, ix., 175), that cedar, although apparently well known to the Ancients as a valuable tree, had never been grown in Italy until carried from England to Pisa in 1787. Habitat. Cedar of Lebanon.

The Deodar is usually though not always monœcious, and is roughly distinguishable from the Lebanon and Atlas cedars by its drooping branches and longer needles. Though gregarious it rarely forms pure forests, being found with blue pine, spruce, silver fir, oak, yew, poplar, horse-chestnut, etc. Gamble says that good seed years come about once in four or five years, and in suitable localities, where the seeds can get through the grass, weeds and moss of the surface covering, natural reproduction is very prolific. Artificial propagation also is not difficult, *deodár* being easily grown in nurseries, and with care successfully transplanted. Young plants suffer from waterlogging, and it is therefore best to transplant them from April to May. *Deodár* is probably at its best in good localities when about 12 feet in girth, but it can reach a much greater size, trees of 30 to 45 feet in girth, and 100 to 240 feet in height. It prefers a light soil and gneiss, granite or even limestone sub-soil; in the Himalaya it seeks the northern and western slopes, thus avoiding the rain, and in cultivation does not succeed either at Darjeeling or on the Nilgiri hills, where there is too much clay and too much rain. Cultivation. Transplantation. Size.

This is the chief TIMBER of Northern India. It is light yellowish-brown, scented and moderately hard. When well seasoned its weight rarely exceeds 35 lb. per cubic foot. It is very durable as well as immune from white ants, hence is extensively used for railway sleepers. It is believed that the *deodár* timber of certain buildings in Kashmir and Kanáwar may be 600 to 800 years old. Accordingly it is held in considerable esteem for bridge-work and house-building (though its scent is by some regarded as too strong for interior fittings). It is rather brittle, however, and does not take paint nor varnish freely. In wood-carving, especially that of the Panjáb and Kashmir, *deodár* is of course pre-eminent. The Muhammadan and Sikh work are directly adapted to it, and the characteristic feature of old Kashmir wood-work may be said to have been the bold and effective *pinjra* or lattice panellings made of this wood. Further details as well as illustrations of *deodár*-carving may be found in *Indian Art at Delhi*, 1903 (103 and *seq.*), and the reader should also consult Lawrence's *Valley of Kashmir* (1895, 79–80) for further interesting details. **Timber.** Weight. Durability. Wood-carving.

An OIL (*kelon-ka-tel*), which resembles crude turpentine, is obtained from the wood, and is used in veterinary practice. [*Cf.* Gildemeister and Hoffmann, *Volatile Oils*, 1900, 279.] It is also employed by the men who float *deodár* logs down the rivers, to coat the inflated skins by the help of which they pass the rapids. In connection with the arrangements for the Delhi Durbar Exhibition, I observed that certain metallic objects kept in a box of *deodár* wood were beautifully varnished. On inquiry, I found this was due to the action of the oil. It would seem probable that this property may prove of much value. It should certainly be investigated. The aromatic wood (*bhadra-kashtha*) is employed in Native **Oil.** Varnish.

Medicine.

MEDICINE, and the Arab physician Avicenna (about 1000 A.D., ii., 2, 213) said that it was called *sanúbar-el-hindi* and that it was useful in rheumatism, paralysis, etc. Ebn Baithar republishes the information given by Avicenna. [*Cf.* Celsius, *Hierob., etc.*, 1745, 74–105; Veitch, *Man. Conif.*, 1881, 134; *Tropische Agri.*, v., 258–61.]

Trade in Cedar.

Trade.—It is next to impossible to give a definite statement of the annual supply of this timber. It is floated down the rivers in the form of logs, sleepers, or scantlings. The oil which it contains prevents it getting waterlogged, so that comparatively speaking few pieces get irretrievably lost; nevertheless the obstacle that bars an extended use is the cost of transit from the forests to the markets. The *Forest Administration Reports* of the Panjáb, of the North-West Frontier Province, and of the United Provinces give particulars of the *deodár* removals from the forests owned or leased by Government, as also of the imports of that timber from Native States or foreign territory. The Statistical Department of the Government of India also gives particulars of the Trans-frontier traffic in which certain facts are given of imported timber. Comparing and analysing all these and such-like returns it may be affirmed that the annual supply obtained by the plains of India comes to approximately from 3 to 4 million cubic feet of this timber. The supplies come mainly from the forests of the Panjáb proper (Chamba, Kullu, Kangra, Bashahr, etc.), of Kashmir and Afghanistan, of Hazara, Kagan eastward to Jaunsar—the Tonse, Jumna, Bhagirathi, etc.

Indian Supply.

[*Cf. Paulus Ægineta* (Adams, Comment.), iii., 450; *Taleef Shereef* (Playfair, transl.), 1833, 83; McDonell, *Ind. For.*, 1885, xi., 213–20; Mian Moti Singh, *Ind. For.*, 1882, viii., 268; 1893, xix., 168–74; *Ind. For.*, 1898, xxiv., 61; *Pharmacog. Ind.*, iii., 380–2; Wiesner, *Die Rohst. des Pflanzenr.*, 1903, ii., 147, etc.; McIntire, *Ann. Repts. For. Dept. Working Plans Pb. For.*, 1895; etc., etc.]

D.E.P., ii., 237–9. Black-oil.

CELASTRUS PANICULATA, ***Willd.; Fl. Br. Ind.***, i., 617; *Pharmacog. Ind.*, i., 343–5; Gamble, *Man. Ind. Timbs.*, 1902, 175–6; Brandis, *Ind. Trees*, 1906, 162; CELASTRINEÆ. The Black-oil plant, *mál-kangni, mál-kungi, sankhu, kujúri, jiotish-mati*, etc. A scandent shrub of the outer Himalaya from the Jhelum to Assam, ascending to 4,000 feet, also of Eastern Bengal, Bihar, South India, Burma and Ceylon.

Oil.

Medicine.

The seeds yield by expression a deep scarlet or yellow OIL, which is used in MEDICINE for external application. It is also burnt in lamps and employed in certain religious ceremonies, but its chief interest lies in the fact that by destructive distillation along with benzoin, cloves, nutmegs and mace is obtained the *oleum nigrum* of pharmacy, an empyreumatic fluid usefully employed, according to Dr. Herklot, in the treatment of *beri-beri*. In doses of 10 to 15 drops, black-oil is powerfully stimulant and diaphoretic. It is chiefly manufactured in the Northern Circars, the best quality being that of Vizagapatam and Ellore. The price of the seed is said to be about 2 annas per lb., and the oil about Rs. 20 per cwt. Moodeen Sheriff (*Mat. Med. Mad.*, 1891, 106–8), the *Taleef Shereef* (Playfair, transl., 1833, 148) and other writers say that the seeds are supposed to have the property of stimulating the intellect. The red seeds and the leaves are also employed in Native medicine. [*Cf.* Gamble, *Man. Ind. Timbs.*, 175–6; Cooke, *Fl. Pres. Bomb.*, i., 231; Duthie, *Fl. Upper Gang. Plain*, i., 158–9; Brandis, *Ind. Trees*, 162; etc.].

Oleum Nigrum.

Prices.

D.E.P., ii., 245. Cement Materials.

CEMENTS and materials used.—*Agri. Ledg.*, 1902, No. 5, 142–4; *Ind. Art at Delhi*, 1903, 95–6, 218; *Papers relating to Magnesia Cement* (a reprint of reports, letters, etc., dating from 1826 to 1837), issued by Madras Government.

Cements are commonly distinguished under five groups:—(*a*) calcareous; (*b*) gelatinous; (*c*) glutinous; (*d*) resinous; and (*e*) various materials. Since nearly all cements contain lime, the reader is referred to the article on that

subject (pp. 695, 713). The following are the chief vegetable and animal substances employed as constituents in special cements, and mostly along with lime.

Adenanthera pavonina, *Linn.*; seeds (see p. 25).
Ægle Marmelos, *Corr.*; wild fruits (see p. 26).
Agave; sap (see p. 35).
Allium sativum, *Linn.*; fresh juice (see p. 58).
Borassus flabellifer, *Linn.*; juice (see p. 171).
Carthamus Oxyacantha, *Bieb.*; oil (see p. 276); also *cf. Agri. Ledg.*, 1904, No. 11).
Cocos nucifera, *Linn.*; jaggery and milk (see pp. 361, 929).
Commiphora Agallocha, *Engl.*; the gum-resin (see p. 400).
Gelatinous Cements; see **Isinglass** (p. 695).
Melanorrhœa usitata, *Wall.*; oleo-resin (see p. 779).
Oryza (glutinous rice); (see p. 826).
Sugar; *gúr* or jaggery used in *chunám* (see p. 956).
Triticum; gluten of wheat-flour (see p. 1088).
Typha angustata, *Chaub and Bory.*; the down from ripe fruits (see p. 777).

CERIOPS CANDOLLEANA, *Arn.*; also **C. Roxburghiana**, *Arn.*; *Fl. Br. Ind.*, ii., 436; Gamble, *Man. Ind. Timbs.*, 333; Prain, *Rec. Bot. Surv. Ind.*, ii., 306; Cooke, *Fl. Pres. Bomb.*, i., 473; *Agri. Ledg.*, 1902, No. 1., 32–4; Brandis, *Ind. Trees*, 304; RHIZOPHOREÆ. The Mangrove, *kirrari, kiri, chauri, gorán, madá, tengah, kabaing*, etc. D.E.P., ii., 261. Mangrove.

The vernacular name *gorán* or *garán* applies to both these plants, and in fact they are not economically distinguished. The former is a small evergreen tree of the muddy shores and tidal creeks of India, especially common in Sind; and the latter a large shrub of similar conditions in the Sundribans and the coast of Chittagong down to Tenasserim. The barks of both trees yield an important TAN. A sample of tannin-extract prepared in the Sundribans and examined in England in 1900 was not, however, much valued because of its dark colour. Prof. Trimble of the Philadelphia College of Pharmacy found 23·07 per cent. of tannin in the dry bark of a sample of *C. Candolleana* sent from Singapore, and 31·56 per cent. in a Bengal sample. Other Bengal specimens were found to yield on the dry bark 30·20 per cent. and 18·30 per cent. (Hooper); 17·77 per cent., 21·54 per cent., 13·23 per cent. (Dunstan). [For further details *cf. Imp. Inst. Tech. Repts.*, 1903, 186–90; *Agri. Ledg., l.c.*] About ten to twelve thousand maunds of Mangrove Bark are sold annually for tan in the Calcutta market at about 10 annas per maund of dry bark. The extract is also used as a DYE to give a brownish-red colour to cloth, but especially a good black and purple in conjunction with indigo. In the Malaya the cloth is first dyed in Mangrove-extract, then dried, and subsequently dipped in indigo. [*Cf. Kew Bull.*, 1897, 91–2.] The whole plant is astringent: a decoction of the bark is applied to stop hæmorrhage, and on the African coast the young shoots are employed in the preparation of a substitute for quinine. The TIMBER of most of the species is hard and that of *C. Candolleana* is used for knees of boats. It is a superior fuel, and makes excellent charcoal.

Tan. Sales. Dye. Medicine. Timber.

CHENOPODIUM ALBUM, *Linn.*; *Fl. Br. Ind.*, v., 3; Duthie and Fuller, *Field and Garden Crops*, iii., 21; Cooke, *Fl. Pres. Bomb.*, ii., 501; CHENOPODIACEÆ. The White-goose-foot, *bathú-sag, chandan-betú, lúnak*, etc. D.E.P., ii., 265–6. Bathu.

There are various cultivated and wild forms of this ubiquitous plant, *e.g.* *album* proper (*chandan-betú*), *viride* (*bettú-shak*), *purpureum* (*lal-bethi*), etc. From the point of view of the present work the interest lies in the fairly extensive cultivation in the higher Western Himalaya as a food-grain and pot-herb. A sample of the seed sent from the Panjáb and examined at the Imperial Institute gave the following results:—water 8·3 per cent., albuminoids 18·4 per cent., starch 19·2 per cent., oil 21·1 per cent. The nutrient ratio was 1·377 and the nutrient value 86. Church (*Food-Grains of Ind.*, suppl., 8) says that "analysis amply confirms the Indian opinion of its highly nutritious character." The wild plant is regularly collected as a pot-herb and green vegetable. The leaves are rich in potash-salts. A decoction of the plant is used as an adjunct in indigo-dyeing and the seeds are employed medicinally (see **Vinegar**, p. 1110). [*Cf.* Buchanan-Hamilton, *Stat. Acc. Dinaj.*, 169, 194.]

Food. Medicine.

D.E.P., ii., 268–9. Chittagong Wood.

CHICKRASSIA TABULARIS, *Adr. Juss.*; *Fl. Br. Ind.*, i., 568; Gamble, *Man. Ind. Timbs*, 156–7; Talbot, *List Trees, etc.*, 1902, 80; Cooke, *Fl. Pres. Bomb.*, i., 1903, 216–7; Brandis, *Ind. Trees*, 144; MELIACEÆ.

The Chittagong Wood or White Cedar, *chikrassi, lal-devdár, saiphra, saipropaon, pabba, aglay, agil, dalmara, yinma*, etc. A beautiful tree met with in the tropical forests from Sikkim to Chittagong and Burma, and from the Konkan and Deccan to Mysore, Malabar and Ceylon.

Timber. It yields a beautiful yellowish-brown, richly veined satiny TIMBER, suitable for furniture, piano-cases, tables, etc. Gamble remarks that it deserves to be better known and exported from convenient localities like Chittagong, where

Gum. it chances to be plentiful. It also yields a transparent yellow GUM, an astringent

Dye. BARK (used medicinally), and flowers that afford both a red and yellow DYE. [*Cf. Pharmcog. Ind.*, 1890, i., 339; R.E.P., *Circ. Letter*, 1894–5, No. 25; *Prog. R.E.P. Office*, 1894–5, 1896–7, 1897–8, 1900–1; *Settl. Oper. Sagaing*, 1893–1900, 48.]

D.E.P., ii., 270-1. Satin-wood.

CHLOROXYLON SWIETENIA, *DC.*; *Fl. Br. Ind.*, i., 569; Gamble, *Man. Ind. Timbs.*, 160–2; Talbot, *List Trees, etc.*, 81; Cooke, *Fl. Pres. Bomb.*, i., 1903, 217–8; Brandis, *Ind. Trees*, 146; MELIACEÆ.

The Satin-wood, *bhera, bhira, billa, bella, billu, bilgu, madula, sengel, jirhul, sali, hurgalu, halda*, etc. A moderate-sized tree of Central and South India, also Ceylon. Is met with in the dry forests of the Circars, Konkan, Deccan and Karnátak, especially on poor soils, such as sand and laterite; common on the Satpuras and the sandstone formations of Kaladgi and Belgaum. Its

Uses. most useful product is its TIMBER, the Satin-wood of commerce, which is largely

Timber. exported from Ceylon and S. India ("Tamil Satin-wood"). It is in much

Brush-backs. demand for cabinet-work, the backs of brushes, picture frames, turnery (makes good stethoscopes), furniture, etc., and locally is utilised in house-building, carts and agricultural implements, but is not a good firewood, as it smokes

Gum. too much. The tree also yields an amber-coloured GUM (of which little is

Dye. known), a DYE, a wood-OIL and an astringent BARK, sometimes used medicinally,

Oil. as also a paste made from the roots. Trees often destroyed on account of

Fodder. leaves being given as FODDER. [*Cf.* Forsyth, *Highlands Cent. Ind.*, 464; *Pharmacog. Ind.*, 1890, i., 338–9; Basu, *Agri. Lohardaga*, 134; Biscoe, *List Hyderabad Trees*, 1895, 5; *Ind. For.*, 1897, xxiii., 52; 1899, 181; *Cat. des Pl. Econ. Colon*, "*L'Hort. Colon.*," Brussels, 1900, 52; Wiesner, *Die Rohst. des Pflanzenr.*, ii., 953; *Imp. Inst. Tech. Repts.*, 1903, 248.]

D.E.P., ii., 272. Babir.

CHRYSANTHEMUM CORONARIUM, *Linn.*; *Fl. Br. Ind.*, iii., 314; Buchanan-Hamilton, *Stat. Acc. Dinaj.*, 195; *Pharmcog. Ind.*, ii., 276–7; *Agri. Dept. Assam Bull.*, 1896, No. 2; *Ind. Pharmacol.*, 1897, 20–2; COMPOSITÆ.

This cultivated little herb is of interest mainly because of the fact that from Dinajpur and Rangpur in Bengal, north-east to Assam, it is extensively

Pot-herb. eaten, and is number 15 in Buchanan-Hamilton's list of *sags* or pot-herbs. This fact seems to have escaped observation until re-discovered by myself while investigating the areas of successful cultivation of ***Bœhmeria nivea***—China-grass. In my report on that subject, published in *The Agricultural Ledger* (1898, No. 15, 517–8), I pointed out that plants of the pea family become scarce, but that a peculiar series of pot-herbs take their places. Among these ***C. coronarium*** was found to hold a foremost position, being known as *babir* in North Bengal, *babui* in Assam, and *jalyniar* in the Khasia hills. It may now be added that after an inspection of the collections preserved in the Royal Herbarium, Kew, I am able to add that only one collector would appear to have previously recorded the observation of this plant being eaten. Speaking of Formosa,

Eaten in Formosa. Walters calls it *tan-ei-tsai* and adds that it is a "herb much used by the Chinese as an article of food." Bretschneider (*Bot. Sin.*, 1892, pt. ii., 76) makes mention of two species of ***Chrysanthemum*** as known to the Chinese classics, the leaves of one of which are boiled into soup. This would appear to be called *ts'iu hua ku*, but in another part Bretschneider adds that he does not know

the edible *Chrysanthemum*. It is, however, remarkable that not a few of the special vegetables of the *rhea* fibre area of India should be more Chinese than Indian plants. For the medicinal and other uses of this plant the reader should consult the works cited in the opening sentence above. Medicine.

CICER ARIETINUM, *Linn.*; *Fl. Br. Ind.*, ii., 176; Duthie and Fuller, *Field and Garden Crops*, 1882, i., 33–6, pl. 8; *Agri. Ledg.*, 1895, No. 3, 37, 42; Mollison, *Textbook Ind. Agri.*, 1901, iii., 73–8; Prain, *Beng. Plants*, 1903, 365–6; Duthie, *Fl. Upper Gang. Plain*, 1903, 256; Cooke, *Fl. Pres. Bomb.*, i., 408; LEGUMINOSÆ. The Common or Bengal Gram; Chick-pea; *cicer* (Latin); *erebinthos, orobos, krios* (Greek); *ceci* (It.); *zisern, kirchern, ziser, kucherebs* (Germ.); *ciceren* (Belg.); *ciche, pois ciche, pois pechu, garvance* (Fr.); *gravancos, garbanzos* (Castilian); *cicerchas* (Sp.). D.E.P., ii., 274–84. Bengal Gram. Chief European Names.

History.—Most of the modern European names, like the English chick-pea or chiche, have doubtless come from the same root as the Latin *cicer*. Others may be viewed as derived from the Greek name, *erebinthos*, or are descriptive of the shape of the seed (*krios*—the ram's head). Hehn (*Kulturpfl. und Haust.* 1894, 210 *et seq.*) identified *cicer* with the Greek *krios* (Dioscorides, ii., ch. 126). Apparently the earliest mention of the pulse in the literature of Europe occurs in Homer (*Iliad*, bk. 13, 589). Some centuries later Theophrastus (about 350 B.C.) assigned the word *erebinthos* definitely to the modern gram. Parched gram is mentioned by Horace as an article of food with the poor. Cicero took his cognomen from this pulse, as Fabius did from *faba*, also Piso and Lentulus from the pea and the lentil. Gram must, therefore, have been a common article of food with the poorer Greeks and Romans long before the Empire. The name "gram" comes from the Portuguese *grao* (*i.e.* grain), and was apparently a special appropriation made in India, because of its being in that country the most general grain given to horses. It is, of course, a pulse, not a grain, in the strict sense, but in South India, where cicer is but little cultivated, the name "horse gram" is given to *Dolichos biflorus*, just in the same way that "green gram" denotes *Phaseolus Mungo*. These pulses, cicer more especially, are frequently articles of cattle food, hence the expression "gram-fed" applied to the animals reared on them. Nikitin, a Russian traveller, who visited Western and Southern India in 1468, was impressed with the fact that in India horses were fed on peas. The old English words calavances, caravances, garavances and garvances are derived from the Spanish *garbanzos*, and were apparently given (and to some extent still are given) to several peas or beans largely used by mariners in place of fresh vegetables, hence very possibly the refrain of the mariners who "live on yellow peas." And these names survived till the beginning of the 19th century, for they occur in Act 54 of George III. (1814, ch. xxxvi.). For further particulars the reader should consult the article Cajanus (p. 199), also Dolichos (pp. 503–10) and Vigna (pp. 1107-8). [*Cf.* Cocks, *Diary*, 1620, ii., 311; Herbert, *Travels*, 1677, 333, 347; Fryer, *New Acc. E. Ind. and Pers.*, 1675, 21; Shelvocke, *Voyage*, 1719, 62; Hamilton, *New Acc. E. Ind.*, 1727, i., 393; Shaw, *Travels*, 1757, 140; Joret, *Les Pl. dans L'Antiq.*, 1904, ii., 249.] History. Gram-fed.

In Sanskrit this pulse is known as *chanaka* or *chennuka*, and in the vernaculars of India—*chana, chunna, chenna, chahna, chano, chania, sanna-galu* or *sanagalu, senagalu, chola*, etc. Occasionally other names are given to it, such as *bút, búta, harbara, kadli, kadalai, hariman-dhakam, kudoly kempa, kadale, kalapai*, etc. The first series are most frequently used in Northern, Central and Western India (down to Gujarat), while the second are specially prevalent in Eastern and Southern India from Bengal, Assam, Burma and west to the Maratha country, thence to the extreme south. In Arabic it is *humez*, in Kabyl *hammez*; in Egyptian *homos* or *omos* and in Persian *nakhúd*. Aitchison says that in Khorasan it is known as *nakhund*. De Candolle observes that south of the Caucasus it is known in Georgian as *nachuda*; in Turkish and Armenian as *nachius* or *nachunt*—names which De Candolle asks whether they may not be connected with the Sanskrit *chennaka*. In India the Arabic and Persian names are often used by Muhammadan writers. Thus in the *Ain-i-Akbari*, written 1590 (Blochmann, transl., i., 62), mention is made of *nukhúd dál* as a pulse, the price of which is given, and it is expressly stated not to be met with in Kashmir (Jarrett, Indian Names. Central Asiatic and Egyptian Names.

transl., ii., 350). It is curious, however, that no mention is made of gram in the *Memoirs of Baber* (written about 1519 A.D.), so that it may fairly be inferred gram was not an important article of food with the army under the first great Mughal conqueror of India. Baber's silence regarding it may, however, have been a pure omission, or a consequence of its not having been a pulse new to him on his arrival in India, for it seems certain it was known to the people of India from a fairly remote period. By Hindus it is invariably described under its Sanskrit name, or some derivation from that. Susruta (*Ayur Veda* (Hessler, transl.), bk. i., ch. xx., 49), for example, alludes to it under the name of *hariman t'kata* as one of the specially wholesome articles of food. The name *harimandkakam* is very largely given to it by the present Tamil-speaking races. It is mentioned in the *Puranas* but apparently not in the *Institutes of Manu*. The vinegar made from the dew found on the leaves is referred to under the name *chana-kámla* by most of the Sanskrit medical writers.

Sanskrit Literature.

Varieties.

Varieties.—While it is quite correct to say of it to-day, as it was when the *Ain-i-Akbari* was written, that Bengal gram is not cultivated to any extent in Kashmir, still there is a special form of the plant fairly extensively produced in the western temperate and alpine regions, between 9,000 and 15,000 feet in altitude, such as in Piti, Lahul, Kumaon and Tibet. This has been described by botanists as a distinct species under the name of ***C. soongaricum, Steph.*** It bears the following vernacular names:—*tizhu, jawáne, banyarts, sárri* or *serri*—names apparently unconnected with those given to ***C. arietinum***; and since ***C. soongaricum*** is only met with in alpine Central Asia, it may be assumed to be there indigenous.

Tibetan Plant.

So also a very special variety or distinct species is known as *kabuli* gram. This has been much talked of recently, and even experimentally grown in India, but with indifferent results. It is apparently a form peculiar to the country indicated by its name, though it is specially mentioned by Buchanan-Hamilton as met with by him in Dinajpur about 1809. It is thus a form that has been experimentally grown in India for a century or more. It is a much more robust plant than the ordinary gram, and has large white seeds. But in addition to these special Trans-frontier varieties, India itself has also several fairly distinct cultivated forms indicated by the colour of the pea, viz. red to yellow, brown, creamy white and almost black. But in no part of India or of its mountainous frontier has any botanist recorded the existence of wild or even naturalised representatives of any form of gram. They all exist purely and simply as cultivated plants, and on the plains are usually *rabi* crops. It seems highly probable, however, that the forms of chick-pea originated in the tract of country between the Caucasus and the Himalaya. And if that opinion be accepted they can be regarded as having been carried into Southern Europe, Persia and India in very ancient times. But it seems probable that at least one of the forms may have originated in Persia, so that the chick-pea may have been also indigenous to that country.

Kabul Gram.

Indian Special Races.

Never seen Wild.

Cultivation. Area.

CULTIVATION.—Area.—During the five years ending March 1905, the average area shown in the volume of *Agricultural Statistics* for British India as devoted to this crop, comes to almost 11 million acres, and for the Native States a little under 2 million acres, so that an estimate of 12 million acres for the whole of India would be under rather than over the mark. The most important producing province is that of Agra, which during the period named possessed an average of 3¾ million acres, or say one-third of the Indian area. This is followed by Oudh (with 1½ million acres), by the Panjáb (which fluctuates very greatly, the area in 1899–1900 having been only 658,468 acres, and the very next year 3,405,121); by Bengal (with approximately one million acres); by Bombay, the Central Provinces and Mysore (with each normally a little under a million acres); by Gwalior (which has as a rule ½ million acres); by Berar, Madras and the North-West Frontier Province (with each about 150,000 acres); by Sind, Upper Burma, Alwar, Bharatpur and Kotah (with each about 70,000 to 100,000 acres); and lastly by all the other Provinces and Native States (which have each much smaller areas). It may thus be accepted that the upper basins of the Ganges and the Indus (which correspond with

Distribution.

Chief Gram-producing Area.

Upper Bengal, the United Provinces and the Panjáb, also the adjacent portions of the Central Provinces, Central India and Rajputana) constitute the great gram-producing area of India. It has been repeatedly pointed out that a line drawn from Bombay to Patna would approximately divide India into two sections, the northern being the great gram area and the southern that in which gram is a very subordinate crop.

Production and Yield.

Production and Yield.—The yield of gram to the acre is annually reported by the various Governments and Administrations. It is shown to vary greatly according to suitability of soil and climate; the highest returns are in the provinces of chief production. In Bihar (the upper division of Bengal) the yield comes to 855 lb. per acre, *for land not irrigated;* in the United Provinces, 800 lb.; in the Panjáb, 634 lb.; while in Bombay, under similar conditions, the yield is only 410 lb. and in the North-West Frontier Province still less—406 lb. But *irrigated land* gives a higher yield than unirrigated: in Bombay as much as 1,200 lb. have been recorded; 950 lb. in the United Provinces; 835 lb. in the Panjáb, and 632 lb. in the North-West Frontier Province. Taking the nine chief producing provinces and accepting for a calculation of total production the mean of the published returns for 1901–2, on unirrigated cultivation, we arrive at the figure of 600 lb. as a possible safe average for all India. This, worked out to 10 million acres, or considerably under the present area, would show a total production of 53 million cwt. But that very large amount would in all probability be under rather than over India's actual supply, since this pulse is largely grown as a mixed crop and also as a garden vegetable, tracts not likely to be fully covered by its recorded acreage as a field crop.

Highest in Chief Areas.

Mean Yield.

Total Production.

It may be useful to take up the provinces one by one and exhibit the features of their gram-cultivation etc., that may be of interest:—

Bengal.

Bengal.—Gram requires the same land as wheat, barley, linseed and peas. It cannot be grown on sandy soils but requires a moderately heavy clay-loam. Five or six ploughings are given, commencing towards the close of the rains. About the latter half of October to the first week in November it is sown, and the crop ripens in February to March. The quantity of seed required ranges from 27 to 36 seers, more being needed when "broadcasted" than when "drill" sown. The plants are pulled up by the roots, made up into loads, and carried to the threshing-floor. The straw and the husks of the pods form excellent fodder. The yield is stated to be about 9·7 maunds (or, say, approximately 800 lb.). The cost of cultivation (according to the *Report of the Dumraon Experimental Farm for* 1902–3) has been put at Rs. 15–1–8, and the money value of the crop at Rs. 44–12–3 an acre. [*Cf.* Buchanan-Hamilton, *Stat. Acc. Dinaj.*, 1833, 174, 184; Basu, *Agri. Lohardaga*, 1890, 34; Barclay, *Fungal Disease, Agri. Ledg.*, 1895, No. 20, 381.]

Seasons.

Fodder.

Cost of Production.

Burma.

Burma.—Cultivation is important only in the upper districts. In Meiktila (*Settl. Rept.*, 1896–8, 10) it is said the land is prepared in October and the seed sown in November after having been soaked in water for a day and then sown broadcast. The crop ripens in February. The plants are tied up in bundles, dried in the sun, and threshed out either by sticks or by being trodden under foot by cattle. The harvest-time, all over the province, is from February to April. One basket of seed to the acre—the yield being 15 to 20 baskets. There are three groups of districts according to date of sowing, viz:—(1) September to October: Lower

Seasons.

Chief Districts: Range in Time.

Chindwin; (2) November: Shwebo, Sagaing, Mandalay, Pakokku, Myingyan, Meiktila, Magwe and Yamethin; (3) January: Minbu and Thayetmyo. The district with the greatest area appears to be Pakokku, followed by Minbu and Sagaing.

C. Prov. Rotation.

Central Provinces.—In these provinces a rotation of *gram*, *massur* (*Lens*) or *butana* (*Pisum*) with wheat is much valued since the soil is thereby so improved that it does not require manure. This has been specially investigated at the Experimental Farm of Nagpur. [*Cf. Rept.* 1900–1, 10, 12; 1901–2, 9–10, 13; 1902–3, 8–9; 1903–4, 7, 8, 9; Voelcker, *Improv. Ind. Agri.*, 1893, 26–7, 234–6.] Gram is sown in October–November and harvested March-April. Two forms are mentioned as specially valued, a grey and a white. It suffers very much from falls in temperature or by hail-storms. In Narsinghpur, Hoshangabad, Betul and Raipur the crop is of special importance, and of Sambalpur it might be said gram is not cultivated. In a "Note on the Outturn of Land Under the Principal Crops," Sir J. B. Fuller has shown that the average outturn ranges from 377 to 860 lb. an acre, and that the standard there accepted was accordingly 600 lb.

Seasons.

Chief Districts.

U. Prov.

United Provinces.—Very little of importance has appeared regarding the gram of these provinces subsequent to the publication of the *Dictionary*. Duthie and Fuller observe that there are two main varieties grown—a large- and a small-grained plant. The former is reddish and the latter light-brown coloured. A black variety is not uncommon and there is also a very large white-grained form known as the *Kabuli*, which is, however, raised mainly as a curiosity. It resembles the Spanish form spoken of as *garbanzos*. Gram is largely grown as a mixed crop with wheat or barley. This would appear to have been the practice in Europe in classic times. Thus, for example, in the *Geoponicon* (a work attributed to the Emperor Constantine, A.D. 300) there occurs an interesting passage to the effect that *cicer* seeds should be soaked in warm water the day before they are sown, and "some add nitre." Then follows the observation that if an early crop be wanted it should be sown together with barley. The Indian practice is thus apparently a very ancient one.

Forms grown.

Mixed Crop.

Seasons.

The seasons of sowing and reaping are those already mentioned, viz. September to October and March to April or May. It is a dry crop mainly, and will grow on soils too poor for wheat. The outturn is on an average said to be 12 maunds (984 lb.), valued at Rs. 30, and the cost of cultivation Rs. 12 to 13. Within recent years the area under this crop has in many districts apparently been greatly expanded and at the expense evidently of wheat. It may be grown on a heavy clay to a rich loam, preferably the former. The tops of the shoots are nipped off with a view to make the plants bushy and thus increase the outturn.

Expansion.

Rajputana and Central India.

Rajputana and Central India.—The seasons of sowing and reaping are those already mentioned. Of Bharatpur it is estimated that the cost of cultivation comes to Rs. 6 to 10, the produce Rs. 20 to 10, and the net profit per acre would therefore be Rs. 14. It is said that the average yield in Ajmir is 300 lb. and in Merwara 446 lb. an acre.

Panjáb.

Panjáb.—This pulse is by Baden-Powell, Stewart and Aitchison spoken of as largely cultivated throughout the province. Numerous passages regarding the methods of cultivation, seasons, yield, etc., will be found in the Settlement Reports and Gazetteers. One feature of interest may be specially noted, namely that the plant grown is said to succeed fairly

Sandy Soils.

well on the sandy soils of many tracts of the province, especially as a mixed crop with wheat. Of Montgomery district it is observed there are both spring and autumn crops. It is not grown in the hill districts, a fact accounted for by some through the curious belief that the crop has a special affinity for lightning and is in consequence often destroyed by it. In most of the Panjáb districts, on the other hand, it is believed that manure is harmful to gram. It is sown in October and reaped in March and April. Christmas rains are beneficial, but if heavy rains fall in spring the crop is believed to be much injured. As a rule gram is not preceded by an autumn crop. The plants are "topped" by hand in order to cause them to branch. But like other *rabi* crops it is ordinarily not weeded. The chief districts are Ferozepore, Ludhiana and Hoshiarpur. [*Cf. Rept. Exp. Farm, Lyallpur*, 1901–2, 17–8.]

Mixed Crops. Two Crops. Seasons. Not weeded.

Bombay and Sind.—Mollison (*l.c.* iii., 73–8) gives a useful account of this pulse as cultivated in Bombay Presidency. He mentions four forms distinguished by the colour of the seed, namely black, dark red to brown, yellow to yellowish-red, and white to creamy. He remarks that the first three are often grown mixed but that the yellow of Gujarat is larger than that of the Deccan and when sold pure commands a higher price than the mixed pulse. The white is met with in Ahmednagar and may, Mollison thinks, be the *Kabuli* gram already repeatedly mentioned. The area of production depends on the extent of the rain that falls in September and October—when abundant, the area is increased. It is grown on the same class of soils as wheat, and the two crops are often interchangeable. Gram is a fairly important crop in the Deccan and Karnátak. It is grown in three ways: (*a*) as a dry crop in deep black soil, and is then usually the sole crop of the year; (*b*) as a dry second crop following rice, and occasionally (as in the Panch Mahals) as an ordinary dry crop after *kharíf* maize; and (*c*) as an irrigated crop liberally manured and regularly watered. In Bombay gram is rarely grown as a mixed crop with wheat or barley, though it is often lined with lineseed or safflower. It is everywhere recognised as a valuable rotation, and in addition to nitrating the soil it forms such a dense surface herbage as to kill weeds and in that way improves the soil. The usual seed rate is about 40 to 50 lb. an acre. [*Cf. Crop Exper. Bomb.*, 1895–6, 6.] It is sown in October and November and ripens in February to March and April. Experiments performed at Poona Experimental Farm (1895, 10–11) confirmed the reputation of the advantage in nipping off the early green buds. But too frequent cultivation of gram on the same land causes liability to disease. Cold is harmful, frost fatal. Cloudy weather and heavy rains during the setting of the fruits are alike harmful. Many experiments have been performed (reported under *Crop Experiments*) to ascertain the cost of production and incidence of assessment. In 1896–7 two fields unirrigated were tested and gave the total value of produce as Rs. 17–12–0 for the one and Rs. 15–15–9 for the other, the assessment showing an incidence of 12·67 per cent. in the one and 16·45 in the other. These fairly represent the average of all results, though no calculation could be applicable to the whole Presidency since the conditions and necessities vary so greatly. [*The Experimental Farm Reports* teem with interesting particulars regarding this crop, and should be consulted.]

Bombay and Sind. Chief Forms. Gujarat Grain. Production. Chief Crops. Rarely Mixed Crop. It kills Weeds. Seasons. Early Buds nipped off. Cost of Production.

Berar.—There is nothing of any material importance to add regarding this province to the particulars already recorded under the

Berar.

Central Provinces and Bombay. It occupies about 24 per cent. of the area devoted to cold-weather crops and is most abundant in Basim, Buldana and Wun.

Madras.

Madras.—Bengal gram is an unimportant crop in Madras Presidency, its place being taken by the horse-gram (***Dolichos biflorus***). The manuals of North Arcot and Coimbatore districts contain, however, brief paragraphs regarding it.

Mysore.

Mysore.—The *Gazetteer* of this State will be found to give some useful particulars in connection with gram cultivation. It is grown on black soil, and as a second crop following *ragi*.

Uses of Gram.

USES OF GRAM.—It would be beyond the scope of this article to afford details of every economic property of gram. The seed is extensively eaten both by men and cattle in every part of India except Madras. [*Cf.* Elliot, *Farinaceous Grains*, 1862, 294–5.]

Food and Fodder.

Parched Gram.

The pea is often parched and used in that form as diet, especially when cooking may be difficult or impossible. It is in this sense frequently of exceptional value to the Indian Army. The seeds are also steeped in water to remove the husks, then mashed up and boiled alone or with onions, etc. (and thus made into a thick soup), or the split peas may be cooked along with rice. Ground into flour gram is used in various ways, such as in the preparation of sweetmeats or biscuits. Although it is by far the most extensively consumed of all cattle foods in India, the results of the effort to introduce it into Europe as an article of horse food have not been encouraging. It would seem that when given in large quantity to animals not accustomed to it, poisonous effects have been observed. It has not, however, been placed beyond dispute that the grain used in Europe was pure gram. If adulterated with the pulse ***Lathyrus sativus*** the effects attributed to gram could be easily understood. [Consult the observations on this subject in the *D.E.P.*, ii., 279.]

Biscuits.

Poisonous Effects.

Pot-herb.

The young tops are largely collected and eaten as a POT-HERB. Moreover when sun-dried they may be preserved and used as required. As a *FODDER*, gram-straw has the reputation of being inferior to that of other pulses owing to the amount of acid liquid (which contains oxalic, acetic and malic acids) found on the dew-besprinkled leaves. Still the stems, leaves and husks constitute important articles of Indian cattle food. They are specially valued for milch-cows, and are cut up and mixed with common straw.

Fodder.

Vinegar.

Medicine.

The property of the green plant in affording an acid liquid often called a VINEGAR has been known from the remotest antiquity. It is systematically collected by spreading clean cotton cloths over the growing plants at night and collecting from these the vinegar with which they have become charged. This is used both MEDICINALLY and in diet. One of the earliest European travellers who described this vinegar-dew was Dr. Hove, who explored the agriculture of Gujarat in 1787. [*Cf.* with Birdwood, Baden-Powell, Moodeen Sheriff, etc.; see also **Vinegar**, p. 1109.]

Nutrient Value.

Chemistry.—Church (*Food-Grains of Ind.*, 1886, 128; suppl., 1901, 12) gives the results of his examination of the husked peas :—The nutrient ratio he found to be as 1 : 3·3 and the nutrient value 84. Similarly ***C. soongaricum*** gave a nutrient ratio of 1 : 2·8 and the coagulable albuminoids amounted to 19·8 per cent., so that this form of the pulse is rather richer in albuminoids and in oil than are the seeds of the common gram. Leather has critically examined numerous samples of gram from all parts of India and has published in *The Agricultural Ledger* (1901, No. 10, 358–9; 1903,

No. 7, 151, 155, 163) the results of his chemical investigations. Mr. Moreland has investigated the question of the extent to which gram may be used in the reclamation of upland *usar* soils. [*Cf. Agri. Ledg.*, 1901, No. 13, 424.]

Reclamation Crop.

INDIAN TRADE IN GRAM.—In a previous paragraph the area has been accepted as approximately 12,000,000 acres and the yield something like 53,000,000 cwt. Gram is consumed very largely locally, so that the returns of foreign trade are comparatively of little value. Gram and millets are very much more the staples of Indian diet than are wheat, barley or rice. A study of the rise and fall in the prices of these grains affords, therefore, a surer indication of the cost of living and of the abundance or scarcity of food than can be learned from almost any other commodity (except perhaps the imports of copper metal). Were it possible to prepare a complete statement of the internal traffic in gram, it would be seen to what extent the resources of one province are drawn upon to supply the necessities of another. Unfortunately the record of internal transactions is very much less complete than the returns of articles received from or delivered to the shipping.

Trade.

Staple Foods of India.

Indications of Famine.

The total exports have rarely exceeded half a million cwt. In 1895–6 they were returned at 633,199 cwt., but the mean of the decade ending March 1904 comes to only 335,000 cwt., or 0·632 per cent. of the estimated total production. In 1906–7 they were 846,583 cwt., valued at Rs. 32,31,744. But of the exports a mean of about 35,000 cwt. goes from Madras, and should therefore be removed from the returns of ***Cicer arietinum*** and credited to those of horse-gram (***Dolichos biflorus***), so that this correction would very possibly bring the exports down to approximately ½ per cent. on production. A feature of interest in recent returns is the growing importance of Sind (Karachi) as an exporting centre. Still another fact may be added, namely that the major portion of the exports is commonly consigned to Mauritius, but sometimes to the United Kingdom; the traffic with the latter, however, seems subject to extreme fluctuations. By the coastwise trade 692,212 cwt. were carried in 1905–6, of which 370,165 cwt. went to Madras, about half from Bombay, and one-sixth each from Bengal, Sind and Burma. Of the rail-borne traffic nothing can be said, since gram is collectively returned with pulses.

Exports.

½ per cent.

Karachi.

Mauritius.

Coastwise Traffic.

Turning now to the available particulars regarding prices of gram. The years 1896 to 1901 have to be excluded from consideration as these were characterised all over India as years of scarcity and famine. But the effect of the increased facilities of railway communication may be said to have raised the price in centres where it was abnormally cheap and lowered the price where it was abnormally dear. Taking India as a whole the price seems to have been slightly increased, but not disproportionately with other commodities or with wages. In Assam gram sold in 1884 at 12·4 seers to the rupee (or say 1¼*d.* per 2 lb.), and in 1903 at 11·85 seers. In Bengal for the corresponding years it was 18·1 and 16·71; in the province of Agra 24·12 and 19·8; in Oudh 25·66 and 22·54; in Rajputana and Central India 21·36 and 18·31; in the Panjáb 32·22 and 21·06; in Sind and Baluchistan 20·49 and 15·76; in Bombay 18·08 and 14·2; in the Central Provinces 26·81 and 17·75; and in Berar 19·84 and 14·81. The mean of all these returns would be 21·9 in 1884 and 17·79 in 1903. That is to say one seer (2 lb.) would in the former year have cost 0·7306 of an anna (or of one penny), and in the latter year 0·8939. But the selection of single years for comparison, and the striking of means and averages in

Prices.

Famine.

Equalised and raised

Averages often misleading.

these, can never be seriously advanced as evidence of value. For one thing it seems likely that the full effect of the years of famine was not effaced by 1903, and that better results would be shown in subsequent years. Local and accidental peculiarities are ignored by all such calculations.

Recent Returns. Still, the figures given are of some interest. Later returns for 1905, which have since come to hand, show the following prices (seers to the rupee):—Eastern Bengal and Assam, 12·61; Bengal, 14·99; Agra, 17·34; Oudh, 17·21; Rajputana, 16·3; Central India, 15·71; Panjáb and N.W. Frontier, 20·63; Sind and Baluchistan, 15·5; Bombay, 13·59; Central Provinces, 16·49; and Berar, 15·14.

D.E.P., ii. 289–316. Peruvian Bark.

CINCHONA, *Linn.*; CINCHONA and PERUVIAN BARK, JESUITS' BARK; *ecorce de quinquina* (Fr.); *chinarinde* (Germ.); RUBIACEÆ. The species of ***Cinchona*** that yield QUININE are the most recently cultivated of all important plants. They are natives of the mountain forests of Bolivia, Peru, and Ecuador, and are chiefly met with in the valleys with an eastern trend from the great Andes, at altitudes between 3,000 and 9,000 feet and also in the western valleys of the central area.

History. History.—Sir George King,—than whom few persons have a higher claim on the respect of the people of India—opens his *Manual on Cinchona Cultivation* with the following passages:—"Of the date and manner of the first discovery of the curative effects of Cinchona Bark, in malarious fevers, we know nothing.

Discovery. And we are almost equally ignorant who the discoverers were, some writers claiming *that* merit for the aborigines of South America, while others assert, and with apparently greater accuracy, that not only did the Indians know nothing of the virtues of the bark, until these were pointed out by their conquerors the Spaniards, but that they still refuse to use the bark as a febrifuge. The introduction of this medicine to Europe is associated with the Countess of Chinchon, wife of a Spanish Viceroy of Peru, who having been cured by its use of an attack of fever, contracted while in that country, brought a quantity of the bark to Europe

Dissemination. on her return from South America about the year 1639." Acquaintance with the virtue of the bark seems, however, to have been disseminated over the world with remarkable rapidity. It was discussed, extolled, and defended by Chiflet in 1653; by Badius in 1656; by Roland Sturm in 1659; by Morton in 1692; and by Pomet in 1694. It was known in London in 1655, and became officinal in the Pharmacopædia in 1677. Fryer, who visited India in 1675, speaks of a "Brachmin" who gave a powder prepared from natural cinnabar in the cure of fever "which works as intallibly as the Peruvian Bark." This curiously interesting anecdote shows the rapidity with which the knowledge of this drug was carried across the globe. A century later it was fully described in an Indian work on

Early Indian Medical Writer. Materia Medica under the name "Bark." This was written by Mir Muhammad Husain (*Makhzan-el-Adwiya*, 1770), who specially remarks that its virtues had been discovered by a sect of Christians called Jesuits. He adds that it bears the name of *kina-kina*. This is its name in the language of the Incas, and it gave origin to the French name *quinquina*, as given by Condamine originally, and to *china* in Spanish. The French obtained the bark in 1679, for it is recorded that Louis XIV. purchased a supply from an Englishman of the name of Talbor or Tabor. Talbor, like many of the Native doctors of India to-day, made his reputation and fortune through a fever mixture the chief ingredient of which was

Plants named Botanically. quinine. Nothing, however, was known to the botanical world of the plant from which the medicinal bark was procured until 1739, when MM. La Condamine and Jussieu studied it, during an astronomical expedition to South America. The former sent a sample to Linnæus from Cajanuma, and in consequence in 1742 it was named ***Cinchona***, and in 1753 Linnæus established the species ***C. officinalis***. The plant is sometimes now known as *var.* ***Condaminea*** after its discoverer.

Grown in Paris. The first living plant was shown in Europe in 1840, having been raised in Paris from Weddell's Bolivian seed, namely, ***C. Calisaya***. Thus, briefly, the medicinal bark was discovered in 1640; the plant was named a century later; and still another century later a specimen was grown in the Jardin des Plantes of Paris.

But if a lady was directly instrumental in the discovery of the great merits of this drug, a no less distinguished lady, the wife of a Viceroy of India (Lord Canning), was closely connected with its ultimate successful cultivation in India. Dr. Ainslie in 1813 lamented the fact that Cinchona was not grown in India. Dr. Royle in 1835 recommended that the Cinchona plants should be taken to India and grown on the Khasia and Nilgiri hills. About the same time Fritze, Miquel and other botanists advanced the claims of Java. No effort was, however, made for twenty years, not in fact until the heavy mortality through fever, during the Indian Mutiny, forced the subject into public attention. It was, moreover, well known that a reckless and selfish process of bark-collection was seriously endangering the world's future supplies of the drug. These circumstances combined to lay emphasis on the final recommendation of the Government of India, viz. that seed and plants should be procured for experimental cultivation in India. In consequence, Mr. (now Sir) Clements R. Markham was entrusted with the delicate and difficult task of procuring supplies. The subsequent incidents and final success which he attained are matters of history, and need not be here detailed. Sir Clements procured the services of several gentlemen whose names are all closely associated with his own, namely Spruce, Pritchett, Weir and Cross. The energetic co-operation of the Director of the Royal Gardens, Kew, guided and controlled all the subsequent efforts. Various consignments of plants and seeds were taken to Kew, and finally carried to India, certain plants having in due course been established on the Nilgiri hills. So far, however, the attempt to introduce the trees into Bengal had been a failure. On the other hand, the efforts of the Dutch botanists and chemists in the naturalisation of *C. Calisaya* and *C. Pahudiana* were crowned with complete success, and in consequence the noble Lady Canning discussed with Dr. Thomas Anderson, of the Royal Botanic Gardens, Calcutta, the desirability of a further effort being made to introduce the most useful species, if possible, from Java into the mountains of Bengal. Shortly after Lady Canning herself fell a victim to the scourge that she aimed at alleviating. Dr. Anderson was, however, deputed to Java, and he brought back with him a fairly large consignment of plants, some of which he left in Ceylon, others in the Nilgiri hills, and finally took a set to Calcutta Botanic Gardens and ultimately to Darjeeling. But many mistakes as to altitude, climate, method of treatment, best stock and the like, had to be corrected before a plantation could be established. Dr. Anderson lived, however, to see his labours brought to a satisfactory conclusion, and then, like the great lady who had sent him to Java, he died suddenly of malarial fever. But his laborious work was placed in the hands of a worthy successor—Sir George King. It would occupy many pages to narrate even the more striking features of the subsequent achievements. Anderson acclimatised the plants in Sikkim; King made their cultivation and the manufacture of quinine a commercial success. Suffice it, therefore, to say that a department has been so organised that the Government of India have long since discontinued to import quinine; the hospitals have been given a limitless supply of the finest quality at less per pound than a few years ago it sold at per ounce, and lastly, and by far the most remarkable accomplishment, packets of one dose are now sold in every Post Office, throughout the fever-stricken tracts, at the nominal cost of one farthing. This invaluable medicine has thus been brought to the very door of even the poorest peasant of India, and it is no wonder, therefore, that recurrent vital statistics mark year by year the steady conquest of India's greatest and direst scourge. Truly, therefore, may it be said of Lady Canning that she died to save others.

Java.

Indian Mutiny.

Sir Clements R. Markham.

Kew and India.

Java.

Anderson and King.

Successful Manufacture.

Post Office Packets.

Lady Canning.

[*Cf.* the following works, in amplification of the enumeration given in the *Dictionary*, may assist the reader to discover the fuller particulars which he may desire regarding the history, botany and cultivation of the Cinchona-yielding plants:—Lambert, *Genus Cinchona, etc., incl.* Vahl, *Dissert.*, 1797–1821; Bergen, *Monog. der China*, 1826; Weddell, *Hist. Nat. Des. Quinq.*, 1849; *Parliamentary Returns E. Ind. Cinchona Plantations*, 1852–75; Markham, *Peruvian Bark*, 1860 to 1880; also *Travels in Peru and India*, 1862, 483–520; Planchon, *Des Quinquinas*, 1864; Howard, *Quinology East Ind. Plantations*, 1869; Triana, *Nouv. Etud., Quinq.*, 1870; Campbell Walker, *Rept. Govt. Cinchona Plant.*, 1876; Cross, *Rept. C. condaminea in Ecuador*, 1861; also *Rept. Mission to S. America, etc.*, 1877–8; Bidie, *Cinchona Cult. in Br. Ind.*, 1879; Moens, *Kinacult. in Azië*, 1882; Gorkom, *Handbook Cinch. Cult.* (Jackson, transl.), 1883; Holmes, *C. Ledgeriana*, in *Journ. Linn. Soc.*, 1886, xxi., 374–80; Nicholls, *Textbook Trop.*

Agri., 1892, 221–9; Heuzé, *Les Pl. Indust.*, 1895, iv., 324–34; Holmes, *Cat. Med. Pl. in Mus. Pharm. Soc. Gt. Brit.*, 1896, 69–81; Lotsy, *Gouver, Kinaonderneming de Local. van het Alcaloid*, 1898; Broekhuizen, *De Kinacult.*, 1898; Reimers, *Les Quinquinas de Cult.*, 1900; Semler, *Trop. Agrik.*, 1900, ii., 242–77; Jumelle, *Les Cult. Colon.* (*Indust.*), 1901, 226–48; *Ann. Repts. Govt. Cinchona Plant. Beng. and Mad. up to* 1904; *Moral and Material Progress and Condition, India*, 206; etc., etc.]

Species, Varieties and Races.—There are about 30 to 40 species of ***Cinchona***, and also numerous hybrids, varieties, and special cultivated races. Indeed so readily do the species cross and sport that it is impossible to grow two or more side by side and obtain from them uniformly pure seed. On this account grave doubts have been entertained regarding the specific values of many well-known forms. The commercial barks of to-day are obtained from about a dozen forms of which ***C. Calisaya*** and ***Ledgeriana*** are the most highly valued. To these would have to be added the special hybrid that appeared in Sikkim some few years ago, and is now spoken of as "the hybrid." The following brief abstract of the more important species may be useful:—

Calisaya Bark.

Sikkim.

C. Calisaya, *Weddell;* The CALISAYA BARK, YELLOW BARK, etc. A very variable species with a trunk, when full grown, twice as thick as a man's body. Largely grown in Sikkim, at moderate elevations (1,500 to 3,000 feet), and one of the most valuable of all forms, but is difficult to cultivate. The seed of this form was originally sent to Europe by Weddell. It was raised in Paris in 1851 and one plant was presented to the Dutch, by whom it was successfully conveyed to Java; and in 1873 Dr. van Gorkum reported that it was the chief form grown in Java—its most important alkaloid being QUININE. It was the species Markham specially charged himself with the task of securing in Bolivia and Peru. But it has many varieties, one of which is of very special merit, viz:—

Quinine.

Ledgeriana.

Var. Ledgeriana.—The story of the origin of this form is very interesting. Mr. C. Ledger was travelling in South America on behalf of Australia in search of an animal resembling the alpaca sheep. His servant mentioned to him that it was difficult for collectors to procure the seed of the finest quality of cinchona because of the suspicion in which all persons interested in that drug were held. Accordingly Mr. Ledger said he would like to get some of the best seed, and in due time he was supplied.

Java Stock.

This was taken to Europe and sold. The major portion went to Java, but a small quantity found its way to the Nilgiri hills and a still smaller portion to Sikkim. The Java seed yielded 20,000 plants, the Nilgiri either failed to germinate or was neglected and lost, and the Sikkim grew and in time became the parent stock of the plants in the present Bengal plantations. In 1880 Mr. Gammie reported of Sikkim that he had 10 acres under ***Ledgeriana,*** and last year's report shows that out of the total 3,306,763 trees in the Government of Bengal's plantations, 2,566,057 were ***Ledgeriana.*** This plant was subsequently introduced into the South Indian plantations, and flourishes well in the Wynaad at 3,000 feet altitude. It yields a high percentage of quinine, and is deservedly the most popular of all stocks. But it is comparatively a small tree, and the yield of bark correspondingly less than with the larger forms. In Java some of the richest stocks are never allowed to seed, but are grafted on to other seedlings of this variety, and the high-yielding forms thus carefully developed and conserved. The same plant taken to India will, however, yield less than half the regular produce in Java.

High Percentage of Quinine.

RED BARK

C. officinalis, *Hook.;* the LOXA or CROWN BARK, the PALE BARK of commerce. This is a native of Ecuador and Peru, and with *C. succirubra* was the species assigned by Markham to his colleague Spruce to discover. It is grown at high elevations (above 7,000 feet) in the Nilgiris, Ceylon and Sikkim, but not extensively. It is a weak, straggling tree, attaining at most only 20 feet in height. Its cultivation in Sikkim has, however, been almost abandoned owing to the climate being too moist, but it is perhaps the most important of the species grown in the Nilgiri hills. Crown Bark.

C. succirubra, *Pavon;* the RED BARK. This is largely cultivated on the hills of South India at altitudes of from 4,500 to 6,000 feet; at higher altitudes the growth is too small to make its cultivation profitable. On the hills east of Toungoo in Burma and in some parts of the Satpura range of Central India it is grown, and also met with in the Government plantations of Sikkim, but is not popular, and is rapidly being replaced by *Ledgeriana.* It is a hardy plant with a bold sturdy stem. In rich and sheltered situations it grows to the height of 50 feet or more. The leaves are bright apple-green in colour, the plantation in consequence looking light and bright while one of *C. officinalis* looks dark and gloomy. Red Bark. South India.

CULTIVATION.

Climate and Soil.—None of the medicinal species will stand frost, though they prefer a cool climate in which the contrasts between summer and winter and between day and night are not very great. At Ootacamund, about 7,500 feet above the sea, the minimum lowest temperature in the shade is about 49° and the maximum 69° F.; at Neddiwattum, 2,000 feet lower, the minimum is about 54° and the maximum 66° F. In the Rangbi Valley, Sikkim, at 3,332 feet in altitude the minimum may be given as 40° and the maximum at 88° F. This might be spoken of as ideal for *succirubra* but rather cold for *Calisaya.* A more congenial climate for both species would therefore be at an altitude of 2,500 feet. In the matter of humidity, the requirements of the cinchona were at first misunderstood. It has been found in the Nilgiris that all the species (particularly the red barks) withstand longer droughts than were thought possible. All the species assume a yellow tint during the rains, and in the Nilgiris all make their most vigorous growth during the time when sunshine and shower alternate. In Sikkim *succirubra* makes most progress during the latter half of the rains, but both on the Nilgiris and on the Himalaya the plants continue to grow for two months after the rains cease. The rainfall of Ootacamund is about 44 inches, that of Neddiwattum 105 inches per annum. The rainfall of the Sikkim Plantations of Rangbi is about 166 inches. The species are impatient of stagnant moisture, and therefore require an open gravelly subsoil, a sloping exposure, and a rich loam (especially so if of volcanic origin) to dry clay soil. Accordingly they succeed better on recently cleared forest than on old exposed grassy lands. Cultivation. Climate and Soil. Temperature. Humidity. Rainfall. Soil.

Propagation.—They may be raised from seeds or multiplied by cuttings or layerings. The seeds may be sown in open beds of specially prepared soil shaded by a temporary roof, or in shallow boxes. The seeds should be sown somewhat thickly and sprinkled over with fine soil. They should be watered fairly freely, and in six weeks they will germinate. When the seedlings have got two or three pairs of leaves they should be transplanted Propagation. Seed: Cuttings: Layerings. Transplanting.

in lines about 2 inches apart each way. When about 4 inches high, they should be again transplanted into lines 4 to 5 inches each way. When 9 to 10 inches high the seedlings will be ready for being placed in their permanent positions, and should be transplanted in wet and cloudy weather. They are then placed at distances of from 4 to 6 feet apart, according to species or local necessity. The red-bark may become a considerable tree, the crown-bark a medium tree, and the yellow-bark a bush or small tree. Wide planting would thus obviously be an error, especi-

Close Planting.

ally for the two last-mentioned forms. In fairly close planting the ground is covered quickly; the plants in consequence shade the soil and check the growth of weeds, protect the surface roots, and produce straight stems that oppose a more compact and thus enduring face to destructive winds. If they are found to be too thick they can be thinned out, and an early crop of bark thus obtained.

Bark.

Bark Cultivation and Preservation.—The first crop, as already mentioned, is usually obtained by thinning out the plantation, when perhaps 25

Thinning.

per cent. may be at once uprooted and barked. This thinning out may with advantage be continued during the fifth or sixth years of growth, when perhaps not more than half the original plants may ultimately be left

Highest Yields.

in the plantation. The bark is richest in alkaloid when the plant is about four years old. It remains at about the same level till the seventh year; after that period the proportion of alkali to bark slowly diminishes. The

Best Age.

modern practice accordingly is to completely uproot a patch after the plants (more especially *Calisaya*) have attained the age of 12 to 14 years. The roots are carefully washed and barked; in fact the richest of all barks are those taken from about a foot or a foot and a half on either side of the theoretical collar. Hence it may be said the roots are of much value, since they contain even more alkaloid than the stems and branches.

Barking.

The bark from both root and stem is then stripped off, care being taken to carry away none of the woody structure adhering. With this object rings are cut round at 18 inches apart, a longitudinal incision is then made between the rings, and the bark thus removed in sections. It is dried in the subdued sun or shade for two or three days, and when quite dry is stored and packed and exported or conveyed to the factory.

With standing trees the bark may be obtained by one or other of the

Lopping.

following methods :—(*a*) ***Lopping*** off branches, and obtaining the bark from these in the way already mentioned.

Coppicing.

(*b*) ***Coppicing.***—That is to say, trees when about six years old are cut down to the ground and barked. Fresh shoots spring up, one or two of which are allowed to grow, and these in time are again coppiced when sufficiently thick to afford useful bark. This method is most suitable for crown-bark.

Shaving.

(*c*) ***Shaving.***—This is a Java system. The bark is shaved off as near to the cambium layer as possible but without injuring it. This is best done by an instrument that resembles an ordinary spokeshave. The bark is renewed quickly unless when the cambium has been interfered with. The best plan is to shave off two strips on opposite sides of the stem, since in this way the tree is not materially injured. In dry weather it may be necessary to protect the wound by tying dry grass over it, but if close planting be pursued this will not be necessary.

Stripping and Mossing.

(*d*) ***Stripping and Mossing.***—This is really only a special modification of the shaving process. The bark is cut off in alternate bands or strips

of 1½ to 2 inches in breadth, the whole stem being afterwards swathed in moss. When the wounds have been barked over, the intervening bands are stripped off and the mossing renewed. This was invented by McIvor in the Nilgiri hills, and is now abandoned in favour of the shaving system.

Shaving *versus* Coppicing.

All renewed bark, whether produced by shaving or mossing, is found richer in alkaloid than the original bark, so that the shaving process, being less troublesome and the cambium less liable to injury, has come into fairly general practice; and moreover the yield of alkaloid is higher by this than by any other method. It may, however, be added that the renewed bark is never so thick as the original, and therefore less in weight. It becomes accordingly a question whether coppicing is not, after all, the most profitable system. It is certainly the least troublesome, and if followed by systematic uprooting and fallowing of the land, allows of complete renovation.

Drying and Packing.

Drying and Packing.—As already indicated, the bark, by whatever process procured, should be dried gradually. In rainy weather this may have to be accomplished in specially prepared drying-sheds, or the bark may be quickly dried in special evaporators. Sun-drying is the best.

Qualities of Bark.

According to the age of the plant, method of collection and drying, there are various grades of each botanical bark. Thus, for example, *root-bark*, *quill-bark* (that from the branches), *shavings*, and lastly *flat-bark* (that from large stems).

Effects of Heat.

Exposure to a high temperature or to prolonged action of direct sun's rays injures the bark. It is best, therefore, to bark the trees in dry weather, to dry slowly, to turn the pieces repeatedly, and to take every precaution to prevent moulding or fermentation. Once properly dried, the bark will keep indefinitely, or at all events for many months, without deterioration; but in drying, the loss in weight depends on the species and method of treatment—the average is usually from 70 to 76 per cent. of the fresh weight.

Manufacture.

PRODUCTION AND MANUFACTURE.—To trace, even in the very briefest manner possible, the history of the discovery and the development of all the methods of manufacture that exist, would take many pages and involve a complete review of the chemistry of cinchona. [*Cf. Journ. Pharmaceut. Soc. Gt. Brit.; Journ. Soc. Chem. Indust.; Chemist and Druggist; British and Colonial Druggist; Pharmacog. Ind.*, etc., etc.]

Indian Experience.

In 1888 the Government of India published for general information the final results of the experiments conducted by Sir George King and Mr. G. A. Gammie that may be said briefly to have resulted in the perfecting of the oil process of manufacture now very largely pursued. This may be said to mark the turning-point of the Indian industry from that of experiment to commercial attainment.

Production.

Area.—The area under this crop has been seriously curtailed. In 1897–8 an official publication reviewed the then available information. It was ascertained that there were 4,346 acres under the crop, of which 68 per cent. were situated in Southern India. The Bengal portion was 1,394 acres, of which only 10 acres were not owned by Government. In the Madras Presidency, on the other hand, the State plantations represented but 800 acres out of the total 2,952. But during the twelve years ending 1897–8 the area had fallen from 14,491 to 6,833 acres, and there is reason to believe that a temporary expansion has since taken place. This

Private and Government.

Decreased Area.

remarkable decrease is believed to represent the discontinuance and adjustment of Indian production as a private venture. The reasons usually given for this are the fall in price of quinine, the greater margin of profit in tea, coffee and other commodities, and the more successful production in Java and other countries. According to the *Agricultural Statistics*, the area in 1898–9 was 6,192 acres; in 1899–1900, 5,006 acres; in 1900–1, 4,903 acres; in 1901–2, 4,930 acres; in 1902–3, 5,260 acres; in 1903–4, 5,014 acres; and in 1905–6, 5,309 acres. Of these areas Bengal had an average of 1,400 acres, of which 70 to 100 acres were private plantations. The area in 1904–5 was 5,269 acres (1,800 acres in Bengal, 3,293 in Madras, and 176 in Coorg). Indirectly certain additional particulars may be learned from the study of the exports to foreign countries. For a good few years past these have fluctuated severely, but manifested a steady decline which more or less corresponds with the curtailment of private interests. In 1899–1900 the exports of bark stood at 3,290,236 lb., but in 1906–7 they had fallen to 494,587 lb., and were made exclusively from South India.

Fall in Price.

Official Statistics.

Trade.

Bengal Factory.

Government Plantations and Factories.—Turning now to the reports of the Government plantations and quinine factories, of which we possess more or less definite information, we learn that in Bengal during 1903–4, according to the report issued by Lt.-Col. D. Prain, the estimated total acreage is not stated, but the expansion is shown to have come to approximately 180 acres. It seems likely that private interests have not, however, materially increased, and that therefore the total area returned by Government in the volume of the statistics of crops may be accepted as representing the Government plantations, viz. 1,400 acres. If doubt exists as to the exact area the number of trees grown is systematically given, and from that a more trustworthy conclusion may after all be drawn. In 1903–4 there were 3,306,763 trees, of which 2,566,057 were *Ledgeriana*, 257,602 *succirubra*, 2,130 *officinalis*, while 463,075 were Hybrid No. 1., and 17,899 were Hybrid No. 2. These figures show an expansion on the corresponding numbers for the previous year that comes to 291,163 trees (practically the equivalent of the expansion of 180 acres). The crop taken from the plantations came to 316,757 lb. of dry bark, but to meet the necessities of the factory 461,467 lb. of bark had to be purchased and mostly imported from Madras. The manufactured products of the year came to 16,404 lb., which consisted of sulphate of quinine (12,314), sulphate of cinchonidine (290), and cinchona febrifuge (3,800). The Bengal factory by official arrangement supplies Bengal, Assam and the Panjâb. The issues from the factory were quinine 12,021 lb., which included an increase during the year in the form of pice packets that amounted to 1,500 lb. The sales of cinchona febrifuge manifested a decrease of 976 lb., and the final working of the Department showed a net surplus of Rs. 66,320.

Number of Trees.

Expansion.

Pice Packets.

Recent Returns.

In the latest report for 1906–7, by Capt. A. T. Gage, which has come to hand since the above was written, it is stated that "the number of Cinchona trees of all sorts on the permanent plantations on March 31, 1907, was 3,698,777. Of this number 3,006,847 were *Cinchona Ledgeriana*, there being 1,770,521 on Mungpoo Plantation and 1,236,326 on Munsong Plantation. The remainder consisted of *Cinchona succirubra* and 77,283 of Hybrid No. 2—both mostly on Mungpoo Plantation." "The amount of bark yielded by both plantations was 429,557 lb., of which

376,025 lb. were *Cinchona Ledgeriana* bark, and the greater part of the remainder Hybrid No. 1 bark. Of the *Ledgeriana* bark, Mungpoo supplies 286,994 lb. and Munsong 89,031 lb." "The total quantity of bark worked up in the factory was 798,500 lb., made up of 513,180 lb. of *Ledgeriana* and 85,320 lb. of Hybrid No. 1. The output of Quinine Sulphate amounted to 16,065 lb. 4 oz., being an increase of 287 lb. 8 oz. on last year's output." The manufacture of cinchona febrifuge was suspended for part of the year and only 2,652 lb. were produced; no cinchonidine sulphate was manufactured, so that the total output of the factory was 18,717 lb. 4 oz. The average yield of quinine sulphate in the bark supplied to the factory was 2·68 per cent.

Output of Quinine.

Correspondingly the records of the Madras plantations and factory may be reviewed. The chief districts are the Nilgiri hills, Malabar, Travancore, Mysore and Coorg—but mainly the Nilgiris. Mr. Standen in his Annual Report for 1903–4 speaks of the old plantations having consisted of 832 acres and the new extensions as being 440 acres, a total of 1,272 acres. The production was only 116,289 lb. of bark as against 166,220 lb. in 1901–2, the difference being due to the policy of restraint in cropping during years of cheap private supply. But to meet the demands of the factory 431,185 lb. of bark had to be purchased from private producers. The issues from the factory during the year were 15,040 lb. of quinine and 3,359 lb. of febrifuge. The supplies go to Madras and Mysore, Bombay, the Central Provinces, United Provinces, Rajputana and Central India, Hyderabad and Burma. The net profit of the department during the year was Rs. 83,340, a highly satisfactory state of affairs.

Madras Factory.

Bark purchased.

Profits.

Net Results.—Practically, therefore, the Government of India's endeavours to acclimatise the cinchona plant may be said to come to this; the annual imports of the drug on behalf of the Government have been discontinued; India has been given a liberal supply of an invaluable drug at a remarkably low price; the working of the two sets of plantations and factories have given lucrative employment to a fair number of persons; lastly a net profit has been secured of Rs. 1,39,660 a year (say £9,310)—a truly creditable record. Recently the Government of India took into consideration the desirability of lowering the price of the packets sold at the post offices. It has been resolved that in future seven in place of five grains shall be given for one pice (one farthing). This has had the immediate effect of increasing the demand, and the future must of necessity witness a considerable expansion both of production and manufacture.

Practical Results.

Increased Demands.

TRADE.—It has been shown that the two Government factories in 1903–4 supplied between them 27,061 lb. of quinine to the hospitals, jails, post offices, etc., of India. In addition there was imported during the preceding five years an annual average of 54,000 lb. of quinine—chiefly from the United Kingdom and mainly into Bengal. In 1904–5 the imports were 68,648 lb., valued at Rs. 6,92,329, and in 1906–7, the latest year available, 71,237 lb., valued at Rs. 6,28,430. These are significant figures. They would seem to show that a successful industry might be organised by private enterprise, to meet the demands that create these imports. But it has to be recollected that in Java both the climate and soil are peculiarly favourable to the cultivation of cinchonas with a high percentage of quinine. Java will, therefore, always hold its own against India, and thus lessen the prosperity of any resuscitated industry. The indents on Government

Imports.

Javan Control.

production have for years been steadily increasing, so that the plantations hardly do more than meet half the requirements of the Government factories; but it is probable the extensions that have been made will reduce the demand on private production. In spite of past failures, however, there would seem every hope that the cultivation of the most approved varieties might be made a profitable adjunct to tea, especially in the Darjeeling district. The difficulty is to obtain suitable land in desirable situations. There would also seem every likelihood that private manufacturing establishments, to use up the bark presently being exported, might prove successful. India's demand for quinine is great and increasing.

Exports. The exports of bark were 3,290,236 lb. in 1889–1900; 2,753,858 lb. in 1900–1; 1,917,259 lb. in 1901-2; 1,579,498 lb. in 1902–3; 1,108,527 lb. in 1903–4; 1,177,394 lb. in 1904–5; and 494,587 lb. in 1906–7. These went almost exclusively from South India and to the United Kingdom. There are said to be in the world 18 quinine factories: 5 in France; 3 in England; 2 in Germany; 1 in Holland; 4 in America; 2 in India, and 1 in Java. But the modern trade centres mainly in Amsterdam. The world's demands for bark average from 14 to 18 million pounds.

World's Demands.

D.E.P., ii., 317–26. **CINNAMOMUM,** *Blume; Fl. Br. Ind.*, v., 128-36; *Pharmacog. Ind.*, iii., 199–210; Gamble, *Man. Ind. Timbs.*, 560–4; Prain, *Beng. Plants*, ii., 898; Brandis, *Ind. Trees*, 532–4; LAURACEÆ. Gamble observes that there are about 24 species placed under this genus and divided into two subgenera, MALABATHRUM taking 20 and CAMPHORA 4 species. It is not intended in this work to discuss at all fully more than two of these, viz. *C. Tamala* and *C. zeylanicum*. A third species, *C. Camphora*, will, however, be found separately dealt with under **Camphor** (p. 245).

Cassia Lignea. **Cinnamomum Cassia,** *Bl.*—This is the plant which in China is regarded as affording the finest quality of CASSIA LIGNEA—the true Cassia bark of the ancients. A sample of this bark was lately sent from the Patkai mountains, on the frontier of Assam, accompanied by fairly satisfactory botanical specimens. These were critically examined by Prain and myself and compared with authenticated specimens of the Chinese plant. There would, therefore, seem no doubt that the best qualities of Assam Cassia are the true CASSIA LIGNEA of commerce. It is possible that to this circumstance is due the improved trade in the Assam bark. [*Cf.* Thiselton-Dyer in *Journ. Linn. Soc.*, xx., 19-24; *Pharmacog. Ind.*, iii., 203–8; Gildemeister and Hoffmann, *Volatile Oils*, 382–91.]

Nepal Sassafras. **C. glanduliferum,** *Meissn.*; the Nepal Sassafras or Nepal Camphor-wood (the *malligiri*), is a large tree of the Southern Himalaya, from Kumaon eastwards to Assam, but especially so in Nepal. Its wood is strongly camphor-scented. It is very readily confused with *C. cecicodaphne, Meissn.* (the *rohu, gun-serai, gún-droi*), a tree of the Eastern Himalaya, especially Darjeeling and Assam. Still further to the east *C. Parthenoxylon* is the Martaban Camphor-wood, and apparently also the Camphor-wood of the Malaya. Camphor-wood is used for boxes, furniture and even canoes, but is brittle.

Camphor-wood. **C. iners,** *Reinw.*; the *hmanthin* of Burma. This large tree is met with in the forests of Tenasserim and the Malay Peninsula. Its timber is one of the camphor-woods of commerce, and according to some writers the bark is one of the qualities of CASSIA LIGNEA. It would seem probable that much of the economic information given in the *Dictionary* and in other works on Indian economic botany, under this species, should be transferred to the *C. zeylanicum* of Western and Southern India. [*Cf.* Holmes, *Pharm. Soc. Mus. Rept.*, 1895–1902, 54.]

Karua. **C. macrocarpum,** *Hook., f.*; *Fl. Br. Ind.*, v., 133; *Carua, Ham., Trans. Linn. Soc.*, xiii., 550-5. This is a small tree of N. Kanara and seems to be the plant described by Rheede (*Hort. Mal.*, 1686, i., 107-10, t. 57) as *karua, bahena* and *tiqui* (*tikhi*), and which he said differed from *C. zeylanicum* of that region by having large fruits, and by its flowering in January instead of July.

From the root bark, as also the leaves, Rheede remarks, an oil was prepared and used as an external medicine. It would seem probable also that this plant affords the *kala-nagkesar* or immature fruits that are sent to Bombay from the Malabar forests. Clusius in his version of Garcia de Orta (*Hist. Exot. Pl.*, 1605, 178) gives a picture of *tamalapatra*, in which he shows unripe flower-buds that closely correspond with the *kala-nagkesar* of modern commerce. They were probably in ancient times employed in flavouring the wine known as Hippocras. It is hardly necessary to give the warning that they must not be confused with Cassie Flowers (see p. 14). The Cassia Bark of Malabar may also come from this plant, though it is doubtless mainly procured from the wild plants of *C. zeylanicum*. [*Cf.* Jonston, *Hist. Nat. de Arbor.*, 1662, 164.] Marco Polo gives interesting particulars of the Cinnamon and Cloves of Yunnan which in some respects recall the traffic in the Malabar products. [*Cf.* ed. Yule, ii., 32, 35, 38, etc.]

Oil.

Kala-nagkesar.

Malabar Cassia.

C. obtusifolium, *Nees*; the *ramtezpat, kinton, bara-singoli, nupsor, patihonda, dupatti, krowai, lulingyaw*, etc., is an evergreen tree of the outer Eastern Himalaya, Eastern Bengal, Khasia hills, Burma, Andaman Islands, etc. It gives a Timber said to be useful for boxes, planking, etc. The leaves are aromatic and used as a spice in place of those of *C. Tamala* and the bark is one of the trade qualities of Cassia Lignea, and after *C. Tamala* is perhaps the best known of all the qualities met with in India; it comes from Assam, Darjeeling and Nepal to Bengal and the United Provinces.

Ramtezpat.

Timber.

C. Wightii, *Meissn.*; is recorded as met with in the Nilgiri hills. Holmes (*l.c.* 55) mentions a sample of thick unscraped bark attributed to this species and sent from Ootacamund. It had a sharp taste recalling the flavour of nutmeg.

C. Tamala, *Nees; Agri. Ledg.*, 1896, No. 38. The Cassia Lignea or Cassia Cinnamon; the *taj, kikra, kirkiria, sinkami, chota sinkoli, nupsor, dopatti, tamálá, thitchabo, thit-kya-bo, zarnab* (tree), *talispatri, tálisha-pattiri, tajpat* or *tejpát, lavanga patte, dieng latyrpat* (leaves), etc. The word *tamáli* occurs in the *Raja Nirghanta*, and *tejpat* is apparently derived from the Sanskrit *tvach*. A moderate-sized evergreen tree of the Himalaya, rare from the Indus to the Sutlej, but common thence eastwards to East Bengal, the Khasia hills and Burma, between 3,000 and 7,000 feet.

Cassia Lignea.

Adams (Comment. in *Paulus Ægineta*, iii., 238) and other writers have identified the *Malabathrum* of the Greeks and of the Romans with the *tejpat* of India. There seems no doubt that the leaf of this plant has been traded in and exported from India for many centuries. The leaf is, in fact, a more important product than the bark.

History of Cassia Lignea.—Owing to the confusion which existed in former times with regard to the Cassia barks, it is almost impossible to give a connected résumé of the history of any one of them. It may be observed that even in the heyday of the East India Company the "Cassia" products mentioned in their records are almost invariably of Chinese origin. Hence Milburn (*Or. Comm.*, 1813, ii., 500), who gives a very clear account of the trade, both in the bark and the buds, warns traders against the coarse, dark and badly packed Cassia Lignea of Malabar. It is, however, interesting to notice that the most recent investigations show such a close connection between the Cassia trees of China and India that the former, which appears actually to extend into Burma and Assam, has been regarded by some authorities as a mere variety of the Indian *C. Tamala*. As already observed, recent specimens of Cassia Lignea leave no room for doubt that the better qualities of the Assam bark are derived from the true *C. Cassia, Bl.*, and are, therefore, the genuine Cassia Lignea of the ancients and the bark which is so largely exported at the present day from Canton. Concerning the Indian Cassia Lignea—the *taj*—there may be said to be two localities of supply, and thus two main sets of qualities: (*a*) Western and Southern India—the bark of *C. zeylanicum* mainly, and (*b*) Eastern and Northern India and Burma, obtained almost exclusively from *C. Tamala* and to a small extent from *C. obtusifolium* and *C. iners*. Gamble suggests that the necessary forest regulations of Darjeeling may have interfered with or restricted the trade. [*Cf. Malabathrum*, Garcia de Orta, *Coll.*, xxiii.; also Comment. by Ball in *Roy. Ir. Acad.*, 3rd ser., i., 409; *Folium Indicum*

History.

Two Chief Qualities.

or *Tamalapatra*, Linschoten, *Voy. E. Ind.* (ed. Hakl. Soc.), ii., 131 ; Jonston, *Hist. Nat. de Arbor.*, 1662, 172) ; Vincent, *Periplus, etc.*, 1800, app., 12-8 ; Wight, *Mad. Journ. Liter. Sc.*, 1839, xxii., reprinted in *Edinb. New Phil. Journ.*, 1840, xxviii., 20–32 ; Flückiger and Hanbury, *Pharmacog.*, 475 ; *Pharmacog. Ind.*, iii., 209.]

CULTIVATION.—In *The Agricultural Ledger* (*l.c.* 3) particulars will be found of the cultivation of *tejpat* in the Khasia and Jaintia hills. About six square miles are said to be under the tree. It is usually found in

Gardens.

gardens or plantations of mixed jack and betel-nut palms. It grows readily where there is heavy periodical rain followed by brilliant sunshine, but excessive and continued moisture injures the flavour of the

Khasia and Jaintia Hills.

leaves. In the Khasia and Jaintia hills the trees are grown in regular plantations seven feet apart ; the seedlings are raised in beds, and planted out permanently when the plants are five years of age. The tree takes five or six years to grow, comes into bearing at ten, and may continue to give annual crops for one hundred years. The cultivation is in

Sylhet.

the hands of the hill-men. In Sylhet the trees are self-sown ; the ripe seeds fall from the trees into the soil and germinate. When the plants are about a foot high they are transplanted. Great care is bestowed upon them when they are young and tender. As constant exposure to the sun would kill the shoots, they are planted behind bushes or trees for protection. The undergrowth is kept down twice a year in the plantations for the first eight or nine years ; after that the jungle is cleared once a year in April. In some plantations the soil is dressed, but in most it is never manured or irrigated.

The *tejpat* and cinnamon trees are different. The former are only used for their leaves, and no bark or only a small quantity is collected in the Khasia hills. No information is, in fact, available regarding special *Cassia Lignea* plantations, though a fairly large trade exists in the bark.

Crop.

Collection and Crop.—"*Tejpat* is plucked in dry and mild weather,

Seasons.

from October to December, and in some places the collecting is continued to the month of March. The leaves are taken once a year from young trees, and every other year from old and weak ones. On an average 15 seers may be obtained from one tree, but the quantity depends upon circumstances ; a tree yields from 10 to 25 seers of leaves in a year. The

Yield.

average yield of leaf per acre in the Jaintia parganas is about 30 seers without, and 2 maunds with, twigs. The whole of the crop from 400 acres was worth last year as much as Rs. 1,100. The quantity of leaves from the Sylhet district last year calculated on the turnover of the traders was estimated at 14,470 maunds, and from the Jaintia district 20,000 maunds."

Plucking.

"In harvesting the *tejpat* the small branches are cut down with the leaves and dried in the sun for three or four days. The leafy branches are then tied up into convenient bundles ready for the market. In the other case, the leaves are separated from the branches and packed in bamboo nets of a cylindrical shape called *bora* or *jungra*, which are four feet long by two feet in diameter. The packages are carried down the *ghaut* roads of the hills by coolies to Sylhet." Mukerji (*Handbook Ind. Agri.*, 1901, 437-8) says that for propagation seed had best be obtained from Sylhet.

Food (Condiment).

Uses.—The leaves are commonly known as *tezpat* or *tejpat*, but since the Natives call the leaves of any species of ***Cinnamomum*** by that name there is some uncertainty as to which particular species is meant in certain

Regions of Supply.

localities. It appears probable that ***C. Tamala*** and its variety ***intermedium*** provide the *tezpat* of Bengal, the United Provinces and the Panjáb,

whilst *C. obtusifolium* to some extent supplements the Bengal supply and *C. albiflorum* that of the Lahore bazárs. Gamble says that both bark and leaves of *C. Tamala, Nees*, and *C. impressinervium, Meissn.*, are collected and exported under the same names and without distinction from the Darjeeling forests. The leaves of all these species are used in food, and also employed with myrobalans in dyeing and in the manufacture of vinegar (see p. 1110).

The outer layer of Cassia bark yields an OIL which is utilised in the manufacture of soap. Full details of the Chinese and other Cassia Oil may be obtained from Schimmel & Co's. *Reports* (April–May, 1903, 16; April–May, 1904, 18–23, etc.). No oil is distilled from these barks in India. Both bark (*taj*) and leaves (*tejpát*) are employed in MEDICINE, the latter being commonly identified with the "*Folia Malabathri*," or "Indian Leaf," which was held in great repute by the ancients. But when the bark is used instead of cinnamon great care is necessary to ensure its not being adulterated with the injurious barks of several species of *Litsœa*. [*Cf. Rept. Cent. Indig. Drugs Comm.*, i., 126.]

Oil. Soap. Medicine. Adulteration.

C. zeylanicum, *Breyn*; Talbot, *List Trees, etc.*, 1902, 283; De Candolle, *Orig. Cult. Pl.*, 146. The TRUE CINNAMON or *dárchiní* (Chinese-bark), *karruwa* (*karua*), *lavanga, ohez, sanalinga, eringolam, kurundu* (= in Ceylon "the wood"), etc.

Cinnamon.

A fairly large tree, native of Western and Southern India, Tenasserim and Ceylon; in the last-mentioned country it is extensively cultivated for its aromatic bark. There is no evidence of the economic cultivation in India of this tree, though it is occasionally planted as an ornamental and useful bush in Bombay, Madras and Bengal. As a wild tree, however, it is plentiful in Western and Southern India from the Konkan southwards, rising on the slopes of the Ghats to 6,000 feet in altitude.

Habitat.

History.—It is somewhat significant that while Garcia de Orta (1563) gives full particulars of both the Malabar and Ceylon industry and speaks of the plant in the former as plentiful and wild, subsequent writers should have ignored this fact and confused the whole subject. Rheede figures and describes two forms of *Cinnamomum* as met with in Malabar. These are doubtless the *C. zeylanicum, Breyn*, and *C. macrocarpum, Hook., f.*, discussed by Talbot. Is this the Camphor-wood called *Bhimsini* alluded to as a lofty tree of the Ghats by Abul Fazl in the *Ain-i-Akbari* (1590, 79) and by Kirkpatrick (*Letter of Tippoo*, 1786, 231)? Many cinnamon timbers are described as "Camphor-woods," and might easily have been thought to be obtained from the camphor tree. The name *lavanga* it will be seen is also given to the Clove (which see, p. 527) as well as to the Nutmeg (see p. 791), and perhaps points to the time when these plants were not separately recognised.

History. Two Forms. *Bhimsini.*

In India various barks, as also twigs with their adhering barks, are sold as CASSIA LIGNEA and CINNAMON. But we are hardly more able to distinguish these than were the 16th and 17th century writers. Cassia bark was historically the first to be known. The finest qualities were moreover said to come from China and the less valuable from Malabar. Cassia bark appears to have been known in China from about 2700 B.C. Malabar Cassia is mentioned by Strabo (A.D. 17) and in the *Periplus*, A.D. 63 (ed. McCrindle, 18). In most of the classic works of India and Arabia a bark is alluded to that can only have been Cassia Lignea or *Dár (dal) Chíní*. It is in Sanskrit known as *tvach* and *guda-tvach* (= sweet-bark). But it is in comparatively modern times only that Ceylon cinnamon appeared in the markets of the world. Garcia de Orta speaks of the Malabar as wild, thus leaving the inference permissible that Ceylon was cultivated (see below under Trade). He tells us that the Chinese traders exchanged their merchandise for the spicy barks of Ceylon and Malabar and carried these to Persian and Arabian ports. He suggests that the name *dárchíní*, given to these barks, took its origin from this circumstance. Garcia would thus seem to have been unaware that cassia bark was also well known in China and hence the Chinese may have only purchased

Indian Traffic. Malabar Cinnamon. Chinese Influence.

Arab Influence.

the Indian as a cheaper quality than their own. The Arabs, through whose hands much of the cinnamon passed, called it *kirfat-ed-dârsini*, a word corrupted into *kirfah* and which survives as *kalfah*, the name given to-day for the commercial bark of Malabar. Garcia observes that the Chinese, in order to enhance the value of the bark sold by them, gave it mythical names and stories. Strabo speaks of cinnamon growing in South India—at the beginning of the torrid zone. The name cinnamon is thus considerably older than the time of the Chinese trade with India and was, in fact, intimately associated with the very earliest Arab dealings.

Ceylon.

The systematic cultivation in Ceylon does not appear to have been undertaken much before the Portuguese and Dutch conquests of the island (De Candolle). It became a State monopoly, and, as Garcia de Orta tells us, rose in price very greatly in consequence. The most stringent and cruel laws were instituted to protect the monopoly, which, on the island passing over to the British in 1796, were mitigated and finally in 1833 the cultivation was made free and thus ceased to be a State monopoly.

Oppressive Legislation.

[Numerous Indian writers might be mentioned on the subject of the production and manufacture of Cassia and Cinnamon, such as :—Acosta, *Tract. de las Drogas*, 1578, 2–18 ; Linschoten, *Voy. E. Ind.*, 1598 (ed. Hakl. Soc.), ii., 76 ; Pyrard, *Voy. E. Ind.*, 1601 (ed. Hakl. Soc.), ii., 358 ; Joret, *Les Pl. dans L'Antiq.*, 1904, ii., 262 ; Clusius, *Hist. Arom.*, in *Hist. Exot. Pl.*, 1605, i., 169 ; Piso, *Mant. Arom.*, in *Ind. Utri. re Nat. et Med.*, 1658, 165 ; Jonston, *Hist. Nat. de Arbor.*, 1662, 162–70, pl. 53–4 ; Herbert, *Travels*, 1677, 342 ; etc., etc.]

Cultivation.

CULTIVATION AND PREPARATION.—The following account of the propagation, cultivation, and method of preparing the bark is mainly an epitomised and annotated version of Nicholls' article (*Textbook Trop. Agri.*, 190–3), and is therefore not a statement of any South Indian industry, for in fact none is known to exist.

Although in its wild condition it grows to a large tree, the plant exists under cultivation as a coppiced bush. It is cut down to the ground at about the sixth year, when straight shoots spring up to be again cut down two years after, and in time the stools become of great size. The straight shoots are mentioned by all the early writers and are figured by Jonston (*l.c.* t. liii.).

Soils.

The best soil, says Nicholls, is a sandy loam mixed with humus, but the tree will grow in the tropics on almost any soil, though unsuitable

Propagation.

soils and climates produce inferior bark. Plants may be raised by cuttings, layerings, or by ripe and fresh seed. The usual way is to plant the seed out in the fields, at distances of 6 or 7 feet apart ; the ground being well broken up, and wood-ashes mixed with the soil. Four or five berries are sown in each hole and branches of trees are laid on the ground to protect the seedlings from the sun. But if dry weather follows germination, which takes place in from two to three weeks, many of the seedlings may perish, and it will in consequence be advisable to have a reserve of plants raised in nursery-beds to fill up vacancies. After the plants are established, little more cultivation is needed than to keep the ground

Weeding.

free of weeds. By the sixth year the first shoots can be cut, when two

Seasons.

or three will usually be 5 or 6 feet high, and in a condition for peeling. Two years afterwards the shoots that grow up after the first cutting may be reaped.

Preparation.—The shoots are cut off and the tops removed so that they are left from 3 to 5 feet long. The leaves and side branches are cleared and two longitudinal slits made with a sharp knife, one on

Separation of Bark.

each side of the shoots. When the cutting has taken place in rainy weather the bark comes away easily, but as a rule it is necessary to rub the sticks firmly with a piece of smooth wood, such as the handle of the knife ; the rubbing helps to disengage the bark. The pieces of bark thus separated, after an hour or so, are put one within the other, collected

into bundles, pressed, and bound together. They are then left for a day or so, until a slight fermentation sets in, which allows of the scraping off of the epidermis and the pulpy matter underneath, by means of a curved knife. The barks are then put together as before, but cut into lengths of about 12 inches, placed on wickerwork platforms, and left to dry in the shade until the second day, then finished in the sun. As they dry they contract into the appearance of quills, hence that name was given to them. The dry spice is made up into bundles of about 30 lb. each, and three bundles are made into a small bale. The bark of the larger shoots cannot be made into quills, but is removed in thick pieces and sold with the bark of the prunings as "chips," which fetch a low price owing to inferior flavour. The estimated yield per acre is said to be 150 lb., but might probably be increased by high cultivation. The true cinnamon, it may be added, is very commonly adulterated, especially in powder form, with the CASSIA LIGNEA discussed above.

Scraping.

Quills.

Adulteration.

Oils.—Three OILS are obtained from *C. zeylanicum*: the bark yields essential oil of cinnamon, to the extent of ½ to 1 per cent.; from the leaves is expressed a brown viscid essential oil, sometimes exported from Ceylon as "Clove Oil" (it has a somewhat similar medicinal value to the true oil of cloves); and from the root a yellow oil which is specifically lighter than water and has a strongly camphoraceous flavour. In their report for April–May, 1904, Schimmel & Co. discuss several reactions for distinguishing between Ceylon cinnamon oil and cassia oil, with which the former is not infrequently adulterated. [*Cf.* Gildemeister and Hoffmann, *Volatile Oils*, 1900, 377–92.]

Oils.

TRADE IN CASSIA AND CINNAMON.—Cassia Lignea.—In Official Statistics returns are given of the imports from foreign countries and of the portions of these re-exported, but no mention is made of the exports of Indian-grown CASSIA LIGNEA. On the other hand, under the name Cinnamon, returns are given of Indian-grown bark from Madras and Bengal, but no mention of Bombay. It would seem probable that these exports of Indian Cinnamon are, in reality, the exports of Indian Cassia Lignea. Regarding the IMPORTS of the bark a slight increase is noticeable, viz. from 20,014 cwt., Rs. 5,41,135, in 1899–1900 to 24,075 cwt., Rs. 6,01,906, in 1902–3, and to 23,421 cwt., Rs. 6,92,559, in 1906–7. The most noticeable features in these imports are the extreme fluctuations in the trade from Hongkong (15,024 cwt. in 1899–1900 to 6,173 cwt. in 1903–4, and 10,955 cwt. in 1906–7), and the corresponding expansion in the traffic from Chinese treaty-ports. There was also a considerable increase (45 per cent.) in the imports from the Straits Settlements up to 1903–4, when the quantity imported was 5,795 cwt., but since then this has fallen to 467 cwt. in 1906–7. Three-fourths of these imports are taken by Bombay—the great Indian emporium in the drug trade. There is also a re-export which usually amounts in quantity and value to about one-fifth of the receipts. The chief countries to which the drug is re-exported are Persia and Turkey-in-Asia.

Indian Trade in Cassia Lignea.

Exports.

Imports.

Re-exports.

The bark known as *kalfah* (to which reference has been made) is imported by Bombay town, coastwise from Malabar, and is apparently used to adulterate the Chinese bark. It sells at about Rs. 5 per maund of 37½ lb., or say 2½ annas a pound. According to the *Report of the Central Indigenous Drugs Committee* (1901, i., 119), the price of Chinese

Kalfah Bark.

Cassia is from 3 to 5 or even 8 annas per lb., according to purity. [*Cf.* also *Mus. Rept. Pharm. Soc. Gt. Brit.*, 1895–1902, 48–56.]

Uses.

Value.—The uses of cinnamon bark and oil, both in food and medicine, are sufficiently well known to render description unnecessary. In India and Ceylon cinnamon is largely replaced by *taj* or *kalfah* barks. The position of the Ceylon cinnamon with India may be judged of by the fact that the imports are unimportant, and moreover low-priced, so that it may be said there is hardly any demand in India for the fine qualities. But, conversely, the exports from India to Ceylon, of locally produced cassia bark or cinnamon, seem of expanding importance. This traffic was 5,393 lb., Rs. 2,530, in 1899–1900; 26,686 lb., Rs. 8,221, in 1903–4; and 21,040 lb., Rs. 7,697, in 1906–7. It goes mainly from Bengal and Madras and to a small extent from Burma. As already stated, there is no evidence whatever of any economic cultivation of *C. zeylanicum* in India, and the bark exported as cinnamon must therefore be Cassia Lignea, or at most wild cinnamon, the collection of which in N. Kanara is mentioned both by Talbot and Dymock as important. It may be here added that so long ago as 1687 Thevenot (*Trav. in Levant, Indostan, etc.*, pt. iii., 109) speaks of wild cinnamon in Cochin.

Imports Low-priced.

Wild Cinnamon Bark.

D.E.P., ii., 329–31. Colocynth.

CITRULLUS COLOCYNTHIS, *Schrad.; Fl. Br. Ind.*, ii., 620; Duthie and Fuller, *Field and Garden Crops*, 1882, pt. ii., pl. 57; *Pharmacog. Ind.*, ii., 59; White and Humphrey, *Pharmacop.*, 1901, 145–6; Cooke, *Fl. Pres. Bomb.*, i., 537; Duthie, *Fl. Upper Gang. Plain*, i., 374–5; CUCURBITACEÆ. The Colocynth, *indráyan, mákal* or *mukhál, khártuma, tuh* or *karwa-tu, ghúrúmba, trúná deda, henzil, kiyási*, etc. A creeping or climbing herb found wild in the waste tracts of North-West (Sind, Dera Ismail Khan, Multan and Bhawalpur, etc.), Central and South India; is indigenous also in Arabia, Western Asia, Tropical Africa and the Mediterranean region.

Habitat.

Wild Fruit.

The fruit (the "wild gourd" of 2 Kings, iv., 39) is in size and shape much like an orange, marble-green on the surface and changing to yellow as it ripens. The fresh fruit is sold by the herbalists of India, being collected from wild supplies. To meet the requirements of the Medical Depôts an effort has been made to cultivate it specially at the Saharanpur Botanic Gardens. The intensely bitter taste of the pulp is due to an amorphous yellow glucoside, *Colocynthin*, which is found in it to the extent of about 0·6 per cent., but not in the seeds. The fruit is a drastic purgative, and is so used both in Native and European MEDICINE. The Indian extract is in fact quite as active as that of the European drug. The yield is about 110 lb. compound extract to 60 lb. dried fruit.

Cultivated.

Medicine.

Oil.

The seeds contain from 15 to 17 per cent. of a fixed OIL which is said to make a useful illuminant, but though inquiries were recently instituted in Sind and other localities, no one could be discovered who was in the habit of using the seeds in any form. For the London market the peeled fruit is imported chiefly from Smyrna, Trieste, France, Spain, and more rarely from Persia. The unpeeled fruit is brought from Mogador. The Indian fruit has a much thinner pulp, which cannot be separated from the rind. According to the authors of the *Pharmacographia Indica*, large parcels, collected and dried up country, come into market in December to January and are sold at about Rs. 1 per 100 fruits. [*Cf. Rept. Cent. Indig. Drugs Comm.*, 1901, 154; Dowzard, *Pharm. Journ.*, Sept. 12, 1903.]

Trade.

D.E.P., ii., 331–3. Water-melon.

C. vulgaris, *Schrad.*; *Fl. Br. Ind.*, ii., 621; Duthie and Fuller, *l.c.* pt. ii., 56, tt. 55–6; Duthie, *Fl. Upper Gang. Plain*, i., 375; Cooke, *Fl. Pres. Bomb.*, i., 537; the Water-melon or *tarbuza, tarmus, kalinda,*

hindwana, kalingad, kalangari, karigo, pitchapullum, etc.; *pateca*, Portuguese, and *batiec indi* (*battikh*) Persian. It appears to be the Anguria of many ancient herbalists and travellers, and the *bathiec, batiec, bittch*, etc., of the Arabs. It is the *abattichim* (melons) sighed for by the Israelites after the exodus.

Habitat. An extensive climbing annual, cultivated throughout India and all warm countries. Is supposed to be indigenous in tropical Africa.

Seasons. It is usually sown in January–February, the fruit ripening in the beginning of the hot season. In the United Provinces a special form, known as *kalinda*, is sown in June and ripens in October. In Western India (Sind more especially) the water-melon is a *kharîf* crop mainly. Very frequently grown on the sandy beds of rivers, where plenty of room and a copious supply of water are available. Mention is often made, by writers on this subject, of a special form grown in Bikanir

Special Races. on almost pure sand, the fruits being often practically underneath the sand. There are thus doubtless many cultivated conditions or states, that vary in the colour and flavour of the pulp, and season and locality of production. The wild plant may be either bitter or sweet without

Bitter and Sweet. any observable structural differences. The bitter form (*C. amarus, Schrad.*) comes very close to *C. Colocynthis*, when that species is cultivated. The bitter water-melon is in Sind known as *kirbut* and is

Medicine. used as a purgative MEDICINE.

The water-melons of the Upper and Central Provinces are the best. They are extensively employed in the preparation of sherbets. The seeds yield a limpid OIL used both as an illuminant and in cooking. In times of scarcity

Oil. they are pulverised and baked into bread. In medicine, they are in considerable demand on account of their cooling, diuretic and strengthening qualities. [*Cf Ain-i-Akbari* (Blochmann, transl.), i., 65; Garcia de Orta, *Pateca, Coll.*, xxxvi.; also Comment. by Ball in *Roy. Ir. Acad.*, 3rd. ser., i., 653; Linschoten, *Voy. E. Ind.* (ed. Hakl. Soc.), ii., 35; Mandelslo, *Travels*, 1638, in Olearius, *Hist. Muscovy, etc.*, 1662, 86; Buchanan-Hamilton, *Stat. Acc. Dinaj.*, 196; Lawrence, *Valley of Kashmir*, 348; Firminger, *Man. Gard. Ind.* (ed. Cameron), 1904, 230, etc. For the *Anguria* or *Batiec* or *Pateca*:—Rauwolf, *Trav.*, ii., 4, in Ray, *Collection Travels*, 1738, 124; Coryat, *Crudities*, 1611, i., 396; Salmasius, *Hom. Hyles Iatricæ*, in *Plin. Exer.*, 1689, 37; Rumphius, *Batteca* or *Battich, Herb. Amb.*, 1750, v., 400–3, t. cxlvi.; Joret, *Les Pl. dans L'Antiq.*, 1904, ii., 252; etc.]

Var. fistulosus, *Stocks;* Duthie and Fuller, *l.c.* pt. ii., pl. 47; the *tandus, tendu, tensi, tinda, meho, alvinda, titak*, etc.

This seems a peculiar form fairly local and much less known than the preceding. Chiefly met with in the United Provinces, Panjáb and Sind, where it is specially designated *dilpasand*. Cultivated along with other melons from

Vegetable. April to October, and eaten as a VEGETABLE, not as a fruit, being cut into sections, the seeds removed, then boiled in water, next in milk. Cut into still smaller pieces it is cooked in curry, and also fairly largely pickled and candied. It is in much demand both by Muhammadans and Hindus, but appears as a rule unknown to Europeans. The seeds are used MEDICINALLY. They are

Medicine. also dried and eaten parched.

CITRUS, *Linn.;* Bonavia, *Cult. Oranges and Lemons Ind., etc.*, 1890; also *Fl. Assyr. Monuments*, 1894, 65–72; Victor Loret, *Le Cédratier*, 1891; Garcelon, *Fifteen Years with the Lemon*, 1891; Moore, *Orange Culture*, 1892; Nicholls, *Textbook Trop. Agri.*, 1892, 144–58; Cooke, *Fl. Pres. Bomb.*, 1901, i., 188–91; Duthie, *Fl. Upper Gang. Plain*, 1903, 139–42; Prain, *Beng. Plants*, i., 306–7; Firminger, *Man. Gard. Ind.* (ed. Cameron), 1904, 276–84; Brandis, *Ind. Trees.*, 122–3; RUTACEÆ.

D.E.P., ii., 333–58. Literature of the Orange, etc.

Production in the Tropics. The different forms of the Orange, the Lemon, the Citron, the Lime

and the Pomelo constitute a tropical assemblage of fruits in many respects comparable with the apple, the pear, the peach, the plum and the cherry —a temperate series—though the former are infinitely more valuable than the latter, because more widely cultivated and more extensively used. Moreover, since the orange is consumed very largely in temperate climes, cultivation in the tropics has to be made on the basis of the foreign as well as the local demands, so that oranges, lemons, etc., have become regular articles of trade all over the world. Until very recently Europe obtained its supplies of these from the warm temperate tracts of South Europe itself and from the islands of the Mediterranean and the Atlantic, adjacent to Africa. For some years the quicker transit of steam navigation has permitted supplies to be drawn from a greater distance than formerly, and both Europe and America have, in consequence, come to be very largely supplied by the West Indies. The great success recently of the fruit trade of these islands has given a useful suggestion of India's possibilities. There would seem every chance that a large trade may in the future be done in exporting some of the fruits of India to Europe, more especially the thin-skinned Bombay pomelo. [*Cf.* Ferrari, *Hesper.*, 1646; Jonston, *Dendr. Hist. Nat. de Arbor.*, 1662, 10–27, pl. vi–xviii.; Commelyn, *Hesper.*, 1683, 1–47; Salmasius, *Plin. Exer.*, 1689, 666–77; Lecomte, *Beschr. Keyser. China*, 1698, 79; Sterbeeck, *Citricult.*, 1712, 1–60, 66–181; Volkamer, *Nurnb. Hesper.*, 1708–14 (2 vols.); Clarici, *Ist. delle Piante*, 1726, pt. iv., 593–751; Rumphius, *Herb. Amb.*, 1750, ii., tt. 24–35; Forster, *Pl. Esc.*, 1786, 35; Gallesio, *Traité du Citrus*, 1811; Macfadyen, *Citrus of Jamaica*, in Hooker, *Bot. Misc.*, 1830, i., 295; Targioni-Tozzetti, *Cenni Storici, etc.*, 1853; also Review of same by Bentham, *Journ. Hort. Soc.*, 1855, ix., 133–81; Risso et Poiteau, *Hist. et Cult. des Orangers*, 1872; De Candolle, *Orig. Cult. Plants* (Engl. transl.), 1884, 176–88; Lelong, *Cult. Citrus in California*, 1900.]

West Indies. India.

Literature of the Orange, etc.

History.—So much has been said on the history of the species of *Citrus* in the works above indicated, that it seems almost superfluous to attempt a review of the more interesting particulars, except such as have a practical bearing on India. The Sanskrit and Chinese records of the properties and uses of these plants carry our knowledge back to a time prior to the first mention of the European tradition of the Garden of Hesperides, with its golden-coloured and beautiful fruits, whatever these may have been. [*Cf.* Susruta, *Ayurvéda*, (d'Hanvantare) ed. Hessler, 1844, iii., 179.]

It seems fairly certain that the citron fruit had been carried to Europe by traders long before the attempt was made to cultivate the plant there. It was valued as a perfume and also used to protect clothes from insects. Pieces of certain imported coniferous woods were similarly so employed, and the Romans appear to have supposed that the fruits brought from Media were those of the self-same plant as the scented *cedron* wood. There can be little doubt, therefore, that the modern word Citrus was derived from Cedron and owes its origin to the circumstance mentioned.

European Classic Authors.

Theophrastus (about 350 B.C.) calls it the *Malum Midicum* or *Molum Assyrianum*, and thus may be viewed as confirming the early traditional source of the Citron. But he speaks of it as raised from seed sown in vases and seems to be alluding to that instance from hearsay, as the practice with the Medes, rather than to be narrating a custom followed by the Greeks. There is, however, an amusing story contained in a fragment of the comedy of the Antiphanes, quoted by Athenæus, which, if it can be trusted, would suggest a possible much earlier cultivation in Europe than can be established by direct historic facts. So again the compilation known as the *Geoponica* (prepared in the 10th century) is supposed to be quoting certain authors who describe the cultivation of the citron several centuries before Christ, but here again it is perhaps hardly desirable to put much confidence in these writers. It may thus be affirmed that

Cultivation in Europe.

direct evidence of cultivation in the gardens of the Romans does not exist prior to the first century of our era.

Palladius (*De re Rustica*, iv., 10), who lived possibly about the fifth century (A.D.), narrates the methods pursued by him in cultivating the plant in his Sardinian and Neapolitan possessions, so that its cultivation in Italy by the 3rd or 4th centuries may be accepted as having been fully established, though for many centuries the progress made in Europe was but slow, down to the 11th or 12th centuries.

Derivation of Name Citron.

It may be said that while the orange is indigenous to China, and the limes to India, that the citron originated very possibly in Persia and Media, while the lemon is so closely associated with the Arabs as to suggest its having come from Arabia. The Arabs, at all events, carried its cultivation to Africa, Egypt and Europe. In the 10th century, for example, we read of them conveying it from the gardens of Oman to Palestine and Egypt. So also it is generally accepted that the fruit held in the hand by the Jews during the Feast of Tabernacles has for many centuries past been the citron. Risso has, however, produced evidence which he thinks goes to show that the Hebrews did not very possibly know the citron much before the beginning of the Christian era, hence he contends that it was very likely not the fruit so used by the early Jews. Other writers have, however, contended that the Jews were scarcely likely to have changed the symbol and yet retained the ceremonial. And it is, moreover, well known that a close relationship subsisted for many centuries between the Hebrews and the people of Media and Persia, so that there is no reason why they should not have known of the citron long before the Romans. There is, however, a long interval between the first European classic references to the plant and the detailed accounts of medicinal and horticultural writers. To bridge over this gap, Loret assumes a knowledge in these plants, possessed by the Arabs, Jews and Egyptians, very much more ancient than the earliest historic record. For example, the earliest Arab and Persian writers who knew of the citron and lemon are :—Serapion (*De Simpl.*, i., 1) and Rhases (*Cont.*, i., *ult.* i., 219), who describe the former, while the latter is alluded to by Ibn Baithar. Avicenna (*De Med.*, ii., 2, 116, 433)—the author most frequently cited—apparently confused these plants. [*Cf. Paulus Ægineta* (Adams Comment.), 1847, iii., 472.]

Arab Writers.

The orange was not known until much later than the citron or lemon. Targioni-Tozzetti tells us that it was conveyed from India to Arabia about the 9th century. We have no knowledge of its having reached Europe for a couple of centuries later, when it seems to have been carried by the Moors to Seville. In the 13th century we read of its cultivation at Palermo and Rome. But, according to the most generally accepted opinion, the bitter orange reached Europe before the sweet. Lecomte says that the Portuguese claim to have taken the sweet orange from China to Portugal somewhere about 1545.

Indian Authors.

It is remarkable that many of the Indian authors, who might be expected to afford useful historic particulars regarding the citron, lemon and orange, are silent regarding these plants. Marco Polo makes no reference to them, but Varthéma (*Travels* (ed. Hakl. Soc.), 1863, 190), who in 1510 visited Cananor and subsequently Ceylon, speaks of the sweet oranges (*melangoli*) of both places, and says of Ceylon that they were the finest in the world. Vertomannus (*Voy.*, in *Hakl. Voy.*, 1811, iv., 577), a gentleman of the city of Rome, who also visited Cananor and Narsinga in 1503, says the " soyle beareth neyther wheate nor vynes, or fewe other fruites, except Oranges and Gourdes." Baber (*Memoires*, 1519 A.D., 327–9) mentions nine different kinds of *Citrus*, as known to him. This is the earliest complete statement regarding Indian cultivation. The *Ain-i-Akbari*, written 1590, amplifies some of the particulars given by Baber, but adds nothing very material. [*Cf.* Blochmann, transl., i., 69; also Jarrett, transl., ii., 124.] The Emperor Akbar, we are told, encouraged the cultivation of all fruits and brought expert gardeners for that purpose from Persia and Tartary, who doubtless carried to India with them all that was good and desirable in the way of new fruits from their own countries.

Linschoten (*Voy. E. Ind.* (ed. Hakl. Soc.), 1598) makes frequent mention of the oranges, lemons, etc., of India, Ceylon and other countries visited, but in such language as to imply that his readers knew everything about them. Rheede, on the other hand, who, in 1686, figured and described the plants of Malabar, and thus practically of Cananor, makes no allusion to the orange or the lime, while Herbert (*Travels*, 1677, 333) speaks in the highest terms of the oranges and lemons of Mangalore : in the case of the oranges, " the rind," he tells us, " was no less pleasant than the juice." A century or so later Rheede and Herbert were followed by Rumphius, who gives a full description of several

Wild

oranges, lemons and pomelos. One or two of these he speaks of as wild. The
China. sweet orange, however, he regarded as a native of China, but adds, "some consider it a native of Amboina." Numerous writers refer to the efforts made in India to improve and increase the orange and lemon supplies of that country. There need, therefore, be little cause for surprise that the oranges of Cintra
Cintra. should have reached India even before Baber's time. Dr. Hunter long years ago suggested that the name for one of our best-known forms of orange, viz. *sengtereh* (of Baber) or *santara* (as it is nowadays called), was but a Hindustani corruption of Cintra, thus indicating its having been brought from Portugal. The name ***aurantium*** given by botanists to the orange does not come from *auram* gold, but is derived from the Arabic *nárandj*. This became *nárendj* (*narang*) in the Persian, and its equivalent in Sanskrit is *nágaranga* and in the Hindustani *nárangi*. Names that begin with *nar* generally denote fragrance. The name orange came to English through the Moors, and became *náranjo* in Spanish, *laranga* in Portuguese, *arancio* in Italian, *oranger* in French, *orangenbaum* in German, and the like. [*Cf.* Ligon, *Hist. Barbados*, 1657, 69; Terry, *Travels E. Ind.*, 1665 (ed. Havers), 343; Ovington, *Voy. Suratt*, 1689, 423; Le Comte, *Mem. de la Chine*, 1696, i., 173; also Bretschneider review, *Hist. Europ. Bot. Disc. in China*, 15; Forster, *Pl. Esc.*, 1786, 35; *E.I.C. First Letter Book*, 81; Wise, *Hindoo Medicine*, 191; Wiesner, *Die Rohst. des Pflanzenr.*, i.; 653, ii.; 584, 631; Joret, *Les Pl. dans L'Antiq.*, 1904, 282–3.]

D.E.P., ii., 335–48. Orange. **C. aurantium**, *Linn.; Fl. Br. Ind.*, i., 515; Roxburgh, *Fl. Ind.*, iii., 392; Woodrow, *Note on the Oranges and Lemons of India*, 1890; Deman, *Relative Merit of Stocks on which to Bud Oranges, U.S. Dept. Agri. Bull.*, 1891, No. 4; also *Division of Pomology, Bull.* No. 1, 57–87; *Rept. Settl. Amherst*, 1891–2, 47–50, 160–1; 1896, 24–5; *Kew Bull.*, 1894, 117–9; 1895, 266–71; Webber, *Fert. of Soil as affecting the Orange in Health and Disease*, in *U.S. Yearbook Agri. Dept.*, 1894, 193–202; Stephen, *Supt. Gov. Gardens, Nagpur*, 1899; Mukerji, *Handbook Ind. Agri.*, 1901, 490–2; Aaronsohn und Soskin, *Die Orang. von Jaffa*, in *Der Tropenpflanzer.*, 1902, vi., 341–62; Cooke, *Fl. Pres. Bomb.*, 1903, i., 190–1; Duthie, *Fl. Upper Gang. Plain*, 1903, 141–2; The Bitter (or Seville) and also the Sweet Orange.

Bitter. The bitter (or Seville) orange, though sometimes spoken of as indigenous to India, is there very little cultivated. The so-called wild, or perhaps only fully acclimatised plants that have been recorded as met with, are botanically nearer the sweet than the bitter (or marmalade) orange. It seems highly probable, on the other hand, that at least some of the forms
Sweet. of the Sweet Orange came to India *viâ* Assam, the route along which many other Chinese plants have passed westward into Hindustan. There may be said to be four or five chief centres of Indian orange production:—Sylhet in Assam; Nagpur in the Central Provinces; the lower ranges of the Eastern and Central Himalaya (Sikkim, Nepal, Garhwal and Kumaon); Delhi in the Panjáb; and the Deccan and South India (Poona, Coorg, etc.).

Chief Kinds. Bonavia speaks of four chief races of this fruit, viz. (1) the *Santara* (a word which he writes "Süntara" and regards as of Sanskrit origin and not (as stated above) a corruption from *Cintra*); (2) *Keonla*, or the common *naringí*, produced here and there all over the country in gardens, not special plantations; (3) the *Malta* or *Portugal*—the blood-orange, introduced in 1852 and now fairly successfully produced at Gujranwala and also in gardens at Lucknow; and (4) the *Mandarin* of some writers (***C. nobilis, var. major***), a native of China and Cochin-China and the *Tanjerine* (***C. nobilis, var. minor***). Both these are occasionally met with in gardens but can hardly be regarded as important Indian fruits, although one of them appears to have been crossed with the *santara* in producing an orange commonly met with in some parts of the Deccan and South India, which is sometimes called "Indian Mandarin."

Santara. The *santara* or *sungtura* (*nágaranga* of Sanskrit) is by far the best

quality, and may be said to be distinguished by its yellow colour and loose skin or jacket. This is the orange of the special Indian plantations where orange-growing becomes an important industry. But there would appear in India to be several very distinct forms of the *santara*, due very possibly to peculiar methods of cultivation or special climates. The distribution of the races of *santara* orange might be given as follows :— *in the north*, Nagpur, Delhi, Alwar, Gargaon, Lahore and Multan ; *in the west and south*, Poona, Shevaroy, Madras, Coorg and Ceylon ; *in the east*, Nepal, Bhutan, Assam, Khasia and Burma. Races.

The ***Sylhet*** or more correctly the ***Khasia*** orange is the best of the series, and it may be described as the fruit known in Europe as the China orange. One of the most useful papers on this subject is that by C. Brownlow (*Journ. Agri.-Hort. Soc. Ind.*, 1869, 372, briefly reviewed in the *Dictionary*). The Sylhet orange, he says, is invariably raised from seed, and the plants come into bearing in four to six years. It is believed that the seedlings do better than grafts or buddings, though the latter come sooner to maturity and afford a more uniform quality. When grafting is pursued the stock usually employed is the lime, and some say the wild plant is preferable to the cultivated. Sylhet and Khasia. China Orange.

Since the present article was penned, B. C. Basu has contributed (*Agri. Journ. Ind.*, 1906, i., pt. i., 62–7) a most interesting account of the Khasia hills orange and its cultivation, for which space can only be found for the merest abstract. The area where produced, he observes, is comprised within one hundred square miles. The plantations commence on the plains and rise to an elevation of 1,500 feet. The gardens extend thus for some distance into the interior along the deep valleys which cut up the southern face of the Khasia hills. From that narrow tract of country is drawn the bulk of the oranges consumed in Bengal and Assam. The great earthquake of June 1897 destroyed, however, a large number of the orange gardens, many of the most productive of which lay on the banks of the hill streams and owed their fertility to the silt left by the annual floods. The orange is said to do best on limestone soil. The Khasia people recognise only one variety, though they admit a wide range in quality exists—dependent mainly on soil and the aspect of the garden. The special merits of individual plants are not perpetuated owing to the almost invariable habit of raising stock from seed. The fruits with thick rind are preferred even though the pulp is less juicy, because they stand handling better. So also late ripening is advantageous in point of price. Khasia Hills. The Earthquake. Limestone. Raised by Seed.

Basu's account, it may be observed, differs here and there very slightly from that given by Brownlow. Seedlings, he says, are transplanted when two or three years old, and during May and June. A hole is made and the young plants deposited at distances approximately of 10 feet apart. Manure is never used. By the end of the rains a number of shoots have usually formed, and in time one of these is preserved, and the rest, as also the parent stem, removed. The plants begin to bear in eight to ten years and the duration is uncertain owing to the ravages of the borer insect, which destroys large numbers of plants annually. The orange season commences in November and closes in March. The export is in the hands of Bengali traders, who mostly live in Sylhet, hence the orange being often spoken of under that name. The usual wholesale price is from Rs. 10 to 20 per " hundred," equivalent to about 2,300 fruits. The supply intended for Bengal is taken down to Chhatak. If carefully Transplanting. Come into Bearing. Season. Price.

arranged on a trellis, no two fruits being allowed to touch each other, and then suspended from the roof of the house, the fruit may be preserved for months.

Supply in Cold Season.

This orange is conveyed by boat to Calcutta, where it is sometimes spoken of as *kamlá-nebu*, from which circumstance Prain thinks it may be inferred the orange was derived from the kingdom of Comilla to the east of Calcutta, and not from Upper India. There is but one complaint in Bengal against the present supply, namely that it comes in the cold in place of in the hot season. This has led to numerous efforts, with indifferent results, to obtain a second supply of equal merit from other localities. In Kullu, for example, the fruiting season is much later, and an effort has accordingly been put forth to send supplies to Simla in April and May.

Possible Hot-season Supply.

Nagpur.

Nagpur.—Mr. J. H. Stephen, Superintendent of the Government Botanic Gardens, Nagpur, published in 1899 an instructive account of the production of oranges in the Central Provinces. Mr. A. Ross, in a letter published in Firminger (*l.c.* 277), furnishes other particulars of interest. Stephen inspected several large orange plantations and found that where carefully cultivated and liberally irrigated the trees were healthy and fruited freely; where neglected, the yield was so low that the gardens were not remunerative. In every instance the plant grown was the Nagpur *suntra* budded on the sweet lime. This is believed to produce a thinner skin and a sweeter and more luscious fruit than when budded on the citron or *jambiri*. The Sylhet system of raising from seed seemed nowhere to be followed, because it is believed that such plants take from fifteen to twenty years to come into bearing. The lime is sown in January to March, and when a year old the budding of the orange is made on the seedlings. They mature in the sixth or seventh year, and in about nine to twelve years are in full bearing; after that date they decline. In Nagpur the orange yields (or can yield) two crops a year. The plants flower in February to March, and the fruit is ripe in November to December or January. The second flowering is in June to July, and the fruit ripens in March to April. The oranges of the second crop are the sweetest, and, coming as they do at the beginning of the hot season, are much valued. These are plucked green, and thus are rarely allowed to change into the characteristic yellow colour of the other crop. On this account some writers have regarded them as being bergamot oranges.

Careful Cultivation.

Budding on to Limes.

Full Bearing.

Two Crops.

Seasons.

Later than Sylhet.

Manure.

About the middle of May the roots are exposed and the plants manured (according to Ross, the roots are exposed and the manure given in October). Pruning is unknown in the Nagpur groves, and, except to be watered freely in the hot season, the plants receive little or no further attention. R. S. Joshi, Rai Bahadur, has just published an account of the orange cultivation of these provinces (*Agri. Journ. Ind.*, 1907, ii., pt. i., 64–9) which will be found to richly repay perusal. In the details of cultivation he makes, to all intents and purposes, the same facts as already exhibited. He urges the necessity for high cultivation, especially on soils with a liberal supply of lime, and reaffirms belief in budding. "The stock generally used," he says, "is the sweet lime (*mitha nimbu*), but the common citron (*zamburi*) is also very often utilised. Buds of the orange grafted on the latter stock produce trees which yield fruits with a very loose skin, whilst those on the former stock have a more closely

High Cultivation.

Influence of Budding.

adhering jacket, showing that the stock has a distinct influence on the bud. The loose-jacket oranges are preferred for local consumption but are not so good for export, as they do not stand carriage well. Trees raised from citron stock come into bearing more quickly and have a somewhat longer life, but the fruit from the sweet lime is sweeter and has a thinner skin."

Diseases. Speaking of the diseases of the orange, Joshi says that in Nagpur the most serious is caused by a fungus which results first in the withering of the tips of the branches, the rot gradually extending down till the whole tree is destroyed. The produce of the Nagpur gardens goes mainly to Bombay, but recently Calcutta has drawn on the Central Provinces. If the late crop could be made a special feature, it seems probable the Nagpur supply would be much appreciated by Bengal.

Exports to Bombay.

Delhi. Delhi.—The oranges of this locality are inferior to those of Sylhet and Nagpur. The rind is thick and the juice relatively poor, both in flavour and quantity. The supply of the so-called Delhi orange, which, in addition to meeting the local markets of the United Provinces and the Panjáb is to some extent drawn upon by Bombay, comes from the neighbourhood of Delhi itself and from Gargaon, Saharanpur and Alwar, etc. Nepal, Garhwal and Kumaon produce small but sweetly flavoured *santara* oranges. Dr. Bonavia tells us that the sweetest orange he ever tasted was grown in Nepal.

Santara Oranges.

Poona. Poona.—Woodrow wrote a useful report of the orange cultivation of Western India which was published by the Director of Land Records in 1890, and subsequently epitomised and amplified by Cooke. In addition to the *santara* orange, the *ládu* of the Deccan is largely produced. This has often a malformation in the form of a supplementary series of pips near the apex. The Mozambique orange and also the Mandarin, or what is so called (*lál ládu*), are frequently met with. Indian Mandarins are good to look at but inferior in flavour, and, as already observed, the *lál ládu* is probably only a hybrid Mandarin.

Hybrid Mandarin.

Coorg, Mysore and Nilgiri. The *Coorg, Mysore and Nilgiri* oranges are much spoken of, and constitute the chief supply of the city of Madras. The Coorg is the form most in demand. It seems a cross between the ordinary *santara* and the Maltese. Mr. Gustav Haller (*Agri. Journ. Ind.*, 1906, i., pt. ii., 127–9) has very recently written a useful account of the "Orange Cultivation in Coorg." The method of cultivation he speaks of as very simple. Seeds are sown in nurseries, where the plants remain till they are one or two feet high, and are then transplanted 18 to 20 feet apart. The only subsequent attention given is to protect the plants from damage by cattle and to keep the fields clean. At six to seven years the first crop is picked; and if success is to be attained the plants must now be manured, but very little is usually done in this respect. The flowering seasons are October to December, and again April to June. The fruits of the former are of little consequence, as they do not ripen properly and constitute the so-called monsoon crop, for which there is little demand. The other crop is of great value, is harvested from January to March, and is known as the hot-season crop. The average duration of the plants would appear to be about thirty years. Lastly, Haller discusses the diseases and pests of the orange, and mentions a *Loranthus* parasite and the borer beetle as being the most prevalent.

Raised from Seed.

Bearing.

Seasons.

Diseases.

Trade. *Trade in Oranges.*—It is quite impossible to furnish any particulars

as to the extent of the traffic in these fruits. They do not appear separately in either of the records of internal traffic or external trade. In the *Assam Administration Report* for 1901–2 it is stated the exports from that province came to 74,000 maunds, valued at Rs. 2,80,000. But we have no information as to the area and yield for the whole of India, and therefore the total production cannot be even conjectured. The suggestion has been made above that India might with advantage follow the lead given by the West Indies, and look to Europe and even America as hopeful markets for the profitable disposal of surplus fruits. Before this can be seriously contemplated production must be put on a more certain basis than at present, and this is not likely to be accomplished until European planters of India are induced to become orange growers. Some few years ago (1894–5) a few parcels of Nagpur oranges were sent to London. Messrs. W. Hutchinson & Co. reported on these. The brokers pronounced the fruit the best they had ever seen, and valued the oranges at 3*d.* apiece. They arrived when the supply of oranges from other countries had come to an end, and were thus much appreciated. The supply was, however, discontinued, and never seems to have been again renewed. To organise and maintain a foreign market an unfailing supply of a fixed quality must be assured. This would mean increased production with the definite idea of export. The demands of the local markets seem to absorb the present supplies, and the profits of production are sufficiently high, it might be conjectured, to have tempted increased cultivation.

Surplus Stocks.

Experimental Parcel.

D.E.P., ii., 349. Pomelo.

C. decumana, *Linn.; Fl. Br. Ind.*, i., 516; Tussac, *Fl. Antl.*, 1824, iii., 73–4, pl. 17, 18; Bentham, *Rev. of Targioni-Tozzetti*, in *Journ. Hort. Soc.*, 1855, ix., 172. The Shaddock, Pomelo, Pumelnose (*pampelmousse*, Fr.); the *maha-nibu, batávi-nebu, sadaphal, chakotra* or *chukotura, bator-nebu, bijoro, papanas, bombalinas, púmplemús*, etc. It has no Sanskrit name. It was known to the early Dutch traders as Pompelmoes (= pumpkin-citron), hence some of the modern names. It reached India and Ceylon in the 17th century.

Habitat.

The pomelo is presumed to be a native of the Malay Archipelago. Introduced into India and Ceylon from Java, hence the name *batávi-nebu*; carried to the West Indies by a Capt. Shaddock. Rumphius, followed by Roxburgh, was the first botanical author who described this fruit, although the suggestion may be offered that the *Pomum Adami Commune* (or Black Lemon) of Ferrari and also of Commelin bears a strong resemblance to the pomelo. It is certain that neither Baber (1519) nor Akbar (1590) allude to it. Buchanan-Hamilton studied (1807–11) the districts of "Dinajpur, Rangpur, Paraniya, Bhagelpur, and Bihar, and the cities of Patna, Shahabad and Gorakhpur. Upon each of these he submitted to the Government a voluminous report," but only one, viz. Dinajpur, was ever published, as written by the author, and that not until 1833. He there says that this plant was known as *batabi*, but that it could scarcely yet be said to have made its way from the gardens of the Europeans (*Stat. Acc. Dinaj.*, 196). In 1897 I personally explored a considerable portion of the districts of Dinajpur, Rangpur and Bogra, and may safely affirm that no village exists now without its pomelo trees. In India and Burma at the present day, it is, in fact, one of the most common of fruits, but more especially so in Bengal and South India than in the United Provinces, the Central Provinces or the Panjáb. The best quality

Introduction into India.

Rapid Distribution.

is the thin-skinned Bombay pomelo, hence the South Indian name of *bombalinas*. Bombay Pomelo.

It is a favourite with the Natives of India, the pulp being either white or red, according to the variety grown. The best fruit is to be had about Christmas time, but certain qualities may be got very nearly throughout the year. In Bengal the season is August to December. The name "Pomelo or Pompoleous" (in Cape Colony, Pomelnose) is usually given to the large-sized fruit, "Shaddock" to intermediate sizes, and "Forbidden Fruit" to small forms. The cells of the pulp are very large and naturally separate from each other—a peculiarity that has led some people to speak of it as the "Grape Fruit" or "Grape Orange." The separated pulp is largely eaten in India as salad. The Bombay pomelo is the one that should be most cultivated and exported. It may be raised from seed sown in February, or by budding in February to March on the common lime, or by layers made in pots supported high among the branches. Seedlings take longer time to come into bearing than layerings or buddings, and are less certain. Season. Propagation.

The exports from the Bahamas, Cuba, Jamaica and Florida to the United States have recently assumed considerable importance. The traffic from the Bahamas alone was in 1902, 728,000 fruits. This shows what might be done were India to commence to export Bombay pomelos to the United Kingdom. Exports.

C. medica, *Linn.; Fl. Br. Ind.*, i., 514. There are many very distinct forms of this species met with under cultivation in India. Of these, the following abstract of the voluminous information available may help the reader to discover the special details desired :— D.E.P., ii., 349–58.

1. **Var. medica proper.**—The Citron, Adam's Apple, etc. Bears many names in the vernaculars of India, such as *bijaura* or *bajauri* and *bijori* (suggestive of the province of that name in Kafaristan which Baber tells us was famous for its citrons even in 1519), *limbú, nimbu* (or *bara nimbú*) *turanj* (its Persian name), *honsa nebu, beg-pura, balank, mavalung*, etc. Its Sanskrit names are *mátulunga, phalapura* and *vijapura*. Is said to have been found wild in Chittagong (an opinion not alluded to in Prain's *Bengal Plants*); by others it has been reported as wild in the Khasia and Garo hills and also in Kumaon. Citron.

The Citron is cultivated sparingly in the warm moist regions of India, one form being so large as to resemble a pomelo (is possibly the Poncire citron of Europe.) Another is the fingered citron, a curious fruit that Bonavia recognises in some of the decorative designs of Assyria. It seems to be intimately associated with most of the weird fables that gravitate around the *Citrus*. The citron is best propagated by seeds or layers. Firminger alludes to the fruits being in Assam ripened within earthen jars before being removed from the tree. A similar practice may have originated the stories of citrons in the form of human faces, owing to the fruits having been grown within moulds of the desired form. Cultivation. Fingered Citron. Moulded Citrons.

2. **Var. Limonum** or **Lemon.**—The word lemon comes from the Arabic *limún*, and through the Persian became the Hindi *limu, limbu or nimbu*. It is specifically known to the Indian people as the *pahari* (hill) *nimbu, karna* (or *korna*) *nebu, kimti, meta-limbu, thora-limbu*, and as the *kalambak* of Arabic and *kalínbak* of Persian.

The wild form of the lemon has not been recorded as met with in India—the plant mentioned by Royle, Madden and others was more probably the *lime* than the *lemon*. Lemons are, however, fairly extensively cultivated here and there all over India. Still, the true lemon

is hardly one of the regularly grown fruits, in the gardens of the people generally, but rather of the well-to-do and the curious.

Sour Lime.

3. **Var. acida**; *Kew Bull.*, 1894, 113–6, 177–82 and pl.; the Sour Lime of India.—This is the lemon of most popular writers, and is undoubtedly a native of India. It is the true *nibu* or *nebu*, *nimbu*, *libu*, etc., and is the *jambiri* of Baber, the *jambira*, *limpáka*, *nimbuka*, *vijapura* and *vijaka* (according to Dutt) of the Sanskrit authors (Susruta (ed. Hessler), 1844, i., 86). This is the plant usually met with in a wild state in the warm valleys of the Himalaya. There are numerous cultivated forms of it, the two chief being a round lime (*páti-nembu*) and a long lime (*kághzi* (*kaguji*) *-nimbu* or thin-skinned *nebu*). The thin-skinned limes of Jaunpur and Azamghar are celebrated. Then there are in addition the *patí* or small round lime, the *gorá* or oval fruit, the *Chini-gora*, which much resembles an orange, the *kámuráli*, a very large lime, the *khatta* of Upper India, the Bajoura limes—a sort of citron-lemon, the *gungolí* and *Bihari* and many others.

Cultivation.

The Sour Lime is easily reproduced by layers or seeds, the finer qualities being budded on the commoner and hardier wild stocks. The wild lime is, in fact, the chief budding stock for all species of orange, lemon or citron. The juice of this fruit is universally used for flavouring soups, curries, fish, etc., since it imparts a pleasant acid taste and agreeable flavour. It is also largely used in domestic medicine. The small sour limes are extensively employed for sherbets and in the manufacture of lime-juice, and the large ones made into various preserves. Baber refers to several forms of lime, so that we have abundant evidence that they have been known and valued in India for many centuries.

West Indies.

In the West Indies the lime is specially grown in Montserrat, Dominica, Jamaica and Trinidad on account of the juice—the lime-juice of commerce. The reader will find a highly instructive paper on the West Indian Lime Industry, written by A. J. Brooks (*Journ. Roy. Hort. Soc.*, 1907, xxxii., 172–88). It will be found to deal with the following among other subjects of interest:—History, Cultivation, Pests, Fruiting, Essential Oil, Raw Juice, Concentrated Juice, Citrate of Lime, Green Limes, Improvement of the Lime, etc. Brooks informs us that "the juice is exported in its natural or 'raw' state, or as 'concentrated' juice, the latter being one of the chief sources of citric acid." There would seem no good reason why India might not participate in this trade.

Sweet Lime.

4. **Var. Limetta** or Sweet Lime of India—the *santara nibu*, *mitha-nibu*, *amritphal*, *elemitchum*, *thanbaya*, etc., and the *madhukarkatika* of Sanskrit.

Baber's Opinion.

Wight regarded the sweet lime as indigenous to the Nilgiri hills. It was known to Baber, who apparently did not much appreciate sweet limes or sweet oranges. In the Turki copy of his *Memoirs* there is a footnote written by his son Humaiun to the effect that Baber's dislike to the *amratphal* was "a consequence of his having been long and much addicted to the use of strong drinks, whence he naturally did not like sweet things." It has, however, very little flavour except that of sweetness, but being in season in August to October, when oranges are not procurable, it is much appreciated by many persons as a cooling and refreshing fruit. But it seems highly likely that the sweet lime has by many writers been frequently confused with the bergamot or green orange. It is eaten fresh, or after being preserved or cooked.

Budding Stock.

The sweet lime is very largely employed by the Delhi orange-growers as a stock on which to bud the *santara* orange, and this circumstance may to some extent account for the peculiar flavour of the best Delhi oranges.

Conclusion.—It has not been found possible to afford space for more

than the merest outline of this subject. Details of cultivation, of the diseases to which the various species are liable, as well as of their respective industrial and medicinal uses, have had to be all but omitted (see **Vinegar**, p. 1110). Consult the *Pharmacographia Indica* for therapeutic facts, and for particulars regarding the perfumes, Gildemeister and Hoffmann's *Volatile Oils* (1900, 460–85); as also the admirable paper by Burgess and Child in the *Journal Society Chemical Industry* (December 1901).

Industrial Developments.

The cultivation of oranges, lemons, pomelos and limes of India, if organised on a more extended and systematic fashion than at present, would of necessity involve full advantage being taken of each and every profitable outlet, such as the preservation of the fruit (candied), the production of lime-juice, and the manufacture of perfumes and oils (citral, bergamot, neroli, etc., etc.). The "oil of lemon" is one of the chief industries of Sicily. The summer crop is exported as fresh fruit, the autumn or winter crop is manufactured locally into the juice and oil for which that island is famed. But it is regarded as very injurious to allow a tree to fruit twice a year, and hence the December crop is, as a rule, preferred. The lemon begins to yield when five years old. When fifteen to twenty years it gives 1,000 fruits, and when full grown may afford from 3,000 to 5,000. In the production of oil and juice, the fruit is cut into pieces, the pulp scooped out from these, the peel soaked in water for an hour or two, and then pressed by hand over a sponge in order to separate the oil. If candied peel is to be prepared, only half the oil is so expressed, otherwise as much as can be squeezed out is taken, and the waste peel given to cattle. The pulp is pressed for juice and the residue used as cattle food. Such is in brief the process usually adopted in the preparation of lemon oil and lemon juice in Sicily.

Oil of Lemon of Sicily.

Future Trade.

If an Indian industry were therefore organised, a large share in the profits of cultivation would have to be derived from these and other sources. Much care would have to be expended in selecting the best stock and in ascertaining if the lime, in place of the lemon, would meet all the necessities of trade. The lime would in all probability be better suited to the climate of most districts of India, but there exists a wide range of forms from which to select. To organise an export traffic in fresh fruit, it would be indispensable to have special shipping arrangements, since the fruit would be greatly injured if consigned to the hold along with mixed cargoes. Quick transit, careful packing, and good storage are essential to success. [*Cf. Kew Bull.*, 1892, 108; 1894, 114; 1895, 266–71.]

D.E.P., ii., 360–8. Clays.

CLAYS, BRICKS, POTTERY, ETC.—Ceramic Art and Wares.—Montgomery Martin, *Hist. E. Ind.* (compiled from Buch.-Ham. *Repts.*), 1838, i., 347–9, 535–6; ii., 165, 167–72, 256–7, 948–55, pl. xiv.; iii., 208, 681; Mallett, *Rec. Geol. Surv. Ind.*, 1889, xxii., 139–48; Holland, *Rec. Geol. Surv. Ind.*, 1905, xxxii., pt. i., 104. The *gil, chikni, chikita, matí, sangi-i-dalam, káli-munnu, tannab, krishna mirtika*, etc.

Sir T. H. Holland, Director of the Geological Survey of India, in his *Review of Mineral Production* (*l.c.* 104), observes that "no statistics approaching any degree of completeness are obtainable to show the extent of the undoubtedly great industrial value of the clays in India. They include the common clays used all over the country for the manufacture of bricks, tiles, and the cheaper forms of pottery; finer varieties, used

for glazed pottery, which in places has obtained a reputation for artistic merit; fire-clays, raised in considerable quantities on some of the Gondwana coal-fields; and fuller's-earth, which is mined in the Central Provinces and in Rajputana." In these brief sentences Holland has furnished the chief kinds of clays met with in India. In the remarks that follow, these will be severally dealt with, except that, as a matter of convenience, the clays used for all kinds of pottery (unglazed, painted and glazed) will be taken up last instead of second :—

Bricks and Tiles.

k and Tile Clays.—Until the middle of the last century it was thought necessary to import bricks from England, and that prejudice served to destroy the hopes of Mr. George Macdonald, who in 1866 became virtually the pioneer of European brick-making and pottery in India. He failed disastrously to interest the Government engineers and the building trade in the products of his factory at Raniganj (Raneegunge). In 1881 Mr. J. H. Glass directed attention to the Jabbalpur supplies, and as a consequence the Geological Department deputed Mallet to inquire into the clays of the Central Provinces, the result being that the claims of Umaria were urged very strongly. It was pointed out that Gondwana clays were abundant, coal and fire-clay on the spot, felspar obtainable within four miles, while chalcedony might be collected in the Mahanadi near Chandia. Messrs. Burn & Co. had meantime founded their potteries on the very spot where Macdonald failed. It is said they now turn out about 30,000 bricks a day, including glazed bricks for bathrooms, and blue-chequered damp-proof bricks for stores and godowns. And about the time of Mallet's report they extended their operations by opening out their Jabbalpur works.

History of European Production.

Early Indian Production.

But bricks were used in India long before the arrival of the English, and some very old edifices, fortifications, etc., seem to have been constructed with large thin bricks not unlike those employed in ancient Europe. Such bricks were recently found, for example, by Dr. Stein in the ruins of the *stupas*, etc., of ancient Khotan, of a date of the 7th or 8th century. Abul Fazl, the chronicler of the Emperor Akbar's reign, mentions three kinds of bricks, "burnt, half-burnt, unburnt," and observes that the Emperor had fixed the price for these. The first kind, he adds, were usually made very heavy. [*Cf. Ain-i-Akbari*, 1590 (Blochmann, transl.), 1873, 223.] These three grades are met with to the present day all over India, and in fact most houses, garden walls, etc., of the peasants of India are mainly constructed (when bricks are used at all) of sun-dried bricks. But if Indian fired bricks have not hitherto borne a very high reputation for strength and durability, it has been upheld that the cause of inferiority should more often be sought in the process of manufacture than in the material used. A writer in *Indian Engineering* (August 4, 1900) pointed out that in making bricks by hand it was very difficult to get the edges sharp and well defined, the only way to obtain this being to use none but well-made moulds and to reject at once any mould found to be in the slightest degree cracked or damaged. That difficulty is to a large extent overcome by the use of machinery, though an even greater disadvantage at once arises, namely that machine-made bricks have to be transported from the brick-field to the building site, thus materially adding to their cost. In India it is usual to manufacture hand-made bricks near the place where they are to be used, and it is highly

Three Kinds.

Strength and Durability.

Machine-made.

likely, therefore, that the clay employed is not always the best that could be desired or discovered, were a search made a little farther afield. Finally, of course, the Indian climate is a very serious consideration.

With regard to Native-made bricks, interesting particulars have been published by Hoey (*Monog. Trade and Manuf. N. Ind.*, 1880, 162). He there observes that "good bricks of the size used in Government buildings are sold by the *puzawewala* at Rs. 7 per 1,000," whilst the "imperfectly burnt are called *tharra*, and sell at Rs. 4 per 1,000." Lucknow, of which Hoey was specially writing, is naturally a great brick-burning centre, owing to the lack of stone thereabouts. Ornamental bricks, moulded on the face with figures and patterns, were formerly made in many parts of Bengal. Good examples are to be seen in some of the temples in Chandernagore and Hughli, but more especially at the Kantanagar temple near Dinajpur. In North India, more especially in Lahore, carved bricks may be seen in the buildings of the well-to-do. Price. Moulded.

It would seem likely, however, that the most important brick-making centre of India is the immediate neighbourhood of Calcutta. Tanks are dug that can, as desired, be flooded from the river. A deposit of fine clay is laid down and successive floodings are made till a workable bed of clay has been secured. Statistics are unfortunately not available as to the extent of production, but that the traffic is large can be judged by the fact that practically all the better-class houses of Calcutta are constructed entirely of brick. It is said that the largest brick factory in India is that of Akra, near Calcutta, which turns out 20 to 30 million bricks annually. The Calcutta bricks are, for the most part, fired by furnaces, not kilns. [*Cf. Min. Rev.*, 1898, 59.] Calcutta.

Tiles.—The firms concerned in the manufacture of bricks are also, in many cases, producers as well of tiles, pipes, etc. To a very large extent machine-made tiles, being lighter, better and more durable, are displacing the old heavy clay tiles made by village potters. Tiles.

Brick and Tile Works.—It is sometimes affirmed, however, that the best tiles employed in India are still imported from Europe, the price being Rs. 15 per 100 (*Capital*, Oct. 15, 1903). In the S. Kanara district there were in 1894, 1,097 brick and tile burners and sellers; also eleven brick and tile factories in the town of Mangalore, eight being managed by Natives. Mr. Sturrock estimated the annual outturn of bricks at these factories to be 300,000, most of which are exported by sea to Bombay and other west-coast ports. The manufacturers sell the bricks at Rs. 35 per 1,000. [*Cf. Man. S. Kanara*, 1895, 143–5.] According to official statistics, the brick and tile works or factories throughout India employed in 1902, 6,255 persons; in 1903, 6,435; and in 1904 double the number, viz. 13,781. These figures are admittedly open to question since they can hardly include the Native brick-makers, but represent rather the personnel of the Brick, Tile and Pottery Works run on European methods, such as those at Raniganj, Jabbalpur, Aligarh, Bareilly, Mangalore, Feroke, etc. It may be mentioned that at the Raniganj potteries alone over 1,400 persons are employed, of whom about one-quarter are women engaged in porterage. The three tile works of the Basel Mission near Mangalore employed 540 hands in 1903, and the three works at Feroke, Malabar, 650 hands. **Brick and Tile Works** Persons Employed.

Fuller's-earth, also Edible and Medicinal Clays.—There is little information of a recent nature on these materials. Rauwolf, who travelled in the East (in the middle of the 16th century), mentioned of Tripoli that an ash-coloured earth called *nalun* was employed for washing the head, and that another earth called *jusabar* was eaten by women. That sentence might be almost given as true of India to-day. A pale **D.E.P., ii., 361–2. Fuller's-earth.**

Multáni Mattí. yellow mud is eaten medicinally, and sold under the name *Multáni mattí*. An earth known as *sang-i-basrí* is said to be imported from Persia and used in tonic preparations, owing to the iron which it contains. Saucer-

Edible Earths. shaped chips of partially baked clay are sold in the Calcutta bazár for eating. Montgomery Martin (*Hist. E. Ind.*, 1838, ii., 167) refers to a substance called *khari* eaten by women in Bengal. Hooper (*Rept. Labor. Ind. Mus.*, 1905–6, 37–8) gives particulars of 33 samples examined. Silica was the largest constituent, eight samples having 80, twelve 70, and six 60 per cent. The analysis showed that these clays had no food value. [*Cf.* Hooper and Mann, *Memoirs As. Soc. Beng.*, i., No. 12, 249–70.] It is probable that all these clays are nearly allied to fuller's-earth, which

Detergent. in India is employed as an external application to purify the hair and skin, in washing the cloths used in the manufacture of lac, indigo, etc.,

Weighting of Fabrics. as also for weighting fabrics. It is interesting to add that the *Institutes of Manu* records the punishment to be meted out to manufacturers who add too great a weight to the textiles they produce. The following are said to be the best-known Indian sources of fuller's-earth—Colgong in the Bhagalpur Division of Bengal; the Central Provinces; the district near Kolath in Bikanir, Dera Ghazi Khan and Multan in the Panjáb. Holland says fuller's-earth is mined in the Central Provinces and in Rajputana.

Fire-clays. **Fire-clays.**—These clays are capable of resisting a very high temperature without fusing or fissuring. They should be as nearly as possible free from lime, iron or alkaline earths, which promote the fusion of silica as in glass-making. In Europe the best clays for this purpose are found below coal-seams, and in spite of the different age of the Indian coal-fields, the underlying clays are found to be available for the production of a fairly good fire-brick material. Fire-bricks are manufactured in considerable quantities by Messrs. Burn & Co. at Raniganj, the clay being obtained locally. Promising fire-clays are also found at Jabbalpur, at Jowai in Assam, and at the Chanda, Umaria and Gondwana coal-fields. It is probable that with proper manipulation some of the pottery clays, not hitherto used for the purpose, would afford perfectly refractory materials.

Pipe-clay. **Pipe-clay** (*namam*, *kharra*, etc.), so called in English from its being used for tobacco-pipes. It much resembles China-clay, but possesses more silica. Ball makes no mention of the existence of pipe-clay in India, but Moore (*Man. Trichinopoly*, 1878, 67) states that a fine bed of it occurs between Terani and Kárai. Pipe-clay has also been mentioned as a product of the Madras forests. [*Cf. Madras Man. Admin.*, 1885, i., 313.] An anonymous correspondent of *The Madras Weekly Mail* (April 20, 1905) stated that the clay used in the ornamental pottery of Karigeri in North Arcot was a form of pipe-clay.

Pottery-clays. **Pottery-clays.**—The pottery-clays of India might be popularly assorted according to three degrees of purity, viz.:—(*a*) *kaolin*, China or porcelain clay; (*b*) ordinary white or glazed pottery clays; and (*c*) red or tile and flowerpot clays. The third has perhaps been sufficiently indicated above in connection with brick and tile clays, since most average

Kaolin. good brick clays may be used for unglazed pottery. Kaolin, besides being employed for porcelain, is utilised in the paper and soap industries. It is sold in the form of large lumps of a white or yellowish-white

colour. It fills up the pores of the paper and gives a smoother and more absorbent surface. [*Cf.* Cross and Bevan, *Paper-making*, 1900, 197.] It is formed by the gradual disintegration of felspar under the action of air and water, and consists essentially of a silicate of aluminium. Its quality depends upon its whiteness and freedom from the coarser micaceous particles. Although there is probably nowhere in India an occurrence of the finest porcelain-clay, such as that of the south-western counties of England, yet there are several districts where fine white clays exist and are utilised for pottery. In fact the chief districts where such clays occur are naturally more or less identical with the localities whence the Indian Art potteries are produced. The following brief statement may be useful :—

Paper-making.

Ceramic Ware.—There are three classes of pottery :—(*a*) Aboriginal work, (*b*) Hindu work, and (*c*) Muhammadan work. Ceremonial usage amongst the Hindus requires that pottery, whether polluted or not, shall be thrown away on certain specified occasions, so that there has arisen a large trade in a cheap material where artistic developments would be superfluous. So far as the production of this everyday domestic pottery is concerned, the potter will probably always hold an important position in village life. But even *he* is beginning to feel the stress of competition. Glazing is unnecessary unless the ware be meant to hold water, and since artistic ware has mainly been produced in the way of grain or pickle jars, painted or lacquered pottery is equally serviceable and infinitely cheaper than glazed ware. Indeed, with the exception of the few examples discovered in association with the Dravidians of South India and the fragments of old pottery found in the Charsada excavations near Peshawar, there is no reason to suppose that glazed earthenware vessels were at all used in India prior to the Muhammadan conquests. The former of the two exceptions possibly is suggestive of the origin of the apparently spontaneous art of glazing found at Vellore in North Arcot. Beyond the frontier of India, moreover, it has been recently shown by Stein (*Ancient Khotan*) that an advanced knowledge existed from perhaps the second century of our era. It is just possible, therefore, that the discoveries both in the south and north of India of old glazed pottery (and even of glass) indicate Buddhist rather than Hindu work. But that the glazed pottery of India, as generally accepted by European connoisseurs, began with the Muhammadan traffic in coloured tiles for mosques and tombs there can be no doubt. To this day the village potter (*kumhár*) is nearly always a Hindu, and he makes unglazed pottery, whilst the ceramic artist (*kuzagár*, *kashígár*) is ordinarily a Muhammadan (except in such rare and notable cases as that of the Hindu *kuzagárs* of Delhi). Moreover the *kuzagár* often purchases from the village potter sun-dried vessels which he afterwards ornaments and fires. It is a matter of everyday knowledge that the glazed vessels of recent times, so eagerly purchased by visitors to India, are but special adaptations gladly pursued by the Indian craftsmen with the decadence of the demand for tiles. In any case all present-day glazed pottery in India (except perhaps the Vellore work) is Indo-Saracenic in design, is made by Muhammadans, and sold exclusively to Muhammadans or Christians. Mr. Hughes Buller and Mr. Gupte recently discovered a kiln and rude contrivance for making pottery in Baluchistan, which seemed to have been used for making glazed-ware, since fragments of such pottery were found near by. Mr. Buller is of opinion that the fragments in ques-

Ceramic Ware.

Potter's Position.

Painted Pottery.

Glazed Pottery.

Muhammadan Influence.

The *Kumhár* and the *Kuzagár*.

Indo-Saracenic.

tion are Persian in technique, a view supported by the circumstance that there are no records of an indigenous Indian glazing art in Baluchistan.

Deterioration. The modern demand for cheap Indian work is rapidly causing a deterioration from the original tile models of former times. Fortunately the shapes of the unglazed and painted wares, platters, cooking-pots, water-jars, etc., are as yet uncontaminated by foreign demands and hence remain graceful and well worthy of study, alike by the antiquary and the artist.

[*Cf.* Birdwood, *Indust. Arts Ind.*, 1884, 387–418 ; Mukharji, *Art Manuf. Ind.*, 1888, 283–93 ; *Journ. Ind. Art*, 1885, Nos. 9 and 10 ; 1886, Nos. 12, 14, 16 ; 1887, Nos. 17, 19, 20 ; 1888, Nos. 23, 24 ; 1889, No. 28 ; 1890, No. 29 ; 1891, No. 33 ; 1892, Nos. 41, 42 ; 1894, No. 52 ; 1895, Nos. 55, 57, 58 ; 1897, No. 45 ; *Monographs, Pottery and Glassware* :—T. N. Mukharji, *Bengal*, 1895 ; Maconochie, *Bombay*, 1895 ; Dobbs, *United Prov.*, 1895 ; Taw Sein-Ko, *Burma*, 1894–5 ; Watt, *Ind. Art at Delhi*, 1903, 80–98, pl. 20 (*a*).]

Import Trade. ***Trade.***—The value of the *EARTHENWARE* and *PORCELAIN* (excluding earthenware piping) imported in 1899–1900 was Rs. 19,90,369, but it rose in the succeeding years, until in 1903–4 it reached Rs. 28,00,038, and in 1906–7 Rs. 38,99,824. The United Kingdom usually supplies 50 per cent., whilst Belgium, Germany and the Straits Settlements contribute between them about 40 per cent. The chief receiving provinces in 1906–7 were Bengal, Bombay and Burma, which took respectively quantities valued at Rs. 14,22,977, Rs. 12,27,104, and Rs. 8,93,767. A small proportion (Rs. 2,58,929 in 1906–7) was re-exported and sent to Persia, Arabia, the United Kingdom, Turkey-in-Asia, East Africa, etc. *EARTHENWARE PIPING* (which is mentioned separately in official statistics) is imported from the United Kingdom, and in 1906–7 amounted to 31,347 cwt. (Rs. 2,16,808), most of it being received by Bombay. *BRICKS AND TILES* are taken by India, principally from the United Kingdom and into Bombay.

Contributing Countries.

Receiving Provinces.

Imports. Both in quantity and value the imports increased by more than 100 per cent. during the five years ending 1903–4. In the first year of that series they were in number 3,641,594, valued at Rs. 2,14,255, and in 1903–4 they were 7,135,872, valued at Rs. 5,16,610. Since then they have continued to increase to 14,922,191 (Rs. 10,64,560) in 1906–7. India also imports a small quantity of *CLAY*. The amount in 1906–7 was 56,889 cwt., valued at Rs. 96,557, and the country chiefly concerned may be said to be the United Kingdom, the supply being consigned to Bombay, Bengal and Burma.

Exports. The total value of Indian *EARTHENWARE* (except piping) exported in 1906–7 was only Rs. 44,709, consisting of certain small consignments from Madras, Bombay and Bengal to Ceylon and the United Kingdom. *EARTHENWARE PIPING*, not included in the above, is exported chiefly from Bengal to the Straits Settlements. The amount in 1906–7 was 7,690 cwt. (Rs. 34,368). The exports of Indian bricks and tiles go principally from Madras to Ceylon. In 1899–1900 they were valued at Rs. 68,797, and in 1906–7, Rs. 1,03,314.

D.E.P., ii., 378–95. Coal. **COAL.**—Ball, *Man. Econ. Geol. Ind.*, 1881, 59–119, 592–604 ; *Mem. and Rec. Geol. Surv. Ind. for past 20 years* ; Watt, *Rev. Min. Prod. Ind.*, 1894 *to* 1897 ; Dunstan, *Coal Res. Ind.*, in *Journ. Soc. Arts*, Feb. 1902 ; *Imp. Inst. Tech. Repts.*, 1903, 319–77 ; also *Rec. Geol. Surv. Ind.*, 1906, xxxiii., 241 ; Holland, *Rev. Min. Prod. Ind.*, 1898–1903, in *Rec. Geol. Surv. Ind.*, 1905, xxxii., 17–45 ; 1907, xxxvi., 66–71 ; *Stat. Min. Prod. Ind.*,

1890 to 1904, etc. etc. The *koyelah, koyala, koelo, kolsa, kari, simai-karri, boggu, sima boggu, iddallu, misu-e, midu-ye*, etc.

History.

History.—Coal has doubtless been known to the Natives from time immemorial, but was neither mined nor traded in until sought out by the early European residents in India. Even at the present date it is little if at all used in the purely indigenous industries, and hardly ever employed for domestic purposes. But this state of affairs is perhaps little to be surprised at when it is recollected that the first licence to dig for coal in England was granted by Henry III. in 1239: it was then designated "sea-coal." In 1306 the use of coal in London was prohibited, but in 1325 a trade had been organised between England and France in which coal was exported and grain imported. About this time also Newcastle became famous for its coal, and for a couple of centuries at least fleets of ships sailed from thence to supply London and the other ports of England, as also France, Holland and Germany. It would be beyond the scope of this article to follow the growth of the European knowledge in coal or to narrate the discovery of the other coal-deposits that finally overthrew the supremacy of Newcastle. By 1776 we read that Sunderland, Blyth, Hartley, Durham and several other centres in both England and Scotland had commenced to export coal independently of Newcastle and of the charters granted to the original seat of the trade. It was only natural, therefore, that the European residents in India, in the middle of the 18th century, should have begun to think of a possible Indian supply of an article that had been proved of so great value in their home countries.

First Licence issued in England.

Supremacy of Newcastle.

In 1774 Warren Hastings granted a mining license to two of the Company's servants, namely Mr. Suetonius Grant Heatly and Mr. John Sumner. The former gentleman, we learn, had discovered coal in "the districts of Bheerbhoom and Pachete." Mr. Heatly (son of the discoverer and original worker of the Bengal mines) tells the story of his father's labours, in an article which will be found in the *Journal of the Asiatic Society of Bengal* (1842, xi., 811–35). Unfortunately the coal Heatly produced was reported as being much inferior to that of England, and this circumstance, together with the indifference of Lord Cornwallis to measures calculated to develop the internal resources or promote the external commerce of India, led (according to Heatly, junior) to the neglect and apathy that characterised the first few years of coal-mining in India. In 1777 Farquhar and Motte asked permission "to bore cannon and to cast shot and shell in the district of Jherria, lying between the rivers Dummuda and Burraker." They gave as their reason for the selection of that locality that it "abounds in iron ore and is contiguous to the coal-mines of Messrs. Sumner & Heatly." Williamson (*Wild Sports in the East*, 1808, i., 7, 8) alludes to Indian coal, but remarks that the Company "finds it easier to send coal from England, as ballast, to their arsenals abroad, where quantities are occasionally used in fusing metals for casting ordnances." But apparently about this very time the London Directors of the East India Company had actually complained of the heavy charges involved by the indents for the coal made by their Indian representatives, and they accordingly recommended an inquiry whether charcoal could not be substituted; and if not, they further recommended the transference of the ordnance works to England. The Earl of Minto was at the time Governor-General of India, and to his enlightened action may be attributed the birth of the present prosperous trade in coal. He directed that Indian coal should be submitted to actual tests by the military authorities in India. Col. Hardwicke accordingly performed experiments but reported once more very unfavourably (dated May 19, 1809), and the subject of coal for a time dropped out of notice. But in 1814 the Marquis of Hastings once more urged on the Military Board the desirability of ascertaining beyond doubt "whether the coal of India was of a quality calculated for the purpose of the forge." His lordship announced that a fully qualified person would be appointed to examine the mines, who would be furnished with the necessary apparatus to make borings and who would for experimental purposes procure a supply of coal from such a depth as to ensure that it would represent the average quality. Previous experiments were thus discredited owing to the coal used having been obtained from the surface and therefore much deteriorated. By this time we hear of a Calcutta merchant having commenced to use Bengal coal, notwithstanding the unfavourable reports published by the Military Board. Coal was, in fact, being regularly conveyed by boat down the Damuda river to Calcutta, and it is therefore not to be wondered at that

First Indian Licence.

Influence of Lord Cornwallis.

Heavy Charges through Coal Indents.

Earl Minto's Action.

Marquis of Hastings.

Calcutta Merchant.

Expert Report.

the Viceroy should have once more called for a thorough inquiry. Mr. Rupert Jones accordingly went from England on purpose to examine the Bengal coalfields, and his report (written in 1815) will be found in the *Asiatik Researches* (1833, xviii., 163–70). Needless to say this gave new life to the Indian mines and proved that indifference and obstruction to the use of a new material had more to say to the unfavourable opinions previously published than the actual inferiority of the coal—at least for many of the purposes for which English coal was being imported. But in passing it may be added that Mr. Jones himself did not realise the full value of his investigations. He foretold increased prosperity to Calcutta, through the coal he had discovered being a better and more economical fuel for burning the Sylhet limestone than the firewood then in use. Jones apparently knew little of the great revolution steam was destined to effect, nor of the imperative necessity of an abundant and cheap supply of coal for commercial and industrial prosperity.

Indian used for burning Sylhet Lime.

First Indian Company, 1820.

Mr. Jones received an advance from Government of £4,000, on easy terms, to enable him to work the mines, but in 1820 he came utterly to grief. Fortunately a number of Calcutta firms stepped into the breach. The first regularly constituted Indian mine under European supervision and capital was opened in Bengal in 1820 (Raniganj mine). In 1839 the output was 36,000 tons. Still, little progress was made till the construction of the East Indian Railway in 1854 tapped the coalfields. But even then the progress was but slow until the jute mills of Calcutta had been started and the other directions of manufacturing skill originated, that gave vitality to the Eastern capital. Apparently 1857–8 was the first year of specially recorded production, when 293,443 tons were taken from the Indian mines and 92,983 tons imported. From that date the prosperity of coal-mining was assured. It became the direct expression of a rapidly expanding modern commerce. This may be briefly exemplified. In 1868 the output was 459,408 tons; in 1878, 925,494 tons; in 1898, 4,608,196 tons; in 1904, 8,348,561 tons; and in 1906, 9,783,250 tons. Of these the Bengal mines supplied 88 per cent. [*Cf. Moral and Mat. Prog. Ind.*, 1905–6, 114.] One of the difficulties experienced in this remarkable trade has been for the railways to keep pace in the supply of the rolling stock necessary. In 1885 there were 95 mines, of which 90 were in Bengal; in 1900 there were 286 coal-mines in operation, of which 271 were in Bengal; in 1906 there were 307, of which 274 were in Bengal. The number of mines only partially represents progress, on account of the tendency for small mines to be grouped together as a smaller number of large ones. The greatest development has taken place in the Raniganj field, owing to the collieries being only 120 to 140 miles from Calcutta. Jherria, some 40 miles more distant, has recently given evidence of having very likely permanently overtaken Raniganj. But no less vigorously have the Giridih fields been pushed forward. It can now be affirmed that India is rapidly approaching the state of being able to meet all her own wants for fuel. The imports have been shrinking steadily for years, and in 1903–4 were one-fourth of the quantity taken nine years previously. And of these imports Bombay—a province remote from the Indian mines—consumes by far the major portion, viz. 148,311 tons out of a total of 179,935 tons in 1905–6. England, Australia and Japan are the supplying countries. But a new trade has arisen, namely in coal exported to Indian Ocean ports—a traffic that it would seem is instantly stimulated and permanently strengthened by the strikes and other accidental causes which in Europe and Japan tend to raise the price of coal. A vivid conception of the present magnitude and importance of the Indian coal industry may be had from the circumstance that in 1903 the output came to 7½ million tons, while the outputs of both Canada and Australia were each just under 7 million tons; and the Indian production has since risen to almost 10 million tons. But a still more significant fact may be added in conclusion, namely that Indian coal is the cheapest in the world. The average pitmouth price was in 1902, Rs. 2–12 (3*s.* 8*d.*) and in 1906 Rs. 2–15 (3*s.* 11*d.*) per ton, while in the United States the corresponding average price was 5*s.* 8¼*d.*; in Australia 7*s.* 9*d.*; in the United Kingdom 8*s.* 2¾*d.*; in Germany 8*s.* 10½*d.*; in Canada 9*s.* 3*d.*; and in New Zealand 10*s.* 0*d.* An interesting series of articles on "Dear Coal" will be found in *The Textile Journal* (May, July and December, 1900).

Jute Mills.

Production in 1857–8.

Coal-mining Assured.

Rolling Stock

Mines.

Raniganj.

Jherria.

Giridih.

Imports Shrinking.

Exports.

India's Position in the World's Supply.

Indian Coal the Cheapest in the World.

The annual reports, etc., of the Indian Mining Association and those of the Bengal Chamber of Commerce are usually of the greatest interest and value in setting forth the progress or the disabilities of the mining industry. But it

may be added that none of the early European travellers in India make any mention of coal, prior to the first decade of the 19th century. This is abundantly exemplified by the silence of Milburn (*Or. Comm.*, 1813) and of Macpherson (*Hist. Europ. Comm. Ind.*, 1812), two authors who were certain to have had chapters on Indian coal and India's requirements in coal had these been questions of public importance at the time in which they wrote.

Silence of Early Travellers.

OCCURRENCE AND DISTRIBUTION OF COAL IN INDIA.

Holland (*Rev. Min. Prod. Ind.*, 1905, 1907) has furnished so comprehensive a statement of India's coal resources that it is hardly necessary to do more than give an abstract of his opinions in order to bring the *Dictionary* up to date. He confines attention to the coalfields actually being worked or those likely to be worked in the near future. The particulars that follow in this chapter are, therefore, derived very largely from Holland's instructive and practical Reviews :—

India's Coal Resources.

" Most of the coal raised has been obtained from the Gondwana system of strata in Peninsular India, where the coal-mines, being nearer the coast and generally within touch of the main railway lines, have been developed more rapidly than those of the extra-Peninsular Cretaceous and Tertiary coal-beds." The Gondwana mines furnished in 1906, 95·56 per cent. of the total supply. It may be useful to exhibit the chief groups of mines categorically :—

(*A*) ***GONDWANA COALFIELDS.***—1. ***Raniganj and Jherria in Bengal.***—Raniganj was the first to be developed and formerly had the largest output, but since 1906 the lead has been taken by the Jherria mines farther west in the Damuda valley. These mines are tapped by the E.I.R. and by the B.N.R. systems. " The coal from the Raniganj field is mainly derived from seams in the highest beds of the Damuda series, the lowest, or Barakar stage, being less developed in the exposures along the northern margin of the field. In the Jherria field the converse is the case : the uppermost stage has yielded poor coal, whilst in the Barakar series there are some eighteen well defined seams of which the upper eight include enormous supplies of good coal. The two classes of coal present a well-marked and constant difference in the amount of moisture they contain : the older, Barakar, coals, both in the Raniganj field and in Jherria, contain on an average about 1 per cent. of moisture, whilst the average for the younger coal of the Raniganj series is 3·8 per cent. in the lower seams, and nearly 7 per cent. in the upper seams. There is a corresponding, but less marked, difference in the proportion of volatile hydrocarbons, which form a larger percentage of the younger coals than of those at lower stages in the Damuda series."

Raniganj and Jherria Coalfields.

Amount of Moisture.

2. ***Giridih in Bengal.***—" The small patch of coal-bearing Gondwana rocks near Giridih is practically divided between the Bengal Coal and the East Indian Railway Companies. The chief wealth of the field is stored in a 15-foot seam of good steam and coking coal near the base of the Damuda series." It has been estimated that the remaining workable supplies probably do not exceed 77 million tons. [*Cf.* Saise, *Giridih Coal Fields and Notes on Methods of Working*, in *Rec. Geol. Surv. Ind.*, 1894, xxvii., 86–100.]

Giridih.

3. ***Pench Valley in the Central Provinces.***—An interesting development is the opening out of the Pench supplies. In 1905 the production was 1,104 tons, and in 1906, 32,102—in spite (adds Holland) of the imperfect railway facilities. This field is of special value to the mills of Bombay and the Deccan.

Mohpani.

4. ***Mohpani in the Narsinghpur District of the Central Provinces.***—This colliery has been worked since 1862 by the Nerbudda Coal and Iron Company. It has made little progress, but a new area some two miles farther west has been discovered and operations commenced. Medlicott published in 1872 a paper entitled *Notes on the Satpura Coal-basin* that should be consulted regarding the coal of this area. More recently Mr. C. J. Dalby of the Bengal-Nagpur Railway submitted in 1892 a report on the Rampur Coalfield. Also Mr. G. F. Reader, Mining Specialist, published (*Mem. Geol. Surv. Ind.*, 1901, xxxii.) a more detailed account of these fields.

Warora.

5. ***Warora in the Chanda District of the Central Provinces,*** and about 62 miles south of Nagpur, has been worked since 1871 by the State. About half the coal raised is taken by the G.I.P. Railway, the rest going to the cotton-mills and factories of the Central Provinces. This coal is liable to spontaneous combustion, and a large part of the field has been lost through fire. "The Warora colliery has been worked under distinctly greater natural difficulties than those usually met with in Bengal." "The returns for labour at Warora, notwithstanding the difficulties arising from water and liability to spontaneous combustion, show that the system of mining adopted permits of a satisfactory output per person employed, whilst the deaths due to accidents have been reduced to a low rate." "Another three or four years will probably see the end of the Warora colliery, but, with the extension of the Wardha Valley line southwards, the extensive deposits near Bellarpur will be opened up." Prospecting operations have recently commenced on the known thick coal-seams in the Wun district, Berar. These coal-fields are fully described by Hughes. [*Cf. Mem. Geol., l.c.* xiii., 1.]

Spontaneous Combustion.

Future Mines.

Singareni.

6. ***Singareni in the Nizam's Dominions.***—"The great belt of Gondwana rocks near the north-west end of which Warora is situated stretches down the Godavari valley as far as Rajamundry, and at one or two places the equivalents of the coal-bearing Damuda series in Bengal are found cropping up from below the Upper Gondwana rocks. One of these occurrences near Yellandu in the Nizam's Dominions forms the coal-field well known by the name of Singareni. The principal seam of coal, some 5 to 6 feet thick, being worked at the Singareni colliery was discovered by the late Dr. W. King of the Geological Survey in 1872, but mining operations were not commenced until 1886." "Coal-mining at Singareni has been accompanied by a heavier loss of life by accidents than in the general run of Gondwana fields." The opinion seems upheld that for steam purposes Singareni coal is considerably inferior to Bengal coal and is not a coking coal. These circumstances would seem largely to account for the slow progress made with this coal in South India. The Reports of the Hyderabad (Deccan) Company, Ltd., afford useful particulars regarding the mine.

Heavy Loss of Life.

Umaria.

7. ***Umaria, Rewah State, Central India.***—The Bilaspur-Katni Branch of the Bengal-Nagpur Railway passes through this small coalfield. "The quantity of workable coal in this field is estimated at about 24 million tons." "The four coal-seams being worked vary from 3 to 12 feet in thickness and dip about 4° to the north-east. The mines were opened in 1882 under the direction of Mr. T. W. H. Hughes of the Geological Survey and were controlled by Government until the 1st of January, 1900, when they were handed over to the Rewah State." Most of the

coal raised is sold to the Indian Midland and to the Bengal-Nagpur Railways. [*Cf. Ann. Repts. Rewah State Collieries*, 1899–1903.]

(B) CRETACEOUS AND TERTIARY COALFIELDS.—"The younger coals are nearly all of Cretaceous and Tertiary age, although some thin and poor seams of Upper Jurassic coal have been worked in Kach. The Cretaceous beds occur in the Khasia and Garo hills of Assam, where they are found in small basins resting on the Archæan schists and gneisses. The Cretaceous coals of Assam are generally distinguished by the inclusion in them of nests of fossil resin, and this character was noticed in the coal recently discovered to the north of Shillong." Younger Coal.

"Coal of Tertiary age is found in Sind, Rajputana, Baluchistan and along the foothills of the Himalaya, further east in Assam, in Burma, and in the Andaman and Nicobar Islands. The most frequent occurrence is in association with nummulitic limestones, though the richest deposits, namely those in North-East Assam, are younger, probably Miocene in age. Of these extra-Peninsular fields, the only ones producing coal are of Tertiary age."

"On the whole, the younger coals, which are being worked in extra-Peninsular areas, differ from the Gondwana coals in containing a larger proportion of moisture and volatile hydrocarbons, and though as variable in composition as they are in thickness of seam, coals are obtained, as for instance in Assam, with a remarkably low percentage of ash, and having a high calorific value."

8. ***Makum in North-East Assam.***—This is being worked by the Assam Railways and Trading Company, who commenced operations in 1881. "The collieries are connected by a metre-gauge railway with Dibrugarh on the Brahmaputra river, which, being navigable, forms both a market and a means of transport for the coal. The most valuable seams occur between the Tirap and Namdang streams, where, for a distance of about five miles, the seams vary from 15 to 75 feet in thickness. The average dip is 40°, but as the outcrops in many places are several hundred feet above the plains, facilities exist for working the coal by adit levels." "The coal has the reputation of being a good fuel, and forms an excellent coke." [*Cf.* Mallet, *Coal Fields Naga Hills, Assam*, in *Mem. Geol. Surv. Ind.*, 1876, xii.; La Touche, *Coal Fields Jaintia Hills*, 1889; Bose, *Rept. on Um-Rileng Coal-beds, Assam*, in *Rec. Geol. Surv. Ind.*, 1904, xxxi.; A.R.T.C., Ltd., *Ann. Repts.*, Nos. 1–21.] Makum.

9. ***Shwebo District in Burma.***—Coal occurs in various parts of Burma. Within the past few years it has, for example, been definitely ascertained that in the Nammaw field (30 miles from the Mandalay-Lashio Railway) there are seams of lignitic coal 10 feet thick. [*Cf.* Jones, *Notes on Coal, Upper Burma*, in *Rec. Geol. Surv. Ind.*, 1887, xx., 170–93; Noetling, *Upper Chindwin Coal-fields*, 1890; Primrose, *Rept. Prosp. Oper. in Tenasserim*, 1891-2; Bose, *Notes on Geol. Tenasserim Valley*, in *Rec. Geol. Surv. Ind.*, 1893, xxvi., 148–64; George Scott, *Upper Burma Gaz.*, ii., pt. 1., 230–8; Nisbet, *Burma Under Brit. Rule and Before*, 1901, i., 389–92.] Burma.

10. ***Baluchistan.***—Possibly the most important coal-deposits of the west are those in Baluchistan, where, however, the disturbed state of the rocks makes mining difficult, expensive and dangerous. The best mines are those of Sor (south-east of Quetta), the Bolan and Khost. From the last-mentioned mine the output in 1906 amounted to 32,500 tons. Baluchistan.

11. ***Dandot in the Jhelum District of the Panjáb.***—The Dandot Dandot.

plateau of the Salt Range. The only valuable seam varies in thickness from 18 to 39 inches and forms a basin under the nummulitic limestone. The mines have been worked by the North-Western Railway since 1884. [*Cf.* N.W.R., *Ann Rept. Working Mines*, 1896–1903.]

12. ***Bhaganwala.***—At the eastern end of the Salt Range—a seam of variable thickness also worked by the N.W.R. [*Cf.* Baden-Powell, *Pb. Prod.*, 1868, i., 27-34; Morris, *Hazara Coal*, 1889; La Touche, *Bhaganwala Coal Fields, Rec. Geol. Surv. Ind.*, 1894, xxvii.]

13. ***Mianwali District***, about two miles north of Kalabagh. This is classed as Jurassic coal, but so far regular mining has not been started. More promising Tertiary coal occurs at Maidan, 24 miles further west. [*Cf.* Simpson, *Rept. on Coal, Is Khel*, in *Rec. Geol. Surv. Ind.*, 1904, xxxi.]

14. ***Kashmir.***—The Jammu Coalfields—Tertiary; commenced to be worked in 1903. Washed and briquetted Ladda coal would be nearly as valuable as Bengal coal, but could not compete in price. [*Cf.* La Touche, *l.c.* xxi., 188; Simpson, *Mem. Geol. Surv. Ind.*, 1904, xxxii.]

Bikanir.

15. ***Bikanir in Rajputana.***—A lignite of dark-brown colour, with included lumps of fossil resin, occurs in association with nummulitic rocks at Palana in the Bikanir State. In 1898 mining operations were commenced at a point where the seam was found to be 20 feet thick. "The physical characters of the natural fuel form a drawback to its use in locomotives, but experiments recently made are said to show that satisfactory briquettes can be made in which the proportion of moisture is reduced, and the fuel made less vulnerable to atmospheric action." The proximity to railway demands seems likely to counterbalance the inferiority of this coal, of which the output in 1906 amounted to 32,372 tons.

Labour.

WORKING OF MINES: Labour, etc.—Holland may be still further placed under contribution: "Coal-mining in India, from the point of view of labour, is quite ahead of all other forms of mining. The number of persons employed daily has averaged 84,805 for the years 1898 to 1903." During 1904 the number rose to 92,740, of which 75,749 were employed at the Bengal mines. The Bengal coal-mines thus took 81·7 per cent. of the total labour supply. "It will not be surprising to those who know the habits of the Indian coal-miner to learn that the output per person employed is lower than in any other part of the British Empire except in Cape Colony, where cheap Native labour is largely employed. During the years 1901 and 1902 the outputs of coal per person employed in Indian mines were respectively 70 and 75 tons, whilst for the rest of the British Empire the corresponding figures were 281 and 285 tons." "An important consideration, naturally, in every mining community is the risk of life involved in the occupation. As far as coal-mining is concerned in India, the industry, so far as it has progressed, has shown not only a very low death-rate from isolated accidents, but also a noteworthy freedom from disasters, which in European countries have done more perhaps than statistics to force special legislation for the protection of workers in 'dangerous' occupations." "The average death-rate from such accidents has been 0·88 per thousand employed, while the average for the rest of the British Empire comes to 1·54 per thousand—in the U.K. 1·24." But if the death-rate be expressed to the tonnage of coal raised, India is shown up in a much less favourable light. New Zealand heads the list of successful mining from this standpoint with 1·47 persons killed per one million tons of coal raised in 1902; Queensland 1·99; Nova

Output per Person.

Death-rate.

Expressed to Tonnage.

Scotia 4·35 ; United Kingdom 4·42 ; Victoria 4·44 ; India 10·23 ; Transvaal 14·47 ; New South Wales 17·67 ; Cape Colony 24·16 ; Natal 26·99 ; and British Columbia 99·48. India is thus by no means the country in the British Empire that shows the worst result.

Indian System of Mining.

" The almost universal practice in Indian coal-mines is to extract the coal on the system variously known as the " bord and pillar," " post and stall," or " stoop and room " system. Although this system in Europe is fast being superseded by the more economical " long-wall " method, yet, owing to the thickness of most of the Indian seams, it is not easy to devise any more suitable plan of working. It is undoubtedly wasteful, for the pillars form from 25 to 65 per cent. of the available coal, and at the present time except in certain mines, where local-trained labour and efficient supervision are possible, their extraction is not even contemplated."

Holland points out that the strong roof in the Gondwana rocks, the freedom from disturbances, and the comparative lightness of the overburden are features of strength and safety not fully appreciated by those who have gained their experience in countries where these advantages do not prevail. In the Giridih coalfield the system of working thick seams there pursued, which is a modification of the South Staffordshire method suggested by Mr. T. H. Ward, allows of 90 per cent. of the coal being removed. Adamson (*Trans. Min. and Mech. Engin.*, 1903, lii., 202) has described fully the " working of a thick coal-seam in Bengal." " In the Makum field a highly inclined seam, 75 feet thick, is worked also on a modification of the South Staffordshire system of 'square work.' The coal is removed in two, or sometimes three sections, the top section being removed first, and a parting of stone and coal being left untouched between each pair of sections. In the Dandot and Khost mines, thin seams are worked in one operation, on a modified 'long-wall' system."

Mr. Ward's Method.

PROPERTIES AND USES.—It is difficult, if not impossible, to give a general statement of the properties of Indian coal : the two great geological groups already established differ in almost every essential, and, moreover, the coal varies not only between mines within the same formation but even within the seams of one and the same mine. Averages are therefore often very misleading. The late Mr. H. B. Medlicott accordingly very rightly observed, " In both regions the quality of the coal varies much, as in all coal-measures ; but the best in both reaches a very high standard, almost if not quite up to that of high-class English coals. In the Gondwana (Bengal) coal the general defect is an excess of ash, and also in some an excess of moisture ; while in the Tertiary (Assam) coal the percentage of ash is low, but that of the volatile combustible matter high, producing a lighter fuel." Medlicott then furnished a table to show the results of various chemical examinations, and, as little of material importance has since been learned, it may be here reproduced :—

Properties.

D.E.P., ii., 379.

Excess of Ash

	Bengal.		Assam.	
	Average.	Best.	Average.	Best.
Fixed Carbon	53·20	66·52	56·5	66·1
Volatile exclusive of moisture	25·83	28·12	34·6	33·5
Moisture	4·8	0·96	5·0	—
Ash	16·17	4·40	3·9	0·4
	100·00	100·00	100·00	100·0

These average results, so far as averages go, will be found sufficiently near the truth for all practical purposes.

Moisture.

The moisture and the ash are the chief detractive features of coal. "Dr. Saise (*Rec. Geol. Surv. Ind.*, 1904, xxxi., 104–7) calls attention, however, to the remarkably constant differences in the percentages of moisture held by coals from the different geological horizons in the fields. In the case of the Barakar stage, which is the lowest in the series, the moisture amounts to only 1 per cent., while in the lower seams of the Raniganj stage it averages 3·81 and in the upper seams 6·86 per cent. There is a parallel but less pronounced variation in the amount of volatile hydrocarbons : in coal from the Barakar stage the average is 26·57 per cent. ; in the lower seams of the Raniganj stage it is 31·70, and in the upper seams 32·22 per cent."

Volatile Hydrocarbons.

In the *Records of the Geological Survey of India* (1904, xxxi., 237-9) will be found certain results of the coal and coke assays made by Mr. E. P. Martin and Prof. H. Louis at the instance of the Right Hon. Sir E. Cassel, on carefully procured samples from the Jherria and Raniganj fields. It is explained that the samples reported on had been taken from across the entire working face of the seam, and were not picked from a promiscuous pile at the pit mouth or taken from a particular part of the seam. Space cannot be afforded to republish the tables in the original form in which they appeared, but the following averages of the returns may be here given :—

Coal.	Fixed Carbon.	Volatile Matter.	Sulphur.	Ash.	Moisture.	Lb. of Water evap. by 1 lb. of Coal.
Jherria Field .. (12 samples)	60·5	22·0	0·55	16·49	1·0	12·71
Raniganj .. (4 samples)	52·31	31·43	0·47	14·10	1·68	12·88

Coke.	Carbon.	Sulphur.	Phosphorus.	Ash.	Moisture.
Jherria Coke .. .. (9 samples)	75·16	0·65	0·17	24·64	0·48

Commenting on these results, Holland observes : "The beds in which the coal is now being mined in the Jherria field were long ago correlated by the Geological Survey with the Barakar series of the Raniganj coal-field, and it is interesting to notice that the low percentage of moisture recorded by Saise in the coal of the Barakar series in the Raniganj field is characteristic also of the Barakar coal in the Jherria field. In the case of the Barakar coal from the Raniganj field the moisture amounted on an average to 1·0 per cent., whilst in the case of these Jherria coals the average for moisture is 0·90 per cent."

Moisture.

A comprehensive report on the composition and quality of Indian coals, by Dunstan, will be found in the *Records of the Geological Survey of India* (*l.c.* 1906), where complete analyses of coal from all fields above mentioned (excepting those recently opened) are recorded.

Evaporation of Water to Coal Consumed.

In a recent practical experiment conducted with Seebpore coal at the National Jute Mills, Calcutta, by Mr. F. Grover of Leeds, it was found that that particular coal would evaporate 7·97 lb. of water, equivalent,

had certain conditions obtainable in England prevailed, to 8·5 lb. The corresponding efficiency of the best Cardiff coal, it is believed, is but 9 lb. This result has been hailed by certain Indian newspapers as a new discovery of the greatest public interest and value, and one which refutes completely the unfavourable opinions often upheld regarding Indian coal in general. From the remarks already made it may have been inferred that for many years past it has been recognised that the finest Indian coals are little inferior to the best English and Welsh. But laboratory results are theoretical more than practical, and Mr. Grover's experiments are therefore of considerable importance. He has shown, for example, that the assays revealed the percentage of ash to be 11·5, while in the practical tests it came to 16·7 of the original weight. This is the expression of the practical difficulty of firing, and similar instances exist in other directions without invalidating the relative values of chemical assays. But so important is this question of ash that, as pointed out by Grover, a sample of coal could be carried 54 miles farther than another with which it was compared without exceeding the cost per ton of its combustible constituents.

Practical Difficulty of Firing.

TRADE.—Production and Supply.—In 1883 there were but two localities of Indian coal-production, viz. Bengal and the Central Provinces, and the total output from the mines in these provinces came to only 1,315,976 tons. Ten years later there were nine Indian centres of production (Burma, Assam, Bengal, Central India, Panjáb, Baluchistan, Central Provinces, Nizam's Dominions and Madras) and the output had been doubled (2,562,001 tons valued at Rs. 86,20,278). Still ten years later (1903) there were ten centres of production (Madras had disappeared and Kashmir and Bikanir had been added), but the output increased to 7,438,386 tons, valued at Rs. 1,94,95,741. These figures speak volumes for the mining enterprise of India, but the low price obtained (3*s.* 8*d.* per ton at the pit mouth in 1903) probably indicated that until the metallurgical industries have developed into important consumers of coal, present production may be viewed as approaching the limits of demand. But a hopeful sign of the suitability of Indian coal for all ordinary industrial purposes is the downward course of the imports of foreign and the upward tendency of the new trade in exporting Indian coal. This view receives confirmation when it is known that the increased production of the Indian mines has been on a higher ratio than necessitated by the enhanced demands of the railway *plus* the exports, so that we are warranted in concluding that the industries of India have made a substantial advance within the period in question.

Production.

Expansion.

Limits of Demand.

Exports.

Railways.

Foreign Trade.—The record year in the imports was 1888–9, when (including Government Stores) India drew from foreign countries (mostly the United Kingdom) 877,843 tons of coal, coke and patent fuel, valued at Rs. 2,00,95,105. Five years later (1893–4) the imports were 591,007 tons, valued at Rs. 1,03,52,699; in 1898–9 they had decreased to 379,225 tons, valued at Rs. 73,60,786; in 1903–4 they were only 206,829 tons, valued at Rs. 38,66,882; and in 1906–7, 262,286 tons, valued at Rs. 49,47,445. Thus there can be little doubt the imports have given place to local production, and obviously so when in 1903, 7,438,386 tons of Indian coal were supplied for about the same sum as fetched only 877,843 tons of foreign coal in 1888.

Imports.

Steady Decline.

Relative Price.

The following shows the Imports and Exports of Coal, Coke and

Patent Fuel during the years 1897–8 to 1906–7 (including Government stores) :—

Imports and Exports.

Year.	Imports in Tons.	Exports in Tons.
1897–8	276,407	213,146
1898–9	379,225	327,207
1899–1900	481,190	304,887
1900–1	142,467	542,023
1901–2	285,786	525,047
1902–3	228,562	431,801
1903–4	206,829	493,070
1904–5	275,205	594,251
1905–6	186,911	837,251
1906–7	262,286	940,054
Average	272,486	520,873

Coke to Coal.

In these returns each ton of coke has been counted as 1½ tons of coal.

It has been urged that the above figures are unimportant when contrasted with present production. That may be quite true, but only so long as it is recollected that the imports are now just one-fourth the quantity of those in 1888–9 and that the exports have now (1906–7) exceeded the transactions of the record year of imports. As illustrative of the normal direction of the foreign traffic, it may be explained that by far the major portion of the imports comes from the United Kingdom. The analysis of the total supply in 1906–7 would be as follows :—from United Kingdom 227,158 tons ; from Japan 4,505 tons ; from Australia 25,863 tons, and from all other countries the balance. The receiving province is Bombay, which in 1906–7 took 220,751 tons out of the total (262,286 tons). Of the exports, Ceylon and the Straits Settlements are the most important foreign receiving countries. Out of the total exports in 1906–7 Ceylon took 404,149 tons and the Straits 293,788 tons, and these figures approximately represent the relative demands of the countries named during the past five years. Practically the whole of the exports are made from the port of Calcutta, which being near the Bengal fields is the natural centre of distribution.

Imports.

Receiving Province.

Exports, Receiving Countries.

To dream of a future of greatly expanded foreign export of coal from India does not necessarily involve the acceptance of a literal fulfilment of Horace Walpole's reputed prophecy that "England will be some day conquered by New England or Bengal." An export trade has become an established fact and one of great possibilities. His Excellency Lord Curzon, after inspecting a portion of the Jherria Coalfield, addressed a company of gentlemen interested in the coal-mining industry on January 22, 1903. Speaking of the foreign trade, his lordship said :—"Indian coal can hardly be expected to get beyond Suez on the west or Singapore on the east. At those points you come up against English coal on the one side and Japanese coal on the other. But I wish to point out that there is a pretty extensive market between, and I think that Indian coal should make a most determined effort to capture it."

Possible Future Market.

Coastwise Trade.

Coasting Trade.—The foreign exports represent, however (on an average) but one-fourth the total exports by sea from Calcutta. The other port towns of India itself draw very largely on Bengal for coal. Bombay is by far the most important receiving port : in 1905, 1,067,779 tons were consigned to the western capital. Then comes Rangoon, which in 1905 took 361,572 tons of Bengal coal ; Karachi, 343,406 ; Madras,

199,425 ; Goa, 21,228 tons, etc. It is by seizing this interprovincial trade that the Bengal mines have so effectually curtailed the foreign imports.

Internal Trade.

Rail-borne Traffic.—But it must not be forgotten that the figures quoted are neither the total exports from the Bengal mines nor the total receipts of the towns in question. Large quantities are carried by rail and river, and of course from all the other mines besides those of Bengal. The figures reviewed are alone those of the traffic by sea. The total transactions by rail in 1906–7 came to 7,648,688 tons. The corresponding returns for 1899–1900 were 3,921,623 tons. Calcutta drained in 1906–7, 5,353,013 tons, all but 1,868 tons being from the Bengal mines. The United Provinces of Agra and Oudh in the same year received 688,507 tons, chiefly from Bengal. This represents the manufacturing enterprise of Cawnpore mainly. Bombay Presidency obtained Bengal or foreign coal from Bombay town, but over and above fairly large quantities from the Nizam's Dominions, the Central Provinces, Bengal and Rajputana. Madras Presidency procured its coal from the Nizam's Dominions and the Madras ports (and therefore very largely Bengal coal). Lastly Mysore State drew on the Madras ports, and consequently consumed Bengal coal chiefly. The bulk of these rail-borne transactions, it may be presumed, are concerned with the internal industries, since the railways derive their supplies direct from the mines, which are often owned and worked by the railway companies.

Bengal supplying Cawnpore and Bombay.

Singareni supplying Madras.

Indian Production.

OUTPUT OF THE INDIAN MINES.—It may suffice the purposes of this abstract of information regarding the location, extent and prosperity of the Indian mines to furnish a collective statement of the production for all India :—

YEAR	ASSAM.	BALUCHISTAN.	BENGAL.	BURMA.	CENTRAL INDIA.	CENTRAL PROV.	HYDERABAD.	PANJÁB AND KASHMIR.	RAJPUTANA.	TOTAL.
	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.
1898	200,329	13,372	3,622,090	6,975	134,726	149,709	394,622	85,862	511	4,608,196
1899	225,623	15,822	4,035,265	8,105	164,569	156,576	401,216	81,835	4,249	5,093,260
1900	216,736	23,281	4,978,492	10,228	164,489	172,842	469,291	74,083	9,250	6,118,692
1901	254,100	24,656	5,487,585	12,466	164,362	191,516	421,218	67,730	12,094	6,635,727
1902	221,096	33,889	6,259,236	13,302	171,538	196,981	455,424	56,511	16,503	7,424,480
1903	239,328	46,909	6,361,212	9,306	193,277	159,154	362,733	44,703	21,764	7,438,386
1904	266,765	49,867	7,063,680	1,105	185,774	139,027	419,546	45,864	45,078	8,216,706
1905	277,065	41,725	7,234,103	—	157,701	147,265	454,294	62,622	42,964	8,417,739
1906	285,490	42,164	8,617,820	1,222	170,292	92,848	467,923	73,119	32,372	9,783,250

With a view to supply the names of the chief mines, to exhibit their classification both geologically and geographically and to demonstrate their output, the following further statement may be given :—

Classification of Mines.

Output of the Gondwana Coalfields for the Years 1901–6.

COALFIELD.	1901.	1902.	1903.	1904.	1905.	1906.
Bengal :—	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.
Daltonganj ..	3,881	19,352	33,557	50,517	71,294	87,768
Giridih ..	694,806	776,656	766,871	773,128	829,271	803,321
Jherria ..	1,946,763	2,420,786	2,493,729	2,889,504	3,070,588	4,076,591
Rajmahal ..	436	219	335	274	414	577
Raniganj ..	2,841,699	3,042,223	3,066,720	3,350,257	3,262,536	3,650,563
Central India :—						
Umaria and Johilla ..	164,362	171,538	193,277	185,774	157,701	170,292

Output of the Gondwana Coalfields for the Years 1901–6—continued.

Coalfield.	1901.	1902.	1903.	1904.	1905.	1906.
Central Prov. :—	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.
Bellarpur ..	—	—	—	90	148	916
Pench Valley	—	—	88	—	1,104	32,102
Mohpani ..	43,046	43,645	31,443	26,618	22,998	27,503
Warora ..	148,470	153,336	127,623	112,319	123,015	32,327
Hyderabad :—						
Singareni ..	421,218	455,424	362,733	419,546	454,294	467,924
Total of Gondwana Beds ..	6,264,681	7,083,179	7,076,376	7,808,027	7,993,363	9,348,884

Output of the Cretaceous and Tertiary Coalfields for 1901–6.

Coalfield.	1901.	1902.	1903.	1904.	1905.	1906.
Assam :—	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.
Makum ..	254,100	220,640	239,328	266,265	276,577	285,402
Smaller Fields	—	456	—	500	488	88
Baluchistan :—						
Khost ..	18,431	25,982	36,444	38,574	34,140	32,500
Sor Range and Mach ..	6,225	7,907	10,465	11,293	7,585	9,664
Burma :—						
Shwebo ..	12,466	13,302	9,306	1,105	—	—
Upper Chindwin	—	—	—	—	—	1,222
Kashmir :—						
Ladda ..	—	1,138	999	270	—	—
Panjáb :—						
Dandot (Salt Range) ..	67,730	55,373	43,704	45,258	61,618	57,438
Attock ..	—	—	—	336	715	10
Shahpur ..	—	—	—	—	289	15,671
Rajputana :—						
Bikanir ..	12,094	16,503	21,764	45,078	42,964	32,372
Total of Tertiary Beds	371,046	341,301	362,010	408,679	424,376	434,367
Grand Total of Indian Coal	6,635,727	7,424,480	7,438,386	8,216,706	8,417,739	9,783,251

Indian Gas-works.

Coal-gas : Coal-tar.—It is exceedingly difficult to obtain information regarding the gas-works of India. In the *Financial and Commercial Statistics* published by the Government of India for 1904 (more recent figures are not available), mention is made of two gas-works, one in Calcutta, the other in Bombay. These gave employment to 581 persons. It is believed there are other gas-works here and there all over the country, but mostly of a private nature, and therefore not returned under "Larger Industries." It is understood also that English coal is largely, if not exclusively, employed in gas-making, and the by-products of these works are doubtless disposed of but are not worked up to the extent customary in Europe. The coals most suited are coking coals that burn with a long flame.

By-products.

In the dry distillation of coal and in the manufacture of illuminating gas, volatile products are obtained that condense and separate into (*a*) a watery liquid and (*b*) a tarry mass. The former is one of the chief sources of ammonia and its salts (see **Alkalis**, p. 48), and the latter constitutes coal-tar. (For *Wood-Tar*, see **Pinus**, p. 890.) The average results with good coal are :—gas 16·6 per cent. ; ammoniacal liquor 14·1 per cent. ; tar 5·3 per

cent., and coke 64 per. cent. From coal-tar may be prepared benzene (the commercial benzol), naphthalene, anthracene and phenol, also pitch. Briefly it may be said that benzene can be converted into aniline, naphthalene into indigotin (indigo), anthracene into alizarine, and phenol into carbolic acid. The reader will find numerous technical works that deal with these substances and their manufacture. [*Cf.* Blount and Bloxam, *Chem. for Engin. and Manuf.*, 1900, 55–87; Rawson, Gardner and Laycock, *Dict. Dyes, Mordants, etc.*, 1901, 93–110.]

Colours.

The coal-tar colours may be spoken of as discovered by Dr. (the late Sir) W. H. Perkin in 1856. He was then engaged in a study of the synthetic production of quinine, when he noticed that aniline on being oxidised gave a colouring matter. This he produced separately and gave to the trade under the name of "Mauve." This was the first of the long series of colours destined in a remarkably short time to revolutionise the tinctorial industries of the world—the Aniline and Alizarine Colours. The influence of these modern mineral dyes has been more destructive to the tinctorial and textile industries of India than is commonly supposed. They have depraved the artistic feelings of the people, and demoralised many of the indigenous crafts. But it doubtless can be upheld that the advances of modern tinctorial science have, in their ultimate issues, been in reality more constructive than destructive. The majority of the Indian vegetable dyes are fleeting, especially the yellows and greens. The best colours are the reds and blues. All Indian dyes are relatively expensive and troublesome, and one of the most imminent modern dangers lies in the fact that there are good and bad, cheap and dear, fast and fleeting qualities of the coal-tar dyes. It has been in fact computed that there are at present about 2,000 distinct colours of this kind offered for practical use, the manufacturers of which are often prepared to send expert dyers to the workshops of their customers in order to instruct the operatives in the technicalities of the dyes they sell. Recently it has moreover been proposed that a "key-board" of colours should be established, with fixed numbers for each shade, so that the buyers of Indian goods may be able to dictate the colours to be used. This may be desirable for certain commercial transactions, but with the art crafts it is likely to prove pernicious. All the famed natural dyes and tinctorial combinations of India have been already imitated and their vernacular names given to the fabricated coal-tar preparations (*e.g.* **Peori dye**, p.'765), so that nothing is left undone that could expedite the complete overthrow of the indigenous crafts. This statement is abundantly upheld by the returns of the imports. The Anilines and Alizarines received by India were in 1876–7 valued at Rs. 4,60,266; in 1886–7 they were Rs. 10,08,034; in 1896–7 Rs. 60,63,256; in 1903–4 Rs. 82,67,010; in 1905–6 a slight decrease, namely to Rs. 75,71,314; and in 1906–7, Rs. 74,92,704. In another article (under **Indigofera**, p. 683) mention will be found of the progress in synthetical production of indigo.

Demoralised Indigenous Crafts.

Expensive.

Indian Dyes imitated.

Expansion of Trade.

Coal: Coke.—An inferior quality of coke is obtained as a by-product of the gas-works. It should not contain more than 10 per cent. ash; it is useful for burning cement and lime, or for domestic purposes. When coal is carbonised in ovens for the express purpose of producing coke, larger quantities are used than during gas-making. Coke is the main product, not the by-product. The coke is therefore superior because it has a higher calorific value. Caking coals are those best suited for

Coke.

Two Kinds.

Caking Coals.

coking because they form a compact coherent coke, but mixtures of caking and non-caking coal can be successfully carbonised. [*Cf.* Blount and Bloxam, *l.c.* 83.]

Manufacture.

For many years past the Raniganj, Jherria and Giridih mines have manufactured coke. Their output was in 1902 returned at 128,910 tons, of which Raniganj produced 86,000 tons. Coke-making is a most important industry, and one in which the future will doubtless record much progress. It means the profitable utilisation of coal waste, and the accompanying prosperity of the metallurgical industries. There are two qualities, "hard" and "soft." Ward (*Rec. Geol. Surv. Ind.*, 1904, xxxi., 92 *et seq.*) has recently published an interesting paper in which he urges the necessity of introducing improved methods of manufacture of coke with a view to recover the valuable by-products presently being wasted. Commenting upon this paper, Holland has explained that the backwardness of India in this matter proceeds from the limited demand for coke for metallurgical purposes. "At present about 300,000 tons only of Indian coal are converted annually into coke, though a demand will naturally increase with the development of metallurgical industries. Even as matters stand at present Mr. Ward has shown that there is good ground for assuming that the additional outlay necessary for closed ovens of the 'recovery' as well as the 'non-recovery' type would be repaid. Assuming that the coal used for coke-making in India contains on an average 0·75 per cent. of available nitrogen, the present system of manufacture in open ovens means an annual loss of 2,250 tons of nitrogen, sufficient that is for the manufacture of 10,613 tons of sulphate of ammonia, which at £13 a ton is worth £137,969 or more than 20½ lakhs of rupees." As showing the full value of this contention it may be mentioned that it has been ascertained that Java imported in 1901, 21,700 tons, and in 1902, 23,400 tons, of sulphate of ammonia to be used as a sugar fertiliser.

Two Qualities.

Improved Methods.

Backwardness of India.

Loss of Nitrogen.

Sulphate of Ammonia.

Experiments recently made on a large scale in Germany and America have confirmed the conclusions referred to above with regard to the suitability of Bengal coal for the recovery of ammoniacal by-products, and arrangements are now well advanced for the erection of recovery-ovens on the Giridih, Raniganj and Jherria fields. With a view to improving the local market for the products, experiments are being conducted by the Agricultural Department to test the suitability of ammonium sulphate for Indian sugar-cane and other crops, whilst to meet the probable demand for sulphur the Geological Survey has organised prospecting operations on a large scale in connection with the copper sulphide deposits known to occur within easy distance of the coalfields in Bengal.

Recovery-ovens.

Sulphur.

Literature of Coke.

But to conclude these remarks on coke, it may be observed that so much has been written on the subject that to give even the more useful references would occupy much space. The *Journal of the Society of Chemical Industry* teems with descriptions of methods, apparatus and processes in all countries. Similarly, innumerable passages occur in these journals on the distillation of coal; on gas-making; on the gaseous products of coal; on the relation of petroleum to the hydrocarbons of coal; on the influence of lime on coal; on the determination of the nitrogen in coal; on coal-tar; on ammonia, etc., etc., subjects intimately associated with the future of the Indian coal and coke supplies. [*Cf.* Weeks, *Man. of Coke*, 1892.]

Coal: Patent Fuel and Briquettes.—In connection with the observations already made regarding Bikanir, Kashmir and other coals it has been explained that an industry has been organised in the production of briquettes from these inferior coals. This overcomes their excessive moisture and makes them useful fuels. In Europe and America briquettes are produced in many different ways and of widely different materials. It would be beyond the scope of this work to deal with all the forms of briquettes, but the subject receives interest in India through the possibility afforded of utilising coal waste and working up inferior coals. Briquettes.

Other methods of utilising the waste coal and bituminous materials might be mentioned, such as the manufacture of what is known as "water gas," "mond gas" or "heating gas." [*Cf. Imp. Inst. Tech. Repts.*, 1903, 345–6.] The conversion of the accumulation of combustible waste material, near the Indian mines, into gas and finally into electric power might become of infinite value not only to the mines but to numerous possible future industries likely to be originated in their immediate vicinity such as chemical works, potteries, etc. Coal Waste. Electric Power.

COCCUS CACTI, *Linn.;* Milburn, *Or. Comm.*, 1813, ii., 208; *Proc. Board Agri. Madras*, Nov. 18, 1895, Coccidæ. The Cochineal-insect, Scharlach-worm, *kirmdána, kirmaz, kiranda, kirm*, etc. A Scale Insect native of Central and South America, Mexico, Guatemala, etc., and distributed by cultivation to the West Indies, Teneriffe, the Canary Islands, Algeria, to some extent even to Spain and also to Java, India, etc. D.E.P., ii., 398–409. Cochineal.

There are said to be two forms or qualities of this insect, the *grana fina* and *grana sylvestris*. The former is generally spoken of as the cultivated and the latter as the wild cochineal. The cultivated insect is both larger and more valuable than the wild, but whether these are distinct species or only races of the same insect cannot even now be said to have been definitely settled. The *grana fina* is reported to be a native of Mexico, whilst the *grana sylvestris* comes from South America. As against all this confusion only two certain facts can be set, the first being that recent and properly authenticated attempts to cultivate the true *grana fina* in India have utterly failed; the second that on three occasions a *Coccus* (possibly *grana sylvestris*) has, so to speak, broken loose in India and utterly destroyed the *Opuntia* throughout large tracts of the country. Two Forms of the Insect. Habitat.

The Cochineal insect was discovered by the Spaniards in Mexico in 1518 and made known to Europe in 1523, but it was not until 1703 that Leeuwenhoeck exposed the error of regarding the insect as a seed (*grana*). It is just possible that the Portuguese may have attempted to introduce it into India in the 17th century, since in 1786 Dr. Anderson of Madras sent to Sir Joseph Banks specimens of a dye-yielding *Coccus* which may have been a form of cochineal; and this seems to have determined the East India Company to endeavour to introduce the true insect. Accordingly in 1795 Captain Neilson (Royle, *Prod. Res. Ind.*, 1840, 60) brought from Brazil some *Opuntia* leaves with the insects still adhering. This was apparently, however, the *grana sylvestris*. But, as already stated, there is no knowledge of the acclimatisation of the *grana fina* in India. I may express my indebtedness to Major D. G. Crawford, I.M.S., for having called my attention to a passage in Seton Karr's *Selections from the Calcutta Gazetteer* (ii., 602):—"Nov. 10th, 1796. Rishra advertises for sale 'that pleasant and well-known villa of Rissura, about 50 bighas of ground and 120 bighas of Nepaulry, fully planted and now ready to receive the insect.' The well-known villa may have been Warren Hastings' house at Rishra." It is not known whether a purchaser was ever found, but there is no doubt that about the time indicated, Indian public opinion was greatly concerned with the prospect of a satisfactory acclimatisation of the true cochineal. The chemical achievements of subsequent years completely obliterated, however, all interest in the dye, and Rishra is no more a popular resort but a jungle of Opuntia and other weeds. [*Cf.* F. Brandt, *Cult. of Silk*, résumé from *Rec. Madras Govt. and Board of Rev.*, 1871, 2 (Cochineal History. Introduction into India. Nepaulry. Warren Hastings' House.

introduced by Dr. Anderson); also "*Nopalry*" (defined as "Garden for Cultivation of Cochineal Plant and Insect"), 13.]

Food of the Insect.

The favourite (and apparently the exclusive) food-plants of cochineal are various forms of ***Opuntia*** or ***Nopal***—the prickly pear (see Opuntia, p. 822). The *grana fina* feeds mostly on ***Opuntia coccinillifera***, *Haw.*, whilst the *grana sylvestris* is reported to live on several species, including ***O. monacantha***, *Haw.*, and the common Indian form ***O. Dillenii***, *Haw.* Considering the prevalence of the species of ***Opuntia***, it may be said there are not many recently collected specimens of the genus from India in the Royal Herbarium, Kew. Five species are, however, represented by the sets present, and these in alphabetical sequence are: ***O. decumana***, ***O. Dillenii***, ***O. ficus-indica***, ***O. monacantha*** and ***O. tuna***. There is no specimen of ***O. coccinillifera***, and—which may also be regarded as somewhat significant—there is only one sample of ***O. Dillenii*** from Madras, and that contributed in 1886, so that it would almost seem as if that plant had not been known, or at all events little experimented with in South India, much before the first decade of the 19th century. On the other hand, there are admirable samples from Madras of the other species just named, which are stated to have been collected from Dr. Anderson's garden on April 19, 1809. These are accordingly historic specimens. Of ***O. monacantha*** it is said that it was "the food of the wild cochineal." That same species has on two subsequent occasions been sent from Madras Presidency and once from the Panjáb, so that it is probably widely distributed in India, and completely acclimatised. Of ***O. ficus-indica*** another Madras historic sheet bears on the label the following observation: "It is not eaten by the wild cochineal." The specimen of ***O. decumana*** was wrongly named ***O. coccinillifera*** in the series from Dr. Anderson's garden, but there is no mention of whether or not the true cochineal insect fed on this or any other species grown in Madras. ***O. decumana*** has more recently, however, been sent from Madras, so that it appears to have become acclimatised. Lastly there is only one sheet of ***O. tuna***, and it also came from Dr. Anderson's garden in Madras. Most of the Indian specimens of ***Opuntia*** preserved in the Herbarium, Kew, bear a parasitic scale insect (possibly a species of ***Diaspis***), but no trace of cochineal. It thus seems possible the sudden extermination of the Opuntias of certain districts (such as that mentioned in Wilks, *Hist. Mysore*, iii., 89, in connection with Tippu Sultan) might be accomplished by the parasite mentioned, without supposing the sudden appearance and disappearance of a form of cochineal.

Herbarium Specimens.

Red and Yellow Flowers.

The fact, however, that certain Indian writers affirm that the cochineal will only feed on red-flowered Opuntia while others say that it prefers the yellow-flowered plant, is perhaps best explained by the supposition that there are at least two races or species of cochineal in India, though as yet not separately recognised by entomologists. Dr. Bourne (*Rept.*, July 26, 1897) obtained *grana sylvestris* insects from Ganjam and found these on the yellow-flowered Opuntia; they lived for a short time, and only a little longer on the red. He accordingly inferred that as a measure of extermination of Opuntia the rearing of any form of cochineal was attended with so much difficulty that it was a failure. But it may thus be asked, would similar failure necessarily result with all the other species of Scale Insect seen on the Opuntias?

Life History of Insect.

The cochineal insect at its birth is viviparous and the male and female larvæ are not distinguishable even under the microscope. After a few days, however, they fasten to the cactus-leaf, lose the power of locomotion, and become covered—the *grana fina* by a short white down, and the *grana sylvestris* by a much longer cottony substance which conceals the insect. The creature destined to become the male is enveloped, along with the females, but in time becomes encased within a separate pouch or purse open at the blottom. From this in due time it emerges as a scarlet fly possessed of long transparent wings. It rarely flies, however, to any distance but jumps and flutters about while visiting the females, and shortly after dies. The female, on the other hand, never emerges from her case as a winged insect, in fact never moves again from the position she took as a larva, but becomes absolutely torpid, round in shape, loses her eyes and even all form of a head. She derives nourishment by means of a hollow pointed tube, which she plunges into the fleshy texture of the cactus. She begins to yield her offspring after about three months, and it is at this stage that the process of "nesting" is begun. Some eight or ten females are picked off the cactus and put into a little bag of cotton-gauze or other cellular tissue, which is fastened to the underside of a fresh cactus-leaf by means of a thorn. The young larvæ escape, seek out good positions, and when fixed repeat their cycle of birth, growth and death.

Propagation.

The female alone produces the dye, and is gathered for that purpose immediately before the birth of her young. It is said that if the insects are stove-dried, their natural white powdery covering is retained, and the more valuable "silver-grey cochineal" produced, but if killed by steam or hot water they lose their covering and "black cochineal" is the result. There is, however, an alternative opinion to the effect that quality depends on choosing the right period to gather the insects. There are three commercial grades, viz. "silver grain," "black grain," and the little valued "granilla." Collection. Grades.

USES AND COMMERCIAL FORMS OF COCHINEAL.—Cochineal was formerly much employed in dyeing wool, silk, and cotton: to-day it is a colour-ingredient of drugs and confectionery, and an artists' pigment. It is almost entirely replaced by aniline dyes. Two different reds are obtainable from it—a bluish-red called crimson, and a fiery-red called scarlet. The great reputation these dyes enjoyed for many years gave to the English language the expression "ingrained." **Uses.** Ingrained.

Cochineal is comparatively rich in tinctorial matter compared with most of the other natural dyes; it contains from 10 to 20 per cent. of the pure substance which exists as a glucoside, "carminic acid," from which the true colouring matter, carmine red, is readily produced. The dye-stuff requires no preparation for the market, but before being employed by the dyer the insects are beaten to a powder. As already observed, the most valuable commercial form is "silver-grey" or "silver grain," the white film which is here retained being due to a natural wax *coccerin* amounting to about 1 or 2 per cent. of the weight of the substance. This silvery coating is sometimes imitated by facing the cochineal with talc and other mineral matter. In dyeing, cochineal is almost exclusively used for the production of scarlet shades on wool in conjunction with a mordant of tin. With alum mordant it yelds a crimson shade. The Spanish historian Herrara tells us that alum was the mordant used by the Mexicans, and certainly, as far as Europe is concerned, it was not until 1643 that "Kuster or Kesler, a German chemist," brought to London the secret of using a tin solution in producing the true scarlet. This secret he communicated to a Flemish painter, who in turn told or sold it to the famous Gobelins, whose tapestries embraced practically the first instances of scarlet-dyed hangings. Carminic Acid. Carmine Red. Alum. Tin.

In connection with painters' colours, red inks, etc., the best-known modern application of cochineal is in combination with alumina and tin to produce CARMINE (*D.E.P.*, ii., 167) which is an almost pure lake. The best quality is known commercially as *nacarat carmine* and is insoluble in water, alcohol, ether, turpentine, etc., but soluble in strong mineral acids. Other lakes prepared with cochineal are Florentine and Crimson-lake. None of the preparations retain their intensity of colour when long exposed to light. [*Cf.* Hurst, *Painters' Colours, etc.*, 1901, 261; Rawson, Gardner and Laycock, *Dict. Dyes, etc.*, 1901, 110; Blount and Bloxam, *Chem. for Engin. and Manuf.*, 1900, 327.] Painters' Colours. Red Ink.

TRADE.—As a dye, cochineal has been to a great extent superseded by aniline dyes, and this supersession appears to be steadily increasing. Thus the average quantity of cochineal imported by India annually during the five years 1894–5 to 1898–9 was 1,829 cwt. During the seven years 1899–1900 to 1905–6 the average was only 1,583 cwt. In 1903–4 the amount had fallen to 1,156 cwt., valued at Rs. 1,19,417, though in 1904–5 it rose to 1,380 cwt. (Rs. 2,22,914), and in 1906–7 to 1,533 cwt. (Rs. 2,62,568). In the same period of twelve years the imports of aniline dyes had increased by just over 100 per cent., totalling in 1906–7, 6,003,849 lb., valued at Rs. 46,55,054. Cochineal comes almost exclusively from the United Kingdom and France to Bombay. The re-export trade has practically vanished. [*Cf. Paulus Ægineta* (Adams Comment.), 1847, iii., 180; Honigberger, *Thirty-five Years in the East*, ii., 258; Hoey, *Monog. Trade and Manuf. N. Ind.*, 1880, 170; *Pharmacog. Ind.*, 1890, ii., 99; De Candolle, *Orig. Cult. Plants*, 274–6; *Kew Bull.*, 1892, 144–8; Mollison, *Rept. on Prickly Pear as Fodder*, 1892; Gennadius, *Opuntia in Cyprus*, 1897; Bourne, *Ind. Agri.*, 1898; Maiden, *Agri. Gaz. N.-S. Wales*, 1898, 9, 980–1008; Thorpe, *Dict. Appl. Chem.*, 1898, i., 575.] **Trade.** Imports.

COCOS NUCIFERA, *Linn.*; *Fl. Br. Ind.*, vi., 482; Fryer, *New Acc. E. Ind. and Pers.*, 1672–81, 7 and pl.; Miquel, *Fl. Ned. Ind.*, 1855, iii., 63–72; Shortt, *Monog, The Cocoanut Palm*, 1888; Nicholls, *Textbook Trop. Agri.*, 1892, 165 *et seq.*; Semler, *Trop. Agrik.*, i., 616–58; Sadebeck, *Die Kulturgew. der Deut. Kolon.*, 1899, 25–33; Mukerji, *Handbook Ind. Agri.*, 1901, **D.E.P., ii., 415–59 Cocoanut.**

284–7 ; Cook, *Orig. and Dist. Cocoa Palm* (contrib. from *Nat. Herb. U.S.A.*), 1901, 257–93 ; Gamble, *Man. Ind. Timbs.*, 1902, 739 ; Safford, *Useful Pl. of Guam* (contrib. from U.S.A.), 1905, 233–43 ; Firminger, *Man. Gard. Ind.* (ed. Cameron), 1904, 198–200 ; PALMEAE. The Cocoanut (Coconut) Palm, Porcupine-wood, known in the chief Indian and Eastern vernaculars as *nárel, náriyal, nárikel, nárgil, maar, tenga, thenpinna, kobbari, nur, kalapa,* (Mal.), *pol* (Sinh.), *ong* (Burm.), *niu* (Poly.), etc., etc. This tall pinnate-leaved palm is indigenous to the islands of the Indian and Pacific Oceans, but now cultivated throughout the tropics in all warm moist situations, such as along the sea-coasts of India and Burma.

Habitat.

Habitat.—The cocoanut is essentially a tropical plant, and while it can grow up to the 25th degree N. or S. latitudes, it but rarely ripens fruit in the extreme limits of its region. From the Bay of Bengal it follows the Gangetic basin inland some 200 miles, but on the coast of India generally does not penetrate for more than half that distance. Buchanan-Hamilton (*Stat. Acc. Dinaj.*, 1833, 150) found that it ripened fruit with difficulty at Dinajpur, but I have seen it do so at Falakata, which is considerably farther to the north, and a writer (*Journ. Agri.-Hort. Soc. Ind.*, 1898) speaks of it fruiting freely at Dam Dim in Jalpaiguri, or 300 miles from the sea. It also fruits abundantly in South Sylhet. It would thus appear that the limit of fruit-production, viz. the 25th degree, is frequently exceeded in the immediate basins of large rivers. Hence it may even grow in Assam, though it will there ripen its fruits very indifferently. On the west and south coasts of India, on the other hand, its cultivated distribution is much more restricted. In Kolaba and elsewhere it may be found on the immediate shore and for 50 to 80 miles inland, ascending the hills to about 3,000 feet. Further to the South in Mysore, for example, it passes inland to nearly double that distance. It very possibly gave the name to the Cocos Islands and is plentiful on the Laccadive and Nicobar groups, but not in South Andaman. Gamble says " the cocoanut palm is not, like the palmyra, a forest tree, though it may be seen practically in forest, grown in gregarious plantations all round the Indian coasts and on some of the islands." The Indian region may thus be said to be the lower basins of the Ganges, Brahmaputra and Irrawaddy, also the Malabar and Coromandel Coasts and adjacent islands—Madras Presidency being the chief producing area.

Fruit Production.

Proximity to the Sea.

Indian Area.

History.

History.—On the assumption that it originated in the islands of the Indian and Pacific, there would be little to prevent its having been carried even by currents of the sea, or in some cases by primitive man, to the western shores of America and to the coasts of Southern China, Siam, Burma and India, in prehistoric times. This is so natural and obvious a supposition as to render most of the learned arguments indulged in by authors on this subject superfluous. The Spanish, Portuguese and Dutch travellers may have greatly aided in its distribution, more especially in conveying it to the east coast of America, to the West Indies and to Africa, but a wide natural distribution had doubtless taken place long anterior to the discovery of America. It is, therefore, hardly of serious consequence whether or not it may have been indigenous to tropical America as well as to certain of the islands of the Pacific. Its natural habitat is undoubtedly maritime. It is known by so many widely diversified names, in the regions of its present production, as to necessitate a vast antiquity. But as possibly indicative of a stronger claim for an Asiatic than an American origin, derivatives from its Sanskrit name *nári-kela* have accompanied the palm eastward very nearly to the shores of America and westward to Madagascar and Turkey, to a far greater extent than can be shown for any other classic or ancient name that it possesses. This does not of necessity involve its being accepted as indigenous to India, but simply that its extended cultivation accompanied Sanskrit influence.

Distribution.

Insular Habitat.

Classic Names.

De Candolle ultimately inclined to the idea of an origin in the Indian Archipelago. [*Cf. Orig. Cult. Plants*, 429–35.] Cook has taken great pains to refute De Candolle's arguments and thus to stoutly uphold an American origin. He maintains that it is no fault of the palm that the early inhabitants of America neglected to record its history, but similarly neither was that neglect India's "fault." We are justified in dealing with the records that exist. Wiesner (*Die Rohst. des Pflanzenr.*, 1903, ii., 419) advances no personal opinion but quotes authority for a dual nationality (American and Asiatic.) Jumelle (*Les Cult. Colon.*, 1901, 88–101) is opposed to the belief that the nuts were brought by currents from America to India and inclines rather to the view of an Indian origin. The plant was known to Cosmas in the 6th century A.D. (who calls it *argellion*, a name doubtless derived from the Sanskrit), and John of Monte Corvino, in the 13th century, speaks of it as the "Indian Nut" (as the Arabs do to this day). [*Cf.* Yule, *Cathay and The Way Thither* (ed. Hakl. Soc.), clxxvi., 213.] It was also seen and mentioned by Marco Polo in the 13th century, under the name "Indian Nut." [*Cf. Travels* (ed. Yule), i., 102; ii., 236, 248, etc.] In later times exhaustive and most picturesque accounts of the cocoanut in India were given by Varthéma (*Travels*, 1510 (ed. Hakl. Soc.), 163), by Linschoten (1598 (ed. Hakl. Soc.), ii., 43–51), by Baber (*Memoirs*, 1526, Leyden and Erskine, transl., 327), and by Abul Fazl (*Ain-i-Akbari*), etc., etc., to whose accounts the well-known description in *Household Words*, and later that of Tschirch (*Indische Heil-und Nutzpflanzen*, 1892, 144–56) appear to owe much. The question of the early European knowledge of the cocoanut is discussed by Rumphius (*Herb. Amb.*, 1750, i., 8), who quotes the passages of Theophrastus (*Hist. Pl.*, iv., 2 (ed. Scaliger), 1644, 286) and of Pliny (*Hist. Nat.*, xiii., ch. 9 (Holland, transl.), 1601, 390) which have been supposed to refer to ***Cocos nucifera***. The names given by these ancient authors are *Cuciofera* and *Cocos*, but *cocos* might be given to any nut. A much more likely derivation is that furnished by Barros (1553), Garcia de Orta and Linschoten, viz. from the Spanish *coco* (*macaco*, Portuguese) applied to a monkey's face, an admirable allusion to the three scars or markings on the base of the shell. *Coca* (a shell) might have been the primitive suggestion of that name. [*Cf.* Oviedo, *Hist. Gen. Nat. de las Ind.*, 1526 (ed. 1851), i., 335; Garcia de Orta, 1563, *Coll.*, xvi.; Acosta, *Tract. de las Drogas*, 1578, 107; Pyrard, *Voy. E. Ind.*, 1601 (ed. Hakl. Soc.), ii., 372–86, etc.); Clusius, *Arom. Hist.*, 1605, i., ch. xxvi.; Boym, *Fl. Sin.*, 1656, f–f2; Thevenot, *Travels in Levant, Indostan, etc.*, 1687, pt. iii., 17; Hamilton, *New Acc. E. Ind.*, 1727, i., 296, 306; Forster, *Pl. Esc.*, 1786, 48; Sprengel, *Hist. Rei Herb.*, 1808, 103, 269; Milburn, *Or. Comm.*, 1813, i., 277–8; *Paulus Ægineta* (Adams Comment.), 1847, iii., 438–9; *Hobson-Jobson* (ed. Crooke), 1903, 228–9, 233–4; Joret, *Les Pl. dans L'Antiq.*, 1904, ii., 299, 360.]

Actual Records.

Early European Knowledge.

Greek and Latin Knowledge.

CULTIVATION.—For seed purposes ripe nuts should be chosen from trees of mature growth but not too old. After being kept from four to six weeks, seed-nuts are planted just below the surface of the soil and about a foot apart. Ashes and salt are freely scattered in the trenches as manure and as a protection against insects. The seedlings thus obtained may be planted out from two to six or more months later, preferably at the beginning of the rains. Such is the usual method, which will be found described fully in the *Dictionary*. In some parts of India, however, the young plants are not removed from the seed-beds for one or even two years. In Java and the South Sea Islands the Natives hang the nuts for some months in the open air, under the eaves of their houses, until the shoots and roots appear. The seedlings are then put into the positions which they are to occupy permanently. This method has been freely adopted by European planters owing to its great saving of labour and the ready facility it affords for rejecting bad or weak plants. A further method is to leave the nuts to dry for four to six weeks and then to lay them close together in a damp shady place until the shoots that appear from them are about 10 to 12 inches long. They are then planted in their permanent positions, and should not stand nearer each other than from 25 to 30 feet apart each way. It should be remembered that for

Cultivation.

Germination.

Distance apart.

fructification the cocoanut requires absolutely open air and plenty of sunshine. The subsequent treatment consists in hoeing the ground around the stems and manuring them, especially with salt, at the beginning of the rains. They may be easily transplanted when only a few years old, and in many cases with advantage, but the new pits into which they are placed must be filled with good soil, manure, and a little salt. [*Cf. Produce World*, Jan. 17, 1896.]

Salt as a Manure.

Yield.

Yield.—Cocoanut palms will bear fruit, according to the locality and the care expended on them, in from five to ten years. They throw out a spathe and a leaf every month, and each flowering spike yields from ten to twenty-five nuts. The yield varies according to the soil, climate, care expended, and also variety grown. It has been placed by some authors as high as 200 to 300, by others as low as 30 nuts per tree per annum, but a safe average might be 80 to 100, or say 5,000 nuts per acre; and at 4 lb. to each fruit this would give a total crop weight of 6½ tons an acre. Lastly, the palm will continue to bear such crops for 70 to 80 years.

Nuts to Acre.

Forms.

Cultivated Forms.—Although the Natives recognise many varieties or races, these are doubtfully distinct botanically. Moreover, they are so numerous that it would be almost impossible to enumerate even the better known "sports" and cultivated conditions that are claimed to exist. There are, for example, 25 commonly counted in Java—Miquel especially describes and names 18 of these and calls them varieties; 40 in the Philippines; 5 recognised in Ceylon; 30 in Travancore alone according to Dr. Shortt; lastly, Jumelle (*l.c.* 92) and Firminger, both compiling from M. Le Goux de Flaise, say of India that it is customary to recognise 7 forms:—(1) *Coromandel* or *Brahmin* nut, a yellowish-red form; (2) the *Kanara*, a very woody ovoid nut; (3) the *Malabar*; (4) *Maldive*, small and spherical; (5) *Achem*, small and ovoid; (6) *Nicobar* or pointed nut, the biggest of all, and (7) the *Ceylon* nut. The Brahmin nut is esteemed for its milk but is inferior in *kopra* and coir. Of Ceylon it is said there are two special dwarf forms: (*a*) the King Cocoanut, which produces a golden-coloured fruit, but rarely attains a greater height than 20 feet. It is confined to the gardens of the better classes. (*b*) A still smaller plant much sought after.

Coromandel, Kanara, Malabar, Maldive, Achem, Nicobar, Ceylon.

Soil.

Soil and Climate.—All writers admit that the palm will grow effectively on sandy soil, but Semler and others point out quite clearly that it must not be dry sand. Many soils otherwise unsuitable can be adapted by adding the necessary manures; thus clay soils can be made porous by admixture of sand and fertilised by the addition of calcareous salts. Jumelle observes that the cocoanut requires heat, moisture, a porous soil, calcareous salts, alkaline salts, a certain quantity of sea-salt, and a fair amount of animal manure. It should be noted, however, that animal manure if too freely applied is apt to encourage a weevil pest (*vide infra*). The best manure (vegetable) appears to be cocoanut husks. [*Cf. Trop. Agri.*, 1893, xiii., 106-8.] Semler observes that the most desirable position is a porous soil sufficiently near the sea that at high tides the sea-water may permeate the trenches cut for that purpose. Cochran (*Trop. Agri.*, 1897, xvii., 173) and Jumelle (*l.c.* 94) give chemical analyses to show how very important salt is as a manure for this palm.

Manures.

Climate.

It is necessary that the temperature should be fairly even all the year round, 75° and 50° F. being the extremes. If the rainfall be evenly distributed throughout the year some 48 to 50 in. will suffice, but if less,

the planter must resort to artificial irrigation. [*Cf.* Baur, *Ind. Gard.*, Dec. 14, 1899; Cochran, *Trop. Agri.*, 1900, xix.]

ADDITIONAL PECULIARITIES OF INDIAN CULTIVATION.—Bombay.—The cocoanut is only common in the south of this Presidency, and its chief value lies in the rich supply of toddy it affords. In Kolaba district, however, the soil and climate are found so suitable that the toddy exceeds the demand. The average annual yield of nuts is said to be about 120 per tree, and each palm may be reckoned to have cost about Rs. 9 up to the point at which it begins to yield. In Thana district the annual yield is estimated at 75 nuts to each palm. The dry nuts are sometimes thrown into a well and left to sprout there, being subsequently put into a nursery: or they are allowed to fall from the tree and then buried. In the Káthiawár district they are planted and grown in pits 3½ by 3 feet in diameter, cut out of solid limestone and filled with mould. In Kanara, Káthiawár and Ratnagiri the cocoanut is abundant, and in the latter district the average annual profit from each tree is said to be about Rs. 1–3–0. During the "*Narral Purnima*" or Cocoanut Festival of the Hindus, which is supposed to mark the end of the monsoon in August, Bombay Natives throw nuts into the sea to propitiate the god of storms. [*Cf. Madras Mail*, Aug. 23, 1899.]

Bombay.

Thana.

Káthiawár.

Cocoanut Festival.

Madras.—This Presidency, especially the Malabar and Coromandel Coasts, is the chief seat of the Indian cocoanut industry. The Laccadive Islands also send their contingents to ports on the Malabar Coast, the produce of both being reckoned together. The Maldives are under a Sultan who is subordinate to the Governor of Ceylon; the coir produced is conveyed to India and lost sight of in the customary trade returns. The Godavari district has been called the "Paradise of the Cocoanut palm," the delta of the river showing an abundance of the trees. Mr. Lushington, District Forest Officer of Kistna, stated in the *Tropical Agriculturist* (Jan. 1, 1895, xiv., 457) that 200 nuts per annum was a very moderate estimate for good fruiting trees in the Godavari district, and indeed an even higher average (250 to 300 nuts per annum) has been quoted for Ceylon highly manured palms (*Trop. Agri.*, April 1, 1893, xii., 650). In Travancore 800,000 trees were counted during settlement operations in 1902, and it is estimated that 25 per cent. should be added for non-taxpaying areas. [*Cf. Capital*, Oct. 30, 1902.] In South Kanara, plantations extend along the whole coast-line, the average to the acre being about 120 trees each, yielding 40 to 50 nuts annually. The seed-nuts are usually not plucked but allowed to fall from the trees.

Madras.

Laccadive and Maldive Islands.

Godavari.

Travancore.

S. Kanara.

In ***Mysore*** there are said to be four varieties of the cocoanut—red, red and green, light green and dark green. Toddy is not made from the palm, as the fruit is more valued. Occasionally a few green nuts are cut for the juice and for their fibre. The Mysore cultivation is to some extent peculiar, and a full account of it will be found in the *Dictionary*.

Mysore.

On the ***Nicobar Islands*** the palm is very abundant, the annual yield being estimated at about 10,000,000 nuts. In the Andamans it is said to be a comparatively recent introducton. In 1901–2 there were estimated to be 42,997 cocoanut trees in bearing and 64,821 not, and in the same year 428,897 nuts were received into the oil-factory at Viper.

Nicobar.

In ***Burma*** success would appear to depend largely on the district. Mason (*Burma and Its People* (ed. Theobald), 1883, ii., 143) says that the palm will not thrive except near the sea, and in many parts the seedlings are believed to damp off. Some years ago it was reported there were 10,000 acres under cocoanuts in the Bassein district of Pegu alone.

Burma.

In ***Bengal*** the cocoanut is plentiful throughout the lower Gangetic basin, but as a rule only in garden cultivation, and the produce is not much in excess of local demand. ***Phœnix*** and not ***Cocos*** is the palm used in this province as the source of toddy and sugar. In the districts of Barrisal, Backergange and Noakhali it is extensively grown in plantations by itself or along with the Areca-nut palm. Throughout Bengal the opinion prevails that to fruit well the lower two or three leaves must be removed in September.

In Upper India and the Central Provinces the cocoanut is not cultivated.

Bengal.

Removal of Leaves.

ENEMIES TO THE COCOANUT.—The greatest danger to which this palm is subject arises from the attacks of various insects, mostly the grubs of beetles. Of these ***Batocera rubus***, a large insect with a reddish-brown head, appears to attack the root and subsequently to find its way into the stem; it is believed to be especially prevalent when the ground has been too richly manured. Jumelle (*l.c.* 100) says a similar insect lays its eggs in the stem and the larvæ bore

Enemies.

Grubs of Beetles.

their way to the terminal bud, which they devour. The danger of such pests is averted in the Straits Settlements by sprinkling the young palms with salt water. Another destructive beetle is ***Calandra palmarum***, a species of Elephant-beetle which destroys both the young leaves and the terminal bud, thus rapidly killing the palm. It is especially prevalent in the Malay States. On the Coromandel Coast boring grubs are extracted by means of a barbed steel probe.

Eaten as a Delicacy.

They are eaten as a delicacy by the Burmans, who are great adepts at extracting them. The Rhinoceros-beetle (***Oryctes rhinoceros***, *Linn.*), a large black or brown scarab, has been reported as especially destructive to palm trees in Madras and Singapore. It damages the trees by cutting holes through the young leaf-shoots.

Weevil.

The larvæ of a large weevil (***Rhynchophorus ferrugineus***, *Oliv.*) kill a great number of trees by tunnelling into the trunks. The only cure for this is extraction, though the use of salt and brine is often beneficial.

Scale Insects.

The leaves of the palm are also much injured by other insect pests and the life-sap sucked from the plant. Certain of the *Coccidæ*—the Scale Blights—such as ***Aspidiotus destructor***, *Signoret*, and ***Dactylopius cocotis***, *Maskell*, are especially destructive in the Laccadive Islands, and are the more dangerous because it is difficult to proceed against them by ordinary methods of spraying. [*Cf.* Maskell, in *Ind. Mus. Notes*, 1896, iii., 1, 66–7.] Semler says (*l.c.* 645) that a large wasp is in the habit of making its nest in the young fruit. The only remedy is the destruction of the nest.

Larger Enemies.

Larger and more easily checked enemies are rats, squirrels, flying-foxes, wild cats, tree-dogs (***Paradoxurus***), etc., which sometimes eat the young fruits and often destroy the terminal bud. As a remedy, Semler suggests that a preparation of cocoanut kernel with arsenic, pulverised glass and strychnine, or the like, should be put into cocoanut shells and hung in the trees. Against rats the mongoose is the best protection. Nicholls recommends covering the trunk of the palm with sheets of tin or galvanised iron for some twelve inches, the rats being unable to climb over these. The young plants must also be protected against the ravages of wild hogs, elephants, cows and porcupines. When a palm has actually been killed by beetles or other pests, care should be taken to destroy the whole stem by fire, as a single palm left lying or utilised for posts, rails, handrails to foot-bridges, etc., may contain and send out enough of the pests to destroy an entire plantation. It has accordingly been suggested that

Infected Timber.

the preservation by planters of infected timber as well as the non-destruction of infected cocoanut-refuse should be made a statutory offence, since such nearly always constitutes a public nuisance and too often involves a public disaster. [*Cf.* Ridley, *Rept. on Destruction of Cocoanuts by Beetles, Singapore*, 1889; Tennet, *Ceylon*, ii., 529; *Ind. Mus. Notes*, 1891, ii., 8–9; 1893, 175; 1903, v., 127; Watt, *Plague in Betel-nuts, Agri. Ledg.*, 1901, No. 8, 140; *Trop. Agri.*, 1904, xxiii., 636; Butler, *Diseases of Cocoanut*, in *Board Rev. Madras*, 1908, No. 786.]

Various Fibres.

FIBRE.—This useful plant yields various fibres or fibrous materials. A delicate tomentum or cotton, found at the base of the leaf, is employed as a styptic. The leaves may be used like those of other palms for many of the purposes of paper. The leaflets of two or more leaves are braided into mats that are used in house-construction. They are also often stripped off and made into brooms, or their midribs separated and so used. Again, the leaves are frequently employed as thatch, and dried they may be utilised as crude torches. The half-fruit (nut with adhering pericarp) is largely used as a scrubber.

Coir.

History.—The important fibre, however, is of course the Coir which is obtained from the thick outer wall of the fruit (or husk). This seems to have been known to the early Arab writers as *kanbár*, being so called, for example, by Albirúní (*cf. Journ. As.*, ser. iv., tom. viii., 266) in the 11th and by Ibn Batuta (*Voyages, etc., Soc. Asiatique*, 1858, iv., 121) in the 14th centuries. Correa (*Lendas da India*, ii., 129–30) tells us that the Governor (Alboquerque) of Cananor devoted much care (1510 A.D.) to the preparation of cables and rigging of coir (*cairo*), of which there was great abundance. Pyrard (*Voy. E. Ind.* (ed. Hakl. Soc.), 1887, i., 250) speaks of the revenue having been paid (in 1610 A.D.) of *cairo* by the Mal-

dives. The word coir did not come into the English language until the eighteenth century. It is doubtless an Anglicised version through Portuguese *cairo* of the Malayal verb *káyáru* = to be twisted (*káyar*, Mal. and *káyiru*, Tam.). Both the fibre and the rope made from it appear to have been exported to Europe in the middle of the 16th century under the name *kánbar*, a misrendering, very possibly, of *káiyar*. But it was actually not until the Great Exhibition of 1851 that coir rope and matting attained commercial importance in England. Thus Milburn, writing as late as 1813, observes that cocoanuts are an article of considerable trade in all parts of India, and that coir ropes are much esteemed there. He says nothing at all of any exports to Europe. It deserves notice, too, that the collections of early letters of the East India Co.'s servants, published by Mr. W. Foster, contain no reference to the cocoanut fibre.

First Exported to England.

Production.—Taking India as a whole, coir is only obtained as a by-product. As will be seen under the notes on trade, the present-day Indian exports are almost entirely made from Bombay and Madras, and it may be said that Madras, Cochin, the Laccadives and Malabar are the only parts of India that produce coir on a commercial scale. According to the *Manual of S. Kanara* (1895, ii., 147–8) about 5,000 persons depend for their living on the manufacture and sale of coir in that district. It is further said that 3,000 cocoanuts produce 1 candy of coir. The cost of raw material and manufacture is about Rs. 15 and the selling price about Rs. 20 per candy. Elsewhere in India the fibre is dark and coarse, and not comparable to the fine qualities of the above-named districts or to that of Ceylon or Singapore. There are many reasons for this. Situation is one; the fibre would seem to become coarser at a distance from the coast; but variety, age at which the nut is gathered, care and skill in steeping, beating, and cleaning the fibre, etc., etc., are all factors of no small importance. If the palm be cultivated for the supply of juice or to afford ripe fruit, the fibre usually proves in the one case imperfectly formed and in the other overripe. Such, at least, is the common opinion, although according to Wiesner (*l.c.* ii., 420) only three varieties of *C. nucifera* are really suitable for the production of coir, viz. *rutila*, *cupuliformis*, and *stupposa*, and the first named gives the finest and most elastic fibre. These are three out of the eighteen forms given by Miquel. Wiesner, however, would appear to have adopted for general application a criticism which Miquel (*l.c.* 65) originally intended exclusively for the Dutch East Indies. In many countries such as Guam a specially long fruit is grown for the express purpose of affording the long straight-bristle fibre. Of Indian coir it has been commonly affirmed that the best comes from Cochin, and that as a result attempts have been made to imitate the light colour of the Cochin fibre by bleaching. But the chemicals used in this process destroy the elasticity of the fibre and render good qualities bad and inferior qualities worthless. Neither does it seem quite clear whether by Cochin coir is meant commercially the produce of the Native State or that of the whole coast of Malabar, or indeed all high qualities from whatever country obtained. It is said that for fibre the nuts should be cut in the tenth month; it would appear, however that a large quantity of ripe nuts are exported to Europe in husk and the coir separated on arrival.

Coir a By-product.

Kanara.

Cost.

Coarse Fibre.

Specific Variation.

Specially Long Fibre.

Cochin.

Bleaching.

Manipulation.—Concise accounts of the various local methods of removing the fibre from the shell and of separating and cleaning the coir have been given in the *Dictionary* (*l.c.* 428–30), to which the reader is referred.

Preparation of Fibre.

Shelling.

Husk. Briefly it may be said that for the first process an iron spike is fixed in the ground with point upwards, and that the nut is so struck on this that the point penetrates between the nut and the husk, and causes them to separate. A Native can treat in this way about 1,000 nuts daily. Although many machines have been tried for this purpose, hitherto none have been found

Retting. which can compete with hand-labour. The husks after being retted in brackish or sweet water for 7 to 18 months are crushed either by hand or by machinery, and the fibre extracted. Fresh water is said to injure the fibre. The retting process is sometimes dispensed with, the husk being steamed till the fibre separates. After being dried the fibre is

Cleaned. " willowed " or cleaned of dust and refuse, and it is finally separated into

Mat Quality. various grades or qualities such as " mat " or long fibres (used for spinning

Broom. purposes) ; " brush and broom ' bristle ' "—the shorter and stiffer fibres ; upholstery, the tow or curled fibre ; and the dust or refuse employed as a manure and for other purposes. The best bristle fibre done up in small bundles, and with the fibre stretched straight and clean, may fetch

Prices. £30 a ton. The mat fibre is worth £20 per ton and the waste £10 a ton.

Lining of Warships. Under a high pressure a cocoanut dust was found to make a rather brittle cardboard which on being touched by water would instantly swell up and close any hole made in it. This was looked upon, some ten years ago, as a valuable discovery for rendering warships practically unsinkable by gun-fire. The ordinary uses of coir, coir-yarn, etc., are so well known in most households, that it seems superfluous to attempt an enumeration.

Rope and String. Coir-matting, coir-ropes, cocoanut brooms and besoms, hassocks, hammocks, " bass " for nursery men, bags for seed-crushers, oil-presses, etc., are amongst the many forms of manufactured coir. Coir rope is especially serviceable in India because it does not suffer from the damp climate, and sails are accordingly sometimes made of coarse coir-cloth. In the Laccadive Islands mats made of cocoanut leaves are used as sails. In Ceylon and India the fronds are split and woven into neat baskets. [*Cf.* Dodge, *Useful Fibre Plants of the World*, 120–3.]

Yield. ***Yield.***—As regards yield of fibre per nut and price, it has been said that 10,000 husks treated in England yield about 50 cwt. of spinning fibre and 10 cwt. of brush fibre. In Ceylon 40 nuts are reported to give 6 lb. of coir (or say 13¼ cwt. to 10,000) ; in Madras 18 large nuts and in the Laccadives 60 small nuts give a similar amount ; but whereas a pound of Laccadive coir spins to 35 fathoms (210 feet), a pound of the coir from large Madras nuts will only measure 22 fathoms (132 feet).

London Market. ***Prices.***—The quotations for Coir on the London market, as published by Messrs. Ide & Christie, October 15, 1907, may be here given. The spot values were as follows :—

	£	s.	d.		£	s.	d.
COIR YARN—							
Common to good Cochin Roping Dholls ..	11	0	0	to	14	0	0
,, ,, ,, ,, ,, Bales ..	12	0	0	,,	15	10	0
,, ,, fair Cochin Weaving ,, ..	14	0	0	,,	19	0	0
Fair to good ,, ,, ,, ..	20	0	0	,,	25	0	0
Good to extra ,, ,, ,, ..	25	0	0	,,	29	0	0
Common to fair Ceylon Dholls and Ballots ..	14	0	0	,,	18	0	0
Fair to good Ceylon Ballots and Bales	20	0	0	,,	22	0	0
Good to extra Ceylon Ballots	23	0	0	,,	28	0	0
COIR FIBRE—COCHIN, common	8	0	0	,,	15	0	0
fair	17	0	0	,,	19	0	0
good	20	0	0	,,	23	0	0
CEYLON, short to fair	6	15	0	,,	8	0	0
clean long	9	0	0	,,	11	0	0

	£	s.	d.	£	s.	d.
Coir Rope—4½ to 6 inch	15	0	0 to	21	0	0
2½ „ 3½ „	15	0	0 „	21	0	0
1½ „ „	15	0	0 „	21	0	0

For the Month of September.

	Landed 1907.	Delivered 1907.
Yarn	190 tons.	485 tons.
Fibre ..	90 „	106 „
Rope	— „	13 „

Stock Oct. 2.

1907.	1906.	1905.
1,600 tons.	2,925 tons.	1,936 tons.
234 „	521 „	794 „
164 „	216 „	88 „

Landed from Jan. 1 to Oct. 2.

	1907.	1906.
Yarn	3,791 tons.	4,861 tons.
Fibre ..	786 „	1,144 „
Rope	112 „	263 „

Delivered from Jan. 1 to Oct. 2.

1907.	1906.
4,723 tons.	5,012 tons.
629 „	1,423 „
143 „	156 „

[*Cf. Text. Journ.*, Sept. 1892; Morris, *Cant. Lect.* in *Journ. Soc. Arts*, 1895, 932–3; Dodge, *Useful Fibre Plants of the World*, 1897, 120–3; *Kew Bull.*, 1898, (add. ser., ii.), 245–8; Hannan, *Text. Fibres of Comm.*, 1902, 151–4; Dunstan *Imp. Inst. Tech. Repts.*, 1903, i., 79.] [For Trade, see Collective Statement in Cocoanut Products, pp. 362–3.]

Copra.

COPRA (KOPRA) AND OIL.—The kernel of the cocoanut sliced and dried either in the sun or artificially is called *Copra* (*Kopra*). It contains from 30 to 50, some say even up to 70 per cent. of fixed oil. The fully ripe cocoanuts only are used in making *copra*, but though the quantity is less the quality is said to be higher in three-quarters ripe than in fully ripe fruits. But the oil may be expressed either from the fresh kernel or from the dried kernel, and by a hot wet or dry cold process. Artificially dried *copra* is often smoked, and as this colours the oil its value is thereby lowered.

Methods of Preparation.

Mr. Cochran (*Man. Chem. Anal.*; also *Trop. Agri.*, May 1, 1893, xii., 665; July 1, 1899, xix., 44) gives the composition of *copra* thus:—moisture 6 per cent.; oil 67 per cent.; albuminoids 6·69 per cent.; carbohydrates 15·21 per cent.; woody fibre 2·11 per cent.; and ash 2·99 per cent. Semler (*l.c.* 653) observes that sun-dried *copra* contains about 50 per cent. of oil, artificially dried 60 per cent., and if dried at the boiling point of water it may contain 66 per cent.

Composition.

Chemical Property.

Oil.—Dunstan (*Edible Oils*, *l.c.* 129) gives his examination of Malabar, Bengal and Bombay samples. The Malabar had an acid value as Koh of 35·21 as compared with Bengal 11·84, and Bombay 9·95; the saponification value of Malabar was 258·2, Bengal being 255·6, and Bombay 255·5; the iodine value of Malabar was 8·54, of Bengal 8·41, and of Bombay 8·25; the Reichert-meissel value of all three was found to be higher than the ordinary standard, viz. Malabar 6·71, Bengal 6·79, and Bombay 6·65; lastly the melting-points were Malabar 23·5° C., Bengal 24·5° C., and Bombay 25·0° C. Blount and Bloxam (*Chem. for Engin. and Manuf.*, 1900, 236) give the saponification of this oil as 209 to 228 and iodine absorption as 7 to 9. [*Cf.* Greshoff, *Rept. Kolon. Mus. Haarlem*, 1903; Bachofen, *Complete Anal. of Cocoanut, showing its demands on the Soil*, in *Times of Ceylon*, Nov. 1899.]

Oil.

Trade Qualities

Extraction.—Various methods of obtaining the oil are resorted to: for example, when pure colourless oil is required the *copra* is boiled with water, grated and squeezed, the resulting emulsion being again boiled till the oil rises to the surface. This is thus a hot wet process. If fresh kernels are used this is called *ável* oil, and if from *copra* it is *muthel*. Moreover there are several special modifications chiefly intended to produce the very

Extraction.

Boiling.

Crushing.

pure white oil which has the highest commercial value. Crude or ordinary cocoanut oil is, on the other hand, produced by crushing the *copra* in a native oil-mill worked by oxen. This is a cold dry process, but some of the most highly prized grades have been cold drawn. The mill is really little more than an enlargement of the druggist's pestle and mortar, but it is so efficacious that the extra amount of oil obtained by employing European machinery does not counterbalance the expenditure involved.

Poonac.

Moreover, the residue of the *copra* is sold as cocoanut oilcake (*poonac*), and the drier the cake the lower its value; the *poonac* is normally worth 25 per cent. of the *copra*.

Cochin Oil.

The best East Indian cocoanut oil is known as "Cochin." This is remarkable, since it is generally thought that ripe cocoanuts are necessary for the oil, whilst green nuts are best for the fibre. Yet "Cochin fibre" and "Cochin oil" both rank highest and possibly from the same reason, viz. that the name Cochin is given to all high grades. However, it is possible, as mentioned above, that what is called "Cochin coir" comes in reality very largely from the Laccadives and the Cochin oil may come from Cochin. In 1897–8 the *Tropical Agriculturist* opened its columns to a discussion as to the reason for the higher price obtained by Cochin compared with Ceylon cocoanut oil. The difference was then said to be about 36 per cent. But in January 1904 there was apparently little difference, and in May 1905 Cochin oil was selling at only 16 per cent. better than Ceylon; hence it may be assumed Ceylon had improved materially.

Improvement of Ceylon.

During the discussion indicated an "Old Cocoanut Planter" observed that perfectly clean and dry *copra* yields an oil which if put in a tumbler is indistinguishable to the eye from a similar glass of water. The inquiry, it may be said in conclusion, resulted in a general agreement on several points, such as that the purity of colour and therefore higher price of Cochin oil were due to the greater care taken in the selection of nuts for crushing and

Smoke-dried.

in the preparation of the *copra*. It was acknowledged that smoke-dried *copra* usually resulted in a tainted oil; that none but quite ripe and quite sound nuts should be used (it was said, for example, that on the Cochin coast the nuts are allowed to drop off the trees); that great care should be taken to keep the split nuts free from dust and dirt whilst drying; and finally, that the excess of stearine in Cochin oil, which makes it prefer-

Superior Quality of Nut.

able for candle-making, is due rather to the superior quality of the nut and more careful cultivation than to any natural superiority of the soil. Almost all Ceylon (European) growers, it may be observed, are agreed that one of the principal advantages of the Cochin climate lies in the fact that the *copra* can be dried in the sun. In the controversy above indicated it was stated, however, that if the *copra* were dried at an even temperature, where smoke could not reach it, the result would be equally good with the sun-

Cold Dry and Hot Wet.

dried nut. But it may be added the difference between cold dry and hot wet expressed oil may be a far more important factor than hitherto recognised in determining the value of cocoanut oil. All the cocoanut

Price.

products seem subject to extreme fluctuations in price. It is generally accepted that the safest standard to purchase *copra* or cocoanuts is the price ruling for the oil.

Uses of the Oil.

The Oil is largely used in India both in cooking and for toilet purposes. Its employment as an illuminant was at one time important but has considerably diminished owing to the introduction of cheap American kerosene, the best qualities of which are cheaper than ordinary

cocoanut oil. It is still, however, occasionally found in some Roman Catholic churches, and in England and elsewhere it is made into candles, especially nightlights. The latter use was a discovery made by Messrs. Price & Co., who introduced candles made with cocoanut oil for public illumination at the time of Queen Victoria's wedding; but in ordinary candle-manufacture the oil has been somewhat displaced of late by palm-oil. [*Cf. Board of Trade Journ.*, Feb. 1898.] In Europe it is extensively employed, particularly in France, where pomades and other fancy toilet articles are produced in great quantity and variety. It is also utilised in the manufacture of salves and lotions of various kinds and to adulterate cod-liver oil. It is considered an effective hair-restorer and is universally so used all over India. The long, black, lustrous tresses of the Filipino women have been attributed to the use of this oil. [*Cf. Hides and Leather*, June 25, 1904.]

Candles.

Pomade.

Hair-oil.

As regards the soap industry, cocoanut oil makes a white, hard soap, which is more readily soluble than almost any other in hard or even salt-water. The form known as "Marine Soap" may be used medicinally in plaster-making and in the preparation of soap liniment, but it has the disadvantage of imparting an unpleasant odour to garments or to the human skin. The Messrs. Lever's Sunlight Soap factories use a large amount of cocoanut oil. A fair proportion of the Native-made soap of India is also prepared by boiling this oil with dhobie's earth, salt, saltpetre, quicklime and water.

Soap.

"Marine Soap."

Vegetable Butter.—The various methods and contrivances for producing vegetable butter—cocoanut butter more especially—may be said to have originated one of the many new aspects of value in this palm. Pure cocoanut oil has for some time been used in part manufacture of margarine, and with advantage, since it supplies a certain amount of glyceryl salts, of fairly low fatty acids, whose absence from ordinary margarine constitute chemically the principal difference between that product and butter. For this purpose the characteristic odour of the oil is removed by treatment with alcohol and animal charcoal. [*Cf.* Blount and Bloxam, *l.c.* 238.] But a far more important industry than the adulteration or fabrication of margarine is the production of cocoanut butter (see **Cacao Butter**, p. 1076). The process of producing cocoanut butter or, as it was subsequently termed, "*palmin*," is said to have been discovered by a German professor, Dr. Schlinck, and developed by him at Ludwigshafen. He produced a pure vegetable fat which for culinary and edible purposes was claimed to be much superior to butter, lard or tallow, all of which contain acids that through heat form undesirable products. [*Cf. Ind. Agri.*, Sept. 17, 1887; *Kew Bull.*, 1890, 230–8; Basu, in *Journ. Agri.-Hort. Soc. Ind.* (*Proc.*), 1890, ix., 62–3.] Dr. Therner, Second Physician of the Imperial Hospital, Vienna, pointed out (*Centralblatt für die gesammte Terapie*, Oct. 1889) that a firm at Mannheim had also produced a cocoanut butter free of fatty acids, such as was suited for persons of impaired digestion. [*Cf. Journ. Board Trade*, June 1901.] The manufacture of these and such like butters was naturally very quickly extended, and indeed Messrs. Loder & Nucoline, Ltd., of Silvertown, London, claim to have preceded even the German firms in producing cocoanut butter and cocoanut suet, which they called "Nucoline" and "Vejsu." Their sales are now on a very large scale, so that their goods are coming daily into extended demand. "Vegetaline" is the name of the product as now manufactured in Marseilles. More recently Messrs. Gaudart

Butter.

Margarine.

Cocoanut Butter: "Palmin."

Free from Fatty Acids.

"Nucoline."

"Vegetaline."

"Cocotine."

& Co. have commenced making what they call "Cocotine" at Pondicherry. Similar factories have also been established in America and elsewhere. [*Cf. Madras Mail*, Jan. 23, 1902; *Ind. Agri.*, Nov. 1902, xxvii., 348; etc., etc.]

Future Prospects.

There is thus an opening for Indian industries in this product which that country will be ill advised to neglect. The importance to Europe of the discoveries briefly indicated lies in the fact that cocoanut butter provides bakers and biscuit manufacturers with a substitute for butter which

Superiority for Baking.

is not only pure and cheap but even better suited for baking purposes than butter proper. One of its chief advantages is that it does not readily become rancid, and recently the use of this butter has been authorised for culinary purposes in the French army, a fact significant of the future demands of the world. The consumption of this product must in fact

"

yearly expand and the traffic become of infinite value. Confectioners are said to find cocoanut butter an entirely satisfactory substitute for the more expensive cacao butter (see p. 1076), the imports of which into England

Independent Position.

have in consequence for some years past materially declined. Cocoanut butter is not, however, strictly speaking, a substitute or even an adulterant of dairy butter, but a substance that commands independent recognition. [*Cf.* White and Humphrey, *Pharmacop.*, 1901, 331; *Revue des Cult. Colon.*, June 1903, No. 126, 324.]

Adulteration of Volatile Oils.

Adulteration.—It should be added that cocoanut oil is sometimes used as an adulterant of volatile oils. It may be detected by the fact that oils so adulterated will solidify wholly or in part in a freezing mixture. Cocoanut oil has thus been found in *cananga*, citronella and palmarosa oils. [*Cf.* Gildemeister and Hoffmann, *Volatile Oils*, 1900, 201.] Cocoanut oil melts at 68° to 82° F.; its sp. gr. at 212° F. is 0·868 to 0·874 and its saponification from 209 to 228.

Poonac.

Cocoanut Oilcake or Poonac.—As observed above, this is the by-product of *copra*, after the expression of the oil. Voelcker (*Essay on the Influence of Chem. Disc. on Agri. reviewed in Trop. Agrist.*, 1896, xv., 800) is

Aattening Property.

said to have observed that the cocoanut cake is better adapted for fattening stock than for young growing animals or store-stock. Its analysis is as follows:—water 9·50; oil 8·43; albuminous bodies 30·40 (containing nitrogen 4·50); mucilage, sugar, fibre, etc., 40·95; mineral matter (ash) 10·72. It was very largely taken up in Australia, after the establishment of Messrs. Lever Brothers' Sydney Oilmills. In the *Tropical Agriculturist* (1898, xviii., 223) it is stated that cocoanut oilcake is not generally used for milch-cows or other milking stock, or in Ceylon for horses; but it is the common food of working bulls, and is considered an excellent fattener for pigs.

Price.

Official statistics of the Indian trade in cocoanut cake are not available, but according to a reply to a correspondent in *Capital*, Feb. 11, 1904, the price in Ceylon was from Rs. 67½ to Rs. 70 per ton, and from 12,000 to 15,000 tons were then shipped annually from Colombo, mostly to

Total Traffic.

Germany and Belgium. The writer apparently did not consider it necessary to take India into consideration. In fact he says Indian *poonac* consists of rape-seed, castor-seed and gingelly (sesamum). Hanausek (*Micro. Tech. Prod.* (Winton and Barber, transl.), 1907, 403–6) gives the appearance of the cake under the microscope. The total exports of Indian oilcake, it may be observed, amounted in 1903–4 to about 60,000

Madras.

tons, of which Madras contributed 47,500 tons. The exports of oilcake appear, however, under two headings (*a*) Cattle Food and (*b*) Manure.

The total for 1906–7 came to 105,379 tons, valued at Rs. 75,99,121. Cocoanut oilcake is chiefly exported from Madras, and consequently constitutes an important item in these transactions. The value of the total traffic and its present prosperity may be inferred from the fact that from all India the exports in 1886–7 stood at only Rs. 1,71,107. This is, however, but indirect evidence of the extent of the Indian exports in cocoanut cake. [*Cf. Kew Bull.*, 1897, 416 ; Leather, *Agri. Ledg.*, 1897, No. 8, 159–60.]

Medicine.

Medicine.—Very full accounts of the medicinal properties of the cocoanut are given in the *Dictionary* and in the *Pharmacographia Indica* (iii., 511–9). Briefly it may be said that, for European medicine, the most important advantages of ***C. nucifera*** are the anthelmintic action of the fresh fruit (especially of the volatile oil of the shell) ; the properties of the milk ; as also the possibility of substituting the oil for cod-liver oil, in cases where the latter cannot be taken. For medicinal purposes the olein is separated from the solid fats, as in the preparation of what the Natives call *ável*. (According to some writers this is named *muthel*, the meanings of *ável* and *muthel* being perhaps reversed.) In making that substance the kernel of the fresh nut is pulped and strained and the oil separated from the milky fluid by heating. A preparation of the same kind is now known in Europe as "coco-olein." Both by Native and European physicians in India the " milk " from the unripe fruit is recommended as a useful refrigerant in fever and urinary disorders, but in Bengal it is commonly believed that the consumption of too much cocoanut milk tends to cause hydrocele. In dyspepsia and consumption Native practitioners prescribe the pulp of the ripe fruit made up with *ghi*, coriander, cumin, cardamoms, etc. This mixture is called *nárikela-khanda*. The flowers and fresh toddy are astringent. The soft, brown tomentum or cotton found outside the base of the leaf-sheath is an excellent styptic, like the corresponding products of ***Borassus*** and ***Caryota***. For an abstract of the somewhat diverse and conflicting opinions of the Arab physicians—Rhases, Avicenna, Serapion, etc.—the reader should consult Adams (Comment. in *Paulus Ægineta*, 1847, iii., 438).

Avel and *Muthel*.

The Milk.

Toddy.

Edible Products.

Food Products.—With a large section of the Indian population the cocoanut is almost a staple article of diet, and a very wholesome one. Natives of all classes consume the soft creamy pulp and cool refreshing water (milk) of the young nut (*dáb*), and also use the same in cooking curry. The terminal bud or " cabbage," though esteemed a delicacy, is not often eaten, because its removal kills the palm. The harder pulp of the matured nut is dried either naturally or artificially and the *copra* thus formed is parched with rice, rasped, and put into curries or made into sweetmeats. The fresh or fermented juice of the stem is consumed as a beverage—toddy (*tari*); by evaporation it is made into *jaggery* (coarse sugar), and by subsequent treatment even refined sugar. Rheede (*Hort. Mal.*, 1686, i., 6) states that in his day a coarse reddish sugar was obtained by boiling the juice mixed with lime. When distilled, *tari* becomes spirit or *arak* and finally vinegar (see p. 1111). The methods of collecting the juice and the manufacture of its products differ very little, however, from those employed with other palms. (See **Borassus flabellifer**, pp. 170–1 ; Cleghorn, in *Edinb. New Phil. Journ.*, n.s.,1861, xiv.) Incidentally it should be observed that in Bengal the cocoanut-palm is not tapped for toddy but in Bombay this is an important industry, although very little sugar is made from it. It may be noted that *jaggery* is not infrequently mixed with lime to make a strong cement which

Copra.

Juice.

Sugar.

Spirits.

Bombay Industry.

Cement.

takes a fine polish. This is especially noticeable in Madras. [See **Cements**, pp. 293, 929.] The word *jaggery* is the trade name in India for all crude unrefined sugar, though mostly palm sugar. It comes from the Sanskrit *sarkará* (sugar) through the Konkani *sakkara*, the Malayal *chakkara* and the Portuguese *jagara* or *xagara*. [For *Indian Palm Sugar*, see **Phœnix**, pp. 886, 929.]

Jaggery.

Desiccated Cocoanut.

The uses of desiccated and shredded cocoanut in European cookery and confectionery, etc., are well known, and need not be particularised. This trade is comparatively a modern one, and might be almost characterised as the chief aspect of European interest in the edible products of the palm. Many patent machines and processes have been brought out, and large factories organised in Europe and America (none in India) for the production and sale of desiccated cocoanut and the manufactures therefrom. It would appear that the growth of this special trade is so important that it is curtailing the export of cocoanuts (entire fruits) from America.

Porcupine-wood.

Timber.—The wood is commercially known as "Porcupine-wood," and is used for rafters and for other building purposes. It makes very pretty and durable furniture, and is also converted into spear-handles, walking-sticks and other fancy articles. [*Cf.* Gamble, *Man. Ind. Timbs.*, 1902, 739.]

Húkah-bowls.

Carved Vases.

Domestic and Sacred Uses.—By Hindus the dried shell is almost universally used as the water-bowl of their smoking-pipe or *húkah* (hence the name *narghili*); less frequently it is the sounding-drum of crude violins. In Madras the shells are made into elegantly carved ornamental vases, lamps, spoons, sugar-pots, teapots, and small unripe ones into snuff-boxes, scent-bottles and the like. Entire shells are obtained by filling them with salt water and burying them in sand. By this process the kernel is destroyed and may be washed out, but the shell will rot quickly unless the nut so treated be fully ripe. [*Cf. Ind. Art at Delhi*, 1903, 133, 169, 196, etc.; Hoey, *Monog. Trade and Manuf. N. Ind.*, 1880, 116.] According to the Emperor Baber (*Memoirs* (Leyden and Erskine, transl.), 327) and the Emperor Akbar (*Ain-i-Akbari*, 1590 (Blochmann, transl.), i., 71) the shell of the cocoanut was even then used to make a kind of violin or mandoline called *ghichak*. Within the nut there is occasionally found a small stone of a bluish-white colour called in India *calappa* and regarded by the Chinese as a valuable amulet. These "cocoanut pearls" are very carefully described by Rumphius. They appear to be composed almost entirely of calcium carbonate and have a very small proportion of organic matter. The leaves of the palm are serviceable for thatch, screens, baskets, matwork, etc.

Violin.

Cocoanut Pearls.

Matting.

Trade.

TRADE IN COCOANUT PRODUCTS.—No sort of estimate can be furnished of the area under this palm or of the total production. The trade returns are moreover scattered under several separate headings, so that a fairly complete statement of even the exports cannot be framed. It will be convenient, therefore, to take up the more important products of the palm separately:—

Fibre.

Coir.—Fibre, Rope and Manufactures therefrom. In trade statistics the exports are shown under the headings "unmanufactured coir," "manufactured coir" (exclusive of rope), and "cordage and rope" (including hemp and coir but excluding jute). The *EXPORTS OF RAW COIR* to foreign countries manifested a steady increase from 1894 to 1900. In the latter year they stood at 70,016 cwt., valued at Rs. 5,65,625. But since 1900 they have greatly fallen off, having been only 25,500 cwt., valued at Rs. 2,26,626, in 1903–4, and 11,317 cwt., valued at Rs. 1,06,634, in 1906–7. This circumstance may be due to increased traffic in manufactured coir (rope matting, etc.), to increased exports in made-up mats or rugs (not returned as coir at all), or to certain rearrangements in official statistics.

Exports, Raw Coir.

Manufactured Coir.

Of the *MANUFACTURED COIR* (excluding cordage and rope) the exports manifest a satisfactory improvement, the traffic for 1903–4 having been returned at 483,355 cwt., valued at Rs. 47,90,110, and for 1906–7 at 559,329

cwt., valued at Rs. 56,00,268. Almost the whole trade is in the hands of the merchants of the Madras ports, the receiving countries being the United Kingdom and Germany. Madras Presidency also supplies the other provinces of India with coir and coir manufactures. These internal transactions were in 1905–6 valued at 15 lakhs of rupees. As already indicated, coir cordage and rope cannot be ascertained separately from hemp, but the total transactions for all India in 1905–6 were 139,870 cwt., valued at Rs. 15,21,131; almost three-fourths went from Madras ports, and hence were in consequence chiefly coir (see **Ropes and Cordage**, p. 924). The imports of coir are unimportant, and come mainly from Ceylon and are consigned to Bengal.

Madras.

Copra and Oil.—The exports of *copra* to foreign countries in the five years 1899–1900 to 1903–4 show a remarkable increase. They stood at 97,029 cwt., valued at Rs. 9,89,377, in 1899–1900; and reached 353,724 cwt., valued at Rs. 42,24,614, in 1903–4; but fell to 126,454 cwt., valued at Rs. 18,95,341, in 1906–7. Of this last amount 125,129 cwt., valued at Rs. 18,76,172, went from Madras ports. The chief recipients were France and Germany. The coastwise traffic in *copra* in 1905–6 amounted in all to 184,066 cwt., valued at Rs. 24,37,736. Bombay sent 47,218 cwt. chiefly to Sind, and Madras 134,546 cwt. chiefly to Bombay. The imports of *copra* from foreign countries have been steadily diminishing and are now unimportant. Statistics of the trade in Indian cocoanut cake are not obtainable separately from those of other kinds of oilcake. The traffic in cocoanut oil to foreign countries in the five years 1899–1900 to 1903–4 increased from 2,245,502 gals., valued at Rs. 27,79,669, in 1899–1900 to 3,379,631 gals., valued at Rs. 48,81,588, in 1903–4; but the trade is subject to extreme fluctuations, and fell in 1906–7 to 959,772 cwt., valued at Rs. 14,17,794. The United Kingdom and United States are the best customers, and the trade is almost entirely in the hands of Madras merchants. The imports, chiefly from Ceylon and Mauritius, amounted to one million gals. in 1899–1900, but were only 999,556 gals. in 1906–7 and very largely from Ceylon. In the last-mentioned year Bengal received 731,281 gals. and Madras 171,215 gals.

Copra and Oil.

Exports.

Imports.

Madras.

Nuts.—The exports of whole cocoanuts to foreign countries, though still small, show a tendency to increase. In 1899–1900 the total stood at 175,250 nuts, valued at Rs. 5,439; in 1902–3 it was 705,535 nuts, valued at Rs. 24,789; and in 1906–7, 365,890 nuts, valued at Rs. 13,853. Natal and Turkey-in-Asia are the chief receiving countries. The coastwise traffic in nuts is very considerable. In 1905–6 the total for all provinces was 81,920,724 nuts, valued at Rs. 25,50,384. Madras is of course chiefly responsible, having exported to Bombay 61,862,664 nuts, valued at Rs. 18,95,327. The imports of nuts from foreign countries amounted in 1906–7 to 10,975,127 nuts, valued at Rs. 4,98,090, and these came chiefly from the Straits Settlements, the Maldives and Ceylon. Bengal took 4,656,504 nuts, valued at Rs. 1,25,325, whilst Burma received 6,090,728 nuts, valued at Rs. 3,64,546.

Nuts.

Madras.

India has not as yet figured in the returns of the world's traffic in either desiccated cocoanut or in cocoanut butter.

Desiccated Cocoanut.

COFFEA ARABICA, *Linn.*; De la Roque, *Voy. Arab.*, 1708–10, 2 pl.; Jussieu, *Mem. de l'Acad. des Scien.*, 1713 (repub. *Hist. Coffee*), 1715; Ellis, *Hist. Acc. Coffee*, 1774 (admirable plate); Plenck, *Ic. Pl. Med.*, 1789, pl. 130; Wight, *Ic. Pl. Ind. Or.*, 1840, i., t. 53; Richard, *Tent. Fl. Abyss.*,

D.E.P., ii., 460–91. Coffee.

1843, i., 349; Oliver, *Fl. Trop. Africa*, 1877, iii., 180; Baillon, *Hist. des Pl.*, 1880, vii., 275–7, 405; Deflers, *Voy. Yemen*, 1889, 143; Raoul, *Cult. du Caféier*, 1894; Heuzé, *Les Pl. Indust.*, 1895, iv., 172–92; Saenz, *Memo. Cult. del Cafeto*, 1895; Lecomte, *Le Café*, 1899; Foreman, *Philippine Islands*, 1899, 337–42; Marcel Dubard, *Les Caféiers*, in *L'Agri. Prat. des Pays Chauds*, 1905, v., pt. 1, 92–100; also in *Bull. Mus. Nat. d'Hist. Nat.*, 1907, 279–83; RUBIACEÆ.

Kahwah.

Bun.

"

Original Acceptation.

The names given to the plant, its fruits, its seeds and the beverage prepared from these, are mostly derived from either of two words:—"*kahwah*," an Arabic term that originally denoted "wine," and "*bun*," the Abyssinian name for the coffee plant or its beans. From these we have *cahua*, *kawa*, *chaube*, *kapi*, *cáve*, *kava*, *café*, coffee and *caféier*; also *boun*, *bun*, *ban*, *ben*, *bunu*, *buncha*. The earliest Arabic writers, however, used the Abyssinian name by itself or in combination: thus Avicenna (11th century) calls it *buncho* and Rhases *bunco*. It was by them viewed as a medicinal plant and one very possibly that came from Abyssinia, so that the appearance of the Arabic name *kahwah* may with safety be accepted as marking the progress into the final development as a beverage. The association with wine may be considered in fact as indicative either of the abhorrence of the zealous followers of the Prophet of anything that savoured of the prohibited alcohol or taken as the direct expression of the curious circumstance that when the coffee beverage was first made known to the Arabs it was in all probability distinctly alcoholic, and thus fully deserved the name *kahwah*.

Habitat.

Distribution.

Habitat.—The true coffee plant would appear to have been satisfactorily established by botanists as indigenous to certain hilly regions of Abyssinia, of the Soudan, of Guinea and of Mozambique. Some doubt still, however, prevails as to its being indigenous to Arabia, though this was claimed by the early writers. Richard throws out the suggestion that it may have been indigenous to Arabia, and carried from thence to Abyssinia. It is certainly extensively cultivated in that country, as for example at Enarrea, Kaffa and Harrar. But Richard adds (as if in part support of his view) that coffee is only used by the Muhammadans, not by the Abyssinians proper. Deflers, on the other hand, speaks of the plant as cultivated in Attara and elsewhere on the mountains up to alt. of 7,000 feet, but as nowhere seen wild in Arabia. These two botanical writers thus take opposite sides in the story of the Abyssinian conquests. Richard believes that coffee was carried back from Arabia, and Deflers that it was conveyed to Arabia, about 100 years before the birth of Muhammad. Raynal, Lecomte, and many authors accept the opinion that the plant was taken from Abyssinia to Yemen.

History.

Roasting the Beans.

Succulent Rind.

History.—If we turn to Arabic literature for confirmation of this view we learn for certain that coffee is not mentioned in the *Koran*, nor of course is there any allusion to it in the Hebrew Scriptures. Thus if the plant be viewed as indigenous to certain tracts of Arabia, it becomes necessary to believe that its merits (if known at all) were appreciated within a very restricted area. Everything, in fact, points to the conviction that the people of Mecca, Medina and Bagdad did not know of coffee till well into the 14th century of the Christian era. Ibn Baithar, born at Malaga and who travelled during the 13th century in North Africa and Syria, makes no mention of coffee. The art of roasting the beans and preparing from these a decoction was apparently a more recent discovery, and one which may have been made in Persia. Prior to that, the *kahwah* that first attracted attention, was a preparation from the succulent rind or pulp of the coffee-cherry. This contains a fair amount of sugar, is often pleasantly enough flavoured, and if a decoction made from it were allowed to stand for some short time it would for certain become alcoholic and might even be distilled into spirit.

DISCOVERY OF ROASTING THE BEANS

Giovan Leone, who visited Egypt in 1513 and wrote a careful account of Cairo, makes no mention of the consumption of coffee, nor is the plant enumerated in his list of the most useful and novel African plants. On the other hand, seventy years later, Prosper Alpinus (*De Pl. Ægypti*, 1592, 26) speaks of the *bon* tree seen by him at Cairo in the conservatory of an Egyptian gentleman, and further he gives full particulars of the decoction, called *caoua*, which he says they prepared from the seeds imported from Arabia Felix and sold in public taverns, in place of wine. In his other work (*De Medecina Method.*) Alpinus remarks that some of the Egyptians used the husks of the coffee-berries instead of the berries themselves. Vesling (in his edition of Alpinus' work published in 1735, 179) adds that coffee-cherries, brought from Yemen, were sold in Egypt as crystallised fruits and regarded as great luxuries. Verzascha (*Kräuter-Buch.*, 1678, 788), while reprinting the account given by Alpinus, speaks of the beverage being served in earthen pots entirely closed up, and adds that the husk makes a stronger infusion than the berries (seeds). The seeds, he observes, are called *bon* and the drink *choava*: he furnishes a picture of a roaster, so that by then, at all events, there would seem no doubt the seeds were regularly roasted and a beverage prepared from them, as well as from the husk. Sandys (*Travels*, 1610 (ed. 1670), 51) alludes to "Coffa-houses" of Constantinople. Pietro della Valle (*Voy. East. Ind.*, 1665) says of coffee, it is "made by a black seed boyled in water which turnes it almost into the same colour but doth very little alter the taste of the water; notwithstanding it is very good to help digestion, to quicken the spirits, and to cleanse the blood." Herbert (*Travels*, 1677, 113, 311) speaks of "Coffe or Coho" as a Persian beverage prepared from "the flower of the Bunny or Choava-berry" and sold in shops. Fryer (*New. Acc. E. Ind. and Pers.*, 1675 (ed. 1698), 225, speaks of "Coho or Tea" as being served at a State ceremonial at which he was present at Bunder Abbas. An apology for mistakes explains that the text was printed in the absence of the author. Hence it may be inferred the "Explanatory Index" was not drawn up by Fryer. In that index "coffee" is given as the equivalent of *coho*. It is thus probable that Fryer himself accepted *coho* as a name fully understood in England. It is of course a variant of the Arabic *kahwah*, which originally denoted the wine prepared from the husk of the coffee-cherry, not the beverage of the roasted seeds. Niebuhr (*Voy. Arabia*, 1770) says that in Yemen coffee made from the seeds is supposed to heat the blood; accordingly the inhabitants of that province compose a drink of the hulls of coffee which in taste and colour much resembles tea. This they esteem wholesome and refreshing. It is prepared nearly in the same manner as that from the seed or bean and is the *coffée à la Sultane* of the French. Deflers observes, "It is well known that the pericarp of the fruit dried in the sun and powdered constitutes the product used under the name of *qischr* for the preparation of a stimulating drink rather like an infusion of tea." "Aromatised with ginger or other spices it is with *qat* the favourite stimulant of the Arabs of Yemen who abstain from the use of coffee prepared from the seed, ground in the Turkish and European fashion."

Egypt.

Beans.

Husks used.

Crystallised Coffee-cherries.

Roaster.

India.

Arabia.

Stimulating Drink.

Turning now to a few of the records regarding Abyssinia: Richard, as already observed, affirms that coffee was not in his time much used by the Abyssinians. Nearly all was taken to Messoah by caravans and from thence dispatched to Moka, where it was sold as Arabian coffee. Henri Lecomte gives a very different account: "From time immemorial the Gallas have used coffee both as food and drink. Originally they made a decoction of the beans and pulp cooked together. The system of roasting was only discovered later."

Abyssinia.

Such then are the observations of early travellers in Arabia, Abyssinia and Egypt, and these may now be linked up with the prevalent opinions and traditions. Coffee made of the roasted seeds would appear to have been first brought prominently to notice at Aden. It was known for centuries previously as a drug, and many of the Arab writers speak of having been made acquainted with its properties through the Persians. Abu Abdallah Muhammad Dhabbani Ibn Said had occasion to visit Persia (according to Galand, Roque and Ellis: Africa, according to Yule and Burnell: lastly Abyssinia according to the authors of the *Pharmacographia Indica*) during the 15th century. On that occasion he found the faithful partaking of coffee. Returning to Aden he took to drinking coffee himself, and recommended his followers to substitute that beverage for the *kát* (***Catha edulis***) which they were in the habit of using. Vaughan (*Pharm. Journ.*, 1852, xii.) gives further particulars regarding Muhammad Dhabbani, but throws no light on the country whence he obtained his knowledge, nor does de Sacy deal with this issue. From Aden, however, the knowledge seems to have spread

Coffee of Roasted Seed.

Aden.

Kát.

to Mecca, Medina and Cairo, and finally within the century after its introduction to Aden, it had been conveyed to Damascus, Aleppo and Constantinople. But in due course the more strict in the tenets of their faith objected to public coffee-houses and to the gaming, singing and dancing that there took place. At various times the effort was accordingly made to repress the traffic and to close the coffee-houses. In 1511 the Governor of Mecca (the Viceroy of the Sultan of Egypt) issued a " Condemnation " of coffee as the united opinion of the priests, doctors and learned men of that town, on the ground that it was a form of wine (*kahwah*) and therefore contrary to the law. It is thus just possible that the beverage then in use was prepared from the pulp of the fruit and was, therefore, actually intoxicating. But the Sultan revoked the condemnation and reproved his viceroy for venturing to prohibit an article of daily food used by the people of the capital of the Empire (Cairo) and by the Sultan himself. Later on (1524), however, the coffee-houses of Mecca had become the scenes of so much rioting that they were closed, by order of the Kadi. In 1533 the people of Cairo were divided into two classes, those who considered coffee lawful, and those who did not. In 1554 the coffee-houses of Constantinople were closed on a new pretext, that possibly marks the more complete establishment of the habit of roasting the seeds. The charred berries (seeds) were considered as charcoal, and thus unlawful as articles of food.

Coffee-drinking repressed.

Pulp of the Cherry.

Roasted Seeds.

Difference of opinion exists regarding the first European who saw and described both the plant and the beverage. Ramusio published in 1554 his *Raccolta delle Navigationi e Viaggi*, and one of the travellers whom he quotes describes a journey from Aden to Rhada which he made as a prisoner. Incidentally he mentions coffee among the plants observed by him, but speaks of it as if he and all his readers were perfectly familiar with the plant so named. We know that by that time it was being used in Constantinople, so apparently it was known some time prior to the actual date of its being chronicled. De la Roque, while characterising the traffic in coffee as quite modern, points out that Peter Belon, who travelled in Egypt and Arabia in 1546–9 and described most of the curious and interesting plants seen by him, makes no sort of allusion to coffee. But about the same time, or shortly after, several other travellers visited both Arabia and Abyssinia, and some mention while others are silent regarding coffee. Similarly John Ray published in 1693 a collection of Voyages and Travels. A few of the authors whose works he gives, deal with Ethiopia and Arabia, and some mention coffee while others do not. Clusius (*Arom. Hist.* (Garcia de Orta), 1574, 214–5) received from Dr. Alphonse Pancius of Ferrara, during the summer of 1573, a few coffee-berries (seeds). These he figured and described, and tells us that they were called *buna* and by some *elkaue* (*al kave*) and that in Alexandria a drink was made from them. Rauwolf visited Aleppo in November 1573 and saw the coffee plant, as also the beverage. He published his account in 1583 (*Beschreit. der Raiss.*, 103). Thus Clusius, not Rauwolf, as is commonly affirmed, should be viewed as the first botanist who examined and described the coffee-berries. Prosper Alpinus, as already stated, had a few years still later given a full account both of the plant and of the beverage, and his statements were published time after time for a century subsquently, without any new information of value being made known.

European Knowledge.

First Botanical Description.

Very few of the early rulers, travellers or botanists of India mention coffee, such as Marco Polo (1290), the *Memoirs* of the Emperor Baber (1519), the *Ain-i-Akbari* (1590), Rheede (1678), and Rumphius (1750). Linschoten (1598) described the preparation of tea in Japan, and his contemporary and publisher Paludanus, in a footnote commenting on that passage, observes that in the same way the Turks prepare a beverage from " the fruit which is like unto the *bakelaoe* (laurel berry) and by the Egyptians is called *bon* or *ban*." Pyrard (*Voy. E. Ind.*, 1610 (ed. Hakl. Soc.), i., 172) speaks of the king and great lords of the Maldives drinking coffee. Tavernier (*Travels Ind.*, 1676, ii., 23–4) says that in his time coffee did not grow either in India or Persia, but that the supplies came from Arabia. He then adds that the principal coffee trade was from Hormuz and Bassora, " where the Dutch when returning empty from Mocha, load up as much as they can with that seed, it being an article which they sell well." From Hormuz it is exported to Persia, and from Bassora to Mesopotamia and other Turkish provinces. (*For accounts by Bontius, Mandelslo and Ovington, see* Camellia, p. 212.)

Early Coffee Trade.

Coffee-drinking.

Down to the year 1690 the world's supply of coffee came from Arabia and Abyssinia. The following historic data may be accepted therefore as fittingly con-

cluding this brief statement. In 1615 coffee-drinking was carried to Venice. In 1644 Peter della Valle took it to Marseilles. John Houghton (*Phil. Trans. London*, 1809, iv., 420) says that Rastall, an English merchant, went to Leghorn in 1651, and there found coffee-houses. In the year following Mr. Daniel Edwards, a merchant from Smyrna, brought to England a Greek servant named Pasqua, who made his coffee. Shortly after Pasqua was enabled to set up a public coffee-house in Cornhill. It is further affirmed by Houghton that Dr. Harvey, the discoverer of the circulation of the blood, frequently used coffee. But Henry Phillips (*Pomarium Britan.*, 1820, 112) says that Nathaniel Conopios, a Cretan, made coffee his common beverage at Baliol College, Oxford, in 1641. This same fact is alluded to by Evelyn (*Memoirs*, 1819, 7) as having taken place in May 1637. In 1675 Charles II., by an ill-judged proclamation, in which he characterised the coffee-houses as seminaries of sedition, endeavoured to close them, but the Act was suspended a few days later. By 1688, according to John Ray, London rivalled the Grand Cairo in the number of its coffee-houses. Lord Bacon (*Sylva Sylvar*, 1658, Century viii., 185), speaks of the *coffa* drink used by the Turks, but he had apparently no personal knowledge of it. In 1657 the Turkish Ambassador Sulaiman Aga made coffee-drinking fashionable in Paris, and in consequence the roasted coffee-berries sold in Paris during 1670 at £5 a pound. It seems probable, however, that through M. Thevenot coffee was definitely introduced about 1667, but that the habit of coffee-drinking was not general in Paris until 1680. In 1690 live seeds having been conveyed to Batavia, a plant was shortly after taken to Amsterdam and in 1712 the Dutch presented a seedling from this to Louis XIV., and still later from that plant seedlings were sent to Martinique. Madame de Genlis (*La Bot. Hist. et Littér.*, 1811, i., 193) tells how M. Desclieux, who went to Martinique in 1720, as Lieutenant of the King, in the same ship with the seedlings, gallantly saved them by depriving himself daily of the greater part of his allotted portion of water—the ship's supplies having run short. He had in consequence the good fortune to see the plants arrive in safety and a new source of wealth thereby added to the island. M. de Candolle, M. Edelestan Jardin and many other writers allude to this incident. In 1723 coffee was taken by the Portuguese to Java; in 1728 Sir Nicholas Laws introduced it into Jamaica, and in 1770 it was conveyed to Rio de Janeiro.

In Venice.

In Leghorn.

In London.

In Oxford.

In Paris.

Cultivation in Europe.

In Mauritius.

The history of the introduction of coffee into India is very obscure. Most writers agree that it was brought to Mysore some two centuries ago by a Muhammadan pilgrim named Baba Budan, who, on his return from Mecca, brought seven seeds with him. This tradition is so universally believed in, by the inhabitants of the greater part of South India, that there seems every chance of its being founded on fact. About the beginning of the 19th century there is no doubt coffee had found its way to India, and in 1823 a charter was granted to Fort Gloster, near Calcutta, authorising it to become a cotton mill, a coffee plantation and a rum distillery. Some of the coffee trees planted in fulfilment of that charter are supposed to be still alive, and about the same time coffee was successfully grown in the Botanic Gardens, Calcutta; but needless to say the industry of coffee planting nowhere found an abiding place on the plains of India but migrated to the hills of South India, in Mysore more especially, and thus into the very region where tradition affirms it had been introduced two centuries previously. The first systematic plantation was apparently Mr. Cannon's near Chikmuglur. This was established in 1830. It is supposed, however, that Major Bevan may have actually grown coffee on the Wynaad at a slightly earlier date, and that Mr. Cockburn's Shevaroy plantation bears the same date as Mr. Cannon's. In 1840 Mr. Glasson formed a plantation at Manantoddy, and in 1846 plantations were organised on the Nilgiri hills. In Ceylon it is believed coffee was introduced by the Arabs prior to the Portuguese invasion of that island. It was commenced to be systematically cultivated by the Dutch from about 1690. In 1825 the first plantation by an Englishman was opened by Sir Edwards Barnes. In 1877 it was estimated that the capital invested in Ceylon coffee was close on £14,000,000. The fungal disease (*Hemileia vastatrix*) appeared about 1869 and spread rapidly, steadily weakening the bushes and reducing their yielding capacity, so that by 1887 the Ceylon industry was completely ruined.

Coffee in India.

First Plantation.

Ceylon Planting.

It would occupy many pages to give anything like a complete enumeration of even the more important works on coffee. [The following in supplement of those already given in the *Dictionary*, and of those mentioned above, will be found specially worthy of study:—Thevenot, *Travels in Levant, Indostan, etc.* (Engl. transl.), 1687, pt. i., 162–3; pt. ii., 11, 21; Dafour, *L'Emploi du Café*, 1671; also

Species and Varieties

Le Café, 1684; Spon, *Tract. de Potu Caphé*, 1684; Blankaart, *Coffee*, 1686; Nichol de Blegny, *L'Emploi du Café*, 1687; Galand, *L'Origine et Progrès du Café*, 1699; Chardin, *Voy.*, 1686 (Engl. ed.), 1811, ii., 279; Ray, *Hist. Pl.*, 1688, ii., 1691; Petrus Petitus, *Homeri Nepenthes*, 1689, 73; Sloane, *Phil. Trans. London*, 1693 (ed. 1809), iii., 623; Pomet, *Hist. Gen. des Drogues*, 1694, i., 204; Bruce, *Travels*, 1790, ii., 226; Macpherson, *Comm. with Ind.*, 1812, 271; Milburn, *Or. Comm.*, 1813, i., 104–6; ii., 530; Law, *Hist. Coffee*, 1850; Thurber, *Coffee, Plantation to Cup*, 1881; De Candolle, *Orig. Cult. Plants*, 1884, 415–8; Van Delden Lærne, *Coffee Cult. Brazil and Java*, 1885; Nicholls, *Textbook Trop. Agri.*, 1892, 91–109; *Pharmacog. Ind.*, ii., 215–25; Elliot, *Gold, Sport and Coffee in Mysore*, 1894; Ferguson, *Coffee Pl. Manual*, 1894; Jardin, *Le Caféier et le Café*, 1895; Burton, *First Footsteps in East Africa*, 1894, i., 12 n., 55 n.; ii., 26; Heuzé, *Les Pl. Indust.*, 1895, iv., 172; Semler, *Trop. Agrik.*, 1897, i., 218–24, 233, 260; Laborie, *Coffee Planter St. Domingo*, 1898; Lecomte, *Le Café*, 1899; also in "*La Géographie*," June 1901; Sadebeck, *Die Kulturgew. der Deut. Kolon.*, 1899, 137–8, 142–5; Morren, *Kaffeeplantage in Der Tropenpflanzer, Beihefte*, March and May, 1900; Mukerji, *Handbook Ind. Agri.*, 1901, 456–62; Lehmann, *Coffee Cultivation, Dept. Agri. Mysore Bull.*, No. 2; Jumelle, *Les Cult. Colon.* (*Aliment.*), 1901, 350–85; Wiesner, *Die Rohst. des Pflanzenr.*, 1903, i., 483.]

Distribution.

Distribution.—The world's supply of coffee, we are thus justified in believing, came originally from Arabia and Abyssinia, but as the demand increased new localities of production were established. The Dutch East India Company pioneered the modern trade by their experimental cultivation in Batavia. Soon thereafter coffee cultivation was successfully introduced into the warm temperate areas (or hilly tracts) of most tropical countries, and in time these not only produced far more than the ancestral regions, but yielded a supply of an even superior quality. Improvements in quantity and quality of necessity rapidly extended consumption until they made coffee one of the most popular of all beverages, and hence with a large number of the inhabitants of the globe it passed from the position of an occasional luxury to that of a daily necessity, rivalled only by tea —the sister beverage of the breakfast table.

Species and Varieties.

Species and Varieties Cultivated.—After the somewhat detailed account already furnished of the chief historic facts regarding the Abyssinian (commonly called the Arabian) coffee plant, it is perhaps hardly necessary to indicate that particular species any further for the present. It is to this day by far the most important cultivated stock, though its liability to blight has caused planters to seek out other forms, in the hope of being able either to replace ***Coffea arabica*** or to use these as strains in hybridisation or as stocks upon which to graft, in the production of blight-proof plants. In this modern aspect of the coffee-planting industry three plants have attracted special attention. These are :—

Liberian.

(*a*) **C. liberica,** *Hiern*;—a native of West Tropical Africa (Liberia, Angola, Golungo, Alto, etc.). But in its indigenous area it is very indifferently cultivated, at most in but small plots along the banks of the rivers. In trade it is called Liberian or Abeokuta Coffee. Sir J. D. Hooker from 1872 advocated in the *Kew Reports* the cultivation of this plant—it was then being experimentally grown at Kew; Ferguson published a History of its introduction, progress and cultivation in Ceylon up to 1878; Thurber, *l.c.* 107–16; *Kew Bull.*, 1890, 107, 245–53; 1892, 277–82; 1893, 25, 204–6; 1895, 12, 273–4, 296–9; 1897, 314; *Progress Rept. Bot. Gard. Nilgiri Hills*, 1881–2; Christy, *New Comm. Pl.*, 1878, i., 1–7; Lærne, *l.c.* 321; *Trinidad Bull.*, 1894, 267–73; Watson, *Cult. Tavoy*, 1893; *Rept. Govt. Bot. Gard. Bangalore*, 1897–8, 11; Vankeirsbilck, *Rev. Agri.*, 1896, x., 135–7, 162; *U.S. Yearbook Agri. Dept.*, 1897, 197; Huettenbach, *Cult. Liberian Coffee*, in *Selangor Journ.*, 1897; *Der Tropenpflanzer*, 1897, i., 290–6; iii., 231; *Journ. Soc. Arts*, 1897, 541; 1903, 461; *Cat. des Pl. Econ.* in *L'Horti. Colon.*, 1900, 63–4; Edmond Bordage, *Revue Agri. de la Réunion*, 1901; *L'Agri. Prat. des Pays Chauds*, 1902, ii., 169, 624; Sadebeck, *l.c.* 145;

Chief Publications.

Produce World; *Planting Opinion*; *Trop. Agrist.*; *Capital*; *Madras Mail*, etc. etc.

Special Cultivation.

This species was thus first made known to Europe about the time the coffee-leaf disease appeared in Ceylon. Its hardier growth led to the opinion, to some extent realised, that it might withstand the action of the blight, and on this account demands were made on the Royal Botanic Gardens, Kew, for plants or seeds. Fortunately the Director of the Gardens was fully able to satisfy these, until the question of seed supply was taken up by the trade. The *Kew Reports* are full of the most interesting and suggestive details regarding the successes or failures attained through the experiments conducted, almost simultaneously, in all the tropical regions of the globe. But in one respect at least they have been disappointing, namely, the plant, though much hardier than the Arabian coffee, has not proved to possess immunity from blight. In fact Sir Daniel Morris pointed out long ago that in the nursery the seedlings often suffer from ***Hemileia*** quite as much as do those of ***C. arabica***, but he added that the plants, if properly cared for, soon attain sufficient strength to withstand the disease.

Immunity from Disease.

Diseased in Nursery.

Warm Moist Locality.

The experience gained in India would seem to support belief that Liberian coffee requires quite as fertile and as deep soils as ***C. arabica***. It prefers a warm moist atmosphere and not much less than 100 inches of rain, distributed if possible throughout the year; but it is very susceptible to drought. Where subjected to dry heat, therefore, shade-trees must be provided if they do not already exist. In Java ***Erythrina*** seedlings are first planted, but soon give too much shade and are accordingly replaced in about five years' time by ***Eriodendron*** seedlings.

Shade-trees.

Low Land.

A shallow soil or one with a large admixture of sand and stones is quite unsuited, as also are heavy clay soils and waterlogged subsoils. But Liberian coffee luxuriates on moisture-retaining soils and on lands that can be, and are regularly irrigated. It, in fact, prefers low-lying tracts to high ground, and accordingly flourishes better on the plains than on the hills. It is true that on the Wynaad and elsewhere it has been successfully grown up to altitudes of 5,000 feet, but that circumstance does not materially detract from the opinion that it is better suited to the plains of the tropics than ***C. arabica***. Hence Liberian coffee has attained its most extensive production in the West Indies, Ceylon, the Malay Peninsula (Selangor), North Borneo, Sumatra and Java, and in India seems likely to attain its chief production in Sylhet, Assam, Burma and the Andaman Islands. Lærne says that it is "little thought of" in Brazil, since "it produces little and that irregularly." On the east-coast lands of Madagascar it has for some years been fairly extensively cultivated. M. Deslandes, Assistant Inspector of Agriculture, says that the plants there grown are hybrids and yield a berry superior to that of African coffee. Being large plants the custom exists of allowing them plenty of space, say 400 trees to the acre. There are several distinct races, some that form much larger plants than others and accordingly require more space. It is just as important with Liberian as with Arabian that the races of the plant should be critically studied. For some years past numerous hybrids have been cultivated all over the world. In the south such have appeared wherever Arabian and Liberian coffee were grown side by side. The stock thus obtained is much valued by many planters, being regarded as enjoying immunity from leaf-blight. But it is usually contended that for young colonies, Liberian has distinct and superior claims. It yields regularly and freely, the fruits do not fall so readily from the bush on their reaching maturity, and it is, when all is said and done, a much hardier plant than the Arabian coffee. On low ground the harvest is abundant, the fruits are large (nearly twice the average size of the Arabian bean), not so delicately flavoured, though of good quality when grown on high altitudes. The berries are more difficult to clean than are those of the Arabian plant, but with proper machinery may be completely deprived of even the parchment; they are rank and oily, though if carefully and slowly dried will fetch a price sufficient to reward all the trouble and expense entailed. According to most writers a drawback to this coffee lies in the fact that it has never been pushed as a commercial commodity on its own merits. The beans seem universally used by middlemen for the purpose of strengthening grades which by themselves would be flavourless.

Madagascar.

Four Hundred Trees to the Acre.

Hardier Plant.

Berries difficult to clean.

(*b*) **C. stenophylla,** *G. Don*; *Bot. Mag.*, 74–5 and t.; *Kew Bull.*, 1893, 167; *Rept. Bot. Gard. Bangalore*, 1893–4, 10–11; 1896, 189–91; 1898, 27; *Rept. Roy. Bot. Gard. Trinidad*, 1896, 13; 1900, 12–3; *Pharm. Journ.*, 1897, 17; Semler,

Sierra Leone Coffee.

Trop. Agrik., 1897, i., 217; *Der Tropenpflanzer*, 1898, ii., 34, 263; *Trinidad Bull., etc.*, 1899, 223; 1900, 315; *Agri. News, West Indies*, 1902, i., 278; ii., 237; *Journ. Soc. Arts*, 1903, 461; *Trop. Agrist.*; *Planting Opinion*; *Madras Mail*, etc., etc. "The Highland Coffee of Sierra Leone." This interesting West African species, Mr. Bentham thought, might be but a variety of *C. arabica*. The seeds were issued from Kew Gardens, and the plant is now being experimentally grown in Trinidad, Java, Ceylon, Mysore (not successfully) and elsewhere. Hybrids have also been formed between it and *C. arabica*, as also *C. liberica*. It grows freely, yields abundantly, but is longer in coming into bearing than *C. liberica*. It gives a highly flavoured Moka-like berry.

Hybrids.

Highly Flavoured Berry.

Congo Coffee.

(*c*) **C. Laurentii,** *Wildem.* (**C. robusta,** *L. Linden*), is another tropical African species that has attracted some attention, though it is but imperfectly known botanically. It is spoken of as "Congo Coffee." An article appeared in *L'Horticole Coloniale* (*l.c.* 64–6) in the year 1900 that gives a good account of this plant. It is spoken of as prolific, as almost immune from the ordinary diseases of coffee, and as yielding a berry of a superior quality with a delicate aroma. It frequents banks of streams and prefers situations moist and not too shady. The plant is not, like *C. liberica*, pyramidal in shape, but is rather rounded in outline. Jumelle (*Les. Cult. Colon.* (*Aliment.*), 1901, 350–85) adds that it inhabits Sierra Leone, on soils formed of decomposed granite or gneiss. Owing to its having been first made known from the Nunez river it is often called "Rio Nunez Coffee." In India and Ceylon this plant has so far failed to justify extended endeavours, but in Dominica the results have been most encouraging.

Loves Moist Situations.

CULTIVATION.

Localities.

Localities and Area.—In this work it is desirable to restrict observation to India, and consequently to allude only incidentally to the coffee-growing of other parts of the world. Particulars of cultivation in Java, Sumatra, Philippines, Ceylon, Queensland, Brazil, West Indies, Central America, Mexico, etc., will be found in the respective chapters of Thurber's *Coffee from Plantation to Cup* and other such works, to which the reader is referred. The actual area under the crop in India cannot be stated definitely, owing to the unwillingness of certain planters to furnish information. The error that exists is, however, a relative one, and tends year after year to be lessened rather than increased. Taking the official returns as they stand, it has to be accepted that the area shown under coffee, during the past thirty years, has manifested severe fluctuations. With a perennial crop this can alone denote the fallowing or abandonment of certain plots and the resuscitation of old plantations or the opening out of new lands, coincident with variations in the world's coffee necessities. Thus, for example, the revolutions that took place in Brazil in 1889, 1891 and 1893, followed as these were by small crops during one or two of the succeeding years, had a highly beneficial effect on the Indian coffee-planting industry. The area returned as under coffee in 1885 stood at 237,494 acres, but for the ten years ending 1895 the mean area in India was 274,000 acres; in 1903, 228,815 acres; and in 1904, 212,964 acres. The latest report of the Commercial Intelligence Department states the area at the end of 1906 to have been 210,688 acres. During the decade ending 1895 prices may also be said to have ruled high, so that the industry was very prosperous.

Indian Area.

Fluctuations.

Brazil.

In addition to the absence of returns as to certain plantations, an estimate of yield to acre could hardly be accepted as even of general application. It accordingly follows that trade statistics almost invariably manifest higher exports than the agricultural data would show as produced. The relation of surveyed areas to actual returns of foreign exports is one of the most profitable aspects of study. Taking 100 to represent the area as also the exports in 1885, the following variations have oc-

curred, every fifth year being selected :—1885, area 100, exports 100 ; 1890, 114 and 63 ; 1895, 120 and 78 ; 1900, 115 and 66 ; 1905, 90 and 97 ; and 1906, 89 and 61. (See prices, p. 391.)

Production.

Production.—The coffee produced in India is practically all exported, the most important markets being the United Kingdom and France, so that the returns of trade afford a useful check on the figures of production. The year of highest export was apparently 1885–6, when 41 million lb. were shipped, or about 6 million lb. in excess of the year's production. Some ten years later (1895) (the record year of production) the exports came to 32½ million lb., or 7½ million lb. less than the recorded production.

The official year of trade returns being from March 31, and that of the agricultural statistics the calendar year, a certain overlapping of data of necessity occurs, and, moreover, reserve stocks over local consumption are usually drawn upon before the new crop comes into market. But taking it all round, the particulars of area and production are substantiated by the actual records of the trade.

Distribution of Areas.

Of the total area, 28,089 acres (according to the Report of the Commercial Intelligence Department) were under immature plants in 1906, so that in the future these will come into bearing and enhance the yield, very possibly to a greater extent than the reduction due to the age and disease of the plants presently returned as mature. In passing it may be here observed that in addition to the actual area under coffee, the planters own 108,581 acres, much of which is available for future expansion should such be found desirable. Analysing the area of production according to the report for 1906, we learn that out of the actual area recorded (196,318 acres), 89,202 are in British India and 107,116 in Native States. *Of the former*—42,646 acres are in the Madras Presidency ; 46,393 acres in Coorg ; 74 acres in Bombay Presidency (Kanara district mainly) ; 84 acres in Assam (South Sylhet mainly) ; and 5 acres in Burma. *Of the latter*—101,489 acres are in Mysore, and 5,627 acres in Travancore and Cochin collectively. If we disregard the isolation into British and Native we learn that the coffee outside the Madras Presidency is ordinarily only about 0·15 per cent. of the total Indian area. It would thus be quite safe to describe Indian coffee-planting as an industry confined to the Madras Presidency. The chief localities are Mysore, Coorg, the Wynaad, the Nilgiri, Pulney and Shevaroy hills. The most important districts are Kadur and Hassan, both in Mysore, Coorg, and the Madras Presidency proper.

Distribution.

British Districts.

Native States.

Persons Employed.

Yield.—On December 31, 1906, there were in all India 31,827 plantations, which gave employment to 24,477 persons permanently and 46,044 temporarily. These figures show a considerable reduction on the previous year, when there were 43,233 plantations. Dividing the figure of area by that of production and striking the mean of all the returns for some years back, the Indian yield would appear to be a little over 100 lb. to the acre, but it fluctuates very greatly ; thus in 1903 the yield would appear to have been 139 lb., while in 1901 it was only 65 lb. It is probable, however, that in all the larger and better-worked plantations an average yield of 2 to 3 cwt. is usually obtained, in European plantations, and ¼ to 1 cwt. in Native. But even that average is misleading, since it is well known some of the better plantations may yield as much as 7 to 10 cwt. an acre. Hence the officially returned acreage divided by the declared production, since it involves a mean of good, bad and indifferent results, cannot

Yield.

be accepted as a method of deriving the yield, though the figures thus produced are suggestive and have, therefore, a certain value.

Climate.

Climate and Situation.—It has been said, and with much force, that a good deal of land at one time and another has been opened under coffee that was never suited to it. Of this nature are some of the Coorg estates (or portions of them) that have a southerly aspect and are exposed to the full force of the east winds. Situation and exposure are factors of prime importance. It seems to be the Indian experience that coffee prefers land standing from 1,500 to 5,500 feet above the sea-level, the exact altitude being controlled to a large extent by latitude. Far to the south higher altitudes would seem necessary than in the more northern tracts. The temperature best suited would appear to range from 55° to 80°. The total rainfall should not exceed 150 inches but about 100 is the amount most frequently commended, provided it be fairly evenly distributed throughout the year; but December to March may be dry. Coffee distinctly requires a humid atmosphere, and in the opinion of most planters the prevalence of heavy winds are more objectionable than a dry atmosphere or a low rainfall. The climate must be open and bracing and the sky not heavily overcast. With *C. arabica* low-lying and damp situations induce disease. As already mentioned, however, altitudes lower and warmer than those indicated for *C. arabica* are suited for *C. liberica*, but even with that species the higher limits of its production give the most valuable berry.

Temperature.
Humidity.
Situation.
Soil.

Soil.—Coffee, although very largely a surface feeder, has a long tap-root which it is most desirable should not be injured during transplanting. The success of the crop depends to a large extent on the depth of the soil. The best soil might be described as a well-drained, ferruginous loam, though certain clays mixed with sand give good results, especially if a fair amount of humus be present or be given as top-dressing. Very chalky soils, as also stiff clays, are useless. It is usually held that soils that contain a fair amount of iron give the best-flavoured berries. But below the subsoil there must rest a bed of very porous material so as to ensure ready drainage. In fact a rocky soil with pouches of loam between the outcropping rocks gives admirable results, as may be seen in many parts of the Shevaroys, the Nilgiris and the Wynaad. The rocks are constantly weathering and thus adding to the soil, while, according to the planters, they also transmit the heat and moisture. [*Cf.* Robinson, Pringle, Voelcker, Lehmann, Leather, etc.] It is, however, unfortunate that no record has been kept of the conditions of land opened out and of the same fifteen or twenty years afterwards, both in estates manured and in those not manured.

Ferruginous Loam.
Rocky Soil.
Manured Soils.

Nursery.

PROPAGATION.—Nursery.—Having selected the site for a plantation, cleared and burned (or piled up in ridges to await natural disintegration) all the trees not deemed necessary for shade purposes, laid out the roads and carried a water supply to the coffee-house, the next most urgent task is to select and prepare the site for the nursery. This must never be on an old coffee plantation, but on virgin ground of sufficient richness that manuring may not be necessary except to add sand with a view to securing its porous nature. But the soil of the seed-beds must be rich in vegetable mould, bear a gentle slope, be well drained, retentive of moisture, and liberally supplied with water for irrigation purposes, since for some time watering is necessary. If not already secured, provision

Sand.
Mould.
Watering.

should be made for shade against the severity of the sun, but drip from protecting trees must be avoided by seeing that they are at a sufficient distance from the seed-beds. The beds should be slightly raised and of a breadth to allow of hand dressing from the dividing paths. In many cases temporary shelters may have to be constructed over the beds. A deep trench had better also run along the top of the entire nursery so as to check the possibility of surface wash. Shade. Trench.

The reader should consult the *Dictionary*, and one or other of the technical reports, cited above, for details of the coffee industry. For example, the varying methods of sowing, transplanting, weeding, pruning, etc., which to some extent are peculiar to each locality, must be sought for elsewhere. All that can be attempted in this work is a review of the facts that are deemed likely to have a bearing on the stability and prosperity of coffee planting. Varying Methods.

Selection of Stock.—One of the most important of all tasks is the decision as to the stock to be grown. Even if the choice has been made of Arabian in preference to Liberian, there still remains the selection of the race or hybrid desired, and the source of supply. The reputation of the seed estate, the age of the parent stock (seven to ten years preferably), the method of treatment of seed, etc., etc., are points of vital importance. The seed should be gathered from healthy plants, the cherries should be fully ripe before being plucked, then hand pulped after maturity, and lastly they should be washed and dried in the shade in such a fashion as to avoid both fermentation and undue drying of the kernels. In fact some planters believe that seeds fresh from the trees should be husked and instantly sown to obtain the best results. The talk of "male" plants and the discussion as to the value of pea-berry as seed, are themes indulged in at the expense of infinitely more valuable topics, but the greatest mistake of all is to suppose that coffee is coffee and that both seed and seedlings may be picked up anyhow or anywhere. Selection of Stock. Age of Parent. Seed should be washed. Pea-berry.

Races and Hybrids.—M. Jumelle (*Les Cult. Colon.* (*Aliment.*), 1901, 352–3) mentions many forms of coffee (apparently all races of *C. arabica*) and his enumeration may be here quoted as suggestive, since some of the races mentioned are already known to the Indian coffee planters. He treats of Moka as the stock typical form of the species and adds:— Races.

(*a*) Vermelho.—A red-fruited coffee much grown in Central America: it is more robust than the type.

(*b*) Amarello of Brazil.—A yellow-fruited plant rich in cafeine but rather bitter in taste.

(*c*) Maragogipe.—The Upland Brazilian coffee, which has seeds nearly as large as Liberian coffee and is very prolific. This form appears to have been introduced into South India and is often referred to by planters, but no one appears to have furnished a report of its special merits or of the success attained with it in India. According to some writers this is a hybrid between *C. arabica* and *C. Laurentii*. [*Cf. Kew Bull.*, 1894, 163–4; *L'Horti. Colon.*, 1900, 62–3; *Agri. News W. Ind.*, 1903, ii., 316–7.]

(*d*) Leucocarpa.—A white-fruited plant found originally in Sierra Leone. Could this be one of the special species of that country and not a cultivated race of *C. arabica*?

(*e*) Soufrière.—A very hardy plant that resists insect pests: the leaves are like those of the type but the seeds much larger.

(*f*) Leroy of Reunion or Pointed Bourbon.—Is more hardy than Moka, has short branches crowded with leaves, and the seeds are pointed at one end.

(*g*) Mysore.—Commercially described as "Cannon's high-priced Mysore." Has round heavy seeds; the branches are ascending; but as the yield is irregular it is being replaced by the next form.

(*h*) **Coorg Coffee.**—This has large flat seeds and is propagated easily. There are several well-marked races such as the "Chick," "Golden Drop," "Nalknad," etc.

(*i*) **Java Coffee.**—This bears branches less horizontal than Brazilian, and the two young leaves at the extremity of the shoots are greenish-yellow in the Javan, and brownish-yellow in the Brazilian plant.

Indian Forms.

The planters of India recognise many more distinct races, but as no one seems to have scientifically described these, and the writer's personal acquaintance with the coffee plant was acquired during one or two very rapid tours of inspection, he is unable to attempt a description or classification of the special Indian races and hybrids. The reader would do well, however, to consult Mr. J. Cameron's various reports on the experiments conducted at the Lal Bagh of Bangalore. He will discover that Cameron discusses the hybrids that have been produced naturally, and explains that their most remarkable feature is their immunity from leaf-disease. But he has apparently not been so successful in the production of crosses as has been the case in other parts of the world. All the same his conclusions on this issue are clear and definite. He is sanguine that hybridisation may be looked to as likely to afford much advantage. The renovation of coffee, he accordingly adds, is "not wholly a matter of soil enrichment." "Next in importance to hybridisation and proper culture, the interchange and special selection of seed must take a high place." It may be here added that much has been said regarding the value of plants formed by grafting, or by inarching, as for example ***C. arabica*** on to rooted plants of ***C. liberica.*** The seeds from such are said to be superior to pure stocks, and in some respects constitute forms nearly as distinct as the crosses and hybrids already mentioned. The *Kew Bulletin* (1898, 30) affords much useful information regarding the hybrid coffees now grown in South India—a subject very greatly developed subsequently by the Indian press. But the industry is much indebted to Mr. W. L. Crawford, Mr. J. W. Hockin, Mr. Brook Mockett and Mr. Graham Anderson—the last-named gentleman having read a paper of great merit before the South Mysore Planters' Association that reviews all the practical results attained.

Stock.

The importance of careful selection of stock cannot, in fact, be overstated, and it is probably not far from correct to affirm that the majority of Indian coffee plantations possess two or more widely different plants treated as if one and the same, the result being irregularity both in quality and yield. The difficulties of the industry preclude any risks being accepted that might be obviated by personal knowledge and care. Hence it is desirable that the nurseries be as near the planter's house as possible, so as to ensure constant supervision, from sowing to picking out and final transplanting. Any departures from the desired type should be instantly removed from the seed-bed, though no opportunity should be lost of studying sports that may appear. Forms directly suited to the climate, soil, and method of treatment pursued in each plantation should be the aim of every planter. But these cannot as a rule be purchased. They must be acquired as local manifestations or crosses specially developed. The study of the seed-bed and the care of the seedlings should be the special charge of the manager himself, not of the overseer or foreman of works. [*Cf.* Lehmann, Lect. in *Planting Opinion*, August 8, 1903.]

Care in Selection.

Planting.

Planting Out.—During the first few years of a plantation it should be dug all over as deeply as possible. After the coffee plants enlarge, thorough and deep trenching becomes more or less impossible without

Deep Trenching.

much injury to the roots of the plants. When about a year old the seedlings are planted out into their permanent positions, but if care be taken to select dull weather for this operation, many planters prefer older plants, say two years old. Much difference of opinion prevails as to the distance apart that the plants should be lined in the estate. The question hinges on the following considerations :—(*a*) the nature of the stock selected ; (*b*) the system of cultivation to be pursued, more especially the size of plants desired ; (*c*) the character of the soil ; (*d*) the degree of shade that exists naturally, or that it is contemplated to afford ; and (*e*) the nature of the climate. In cold countries, where the plants are not likely to attain to any great size, close planting may be indicated, the reverse being the case under influences that might be expected to cause vigorous growth. In India the distances apart usually adopted vary from 4 to 8 feet each way, and 7 feet might be said to be common, or 6 feet between the plants and 7 feet between the rows. This would give 1,037 plants to the acre, but in many estates a considerably larger number exists—in some 5 by 5 feet, or 1,740 trees to the acre. On the other hand, Mr. Leeming of Scotforth, in the Shevaroys, was induced some few years ago to believe that a larger plant and more space would give equal, if not better returns, at a much lower cost than the prevalent system of many small plants. He accordingly removed each alternate bush and reduced his estate to 600 plants to the acre. The result was so very promising that he went still further, and reduced it to 300 or 325 plants to the acre. On the average his bushes now stand 12 feet apart each way. In 1899 I had the pleasure of inspecting Scotforth plantation in company with Leeming, as also most of the other coffee estates of that neighbourhood. And I have to admit that Leeming's plants seemed to me in a healthier condition, and to be fruiting more vigorously, than any coffee seen elsewhere. The yield had been greatly increased, the cost of cultivation lessened, the plants rendered better able to throw off disease, and the produce recorded as fetching a higher price than had been the case under former conditions. These are all powerful arguments. But there may be other considerations and conditions that have to be borne in mind. It does not follow, for example, that plants 12 feet apart each way would give everywhere the same results as on the Shevaroys, nor that each race of the coffee plant would do so. The subject is one, however, that is capable of definite verification, and one moreover that it would seem should be solved by every planter for himself. It would not be a very serious matter to place a plot of a few acres under trial, and if the returns proved unsatisfactory the replanting of fresh stock in place of the old and exhausted plants that had been removed would in time repay the outlay.

Distance Apart.

Plants to Acre.

Effect of Thinning.

Cultural Operations.—It is undesirable to give details of the varied opinions and practices that prevail as to the best systems of "holing" and "planting out." The size and depth of the holes depend very largely on the nature of the soil, the lie of the land, and the amount of money and time the planter is prepared to expend. Where money is not a serious consideration, large holes are made, the removed earth being deposited on the higher side, the holes left exposed for some time to the sun and air, then filled in with surface soil, manure and green vegetation (weeds), but with little or none of the earth previously removed. After a time the fresh soil thus furnished will sink, and this depression must

Planting Out.

be made up with fresh surface soil. Farm-yard manure may with advantage be also given until a little mound has been formed, on the top of which the seedling should be planted. Transplanting should if possible be made during cloudy days, and just before the commencement of the most copious season of rain. Temporary shade should be afforded to the seedlings, in the form of small pieces of crude bamboo matting, or simply leafy boughs or tufts of bracken fern. It is also a good plan, especially in exposed situations, to fix a stake to which the stem may be lightly tied. If exceptionally dry weather follow transplanting, it may be necessary to give one or two waterings. In some cases a nursery is dispensed with and two or three seeds are deposited on the specially prepared hole-mounds, the healthiest one being ultimately allowed to grow and the others cut out or transplanted.

Temporary Shade.

Drains.

Drainage.—Weeding or removal of wild herbage from the plantation, so as to prevent the young coffee from being choked, now becomes an essential operation. If drains have not been provided at the time the estate was being laid out, by this stage they become imperatively necessary. Nothing is, in fact, more important than a good system of drainage. In the *Pests and Blights of the Tea Plant* (2nd ed., 45–66) it has been urged on the attention of tea planters that the objects of a system of drainage are to increase the depth and improve the condition of the arable soil. Every word of what has been said in that work on the drainage of tea is applicable to coffee. And I may further add that during my inspection of the coffee estates of South India I found few had been drained anything like to the extent practised with tea. I accordingly urged the coffee planters to reform this defect.

Improve the Soil.

One of the great advantages of drainage is the admission of air (oxygen) into the soil. The drainage of agricultural lands differs thus essentially from that of the streets of a town. The removal of surplus water is undertaken with a definite object in view, the fulfilment of which determines the position and number of the drains. The water is drawn below the surface, and thus made to carry with it the materials that the combined action of the sun and the air have transformed into a soluble condition. To permit or encourage surface wash is to render the soil sterile, in fact to afford facilities for soil-removal. The deeper the drains the further apart they may be placed, and the deeper the resulting arable soil. But drains of some kind are indispensable for successful coffee planting. In many coffee estates that occupy steep, hilly slopes, a system of *trenching* or *contour catch draining* has come into general use, as a protection against severe and wasteful surface wash. The trenches to some extent answer the purpose of refuse pits for the accumulation of manure. In fact in most instances they assume the condition of parallel chains of pits. If used as pits into which the weeds may be thrown, it is customary to have them cleaned out before the setting in of the rains, so as to afford every means of intercepting the fine soil of the surface wash. The contour drains in the tea estates are usually laid out with a level and the earth removed in their formation thrown on the upper side. This is essential, since the slightest slope downhill would convert them into dangerous surface drains. So again *terracing* is an additional method practised with great advantage on some estates, though apt, when exposed to the south or south-west, to dry the soil unduly. But as with contour drains so with terraces, they must be laid out as nearly level as possible.

Surface Wash.

Pits.

Terracing.

But when slopes are not too great and the soil fairly light, *bunding* is a third method, superior to even trenching or terracing. Instead of cutting out a terrace, a bank of soil is laid across the slope, and the rain thus made to wash this into a natural wide terrace. In many parts of the country bamboos and prunings are used to form fan-like structures upon which the silting-up process may be encouraged. Bunds.

Digging and Mulching.—Lehmann (*Bull. Dept. Agri. Mysore*, 1902, ii.) has very properly pointed out that coffee is so very different from the majority of the plants cultivated in Europe and America, that it does not of necessity follow that approved Western methods are in every detail applicable to it. "For one thing," he observes, "coffee thrives under the shade of large trees, while in Europe, or at any rate in Canada, the cultivated crops invariably suffer near trees of any sort." He accordingly urges that under the climatic conditions and on the soils that prevail in Mysore, it is essential that knowledge of coffee cultivation should be acquired by direct experiment rather than deduced from general agricultural principles. And in that opinion he is assuredly correct. Coffee is as sensitive, Lehmann tells us, as most plants to the injuries caused by caking or baking of the soil. In Mysore, he continues, most soils after being dug and then exposed to heavy rain, followed by bright sunshine, become quite as hard on the surface as they were before having been dug. But surely that peculiarity is experienced throughout the world, and on the pure sands of the deserts of Rajputana as much so as on the rich loams of Northern Europe or the coffee lands of Mysore, wherever rainfall is followed by bright sunshine. It is to check the parching and caking action of the sun that gardeners mulch or litter certain crops as a temporary measure. It is with the same object in view that weeding at the commencement of the hot months is discouraged by the cultivators of most tropical countries. Cameron points out that the annual weed "*Blumea*" (*Ageratum conyzoides*) seen in established plantations can do comparatively little harm and that a light covering of weeds might even do good by preventing the surface becoming overheated. To guard against severe caking and overdrying of the soil is a legitimate and rational aspect of all agriculture. But to advance from that position to the condemnation of tillage and the rejection of the fully demonstrated fact that the breaking-up of the surface soil and its exposure to the action of heat, light, air and water has the effect of reducing non-soluble to soluble compounds and the production thereby of plant food, seems utterly unwarrantable. The protection of the soil against surface wash and surface caking by a natural litter of leaves (mulching) is very admirable and may be very useful as an occasional process of fallowing, but to expect that any lands, however admirably drained, weeded and mulched, could continue indefinitely to yield coffee or any other crop without tillage or manure, is to carry a natural law to a perilous and unjustifiable extreme. Lehmann, by his studies of the manures of coffee, has shown that he never contemplated his recommendations for mulching to be the one and only method of treatment of the soil that was desirable. It would indeed be an unwarrantable assumption to affirm that what may be true with a wild plant must be true universally with the same plant under the abnormal demands of cultivation. It is beside the issue to say that mulching has actually been the system with a group of coffee gardens in Coorg for many years (*Madras Weekly Mail*, March 20, 1902). It might fairly be, and in fact

Digging.

Caking the Soil.

Parching.

Mulching.

Tillage indispensable.

Influences of Manures.

Soil Exhaustion.

has been asked :—" Can it be proved that these very plantations could not have done better during the past?" or, "May they not, even now, be approaching the exhaustion that led to the abandonment of many similar and once fertile estates in that very province ?" It is doubtless true that with rich primeval forest land, if well drained and carefully mulched, exhaustion may not become manifest for many years. But it is equally true that with indifferent soils or exhausted lands, mulching can never take the place of tillage and manure.

Lehmann concludes his very suggestive report—a most valuable paper even though its main contention may not be accepted as constantly and universally applicable—by the following statement of the advantages of mulching :—" The careful preservation of the natural mulch on pieces on which the coffee has ' closed in ' :—(*a*) saves the digging : (*b*) leaves the soil in a better mechanical condition than the usual amount of digging could do : (*c*) probably prolongs the life on an estate and increases its general vigour and productiveness after the first year or two : (*d*) will save a large portion, possibly all the expense of applying bulk manure. Not digging an estate may have the following disadvantages :— (*a*) it is liable to reduce the crop for a year or two : (*b*) it has the tendency to increase the risk of fire."

Advantages of Mulching.

A volume might be written in an attempt to review all the opinions that have been published for and against the tillage of coffee lands. A correspondent, for example, wrote to a Madras paper in 1895 regarding South Coorg—" The change that is worked in a sickly piece of coffee by deep digging is little short of marvellous ; in a couple of weeks' time one would hardly know it for the same piece of coffee." That sentence is fully expressive of the opinions of the vast majority of planters.

Deep Digging.

Manures.

Manuring and Manures.—Cameron (*Rept. Offic. Visit to Coffee Dist., Coorg*, 1898) has much to say on the necessity for high cultivation and the manures best suited for coffee. He discusses farm-yard manure ; bone ; oilcake ; nitrogenous manures, and the fixation of free nitrogen by the aid of leguminous catch crops ; lime ; phosphates ; potash ; green manures, etc., etc., and commends the use of bracken fern for the litter of cattle on account of its subsequent value as a manure. In his concluding observations he remarks : " The application of proper manure in correct quantity and at the most serviceable time, are things which should be assiduously learned from practical experience." So again, one of the most valuable contributions to our knowledge of the art of manuring coffee is the series of studies conducted by the late Mr. William Pringle, and published in pamphlet form by Messrs. Matheson & Co., of Madras. While we have many similar technical reports, some of which will be briefly mentioned below, very little of a practical nature has transpired of the accumulated experience gained during the seventy odd years of Indian coffee cultivation. The planters prefer, as a rule, farm-yard, or bulk manure, as it is called, and are restricted in its use by the difficulty of procuring enough. Lehmann has recently pointed out that the first and foremost consideration is to see that all the essentials in soil-composition are present, in the right proportion and right condition. Fertilisers may then be given in the direction of crop requirements. He, for example, remarks that " the potash fertilisers have, I fear, not received the attention they require. Judging from the analytical results I have seen, most of your soils are rich in nitrogen but relatively poor in potash,

Chief Kinds.

Farm-yard.

Soil-composition.

Potash.

phosphoric acid and lime, and, although much more potash than phosphoric acid is carried off in your crop, potash is but seldom added." So again, many writers have shown, and most conclusively, that if the soil does not possess enough lime, bone and other expensive manures may be worse than useless. Voelcker (*Improv. Ind. Agri.*, 1893, 270), for example, some years ago observed that the differences of practice occur in the manner of applying manures, some planters preferring to throw manure broadcast and to fork it in, others thinking it better to dig a trench round the bush, about a foot or a foot and a half from the stem, and to put back the soil mixed with whatever manure it is intended to apply. "Manures such as bones, oilcakes, etc., are too generally used, because they have always been used, and because there is a general belief in their utility, but it is more than probable that in some cases large sums are needlessly expended on them, while in others lack of lime, potash, or other soil-constituent may be responsible for a diminishing yield."

Bone Manures.

Oilcake (*Poonac*).

The manures and the methods of applying them to one plantation are not always applicable to another, so that no general rule can be laid down, and the indications afforded by the soil itself must be closely followed. In some parts of the coffee area, fish manure is much appreciated as a crop fertiliser, cow-dung being viewed as strengthening the wood. Mixed bone and fish manure produce an abnormally heavy crop. Oilcake (poonac) is believed to strengthen the leaves against blight. [*Cf.* Voelcker, *l.c.* 104–5.]

Fish.

The season for applying manure is also a subject of much difference of opinion, but is possibly best solved by a careful study of the particular manure that it is contemplated to be given. Stem and leaf-forming manure should naturally be given just after the crop has been gathered; those supposed to increase the yield would, on the other hand, best be supplied just before the flowers appear, say in February and March. So again, bone and other manures that take some time to decompose require to be given early and soluble manures much later. Many writers seem, however, to condemn immediate or chemical manures and regard these as possessing few, if any, advantages for coffee.

Season for Manures.

Chemical Manures.

Assimilation of Free Nitrogen.—So much has been said of the advantage of growing (as a sort of rotation) leguminous crops along with coffee, that a volume might be written on that topic alone. The subject is by no means new nor confined in its applicability to coffee. A rotation of clover with grain crops became a principle of all early European agriculture, long before the correct explanation of that system had been discovered. Its application to coffee has been urged by all writers, more especially by Mr. B. Nelson. The use of leguminous shade-trees such as the *sau* of the Assam tea planters (*Albizzia stipulata*) and the *Erythrina lithosperma* of coffee planters are good examples of both shade and nitrogen assimilation. (See below the para. on Shade-trees.) [*Cf. Pests and Blights of the Tea Plant*, 136–47.]

Free Nitrogen.

Leguminous Crops.

Nitrification.—Allied to the study of free nitrogen, though perfectly distinct, are the methods by which the combined nitrogen of the soil or of manures is prepared for plant use and the processes or vehicles of its transmission into the roots. This is defined as the nitrification of the soil. Nitrogenous matter is oxidised and the nitrogen developed into a nitrate chiefly of lime or of potash. Until quite recently it was believed to be a simple chemical process. But it has been ascertained to be a consequence

Nitrification of the Soil.

Ammonia.

of the vital activity of certain organisms, chiefly bacteria. Ammonia compounds are found by the agency of uro-bacteria and other putrefactive organisms before the nitrates are produced. Dr. A. B. Frank (*Lehrb. der Botanik*, 1892, i., 259–75) gives details of some studies of symbiotic fungi found on the roots of certain plants, such as on a few species of *Cupuliferæ* and *Orchidaceæ*. These would seem to aid in nitrification.

Nitrogen Hunger.

A long series of articles from the pen of Mr. H. B. Evans will be found in *Planting Opinion* of 1900, in which he advocates that "Nitrogen Hunger" is one of the chief maladies of the coffee plant. He seems to have assumed that the nitrogen of the soil and of the manures of coffee estates does not exist in an assimilable condition. In other words, that the agents of nitrification are absent to a ruinous extent. This, he would further believe, proceeds from the deficiency of a necessary symbiotic fungus, the function of which (Evans affirms) is the transmission of nitrogen from the soil to the roots of the coffee. Should the existence of a symbiotic fungus be actually established for coffee, the conditions that would favour its extended production might become of supreme importance. But the issue, so far as present knowledge goes, is a pure hypothesis. The presence of a

Janse's Discoveries.

fungus on the superficial roots of the coffee was discovered by Janse in Java. [*Cf. Ann. du Jard. Bot. de Buiten.*, xiv., 113–8.] That fungus was most prevalent in soils rich in humus, and was also found on the roots ramifying among the litter of dead leaves on the surface. But no one has as yet proved that Janse's fungus is actually beneficial to the coffee plant, and Janse himself, like all other investigators, failed to specially cultivate it. Although there are possibilities in this direction, the subject is infinitely less known than the action of the bacteria contained in the root tubercles of the leguminous plants indicated above. [*Cf.* Percival, *Agri. Bot.*, 1902, 764–6.]

Too highly manured.

Concluding this brief review of coffee manures, it may be remarked that Voelcker observes very truly that "a sure sign of the land being too highly manured is the appearance of shoots all up the stem. The indication of a good bush is, on the contrary, the healthy growth of new wood on the branches." [*Cf.* Wall, *Manuring of Coffee Estates*; Burgess-Brown, *Coffee Planting* (17 *years' experience in Ceylon*), 1877; Hughes, *Ceylon Coffee Soils and Manures*, 1879; Munro, *Soils and Manures*; Lawes, *Corresp. regarding Coffee Manures*, in *Planting Opinion*, Aug. 1896; Kramer, *Mededeelingen Pl. Java*, 1899, 3, 73; 1900, 64; 1901, 1, 56; Clarke, Prize Essay, *Management of Soils under Coffee*, 1883; Elliot, *l.c.* 350–82; Pringle, *Madras Mail*, 1891; *Revue des Cult. Colon.*, 1901, viii., 198, 294; Lehmann, Lect. before N. Mysore Planters' Assoc. (reprinted in *Planting Opinion*), Nov. 1900; also subsequent lecture in *Planting Opinion*, Aug. 1903; *Cultura Rational du Cafeeiro*, in *Journ. dos Agri. Rio.*, 1902, ii., 57; São Paulo, *Boletin da Agri.*, Jan. 1902.]

Pruning.

Pruning.—Within the past few years, thanks to the enlightened energy of Mr. Leeming of Scotforth, Shevaroys, there has come into existence two diametrically opposite schools. These may be characterised as the non-pruning and the severe-pruning systems. Having studied the latter for some time, and formed the opinion that certain departures were urgently needed, I became a partial convert to the non-pruning system so ably advocated by Leeming. It would seem, at all events, very possibly preferable to the system of severe pruning that presently prevails. Judged of from the purely botanical standard of the state of health and vigour of

the plants, the non-pruning system seemed superior to the customary form of severe pruning. But I am disposed to add that I can easily conceive of climatic conditions and stock plants where a pruning system would be indispensable, so that I by no means think non-pruning is of universal application. It is, moreover, not new but has for many years been followed in other countries, and even in India has been the practice in vogue with most Native coffee-growers. Leeming would, however, appear to be the first European planter in India who has had the courage of his convictions, and who has not only uprooted two-thirds of the plants on his estate, but allowed those that remained to grow in obedience to soil and atmospheric conditions.

Non-pruning. Severe pruning.

It is customary to speak of coffee-pruning as consisting of three stages, or operations—viz. :—*Topping*, *Handling*, and *Pruning* (proper). The first consists in nipping off the top shoot, so as to check the upward growth. This is done at various stages, usually when the plants are 3 years old, the shoots being then cut at a height of 5 feet ; at other times the nipping off is done much earlier, at 18 months to 2 years, the stem being left at from 2 to 3 feet in height. When the short process is pursued, a sucker (as it is called) soon arises near the top pair of branches and renews the upward growth. This is allowed to continue for a foot more and is then in turn nipped off. A second sucker in consequence rises up and is in like manner checked, when the desired ultimate height of the main stem is attained, namely 4 to 6 feet (usually 5).

Three Stages. Topping.

In the *first* instance (3-year-old stems) there is a terminal snag produced. The topmost pair of branches, below the snag, having the best advantage as to light and air, lengthen horizontally and in due course become so weighted with fruit that the terminal snag of dead wood is split open, and this cleavage increases year after year until many bushes become literally cleft in twain. Admission is thereby given to damp and weather action, also to disease and vermin of all kinds. The aim of the planter in this system of " topping " is to produce a crown or umbrella of primary branches. By what is called " handling," all undesirable suckers and " gormandisers " are systematically removed and every effort made to restrain the bush severely on fixed lines of growth supposed to favour fruiting and be most convenient to the pluckers. [*Cf.* Pierrot, *Cult. Prat. et Ration. du Caféier*, in *L'Agri. Prat. des Pays Chauds*, 1905, v., pt. i., 180–93, 282–301, 411–25, 467–79 ; v., pt. ii., 34–49, 101–8.]

Snag Formed. Cleavage of Stem. Handling.

In the *second* system (largely followed in Coorg), in addition to the terminal snag, with all its possibilities of evil, the growth of the stem is twice checked and snags of dead wood thereby interposed within the stem, which must have the immediate consequence of disarranging and intercepting the circulation of the sap. Nothing could be conceived less advantageous. Moreover, the effort is made by the growth of the secondary branches, ultimately produced, to convert the topmost three or four pairs of primaries into a completely ramified umbrella, that must of necessity render the branches below a useless burden on the resources of the plant. M. Edouard Pierrot recommends a system of pruning that does not seem to me to differ from that followed by the Indian planters. His account of coffee-planting is, however, most instructive, and should be consulted by all interested in the industry.

Interception of Sap Circulation. Umbrella of Branches.

So far as could be learned from personal observation, few subjects are perhaps more urgently calling for reformation, both as an aid against

Reform Imperative.

disease and as a means of enhancing returns, than the system of pruning. Any pruning seemed accordingly preferable to that usually practised. By encouraging a vertical rather than a horizontal growth, the fruiting area of the estate is (if one may so express it) immensely increased. But where, from the nature of the soil, the peculiarities of the climate or the character of stock grown, " coffee trees " could not usually be produced (such as those of Scotforth), it would seem that a pyramidal bush might nevertheless, and with advantage, be aimed at rather than a fruiting umbrella. This might be accomplished in various ways that doubtless would instantly occur to the practical planter.

Vertical *versus* Horizontal.

Suggested Method.

Without desiring to dictate, one method that suggested itself to me while inspecting the coffee estates of the Wynaad may be here mentioned. Plants 4 feet in height, or when they possess 6 or 7 pairs of branches, might be taken in hand. In some plantations, however, bushes only 2½ to 3 years old were seen to possess 15 to 20 horizontal branches, within a height of 4 feet. It is very unlikely that these could all bear fruit, hence perhaps half may have to be removed. But when the approved number of primaries had been secured, the *green terminal shoot*, containing a pair of leaves and a bud, might be nipped off, and at the same time the terminal buds of the topmost three or four primaries similarly destroyed. Care would have to be taken, however, that this plucking off of the terminal buds was done on green not woody shoots. Delay till wood is formed almost invariably involves a snag, and moreover the cutting back of finally matured shoots requires great care and a study of the best age and most favourable season for each locality. The object aimed at by the system suggested would be the production of a pyramidal bush, and if sufficient space were allowed such might ultimately be expected to fruit from the ground to the topmost twig. The check given to the growth of the upper primaries would prevent their attaining the size and weight sufficient to split the stem (in the way already mentioned). The secondaries borne by each primary would in time become fan-shaped, and through the regulation of the lengths of these fans the bush would become completely pyramidal. It is the secondaries borne on the primaries that are the fruiting shoots, and the purpose of the recommendation here offered would be to produce a maximum of such, fully exposed to light and air. Similarly a vertical pyramidal bush might be formed by the development of upward-growing suckers in place of horizontal branches, the main branches being trained to ascend from the stem or its primaries, like those of a poplar. But I need not enlarge on this theme. What seems imperatively necessary is greater spacing, a better-shaped and a more healthy bush. Mr. Leeming's " coffee trees " in these respects, at all events, are as nearly perfect as seems likely to be attained; and where trees are not possible, bushes of a tree shape might be secured in preference to that of an umbrella. (See the remarks above on the tendencies of certain races to produce ascending and of others spreading branches.)

Season of Pruning.

To conclude these observations, it may be said that pruning as presently practised is done about March after the crop has been collected, and consists in removing all shoots that have borne fruit and in selecting and protecting those that are intended for next year's crop. But the pruning must be completed before the flowers begin to form, and in pruning it is often recommended to leave alternately the opposite laterals. All tertiaries, as also diseased branches, are usually cut off. A *handling* is often given just after the flowers appear, in order to remove useless flushing.

Second and Third Handlings.

During a second *handling* suckers and crosswise shoots are rubbed off, without injuring the bark, and, in carefully worked estates, even a third handling is often given. It seems to be an accepted rule that September and October shoots should be preserved, and that as many of those formed in February as can be spared should be removed; but during fruiting the plants are never interfered with. In many estates removal of moss and cleaning the bark is regarded as of great service to the plant and obviates the harbourage of pests and blights.

SHADE-TREES

Shade-trees.

Shade-trees.—When Arabian coffee is grown upon lands of low altitude, shade becomes imperatively necessary, but in these positions Liberian may be successfully grown without any shade. As the upper limits of Arabian coffee cultivation are reached, shade may be largely dispensed with. Much difference of opinion prevails as to the extent and nature of the shade best suited to each region. Cameron (*Rept. Tours in Coorg*, 1898) very properly urges that a mixture of different shade-trees is preferable to one particular tree all over an estate. The balance of soil is thereby secured and a better shade attained. In Mysore tall original trees are generally preferred to the leafy bushes specially resorted to in other localities such as the Shevaroys. If protection from wind be the object aimed at, shelter belts of strong densely branched trees are indicated, but if shade from the sun be the object, much will depend on the severity of the sun and the liability to borer. It is the accepted belief that shade gives a certain protection from that pest, and this circumstance, more than protection from the sun, often determines the nature and extent of the shade-trees desirable. As little shade as possible is necessary during the rainy months, and the maximum shade during the hotter months. The study of the season of new leaf in shade-trees is, therefore, all-important.

Dal.

Dal (***Cajanus indicus***) would make an excellent shade-bush for young coffee, and by its root tubercles and copious supply of leaves it would enrich the soil at the same time, but its liability to fungal disease (see p. 198) might be viewed as rendering it undesirable. Another Leguminous plant has been much appreciated by coffee planters—viz. one or other of the species of ***Erythrina*** such as ***indica, lithosperma*** and ***suberosa***. Mr. B. Nelson (*Planting Opinion*, 1896 to 1899) wrote a series of articles and showed that the use of ***E. lithosperma*** as a shade-tree gave a material increase to the yield of coffee. The Silver Oak (***Grevillea***) is much commended by many planters, but while useful for shade it can have no manurial value. The other trees, fairly extensively employed, may be here mentioned in alphabetical sequence, viz. :—***Acrocarpus fraxinifolius; Albizzia Lebbek, moluccana, procera*** and ***stipulata; Artocarpus Chaplasha, integrifolia*** and ***Lakoocha; Bischofia javanica; Cedrela Toona; Dalbergia latifolia; Ficus asperrima, glomerata, hispida, infectoria,*** and ***mysorensis; Grevillea robusta; Pithecolobium Saman; Pterocarpus Marsupium;*** and ***Trema orientalis***. Many other trees might also be mentioned, such as one or two exotic plants, for example India-rubber (***Manihot Glaziovii***) and ***Eucalyptus***. As catch crops Indian corn has also been tried, and with fair success; and in Coorg, pepper and cardamoms are much resorted to, especially by Native cultivators. [*Cf. Kew Bull.*, 1895, 306; Graham Anderson, *For. Trees in Coffee Lands Mysore*, 1888; *Rept. Agri. Chem. Mysore*, 1901–2, 29–35; *Journ. d'Agri. Trop.*, 1902, ii. 124–5; *Trop. Agrist.*; *Planter*; *Madras Mail*, etc.]

Erythrina.

Silver Oak.

India-rubber.

Pests and Blights.

ENEMIES—PESTS AND BLIGHTS.—To give even the most general outline of this subject would occupy many pages. Having studied with some care the enemies of the tea plant, the first impression left on my mind, on visiting the coffee plantations, was the comparative absence of pests. An ordinary tea garden when compared with a coffee plantation would afford the entomologist ten to every one for his special study. Even the blights or fungal diseases are far less numerous, though one is very much more prevalent and widespread than any of the blights of tea. At the lowest possible estimate there are 200 insect pests on the Indian tea plant, and perhaps not twenty all told on the coffee. But the few that are present are often disastrous to the industry, and thus make up for their specific paucity by their individual voracity. In fact it may be said that two or three insect pests and one or two fungal blights have practically baffled both planter and scientist and have proved so disastrous as to have

ruined the industry over large tracts of country. This is significantly true of Ceylon, the leaf-blight having there proved so completely incurable as to have caused the planters to substitute tea for coffee, as their only escape from ruin. Numerous reports and monographs have been published by Morris, Marshall Ward, Nietner, Bidie, Harman, Cooke, Massee, Barber, etc., so that it cannot be said the subject has been neglected, but so far little progress has been made of a practical nature.

The more important diseases of the coffee plant are the following :—

Leaf-blight.

1. ***Leaf Blight, Hemileia vastatrix, Berk. & Broome, Gard. Chron.***, Nov. 6, 1869, 1157 ; Abbay, *Journ. Linn. Soc.*, 1878, xvii., 173–84 ; Morris, *Coffee Leaf Diseases Ceylon and S. Ind.*, 1879 ; Harman, *Coffee-Leaf Disease Bangalore*, 1880 ; Jardin, *Le Caféir*, 1895, 264–6 ; Tubeuf, *Plant Diseases*, 1897, 352 ; Philip MacMahon, *Queensland Agri. Journ.*, April 1898, ii., 301 ; Massee, *Textbook Pl. Diseases*, 1899, 27, 231–2, 407; Lecomte, *Le Café*, 193–203; Jumelle, *Les Cult. Colon.*, 376–7 ; Massee, *Rev. Genus Hemileia*, in *Kew Bull.*, 1906, 35–42. This fungal disease appears to have been first observed on coffee in Ceylon, about the year 1869, and in South India two years later. It has since appeared in

Distribution.

Burma, China, Java, Sumatra, the Philippine Islands, and been identified as met with in the coffee districts of Africa (even at Victoria Nyanza), and probably wherever coffee is cultivated in the Old World.

Origin.

It has been assumed as probable that ***H. canthii***—a parasite found on ***Canthium campanulatum***—was the parent source of ***H. vastatrix***, the differences observable between the two fungi being in all probability the result of growing on slightly different hosts. So in the same way leaf-blight, seen in Natal and other African plantations, may have originated from ***H. Woodii***—a parasite found on two species of ***Vangueria*** and even on ***Coffea Ibo***. Massee accordingly writes : "It is not at all necessary to assume that the coffee disease has been imported along with the coffee plant from one country to another, taking into consideration the wide distribution of different species of plants attacked by ***Hemileia, vastatrix*** or ***H. Woodii***, both of which are capable of infecting species of ***Coffea***." In India there are some six or seven species of ***Canthium***, fairly abundant wild plants in the coffee area, also a species of ***Vangueria*** both in Kanara and the coffee tracts of Burma. If, therefore (as pointed out by Massee), a practical lesson is to be drawn from these considerations, to start a plantation in a district where these and other allied plants to the coffee are abundant would probably mean disaster. To grow for the purpose of shade, plants belonging to that family would also very possibly be dangerous. All rubiaceous plants should therefore be watched for any appearance of leaf-blight, and exterminated as far as possible from proximity to coffee.

Practical Lesson.

The leaves of coffee are the parts most frequently attacked by ***Hemileia***, though spots are sometimes present on the young shoots as well as on the fruit. These expand in size irregularly, are at first pale yellow, but in time become bright yellow and orange coloured. Though showing through on both surfaces, the spores appear on the under-surface only. These are formed in dense clusters, and emerge from the tissue by the breathing mouths (*stomata*) of the leaves.

Treatment.

While touring through the coffee districts of South India I observed the grub of a minute insect feeding on the spores of this fungus. I was told this had been seen by the planters for some years. It would appear of importance that the life history of that little creature should be worked out, since it may be the planters' greatest friend. When leaf disease is at all serious it is so prevalent as to render most of the methods of treatment, that have as yet been suggested, quite impracticable. Syringing with fungicides, such as the Bordeaux mixture, sulphuring the leaves, removing and burning the leaves, tearing off or punching out the diseased portions, have each and all been advocated and tried with varying, though never with complete, success. The best results as yet recorded have been attained by producing a stronger, more vigorous plant, through increasing the spacing, lessening the shade, improving the drainage, manuring liberally, and restraining the pruner's knife. Under some such treatment

liability to borer may be increased, but leaf-blight brought under control. On some soils, under certain climates, or with particular exposures, leaf-blight never has been serious, and, moreover, either the plants are now better able to withstand the disease or its virulency is being attenuated, because in South India coffee-planting is by no means impossible, in spite of blight and borer. The low prices, through overproduction in South America, are far more serious than all the blights at present known. There would seem little doubt that had the Ceylon planters cultivated and manured their estates more thoroughly and systematically than they did their industry might have been saved. When the disease appeared both soil and plant were exhausted. The rapidity of the destruction that ensued may be thus demonstrated: average yield for the years 1866–8, all over the island (that is, before ***Hemileia*** appeared), was 4·28 cwt. per acre; in 1872–4 it had fallen to 2·93 cwt. per acre, and in 1878 to 2 cwt. per acre. Ruin of Ceylon Plantations.

2. ***American Coffee Disease, Stilbum flavidum, Cooke;*** Massee, *l.c.* 445; Lecomte, *l.c.* 204; Jumelle, *l.c.* 377.

"This disease is almost as destructive to the coffee industry in the New World as ***Hemileia vastatrix*** is in the Old World." "The symptoms of the disease are unmistakable; circular whitish blotches occur on the leaves, often in considerable numbers, and are equally marked on both surfaces. Using a pocket-lens, very minute fungi resembling a miniature pin in shape, and of a clear yellow colour, can be seen grouped on the spots on the upper surface of the leaf. The berries are also sometimes attacked, being marked with circular spots. On the young shoots the pale diseased spots are elongated" (Massee). As this disease has not appeared, so far as is known, on the coffee of Asia, we have the somewhat significant fact of two coffee blights, the one confined to the Old and the other to the New World. A species of ***Stilbum*** does considerable injury to the tea, being the Thread Blight of tea planters. [*Cf. Pests and Blights of Tea*, 392.]

3. ***Leaf-rot.***—This leaf-blight was described by Cooke under the name ***Pellicularia koleroga,*** the specific name being the vernacular for the disease. [*Cf.* also Tubeuf, *l.c.* 518; Lecomte, *l.c.* 203.] It is said to be prevalent in Mysore during July; the leaves, flowers and berries become covered with a shiny gelatinous substance which turns black about the time that the affected parts fall from the plant. Leaf-rot.

Cameron thinks that continuous or heavy rainfall, dense shade, drip, and stagnation of drains favour the development of this blight. Improvements to combat these defects are beneficial. All affected leaves should be burned or dusted with flowers of sulphur. As seen in the Kew Herbarium the leaves are covered with a simple mycelium much as in ***Stilbum***, but without any fructifications. Samples of it have come from the coffee plantations in Venezuela, Costa Rica and Jamaica, as well as Mysore, so that it is fairly widespread and should it commence to assume its complete form, may become a serious pest. It should therefore be kept under control and carefully studied.

4. ***Coffee-twig Disease, Necator decretus, Massee, l.c.*** 327. This Twig Disease is said to be a destructive parasite on coffee trees at Selangor. It commences at the tips of the young branches and extends downwards. Bursting through the epidermis of the shoots are minute white spots, which soon become orange-red in colour and gelatinous in texture. The twigs thereafter turn black and thus appear as if syringed with acid, while at the same time the bark splits as in canker. Twig Disease.

During my tour through Coorg and the Wynaad I was shown a disease that brings to mind the Malay twig disease or canker just described. The tips of the fruiting shoots, including a large number of leaves and berries, become withered and dried up, and in due course turn black. I was unable to discover on these any fungus, but obviously should have visited the plantations at a much earlier season of the year in order to study the distressing disease indicated. The withered fruits, if gathered along with the ripe cherries, greatly lower the value of the crop, so that they are not only a serious loss but a source of danger through their being inadvertently collected. The Indian planters regard the blackened and withered shoots as a consequence of a want of general tone and vigour, and as proceeding from poverty of soil rather than being due to any specific disease. An inspection of the specimens preserved at Kew leads me, however, to suspect Withered and Blackened Berries.

that it is due either to the self-same species, or an allied fungus to that just described as the coffee-twig disease of Selangor.

Borer.

5. ***Borer;*** *Ind. Mus. Notes*, ii., 153. This pest used to be known as "Worm" or "Coffee Fly." It is most troublesome in Mysore, South Coorg and the Wynaad, where in 1865–6 it destroyed whole estates. It has also appeared in the small coffee gardens of Assam and Burma. It is the grub of a beetle, ***Xylotrechus quadrupes, Chevr.***, and is yellowish-red with black transverse lines. It damages the tree by boring holes into the stem, usually a few inches from the ground. These passages are at first transverse, but soon ascend spirally to the growing tip, where the larvæ are matured. The plant early shows signs of death and ultimately withers down to the point where the beetle entered.

***Nim* Oil.**

This pest is most prevalent in hot, exposed gardens, and may be kept in check by free irrigation, good tillage and the growth of large shade-trees. Cameron speaks of *nim* oil, poured into the openings made by the borer, as being useful in either expelling or killing the grub. As a preventative it is believed also desirable to encourage rather than interfere with the nesting of insectivorous birds in the plantation. If the stems of injured trees are collar pruned, new suckers are thrown out and the plants thus renewed, while the borers with the channelled stems are destroyed.

Another borer is the larvæ of the moth ***Zeuzera coffeæ***, *Nietner.* [*Cf. Ind. Mus. Notes*, ii., 157; Watt and Mann, *Pests and Blights of Tea*, 200–1.]

Bugs.

6. ***Bugs.***—Various insects are by planters all called bugs. They belong for the most part to the family known as the *Coccidæ* or Scale Insects. There are four chief pests of this kind, known as Brown, Green, Black and White Bug.

Brown Bug.

The Brown Bug, Lecanium hemisphæricum, *Targ.*; Green, *Coccidæ of Ceylon*, 232–4, pl. 85; *Ind. Mus. Notes*, ii., 168. "This insect was formerly known as the 'Brown Bug' of the coffee plant, and before the advent of the 'Green Bug' was considered the most serious insect pest of that plant." "For some years before the coffee failed, the bug—as a pest— had practically disappeared." It is met with now and again all over the coffee area of India, but nowhere to a very serious extent. It is perhaps most harmful in the Shevaroy, Nilgiri and Mysore plantations. [*Cf. Agri. Journ. Ind.*, 1906, i., pt. i., 77–8.]

Green Bug.

The Green Bug, L. viridæ, *Green; l.c.* 199–203, pl. 69; *Ind. Mus. Notes*, ii., 168. This proved such a scourge in Ceylon that it was practically responsible for the final abandonment of coffee cultivation over the greater part of the planting districts. It first attracted attention in 1882, and by 1886 had been dispersed all over the coffee districts of Ceylon. It attacks weakly trees and almost completely denudes them of all but the two or three terminal leaves. On healthy plants the leaves become black through the attendant fungus, but do not fall off, and the bushes make a vigorous effort to grow. In Ceylon the plants had been weakened by ***Hemileia*** when they became infested with green bug. In 1881 the exports were 452,000 cwt., but ten years later they had fallen to 88,780 cwt., and in 1902 were only 10,000 cwt. [*Cf. Agri. Journ. Ind.*, 1906, i., pt. i., 78.]

Black Bug.

The Black Bug, L. nigrum, *Nietner*; Green, *l.c.* 229–31, pl. 84; *Ind. Mus. Notes*, ii., 168. This bug, though found on coffee, is not so serious a pest as either the brown or green bug.

Mealy Bug.

The White or Mealy Bug, Pseudococcus adonidum, *Linn.*; *Ind. Mus. Notes*, ii., 168. This is a flat oval creature covered with white down arranged in parallel ridges and running across its back. It prefers hot, dry plantations and would seem to be harboured by the species of ***Erythrina*** now so largely grown for shade purposes. In a plantation in the Wynaad where the trees had been cut down, I observed white bug very prevalent on the underground portions of the stems, as also on the roots, and swarming to the neighbouring coffee. Whether or not this observation is of invariable application cannot at present be affirmed, but plants seen to favour the growth of any species of bug should be discouraged in coffee plantations even although the present species has not been recorded as doing serious damage.

Treatment.

Every effort has been made to exterminate these pests. But in the case of green bug, the insect, being green in colour and small in size, was not noticed

until it had been established in Ceylon in such force as to defy all subsequent efforts at extermination. It usually decreases during both very wet and very dry weather. The most hopeful method of dealing with it, as also with all other scale insects, is through their natural enemies. The larvæ of certain ladybird beetles (*Chilocerus circumdatus* for brown bug, and *Scymnus rotundatus* for white bug) live on them, and a minute chalcid wasp breeds within the body of the mature *Lecanium*. So also a parasite fungus (*Cephalosporium lecanii*) kills these insects by living on their bodies.

Grub.

7. *Grub.*—The larvæ of the moth *Agrotis ypsilon, Rott.; Ind. Mus. Notes*, ii., 161; iii., 21; Watt and Mann, *Pests and Blights of the Tea Plant*, 1903, 220–3; Maxwell-Lefroy, *Memoirs, Dept. Agri. Ind.*, 1907, i., 169. The Cutworm, Black Grub or Ringer are very destructive to the seedlings of coffee, as much as 25 per cent. being often found destroyed by this pest. It seems to have been specially destructive in Mysore

The larvæ of the cockchafer, *Lachnosterna pinguis, Walk.*, often do much damage by eating the roots of the young coffee plants. [*Cf. Ind. Mus. Notes*, ii., 149; Watt and Mann, *l.c.* 167–9.]

8. *Other Insects* that occasionally attack the coffee may be here enumerated:—*Arhines destructor, Nietner*, a weevil that eats the leaves *Parasa lepida, Cramer*, a moth that defoliates the bushes; *Narosa conspersa, Walker; Aloa lactinea, Cramer; Euproctis virguncula, Walk.; Trichia exigua, Feld.; Galleriomorpha lichenoides, Feld.; Epithecia coffearia, Feld.; Boarmia leucostigmaria, Feld.*, and *B. zeylanicaria, Feld.; Tortrix coffearia, Feld.; Capua coffearia, Nietner* [*cf. Ind. Mus. Notes*, v., 187], and *Gracilaria coffeifoliella, Motsch.* (recalling *Elachista coffella, G.M.*, in Jardin, *l.c.* 258–9 and pl.), are all moths reported to have been occasionally met with on coffee in Ceylon. So also *Anthomyza coffeæ, Nietner*, is the coffee-leaf borer; *Stachia geometrica, Motsch.*, a species of *Rhynchota* that attacks the coffee-cherries; *Aphis coffeæ, Nietner*, the coffee-louse (parasitised by *Micromus australis*); and *Acarus coffeæ, Nietner*, the coffee-mite. So far as presently known, none of these pests have given any cause for anxiety to the Indian planters.

9. *Other Pests.*—Locusts, Weevils, Rats, Squirrels, Monkeys and Jackals often do much injury—the animals mentioned being very fond of the ripe cherries.

Life of the Estate.—The late Mr. William Pringle very rightly observed that "no matter how healthy a coffee tree may be, no matter how carefully pruned, handled, tended and nourished, its life will end sooner or later. Under favourable conditions, the tree may live for fifty or sixty years; as a rule, it will seldom last thirty. It will, under favourable conditions, be in full bearing in the fifth or sixth year, and may go on for twenty to twenty-five years giving paying crops. Many trees are exhausted in ten to fifteen years by unskilful treatment, borer, and attacks of *Hemileia vastatrix*, etc., and must make room for a new generation. If the vacancies can be successfully supplied and the plants developed in a healthy and vigorous manner, there is no reason why an estate should be limited as to age. If we can so arrange matters as to have a continual succession of young plants coming on and developing into healthy trees to replace those taken out, a coffee estate may be considered as a permanent investment. In suitable localities efficiently drained and manured this can be done: and an estate may be considered to be working under the best possible conditions of perpetuation where from 4 to 5 per cent. of vacancies occur every year that are successfully supplied. It is upon the success of the supplying that the life of the estate depends, and practical planters consider this question one of the first importance in Southern India. It is only when supplies cannot be got to grow that there is a necessity to abandon the estate. With many aspects and under some conditions the plants cannot be raised, except at a ruinous cost."

Age of Coffee Plants.

Permanent Investment.

MANUFACTURE.

Berries. ***Terms Employed.***—The ripe coffee fruit is called the "Cherry"; the contained twin seeds are the "Berries." When only one seed is developed

Pea-berry. it is spoken of as "Pea-berry." This is often upheld to be richer in flavour, and accordingly much has been said about the possibility of producing a plant that would yield mainly, if not entirely, pea-berries. The succulent

Pulp. outer coat of the fruit is the "Pulp," and the inner adhesive layer is known

Parchment. as the "Parchment." The seed-coat within the parchment which adheres

Silver-skin. closely to the seed is called the "Silver-skin." The pulp is commonly removed at the plantation, but it is frequently the case that the berries are sold in parchment and either submitted to treatment in the coast towns or exported in that condition to Europe, where they are hulled and finally prepared for the market. The machinery for this purpose is expensive, and the operation of final cleaning can be as effectually if not better accomplished in Europe than at the plantation. It is believed moreover that the coffee carries best in parchment, so that the extra freight charges are more than compensated for by the quality of the coffee turned out in Europe. [*Cf. Kew Bull.*, 1893, 128–33.]

Cherry. The preparation of the berry from the cherry is effected by certain distinct operations that may be here indicated very briefly. It would, however, be impossible to describe all the methods and appliances used without devoting many pages to this subject.

Seasons. ***Seasons and Crops.***—The blossoms as a rule appear in March and the fruits commence to ripen in October and continue till January. The more gradually the blossom fades the better: a superabundance of flowers is not considered a good prognostication, since only a small percentage

Rain. form fruits. Rain during flowering is unfavourable, but after the fruit has set a shower or two is beneficial. It is usually advocated that none but fully ripe fruits should be collected. In Arabia a cloth is placed below and the bushes shaken, when the ripe cherries fall into the cloth. In India they are hand-picked, and it is believed not necessary that they should

Colour of Cherries. be pink-coloured all round; the slightest tinge is sufficient, and in fact with the appearance of colour the sooner picked the better. The berry (seed) inside will be found to be of a fine dark-greenish or bluish-green colour.

Greenish Tint. It is the endeavour of the planters to preserve this greenish tint as much as possible. Berries that have dried into a reddish or chocolate colour are spoken of as "foxy," and the presence of such lowers very greatly the price. Berries that have fallen to the ground are collected at the end of

Jackal Coffee. the season and are known as "Jackal Coffee."

Pulping. ***Pulping.***—The operation known by this name is the removal of the pulp which surrounds the "berries" (seeds). This is best done day by day on the collections being brought to the factory. If unavoidably delayed it may be necessary to produce fermentation before the cherries can

Machinery. be pulped. There are two chief forms of the pulper, viz. the disc or the cylinder, but a long list of special machines, mostly developments of these, might be given. The principle in both is a grater, working against a smooth

Disc-pulper. chop, adjusted according to the size of cherries. The disc-pulper is the simplest contrivance, and this may be either single or double and worked by hand or steam. A single pulper will accomplish 20 to 25 bushels an hour, a double one 40 bushels, or twice that amount if driven by steam. In design it is somewhat like a cotton-gin: it tears off the pulp and drops the seeds through a sieve kept in position so as to carry forward the pulp

or tails. The best design for a factory is a three-storied building placed against the hillside and so arranged that the cherries are conveyed to the top story without requiring a lift. From there a hopper carries the cherries and water, in a continuous stream, on to the grater. Space cannot be afforded to discuss the other numerous inventions that exist for pulping; suffice it to say that most Indian factories are behind the standard of those in other countries, and that the defects of much of the Indian coffee are due mainly to the imperfections of the factory.

Tails.

Factory.

Indian behind Date.

Native coffee is mostly dried with the pulp attached, then pounded in a mortar. It is thus practically the system followed in Arabia in ancient times, and which is still to some extent pursued in that country.

Fermentation and Washing.—On the beans (seeds or berries) passing through the sieve they are found to be covered with a sticky mucilaginous material. If the contained saccharine matter be not removed it is difficult to dry the berries. This is accomplished either by washing or fermenting, or more generally by both. The period necessary for fermentation depends greatly on the temperature of the atmosphere, but from 12 to 18 hours usually suffice. Mr. Graham Anderson has shown that the amount of saccharine matter depends on the exposure, and that the produce of young trees will not ferment as readily as that of mature plants. The berries, after thorough washing, are spread out to dry on specially prepared platforms which constitute the lowermost portions of the factory.

Washing.

Fermentation.

Saccharine Matter.

Hulling or Milling.—This consists of the removal of the parchment and silver skin from the beans. As already stated, this operation is usually performed by the traders and not by the planters. Many firms, especially at the coast towns, do the milling, such as Staines & Co. of Coimbatore, but a large proportion of Indian coffee is milled in London. The Indian planters seem to be of opinion that this operation might be much improved by better machinery than exists in India. [*Cf. Planting Opinion*, Aug. 1899.] A bushel of parchment coffee will usually give half the quantity of clean beans. The coffee is then assorted into various grades according to size of berries. This not only meets the necessities of various markets, but has the effect of furnishing a uniform berry and one that will roast to the same extent throughout. Nothing injures coffee more than a percentage of small berries that become charred before the others are sufficiently roasted. Charcoal absorbs completely the aroma of coffee, hence charred berries are positively destructive of merit.

Hulling.

Yield.

Assortment.

Size.

Packing.—It is of the greatest consequence also that attention be given to the art of packing. If berries be exposed to the drying action of the atmosphere beyond a certain extent, their value may be thereby greatly depreciated. All the best coffee is accordingly packed in casks, the utmost care being taken that the wood used may not taint the coffee. Packing in sacks or bags is much inferior, and if shipped with mixed cargoes, coffee in bag may be so tainted as to be next to useless.

Packing.

Drying.

Casks.

Sacks.

Adulteration and Substitutes.—This subject has attracted much attention for many years. It may be confidently affirmed that although much difference exists between the coffee of one estate and another, dependent very largely on the process of manufacture and the care bestowed in drying, assorting and packing, direct adulteration never takes place at the plantation. While that is so, there is perhaps no other dietary article so much and so persistently adulterated as coffee. This is very largely a consequence of the legislative measures that prevail in the countries of

Adulteration.

Never done at the Plantation.

Caused by High Taxation.

consumption. When taxed abnormally high, adulteration prevails. But this is often safeguarded by special legislation such as the French enactments that prohibit the vendor from mixing. In England, on the other hand, mixing is so much in vogue that it is often difficult to procure pure coffee. "Our Coffee Mixture" may contain any adulteration conceivable, with perhaps not more than 5 per cent. of coffee. This is the natural consequence of legalising mixtures. Criminality consists alone in selling as "pure coffee" an article that contains anything but coffee. Legally "Chicory" may be the roasted chicory root itself, or the root of an allied plant or other vegetable substance applied for the same purpose.

Mixing.

Chicory.

Adulterants.

The substances mostly employed in adulteration of coffee are the roots of chicory, dandelion, mangold-wurzel, turnips, parsnips, and carrots. The seeds of beans, peas, date-stones, malt rye, burnt sugar, biscuits, locust-beans, figs, etc., are all used. Roasted flour coloured with ferruginous earth and flavoured with the grounds of exhausted coffee or of other even more objectionable substances are often sold as coffee. There seems every reason for believing that the decline of the demand for coffee throughout the world is largely a consequence of the difficulty in obtaining the pure article. For further particulars regarding coffee adulteration confer *Chicory and Coffee*, a lithographed report by J. D. Hooker, John Lindley, Thomas Graham, John Stenhouse, Dugald Campbell, William B. Carpenter and A. S. Taylor, issued by the Inland Revenue office in 1853. This gives the microscopic structure and chemical tests by which the adulterants of coffee may be recognised, and although more recent publications exist on this subject, hardly any are more accurate and authoritative. [*Cf. Food Journal*, March 1870, Dec. 1873; Clifford, *Journ. Soc. Arts*; and Hanausek, *Micro. Tech. Prod.* (Winton and Barber, transl.), 1907, 271–4.]

Examination.

Negro Coffee.

The seeds of several species of *Cassia* are used as coffee substitutes under the name of Negro Coffee. [*Cf.* Hooper, *Rept. Labor. Ind. Mus.*, 1900–1, 23–4.] For "Malt Coffee," consult Hanausek (*l.c.* 354).

TRADE IN INDIAN COFFEE.

Standards.

Commercial Tests.—The value of coffee depends upon many circumstances, such as form of the berry, its size, colour, smell, flavour, age, and uniformity. One of the greatest difficulties is to discover a standard by which merit may be definitely determined. Were it possible to fix a standard, the planters could aim at a definite article. Much has been done in India by Mr. Leeming, Dr. Lehmann and others in this direction, and it is believed their efforts may soon be rewarded. Lehmann found that the quantity of the alkaloid CAFFEINE was no evidence of quality. Caffeine (as shown by M. Bertrand) varies greatly. In *Coffea arabica* it ranges from 0·83 to 1·60 per cent.; in *C. liberica* between 1·06 and 1·45 per cent.; and in *C. stenophylla* between 1·52 and 1·70 per cent. In a series of specimens specially analysed, those that had the highest specific gravity and contained the most nitrogen and phosphoric acid brought the highest price. Colour seems to depend more on the degree of ripeness when collected, and the care taken in manufacture, than on the nature of the soil or the class of plant grown. As a general rule the Old World coffees are inclined to turn yellow, and the New World green. Weight decreases with age and by overdrying. Odour is perhaps the most important criterion, and apparently it can alone be determined by expert opinion.

Caffeine.

Percentage.

Specific Gravity of Berries.

Colour.

Odour.

Yield.

Yield and Cost of Production and Price Realised.—Under the paragraph devoted above to "Localities and Area" will be found all the

particulars on these topics for which space can be afforded in this work. The regions of Indian cultivation, the average production, and the estimates of yield per acre have thus been exhibited. These facts have to be re-read in connection with the returns of trade that have presently to be furnished. It has been shown that an average of 3 rising to 7 cwt. an acre would fairly express the better-class European plantations, but there is a large number of small Native concerns that lower both the average yield and the quality of Indian coffee. It is believed that the Native plantations yield from ¼ to 1 cwt. an acre. The cost of cultivation has been variously put, but it seems probable that Rs. 120 per acre for the best European and Rs. 40 for Native coffee would be safe estimates. The former would include manuring, as also all factory charges. It is generally stated that the lowest cost of production on European plantations is Rs. 80 yielding 2½ to 3 cwt. an acre.

3 to 7 Cwt.

¼ to 1 Cwt.

Cost.

The net cost of coffee has been taken as Rs. 27 a cwt., and since the cost of production is 60 to 70 per cent. wages paid, a fair computation of the value of the industry to the inhabitants of the coffee area may be arrived at by multiplying the European and Native acreage by the estimated cost of production. The mean of all the figures usually published shows one person to be employed on every 2½ acres of coffee. But such calculations are tentative in value only, as there is perhaps no other Indian industry more obscure and misleading, so far as its statistics are concerned, than that of coffee-planting. There are, however, three fairly certain aspects, viz. that the cultivation (see p. 370), production and price have all three seriously declined within recent years. Thus taking the price obtained in 1874 as being 100, we have the following relative prices for Indian coffee down to 1902 :—

Wages.

Labour to Acreage.

Decline.

Year.	Price p.c.	Variation.	Year.	Price p.c.	Variation.
	s. *d.*			*s.* *d.*	
1877	110 0½	120	1894	101 0	110
1879	100 10	110	1897	94 8	103
1882	85 4	93	1898	78 1	85
1884	76 4½	83	1899	65 2½	71
1887	94 9½	103	1900	47 0	51
1889	99 10	108	1901	47 3½	51
1890	106 2½	115	1902	60 1½	65
1893	105 4½	114			

Prices.

During the past five years the actual prices realised were:—1901–2, Rs. 49–0–4 (variation 65); 1902–3, Rs. 49–1–5 (65); 1903–4, Rs. 46–15–2 (62); 1904–5, Rs. 50–6–2 (67); 1905–6, Rs. 48–12–4 (65); 1906–7, Rs. 43–11 (58) per cwt. As with estimates of average yield, so with prices: the average may be quite misleading as a factor of possible results. But, as already observed, competition with the cheap production of Brazil has proved the most alarming feature of the Indian industry.

Competition with Cheap Brazilian Coffee.

Foreign Transactions.—In Milburn's *Oriental Commerce* is given a statement of "the East Indies" coffee imported into England from 1802 to 1810. The total was in 1807, 2,721 cwt. "Company's" and *nil* "Private," while in 1809 there was *nil* Company's and 213 cwt. Private. Throughout the years indicated the imports fluctuated so greatly that the returns are of little value. It is, however, explained that it came from Moka, Java, Bourbon and Ceylon. No mention of India. About ten years later we read of a charter granted for an Indian plantation, and

Imports into England.

Export from India.

by 1853–4 coffee figured among the standard exports from India. In that year the supplies drawn by the United Kingdom from India were valued at Rs. 4,75,980. Ten years later (1863–4) they were Rs. 38,43,910; in 1873–4 they were Rs. 73,98,530; in 1883–4 they were Rs. 1,06,21,380; by still another decade (1893–4) they had begun to shrink, being then valued at Rs. 99,61,631. Turning now to the returns of the total trade for the past six years: the exports in 1901–2 were 255,042 cwt., Rs. 1,25,02,200; in 1902–3, 269,165 cwt., Rs. 1,32,12,628; in 1903–4, 291,254 cwt., Rs. 1,36,73,773; in 1904–5, 329,647 cwt., Rs. 1,66,09,757; in 1905–6, 360,182 cwt., Rs. 1,75,67,240; and in 1906–7, 228,094 cwt., Rs. 99,64,778. The Madras ports furnished the entire amounts, less a fluctuating quantity of from 1,000 to 10,000 cwt. exported mainly from Bombay. Of the receiving countries the United Kingdom heads the list, the consignments thence having been in 1901–2, 116,584 cwt., Rs. 64,25,838; in 1902–3, 155,501 cwt., Rs. 85,10,903; in 1903–4, 152,452 cwt., Rs. 82,71,186; in 1904–5, 187,344 cwt., Rs. 1,05,02,674; in 1905–6, 172,384 cwt., Rs. 96,74,780; and in 1906–7, 82,358 cwt., Rs. 41,22,420—a valuation about equal to that of the supply taken by the United Kingdom in 1883–4. These returns thus allow a comparison to be made with the valuations quoted above of the Indian exports since 1853. After the United Kingdom, France has to be mentioned as the next most important receiving country of Indian coffee; during the past five years the exports to that country have averaged a little over 100,000 cwt. And after France comes Ceylon, which during the same period has taken on an average over 20,000 cwt. of Indian coffee a year.

Rise and Fall in Traffic with U.K.

Total Exports.

Indian Production.

Receiving Countries.

United Kingdom.

France.

Ceylon.

World's Production.

The world's production of coffee has been estimated as close on 15 million bags (132 lb. each), of which 11¼ million bags are furnished by Brazil. The greatest coffee-consuming countries are Holland (18·82 lb. per head, calculated on population of 1900), Belgium (10·53 lb.), and the United States of America (10·60 lb.). After these come Germany (6·6 lb.), France (4·79 lb.), Austria-Hungary (2·17 lb.), and the United Kingdom (0·90 lb.).

Consumption.

Conclusion.—For further details of the Medicinal Properties, the Chemical Composition, the Fiscal Regulations (in India and England) and other such topics, the reader is referred to the library of technical works that exists on these and kindred subjects. Practically every report or book of importance has been consulted in preparing the present brief account, and the citation of publications, paragraph by paragraph, should therefore prove helpful to those who desire fuller details.

D.E.P., ii., 491–500.

COIX, *Linn.*; *Agri. Ledg.*, 1904, No. 13; *Fl. Br. Ind.*, vii., 99–100; GRAMINEÆ. Job's Tears, *gurgur*, *jargadi*, *sankru*, *jhonki*, *ka-si*, *kessi*, *kesai*, etc., etc.

Job's Tears.

History.

History.—So much attention was given by the early botanical writers to the subject of *Coix* that the inference might be drawn that it must formerly have been a plant more extensively cultivated than at the present day. It is generally believed to be the *Lithospermon* of Pliny (bk. 27, ch. xi. (Holland, transl.), 1601, ii., 284). In most of the early works *Lithospermon* or *Coix* is spoken of, however, as a wild plant, or one cultivated as a curiosity only. Gerarde, Parkinson, Miller, etc., all allude to the use of the seeds as beads (bedes). The circumstance mentioned by some of the more directly botanical authors, such as Rumphius and Loureiro, that coix was regularly cultivated in Eastern countries as an article of food, seems to have escaped consideration.

Beads (Bedes)

One of the most beautiful of the early drawings of this plant is that given

by Besler (*Hort. Eystett.*, 1613, ii., 13, fol. 6, f. 1). So accurate, in fact, is Besler's picture that it might be reproduced as a modern sketch. But this is not the only interest in it, for in the text the grain is described as striated, a peculiarity, it may be added, that is possessed alone by the cultivated edible forms of the plant, although no mention is made of its being edible. The plant is also figured by Jacobus Bontius under the name of *Milium Solis* (*Hist. Nat. et Med. Ind. Or.*, 1629, in Piso, *Ind. Utri. re Nat. et Med.*, 1658, 152). Turning from these European records to those of the East, we are informed by the authors of the *Pharmacographia Indica* that the seeds are "mentioned in Vedic literature and appear to have been one of the cereals which were cultivated by the Aryans on the hill slopes of the Himalaya." "The Arab travellers in the East became acquainted with the seeds and named them *Damu Daud*—"David's tears," and afterwards *Damu Ayúb*—"Job's tears." Es-Saghani, who died about the year 1260, mentions them in the *Obáb* as a well-known strengthening and diuretic medicine. The Arabs introduced the plant into the West, and it has become naturalised in Spain and Portugal, where it is still known as Lagrima de Job."

Edible Forms.

Vedic Times.

Arab Names.

Carried to Europe.

It is significant that the word *kasi* (or some very similar word) should appear and reappear all over India as the vernacular name for one or other of the forms of this plant. Thus we have the *ka-si* of the Nágas on the north-east frontier of India, *kasei* in the Central Provinces, *kasai* in Gujarat, *kesai* in Berar, and the *cheik* or *kyeit*, *kulese*, and *kalinse* of Burma, and *kosen* in Japan. The word *ka-si* or *kesi* in India most frequently denotes a cultivated edible form. The cultivation as an edible grain is at the present day closely associated with the Mongolians, and its introduction and distribution in India may have been a consequence of the influence of that people; hence very possibly the explanation of the name *ka-si*. [*Cf.* Joret, *Les Pl. dans L'Antiq.*, 1904, ii., 247.]

Kasi.

Mongolian Grain.

Habitat and Distribution.—There are two undoubtedly wild forms of this plant and several cultivated states. By far the most widely distributed is ***Coix Lacryma-Jobi*** proper. This is met with in the Himalaya, Rajputana, the Central Provinces, Bombay, South India, Bengal, Assam, Burma and the Shan States. But its area extends to China, Japan, the Malaya, the American Continent (North, Central and South), the West Indies, Polynesia, the Mascarene Islands and Tropical as also Northern Africa, and it is cultivated as a garden curiosity in South Europe. It is thus met with throughout the tropics and in all warm temperate countries. The other wild species, ***C. gigantea*** (and its variety ***C. aquatica***), has a much narrower distribution, is a distinctly tropical plant, and is practically confined to India and Burma. Of the cultivated (or semi-cultivated) special forms of ***C. Lacryma-Jobi*** the cylindrical-fruited ***stenocarpa*** has been recorded as met with in the Naga hills, Burma, the Shan States, Tonkin and New Guinea. The flattened—spheroidal—form, the connecting link between ***C. Lacryma-Jobi*** and *var.* ***stenocarpa***, is the special bead form. It is a wild plant met with chiefly in Burma, the Malaya, China and Japan, and has been named by me *var.* ***monilifer***. Lastly, the fully cultivated and edible form, ***Ma-yuen***, is grown (so far as India is concerned) in the Central Provinces, Sikkim, the Khasia hills, Burma and the Shan States, and outside India it appears to be cultivated in Tonkin, China and the Malaya, but apparently nowhere else. Grisebach in his review of Botanical Geography (*Roy. Soc.*, 1846, 86) refers to the edible coix as a special feature in the most important area of production of that grain, viz. Eastern Bengal, Assam, Burma and the Malaya. In fact were a statement prepared of the geographical features of interest in the cultivated plants of British India, ***Coix*** would have to be commented on as characteristic of the tract of country that stretches east by south from Nagpur to Sikkim, Assam, Burma, the Malaya and China, and be regarded as an important food grain with some of the most ancient aboriginal inhabitants, especially those of Mongolian origin.

Forms.

Ornamental.

Edible.

Mongolian Country.

Species and Varieties—In the *Flora of British India*, ***Coix gigantea*** has been treated as a variety of ***C. Lacryma-Jobi***, while ***C. aquatica*** has been regarded as a form imperfectly known. It seems probable, however, that all three are fairly distinct plants, separable from each other by constant characters. Whether they should be treated as but one species, with several fairly well-marked varieties, or two or more distinct species, may be open to doubt. It would seem the safer course, however, to accept them as constituting two species with several varieties under each. The best names, if not the most ancient ones (as already indicated), would be ***C. Lacryma-Jobi*** for the one and ***C. gigantea*** for the other. The latter is preferable to ***C. aquatica*** since it has become better known. The

Forms met with.

Two Species.

species thus isolated are certainly very distinct. They differ in structure of leaf, flower and fruit, etc., as well as in habitat and economic properties. The wild states of *C. Lacryma-Jobi* have the capsular-spathe generally more or less spherical, and only slightly drawn out at the apex into a pyriform shape and obscurely angled and universally bluish-white (never chalky-white). The leaves are broad, often distinctly auriculate, quite glabrous, except for the double row of ascending teeth, along each of the veinlets of the upper surface—a peculiarity that gives the texture of the leaf the appearance of being embroidered and makes it backwardly hispid.

Gigantea-aquatica Series.

The *gigantea-aquatica* series of coix are always wild plants; *gigantea* is found on the lower hills—dry soils—a robust erect plant, the *aquatica* in swamps and most frequently as a floating weed, 20 to 100 feet in length. The capsular-spathe is invariably pyriform, much drawn out on the apex, the actual mouth cut obliquely into an elongated lip, which is often somewhat serrulate, ripe fruit prominently angled, and having two or three furrows along its flattened face, of a dull greyish-white to brown colour and very hard. The leaves are much shorter than in *C. Lacryma-Jobi*, most frequently only faintly auriculate, and the upper (inner) surface is often marked by curious transparent glands, which in the young leaves are tipped with hairs; on the outside the leaves are quite glabrous except near the extremity of the sheath, where a few glands of an exceptionally large size are generally present.

Lacryma-Jobi Series.

The forms of *C. Lacryma-Jobi* in the wild state have the capsular-spathe invariably bluish-white, a colour which rapidly disappears under cultivation. In the variety known as *stenocarpa* the capsular-spathe is elongated until it becomes cylindrical, but when cultivated the tubes (so formed) change in colour to chalky-white or become almost straw-coloured. In other forms, instead of elongating, the capsular-spathe becomes short and spherical, until fruits often not more than an eighth of an inch long are found and others more than double that size, but always broader than long; hence the development in these examples may be said to be in the opposite direction to that in *stenocarpa*.

Cultivated Forms.

When they exist as wild plants the shell in all forms of *C. Lacryma-Jobi* remains hard and polished, and, while it may darken in colour and become pink, brown or even black, is never found soft in texture nor chalky-white in colour. But under cultivation the spathe loses the bluish-white colour, becomes soft-shelled, and of a chalky-white or straw-colour to deep blue, brown or black; but in all these cultivated states it assumes a new character—viz. the leaf-sheath, on being transformed into what I have called the capsular-spathe, retains its veins as pronounced striations, so much so as to give the grain (in husk) a striped appearance. In the elongated semi-pyriform states of cultivated *C. Lacryma-Jobi* there is also a further peculiarity—viz. that a portion at the base of the fruit-spathe becomes constricted into a well-marked annular disc. The condition with a soft and striated shell and basal annulus appears to constitute the variety known to botanists as *Ma-yuen*—a name given in honour of the Chinese General who is supposed to have first pointedly directed attention to the plant.

Edible Grain.

Cultivation as Food.—This curious edible grain might almost be said to be unknown to the inhabitants of India generally, except as a weed of cultivation. To many of the aboriginal tribes, however, such as those of the Central Provinces, Sikkim, Assam and Burma, it is an important article of diet. The plant grown as a regular field crop is invariably one or other of the many forms of the variety *Ma-yuen* already sufficiently described. But in times of scarcity the wild forms of these plants are (all over India) resorted to as articles of food. The grain is held to be sweet and wholesome, the only objections to it being the smallness of the supply and the hardness of the shell. In the forms specially cultivated the shell is soft and amenable to ordinary methods of milling.

Wholesome.

India.

Roxburgh was apparently unaware that coix had to be included among the edible cereals of India, though doubtless he had read Rumphius's description (1750) of its cultivation in the islands of the Malaya, also Loureiro's account of it in Cochin-China. In the *Agri.-Horticultural Society of India* (*Trans.*, 1841, viii., 348) mention is made of the grain being sent from Amherst. Mr. Riley, who presented the sample, said the