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AGRICULTURAL LEDGER.

1904.

(BEING VOL. XI.)

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ERRATA.

No. 3 (1902). The Indian Aconites, page 96, line 9 from bottom, *for* 50 *read* ·50.

No. 3. Iron Ores, page 19, *for* 'Other Papers that may be consulted' *read* The Agricultural Ledger, 1898, No. 17; 1900, No. 14.

No. 6. Famine Foods, page 37, top line, *for* No. 84, *read* No. 82.
" " " " " 61, line 17, *for* Kjeldhal, *read* Kjeldahl.
" " " " " 66, for line 14, *substitute*. THE BEET, SWISS CHARD.

No. 9. Properties of Burmese storax, page 116, line 18, *for* Kaehin *read* Kachin.

ADDENDUM.

Since Agricultural Ledger No. 10 of 1904 was printed, the Director, Land Records and Agriculture, Bombay, has very kindly furnished the names as far as possible of the varieties of Cassava plants successfully grown on the Poona farm from cuttings supplied by Mr. Thomson. The varieties are these:—

Solitoe marilla.
Pacho.
Pie-de-Perdiz.
Mintro.
Chingola.
Cacuagioa.
Langua de-nalo.
Nigritta.
Blanquita.

Conf. Agricultural Ledger No. 10 of 1904, page 126—'Further Introduction of new Races.'

NOTE.

To those who bind the *Agricultural Ledger* two alternatives are suggested; they may bind the issues of each year into an annual volume, or they may keep apart the series into which it is divided.

These Series are as follows:—

I.—VEGETABLE PRODUCT SERIES.
II.—ANIMAL PRODUCT SERIES.
III.—MINERAL AND METALLIC SERIES.
VI.—AGRICULTURAL SERIES.
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XI.—CROP DISEASE AND PEST SERIES.
XII.—MISCELLANEOUS SERIES.

For either purpose indexes will be published. The annual index will continue to appear year by year; the "serial" indexes will appear at wider intervals.

The annual index refers to the numbering which heads the pages: the numbering at the foot, which is consecutive in each Series, will be used in the serial indexes.

Public libraries and similar institutions are likely to find the plan of binding in annual volumes the more convenient one.

I. HENRY BURKILL,

Officiating Reporter on Economic Products to the Government of India.

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(Vegetable Product Series, No. 78.)
(Gums and Resins.)

THE AGRICULTURAL LEDGER.

1904—No. 1.

AQUILARIA AGALLOCHA.

(EAGLE OR ALOE WOOD.)

[*Dictionary of Economic Products, Vol. I.*, A. 1251-8.]

Notes on the Collection of Agar in Assam and Burma, and on the preparation of the bark as a writing material. By DAVID HOOPER, *Curator, Indian Museum, Calcutta, Industrial Section.*

INTRODUCTION.

The present number of the "Agricultural Ledger" deals with the collection and trade of agar wood, and the preparation of the oil as practised in Assam and Burma. An account of the peculiar use of the bark as a writing material instead of paper is also given. This use was noticed by Mr. E. A. Gait, Honorary Director of Ethnography in Assam in 1894, and the Reporter on Economic Products to the Government of India, instituted an enquiry into the subject to which the Deputy and Assistant Commissioners have willingly responded, and contributed valuable notes on the Habitat, Vernacular names, Resin, Bark, Oil, Medicines, Perfume, and Timber of this tree.

It is not intended in this article to give the History of Lign aloe or aloes wood, or refer to the innumerable quotations regarding *agaru* met with in ancient writings. These may be found, by those interested, in the Pharmacographia Indica and the article in the Dictionary of the Economic Products of India.

Aquilaria Agallocha, *Roxb.; Fl. Br. Ind., V., 199; Ind. Kew., I., 166.*

THE EAGLE OR ALOE WOOD TREE.

Vern.—*Agar*, HIND.; *Agaru, ugar*, BENG.; *Agaru, lauha*, SANS.; *Agare-hindi, ud, aud, aude-hindi, ûde-hindi, agalugen*, ARAB.; *Agre-hindi, agar*, PERS.; *U'd, ud farsi*, PB.; *Agara hindiagara*,

AQUILARIA Agallocha.

Notes on the collection of Agar

EAGLE-WOOD.

BOMB.; *Agar, Guj.*; *Agar, aggalichandana*, TAM.; *Krishna agaru, agui, kashtamu*, TEL.; *Sasi, sachi, bislat*, ASS.; *A-kyau*, BURM.; *Kihay sinnah*, SINGH.; *Kaya garu, garru* MALAY.; *Krisana, mahmi*, SIAM.; *Tsanah*, SELUNG; *Nyam-chah, ngacha, chén-siang*, CHINESE.

The name of the wood is Lignum aloes, Pao Daguila-aloes wood, from the Malayalam word agil, Kulambak, aguila wood (*Linschoten*), Calamba, Aggar, Tugge, Agallochum Xylo or Paradise wood. The meaning of the Chinese name is "fragrancy sinking under water" and alludes to the heaviness of the wood (*Bretschneider*). The same character of the wood is indicated in the Sanskrit name *garu* = heavy. The word aloes probably comes from *lauha*, a Sanskrit or Pali word, by transposition not uncommon in Hebrew literature. Others suppose the name to be a corruption of the Arabic term Al-úd. The wood has no connection with the bitter extract obtained from the leaves of species of *Aloe*.

Habitat.

Habitat.—Roxburgh says the **A. Agallocha** is an immense tree, a native of the mountains east and south-east of Sylhet, between 24° and 25° north latitude.

The tree grows in Cachar, Sylhet, Darrang, Jorhat, Sibsagar, Manipur, and the Khasia, Garo, Mikir and Naga Hills in Assam. As a tree of Bengal, it occurs in Tipperah. In Burma it is found in considerable quantities in Tenasserim, specially about the Lenya and Maliwon townships, and on the islands of the Mergui Archipelago. Kurz states that it is found on the Martaban Hills east of Taunghu. In Assam the tree prefers high or "tillah" land at an elevation of over 500 feet above sea level, and in Burma it grows freely in evergreen forests on sloping hills. It attains a height of 60 or 70 to 100 feet, and a girth of 5 to 8 feet. The tree is fit to be cut down for agar collecting at 20 years, but others consider it is not mature enough until it is 50 or 60 years old. The flowers appear in March and April, and the fruit ripens in July and August.

Collection.

Collection of the Agar.—The wood of **Aquilaria Agallocha** in its ordinary state is not of much value, being pale in colour, light and inodorous. But under certain conditions a change takes place in both trunk and branches, the wood becoming gorged with a dark resifious, aromatic juice, and acquiring a greater specific gravity. These portions of the wood are collected and constitute the drug called *agar*, which is esteemed the more in proportion as it is ponderous and abounds in resinous matter. In no other part of the tree is this fragrant resin deposited.

In Sylhet, the collection of aloes wood is a precarious and tedious business; those engaged in it proceed some days' journey into the hilly districts, where they fell any trees they find, young or old, and

COLLECTION.

then on the spot search them for the *agar* deposits. This is done by chopping off the bark and into the wood until they observe dark coloured veins, indicating the proximity of wood of valuable quality, which generally extends but a short distance from the centre of a trunk or branch. In this manner a whole tree is searched through, the collectors carrying away only such pieces as are rich in odoriferous resinous matter. In some districts it is customary to facilitate the extraction of the resinous wood by burying portions of the tree in moist ground, or by allowing the entire tree to remain a length of time (one to three years) after it is cut down, the effect of which is to cause decay in the non-resinous wood and thus render it easily removable by an iron instrument" (*Hanbury*).

Variable content of resin.

Were the wood less soft than it is the labour of procuring this substance would probably exceed its worth, since, there being no external diagnosis, each tree has to be cut down to discover the resin. Sometimes the resinous deposit is found in one out of every dozen trees, and only one in a hundred will yield a rich wood. If the resin should exist the vein will most likely be found cropping up at a point eight or ten feet below the lower bough, on the other side of the bend, if there be any; from here it is followed down as far as it exists or as it is considered necessary. The average yield of a mature tree is three to four seers.

Occasionally, but very rarely, a tree is met with that contains as much as R300 worth of *agar*, in this case the entire substance of the tree, from almost immediately under the bark, becomes converted into *agar* for a considerable way up, so that a single blow of the axe lays it open.

Causes of the deposit.

It is a difficult matter to decide what is the predisposing cause of the secretion of this peculiar oleo-resin. It is not old age as it is frequently found in young trees, and though it becomes concentrated in old trees the secretion makes its appearance at an early age. No fluid resin exudes from the trees naturally, and in Jorhát several trees were specially tapped but no drop of secretion made its appearance.

The formation of the deposit is often referred to disease or decay, but Mr. C. Brownlow of Cachar, writing in 1863, says it is no sign of decay or unhealthiness as the tree apparently continues to thrive as well as the others, and if the parts affected be examined it will be found that there is no hollowness or unsoundness, but that the woody fibre is perfectly sound and merely impregnated or soaked to a greater or less extent with resin.

COLLECTION.

The balance of opinion among Forest officers is that the *agar* is usually, if not always, found where some former injury has been received.

Mr. Brownlow also states that in the male trees only, or as the natives call them *mooneas*, the resinous substance is to be found, and it is vain to look for it in the fruit-bearing or female trees of the same species.

Agar-kumlahs.

The collection of *agar* in Sylhet is carried on by a class of men called *agar-kumlahs*, who are obliged to go considerable distances to find the trees in sufficient numbers. The indigenous population does not trouble to collect the resin. There is no special season for collecting the wood since this depends entirely on the convenience of the collectors. The *kumlahs* frequently start in bands by boats up the valleys taking as much as three months' provisions with them, and well equipped for a long stay in the jungles. The most experienced *agar-kumlahs* are from Pertabghur in the valley of the Lungleh.

Collection in Burma.

In Burma, *Akyau* is known in the islands below Mergui, and is collected by a race of nomadic sea gypsies, the Selungs or Salones. Mason informs us that these people are very reticent about the distribution of the tree and the collection of the resin and endeavour to keep all other tribes ignorant of the extent of the trade.

DESCRIPTION.

Description.—The drug occurs in pieces of extremely irregular shape and size. The largest rarely exceeds a pound in weight, while some of excellent quality is met with as small chips or splinters. The largest pieces have been scooped and trimmed with great care, so as to remove as far as possible all the less resinous portions. The lighter portion of wood called *doom* is the cheapest and is sold for R1 to R3 a seer, the black or brownish-black is the true agar of commerce and is called *ghurkee*, and worth from R16 to R20 a seer. This wood is marked more or less distinctly with innumerable coarse parallel veins loaded with dark resinous matter, and in the interior of the thicker portions hollow spaces are sometimes evident. The wood has a slightly bitter aromatic taste; its odour is peculiar and not remarkably agreeable; some persons compare it to sandal-wood, others to ambergris. When a splinter is held in the flame, the resinous matter melts and burns with a bright flame or smoulders and gives off a pleasant smell of incense.

Spirits of wine separates the aromatic resin from the woody fibre. A good sample yielded Hankury 48 per cent. of matter soluble in rectified spirit. The spirit extract forms a deep reddish-brown solution which produces a milky emulsion when mixed with water.

SUBSTITUTE

Substitute.—A heavy, dark coloured, straight grained, oily and resinous wood, the botanical origin of which is unknown, is imported into Bombay and Calcutta from Zanzibar. It is called Sagar-Tagar, Tuggur or Taggar wood, and is frequently offered as a substitute for the agar of Assam. Like agar it sinks in water, but is recognised by giving a yellow colour to the water which develops a greenish fluorescence. This wood is sent to Delhi, Lucknow, and other large cities of Northern India, where it is distilled with other ingredients to form some of the compound attars so much esteemed by the natives.

Taggar wood.

COMMERCE.

Commerce.—In India the collection of agar is under the control of the Forest Department, and the article itself is included in minor Forest Produce. The trade is necessarily a fluctuating one, and the following statistics will be of interest as indicating the amount and value of the wood exploited.

Trade in Assam.

In 1892 it was reported from Assam that the produce from the **Aquilaria Agallocha** has hitherto been found in the districts of Sylhet and Cachar, and in the former the local capabilities were so overworked that it was considered necessary to give the forests a rest, so that no revenue that year was derived from them. In Cachar also the *mahal* was not sold for that year. Quite recently, however, the *agar* tree has been found in fair quantity, according to report, in the submontane forests of Sibsagar and the Naga Hills; and enquiries for permission to work out this produce having been received from several persons, it is anticipated that a larger revenue than hitherto may be realised from this item in future.

The forest revenue from *agar* during the last eight years shows a decided expansion in the trade, although in 1897-98 it was reported that the trees were becoming scarce and more difficult to find.

1894-95.	1895-96.	1896-97.	1897-98.	1898-99.	1899-1900.	1900-01.	1901-02.
R	R	R	R	R	R	R	R
739.	2,831.	1,395.	424.	1,503.	1,929.	2,765.	4,434.

These amounts were contributed from the districts of Sibsagar, Darrang, Sylhet, Cachar, and Manipur.

Royalty.

The wood is sold by the maund (= 82·3 lbs.) or by the basketful. The royalty per maund is one rupee or somewhat less, and by the basket about R1-8.

The Assam *agar* is sent to Calcutta where it is sorted by the merchants, who in turn sell it to Muhammadans in Turkey, Arabia, and Persia.

Trade in Bombay.

In Bombay there are two kinds of aloes wood, the *Mawadi agar* derived from **A. Agallocha** and the *Gaguli agar* from **A. malaccensis.** It sells in the bazar at R8 to R12 a pound according to

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quality. Irvine records the fact that it sold in Patna fifty years ago at R2-8 per pound.

In England Eagle-wood is stated to bring about £30 per cwt. for 1st quality (Sumatran); £20 for 2nd quality (Malaccan); and £2 10s. for 3rd quality (Malaccan and Indian chips).

Burma.

With regard to Burma the produce has been extracted from the islands of the Mergui Archipelago for many years, and no tax appears ever to have been imposed till recently. The average value of exports from Mergui port for the last three years ending 1898 has been R9,000, this does not of course include large quantities removed direct from the islands by Chinese boats and *kattus* to Penang and Rangoon.

As long ago as 1876 Mr. Lee stated that 8,000 trees were cut annually for the purpose of obtaining this substance. These figures perhaps are exaggerated, but there is no doubt large numbers were cut. The Selungs are said to collect about 1,000 viss a year (1 viss = 3·65 lb), most of which goes to China and Siam.

In 1870 *akyau* was worth from R5 to R22 per viss. In 1881-82 the prices had risen to R50, and in 1898 the wood was worth R60. A sample weighing 30 tolahs, purchased from a forest contractor for the Indian Museum, Calcutta, cost R20. In Rangoon where it is valued both for the preparation of medicine and perfume, it sells for two rupees per *tikka* (a *tikka* is the weight of one rupee). The demand is met entirely from Mergui.

At the Paris Exhibition in 1878 a specimen of aloes wood was shown from Cochin China, and its botanical origin was referred to

Malacca aloes wood.

Aquilaria malaccensis. The wood is highly prized at Saigon where it is known as *tramtoc* and costs not less than 34 francs the kilogramme (2·2 lbs.).

In the sixteenth century, according to Van Linschoten, the best Palo Daguillo and Calamba were said to grow in Malacca and Siam, and were probably the produce of **A. malaccensis.**

USES OF AGAR.

Uses.—From ancient times *agar* has been used all over the East for its perfume and its supposed medicinal qualities. On account of its portability and great value, one of the petty Rajahs of Assam used to send his tribute to the Viceroy, during the Muhammadan rule, in this substance. At one time it was sold by weight against silver and gold. In the present day aloe wood is used largely in China, where it is consumed as incense and in the manufacture of joss-sticks. It is, however, to be met with in Eastern bazars, including those in Syria, where Hanbury found it for sale. In Sylhet a certain quantity is collected each year for the sake of extracting from it a sort of essential oil (*agar-attar*) which is regarded as costly as otto of roses.

In Bombay *agar-batis* or *agar* lights are made of various sweet smelling articles of which aloes wood is the chief ingredient. These substances are mixed with gum benzoin, and a little oil, and rolled into sticks. The sticks are then burned as incense or used as perfume. The price varies from 8 annas to R2 the pound according to the composition.

USE

Woods of this odoriferous nature are used for making beads, rosaries and crucifixes, and the enduring quality of the wood, due to the balsamic resin, renders it an efficient component in mixtures used for embalming the dead. Van Linschoten records that Eagle-wood is much esteemed by Hindus "to burn the bodies of their Bramenes and other men of accoutn, when they are dead, and because it is costly, therefore it is a great honour to those that are burnt therewith as it is to those that with us are buried in tombes of marble stones."

Embalm

Medici uses

The wood is a preventive against fleas and lice, and in the form of a powder is rubbed into the skin and the clothes. In medicine aloes wood is considered a stimulant and cordial in gout, rheumatism and paralysis, also as a stimulant astringent in diarrhœa and vomiting. It is taken internally as a tonic in doses of ten to sixty grains. Under the name of *agalocki* Celsus ranks it among medicines which invigorate the nerves. The wood has long had a place in the Materia Medica of the Pharmacopœias of Europe, but it does not appear to possess any properties that call for its admission to modern local practice.

The attar agar.

Agar-attar.—The *attar* of agar is prepared at the villages of Sryanagar and Rajinagar in Karimganj in the following manner. The wood employed in the manufacture is that of the lowest quality which is worth from R1 to R5 per seer. The *agar* is fine cut into small pieces (*chura-agar*) and is then further reduced by pounding it in a *dhenki* or mortar; the circular band of iron on the lower part of the *siya* or pestle is indented, and this facilitates the disintegration of the *agar* as it is worked up and down. The powdered wood is then placed in a copper vessel called a *deg* which serves as a still and is fixed permanently over a furnace. A basketful of agar dust with 3 to 3½ maunds of water will about fill the still to within six inches of the top, and this is the usual charge. The copper still-head called a *sarposh* to which a tube 5 inches in length is attached, is then fixed on the *deg* and securely luted. A delivery tube (*kham*) bent at right angles connects the head of the still with a bamboo *chungi*, the latter is wrapped round with gunny cloth and acts as a condenser. The *chungi* leads into another copper vessel called a *barupa* or receiver. This receiver is kept immersed in water contained in an earthen vessel called a *márná*, for the purpose of cooling the condensed liquor and preventing loss of oil. The furnace is lighted, and a slow fire is maintained

Preparati

AGAR-ATTAR.

till the evening, when the *barupa* will contain the distilled water, mixed with *attar*. Next morning the liquid is poured into a dish, and the *attar* floating on the surface of the water is removed by the hand or by means of a mussel shell.

On the first day *attar* to the extent of 2 to 5 tolas is obtained, the amount varying according to the quality of the *agar* wood employed, if of a very bad quality only half a tola is obtained. On the next day, the water from which the *attar* has been removed, is returned to the still and more water added until within 6 inches of the top. The distillation is then continued as before when about half the quantity of *agar* will be obtained. The same process is repeated the third day when only $\frac{1}{8}$ or $\frac{1}{4}$ of a tola of *attar* is separated. The price of the *attar* in Assam is ₹3 per tola. The refuse in the still is sometimes sold for ₹3 to ₹5 a maund. When 20 tolas or more are obtained, it is purified and is sent to Calcutta for sale.

Wood.

Wood.—The timber is very light, yellowish-white, soft straight-veined and fissile. Some pieces are closer grained and take a pale-brownish polish. The wood is perishable, but from large trunks dug-outs are sometimes made which with care last for two years. Karens make bows of the wood. The timber though soft is difficult to saw owing to its excessive woolliness.

Brownlow informs us that the Tugger tree is possessed of great vitality and a wonderful power of renewing its bark even when the latter has been scorched off by fire. He says "The wood is disposed in concentric layers which easily separate and should, owing to any cause, the upper layer be splintered or detached, the bark leaves it outside and forms itself on the second layer. Although the wood itself is very perishable and rots completely in one year, the parts that are impregnated with the peculiar resinous substance are protected from decay and last as long as the most durable timbers; hence any *agar* there may be present is easily disengaged a year after cutting over the trees."

Gamble says "Pores small and moderate-sized in short radial lines. Medullary rays fine, numerous, the distance between the two consecutive rays less than the transverse diameter of the pores. Numerous short transverse bands of pores as intercellular ducts filled with a brownish substance."

The growth is moderate, 8 rings per inch of radius. Weight: Kyd gives 20lb; Gamble's specimen was 25lb per cubic foot. Kyd gives P = 203.

Paper Material.

Paper Material.—Mr. E. A. Gait, I.C.S., who was Director of Land Records and Agriculture, Assam, in 1894, drew attention to the fact that the bark of **Aquilaria Agallocha** affords a natural

paper that appears to have been used for ages by the aboriginal tribes of Assam, like the birch bark of the Aryans. The information is found in a paper on the "Abstract of contents of one of the Ahum Puthis" (*Journal Asiatic Society, Bengal*, Vol. LXIII, part 1, No. 2, 1894), written when Mr. Gait was Honorary Director of Ethnography in Assam. The foot-note to the article reads as follows:—

PAPER MATERIAL.

"The *sachi* tree is the same as that known in Bengal as *agar*, the aloes wood of the Bible, from which are obtained the perfumed chips which are so largely exported from Sylhet for use as incense in temples, etc. Although its bark was widely used as a writing material throughout Assam, prior to the introduction of paper, its employment as such seems to have escaped notice.* The following description of the manner of preparing the bark for this purpose, for which I am indebted to Babu Phani Dhar Chaliha, of Sibsagar, may therefore be found interesting. A tree is selected of about 15 or 16 years' growth and 30 to 35 inches in girth, measured about 4 feet from the ground. From this the bark is removed in strips from 6 to 18 feet long, and from 3 to 27 inches in breadth. These strips are rolled up separately with the inner or white part of the bark outwards, and the outer or green part inside, and are dried in the sun for several days. They are then rubbed by hand and on a board, or some other hard substance, so as to facilitate the removal of the outer or scaly portion of the bark. After this they are exposed to the dew for one night, the next morning the outer layer of the bark is carefully removed, and the bark proper is cut into pieces of convenient size, 9 to 27 inches long and 3 to 18 inches broad. These are put into cold water for about an hour and the alkali is extracted, after which the surface is scraped smooth with a knife. They are then dried in the sun for half-an-hour, and when perfectly dry are rubbed with a piece of burnt brick. A paste prepared from *mâtimâh* (**Phaseolus aconitifolius**) is next rubbed in, and the bark is dyed yellow by means of yellow arsenic. This is followed again by sun drying, after which the strips are rubbed as smooth as marble. The process is now complete and the strips are ready for use."

Preparation of bark.

From another description we learn that there is no fixed season for removing the bark from the tree, but it is taken away whenever required. In Golaghat the paper is prepared by scraping both the outer and inner surfaces of the *sachi pât* first with a *dao* or knife and then with pieces of burnt brick. When the pieces are sufficiently thin they are boiled in water, after which they are dried in the sun

Another descriptions.

* Loureiro observed that from the bark of the tree, probably A. malaccensis, the common paper of the Cochin-Chinese was made. (*Ed.*)

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PAPER MATERIAL.

They are finally polished and coloured either with *harital* (sulphide of arsenic) or *hengol* (sulphide of mercury).

Mr. W. Robinson, of the Gowhatti Government Seminary, said in 1841 : "The bark is cut up in long strips by the natives and used as a substitute for paper: their *buranjis*, or chronicles, are usually made of it."

Mr. J. W. Masters, writing in 1843, says the bark may be stripped off in large pieces without much injury to the tree ; it is used to write on and for various other purposes, and makes a very strong and durable paper.

Appearance of the bark.

The natural bark of the tree is tough and pliable, grey on the outside with a thin corky layer and light buff coloured on the inner surface. The liber consists of long white silky fibres of great strength, and resemble those found in Mezereon and Lasiosiphon bark of the Natural Order THYMELIACEÆ. The pieces of prepared bark are in flat strips of various sizes from $2\frac{1}{2} \times 4\frac{1}{2}$ to $8 \times 2\frac{1}{4}$, the latter appears to be the ordinary size for the leaves of the books, a hole passing through the centre allows a string to hold the leaves in position. Some of the pieces measuring $16 \times 4\frac{1}{2}$ inch had merely to be divided into four parts to make the ordinary sized leaves. These smaller pieces had on them a broad border of red pigment while others had an artistic floral design. On one large piece of the bark was depicted a battle scene, one warrior seated on an elephant and the other in a chariot, the weapons of warfare being bows and arrows. It has been recorded that this bark is used for the preparation of sacred documents. Brahmins and Goshais in the habit of performing religious ceremonies in the houses of their disciples or in the presence of the gods in the temple, consider it impure to have their *mantras* written on mill-made paper and therefore retain the custom of writing their sacred books on the prepared bark of the *sachi* tree. This rule, however, is not strictly adhered to, as one specimen of the bark from Sibsagar, prepared as the leaf of a book, consisted of a part of a Sanskrit grammar giving the inflection and tenses of certain verbs The prejudice of the Hindu mind against paper made from old rags will long remain, notwithstanding the detergent action of alkali before they appear in the finished paper. The cost of bark paper compared with that made by machinery is considerable, and although *sachi puthis* have so long been in use in Assam, we have it on the authority of one of the Assistant Commissioners that the bark of the tree as a writing material has now-a-days become rare as the people have recourse to mill-made paper.

Used for sacred documents.

Besides forming the leaves of books the bark is sometimes used as covers for binding books. The Nagas and other hill tribes prepare strips of the bark by which they hang their baskets on their foreheads. The fibre is used for making ropes, but it is not very lasting.

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AGENTS.

In Britain.

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Vegetable Product Series, No. 79.)
(Oils and Oilseeds.)

THE AGRICULTURAL LEDGER.

1904—No. 2.

SAPIUM SEBIFERUM.

(THE CHINESE TALLOW TREE.)

[*Dictionary of Economic Products. Vol. VI., Pt. II.*, S. 842-49.]

CHINESE OR VEGETABLE TALLOW.

ITS PREPARATION, USES, AND COMPOSITION.

By DAVID HOOPER, F.C.S.

Sapium sebiferum, *Roxb.*; *Fl. Br. Ind. V. 470, Ind. Kew., IV., 801*; EUPHORBIACEÆ.

THE CHINESE TALLOW TREE.

Syn:—EXCŒCARIA SEBIFERA, *Muell.*; STILLINGIA SEBIFERA, *Michaux*; S. SINENSIS, *Baill.*; S. SEBIFERA, *Boiss.*; CARUMBIUM SEBIFERUM, *Kurz*; CROTON SEBIFERUS, *Linn.*

Vern:—*Pippal-yane*, HIND.; *Mom-china*, *Chiat-pipal*, BENG.; *Tar-charvi*, UNITED PROVINCES, THE DUN; *Pista*, TRANS INDUS; *Toyc-pippali*, SANS.; *Varicou*, *cay-soi* (seeds) CHINESE: *Huang-yang*, JAPAN; *Arbre à Suif*, *Porte Suif*, FRENCH; *Chinesischer Talg* (The fat), GERMAN.

HABITAT

Habitat.—In China and Japan the tree is indigenous and is cultivated. In the former country it is found in Kiangsu, Chekiang, Formosa, Fokien, Hupeh, Kwangtung, Hongkong, and Hainan. It is chiefly cultivated in Kiangsu, Nganhwei and Chekiang. In some districts near Hangchau the inhabitants defray all their taxes with its produce. It is cultivated and naturalised in other warm countries as Cochin-China, Martinique, the Soudan, in South Carolina, and other south-eastern States of North America. It is hardy enough to grow anywhere in the middle of Europe and flourishes in the open in the neighbourhood of Perpignan in the South of France.

In India it thrives well in the United Provinces and the Panjáb, especially at Paoní, Garhwál, at Ayar Tali, and Hawal Bágh, in Kumaon, and in the Kangra valley.

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Chinese or Vegetable Tallow: its Preparation,

HABITAT.

Dr. Roxburgh's opinion.

Dr. Roxburgh in *Flora Indica*, Vol. III., p. 693, gives his experience of the cultivation and use of the tree. "It is now very common about Calcutta, where, in the course of a few years, it has become one of the most common trees. It is in flower and fruit most part of the year. In Bengal it is only considered as an ornamental tree; the sebaceous product of its seeds is not of sufficient quantity, nor its qualities so valuable as to render it an object worthy of cultivation. Cocoanut oil is better for the lamp, and it is only during very cold weather that the substance becomes firm; at all other times it is in a thick, brownish, fluid state, and soon becomes rancid. Such is my opinion of the famous vegetable tallow of China."

Dr. Maogowan's experience.

Dr. D. J. Maogowan, in a paper read before the Agricultural and Horticultural Society of India in 1850, opposes Dr. Roxburgh's opinion, and speaks in praise of the tree from his experience of several years' residence in China. He shows that the tree is prized not merely for the tallow, though this product constitutes its chief value. Its leaves are employed as a black dye, its wood being hard and durable, may be easily used for printing blocks and various other articles, and, finally, the refuse of the nut is employed as fuel and manure. The husk which envelopes the kernel and the shell are used as fuel for the furnaces for melting the fat. The residuary tallow cakes are also employed for fuel; they remain ignited the whole day and are in great demand for chafing dishes during the cold weather. The pressed cakes also are much valued as manure especially for tobacco fields.

Introduced into Chota Nagpur.

The Tallow Tree was introduced into Chota Nagpur more than sixty years ago. Col. J. R. Ousely reported to the Agricultural and Horticultural Society of India in 1849 that the seed of this tree had been sent to him some five or six years ago by Mr. Griffith. He found the cuttings took most rapidly, and he had 50 or 60 trees thriving in his garden, which were about 12 feet high.

Habit of the tree.

The small glabrous tree is from 24 to 30 feet high, with a whitish grey bark. The leaves are green, but they redden before they fall. The flowers are disposed in red terminal spikes, and produce in November and December hard brown, oval capsules, each containing three cells. The seeds are ovate (12 m. m. long) coated with a thick white sebiferous stratum, and having an acrid penetrating taste.

Propagation.

Like other plants of the croton tribe the tree is propagated by layers and cuttings. Dr. Maogowan states that grafting (apparently meaning thereby layering) is performed at the close of March or early in April, when the trees are about three inches in diameter and also when they attain their growth. The *Fragrant Herbal* recommends for trial the practice of an old gardener who preferred making cuttings by breaking the small branches and

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Uses, and Composition. (D. Hooper.)

HABITAT.

twigs, taking care not to tear or wound the bark. It prefers damp places, and in India luxuriates by the side of streams and in the rich mould of canals. It grows equally well on low alluvial plains, in sandy soils and on the acclivities of mountains. The sandy estuary of Hangchau in China yields few other trees.

Rate of growth.

Mr. J. S. Gamble reports that the growth of the tree in India is rather fast, 6 months per inch of radius. In China the trees are known to be several hundred years old, and though prostrated, still send forth branches and bear fruit. It is easy to cultivate, and is regarded as a handsome and ornamental tree on any landscape.

The Fats.

The Concrete Fat.

The concrete fatty matter which surrounds the seeds serves to make candles and tapers which are white, and keep their colour for any length of time. In China this substance is used in place of animal tallow for the manufacture of candles, soap-making, and also in dressing cloth. In candle-making it is mixed with white insect wax in the proportion of three parts of wax to ten parts of the tallow. These candles are especially used in Buddhist ceremonies, as they burn with a clear inodorous flame without smoke. In religious ceremonies no other material is used. Vegetable tallow is imported from China in hard white cakes weighing about 1 cwt. (41 to 50 kilogrammes). In some blocks the exterior is of a reddish colour, while the inside is of a dull white. It is called locally *Pi-yu*.

The Yellow Oil.

In addition to the solid fat from the seeds the endosperm or kernel yields about 50 per cent. of a brownish-yellow oil called, *Tinjow*, *ting-yu* or *tse-ieow* in Chinese, and is used as a burning oil and also for the preparation of varnishes for umbrellas, etc., on account of its drying properties. It has a place in the Chinese Pharmacopœia, because of its quality of changing grey hair into black and other imaginary virtues. It has emetic properties and acts as a purge.

Method of preparation.

The consistence of the fat depends very much upon the method of preparation and the condition of the seeds operated upon. Dr. Porter Smith thus describes the process employed for obtaining the tallow from these seeds in China. The ripe nuts collected in midwinter are bruised, and the pericarp or shell separated by sifting. They are then steamed in wooden cylinders with numerous holes at the bottom which fit upon kettles or boilers. The tallow is softened by this process, and is separated from the albumen of the seeds by gently beating them with stone mallets, when the tallow is effectually removed by sifting the mass through hot sieves. The tallow still contains the brown testa of the seeds, which is separated by pouring it into a cylinder made up of straw rings laid one on top of the other,

THE CONCRETE FAT.

in which it is put into a rude press, and the tallow is squeezed through in a pure state.* A picul (=133⅓ lbs.) of seeds yields from 20 to 30 catties of tallow, or about eight per cent., besides the oil which is obtained from the albumen by grinding, steaming and pressing it subsequently. This fatty substance is of a whitish colour, hard and tasteless, and melts at 104°F. (40°C.).

Conf. p. 18.

Second method of preparation.

The second is a more simple method adopted in some parts of China where the shells with the coating of tallow and the kernels are bruised in a stone mortar, and the mass is boiled for some time in water, or steam allowed to pass into it. The fat is thus brought to the surface where it floats and is removed as a cake when the water beneath has cooled to the ordinary temperature of the atmosphere.

Third method.

A third method is to extract the pulverised seeds together with their shells with petroleum ether or other solvent. This method is often used in the laboratory and yields a product similar to that prepared by the second method, consisting of the tallow from the outer layer mixed with the thinner oil from the endosperm of the seed.

Pure Vegetable Tallow.

We thus have three kinds of fats from the tallow tree seed depending upon the process employed in separating them. In the first place the sebiferous layer yields the pure vegetable tallow melting at 40°C. and upward. This is hard, brittle, almost colourless, and does not leave a grease stain on paper.

Endosperm Oil.

The endosperm oil, extracted from the seeds after the tallow has been removed by beating, is a light strongly smelling oil, turning a yellowish colour on standing; it has a higher specific gravity and possesses drying properties.

Mixture of Fats.

The mixture of fats obtained from the entire seeds has intermediate constants and properties of the two oils just noticed. It has a softer consistence, melting at about 26°C.—32°C., and is a material which may replace lard for industrial and medicinal purposes. In China it is called *Mouicon*, a mixture of *pi-yu* and *ting-yu*.

Indian made Tallow.

From experiments made in India, and probably owing to the introduction of the endosperm oil in the finished tallow, it has been found that the oil is not hard enough in consistence, and when it has been used in candle-making, it is necessary to dip the candles made of it into wax and so give them a hard external coating. The combustion too of these candles was described as imperfect, and they were said to yield a dim light and a thick smoke.

Experiments in the Panjab.

A large cylindrical mass of tallow, solid, of a pure white colour, and inodorous, was exhibited at the Lahore Exhibition in 1864, and it was hoped then that the tallow tree might become an article of commercial importance in the Panjáb. Since that time, however,

* A figure of the press used in China for expressing the oil from seeds of the tallow tree is shown in *Jour. Agri. Hort. Soc.*, Vol. IV., p. 113.

EXPERIMENTS IN THE PANJAB.

interest in it has declined, and for many years few, if any, attempts have been made to utilise the tallow from this source. The labour and expense involved in collecting the seeds and extracting the tallow are said to have been far in excess of the value of the product.

Samples from Kangra.

Enquiries regarding the prospects of a trade in the oil have recently reached the office of the Reporter on Economic Products from the Kangra Valley. Two samples of material were supplied, and these were said to be available in some quantity. One sample consisted of the husked seed, and was a whitish powder. This contained 63·6 per cent. of fat, which was perfectly crystalline and melted at 39°. The fatty acids melted at 51°. A sample of oil made by the Holta Tea Company in the same district melted at 30°C., and the fatty acids melted at 42°C. In these two cases it was evident that the second sample of fat had a larger proportion of the oil than the other.

Chemistry of the Fats.

Acid value.

Samples examined by Lewkowitsch possessed an acid value varying from 7·07 to 7·51. De Negri and Fabris found 2·4, both for commercial fat and fat extracted from the seeds; De Negri and Sbrenlati give 2·2 as the acid value.

Composition.

According to Maskelyne, vegetable tallow consists of palmitin and olein. A confirmation of this statement may be found in the fact that Hehner and Mitchell obtained no stearic acid crystals from a specimen absorbing 22·87 per cent. of iodine.

Chemical Constants.

The following chemical constants have been obtained from the analyses of various specimens of vegetable tallow as recorded by Lewkowitsch:—

Melting Point.	Saponification Value.	Iodine Value.
36·5 to 46	178·7—203·6	22·86—53
mean 41·2	191·1	37·9

The fatty acids afforded the following constants:—

39—57	181·2—208·5	29·2—54·8
mean 48	194·3	42

It might be explained that the presence of endosperm oil lowers the melting point and raises the iodine value of the above quoted figures. With regard to this oil the following constants were ascertained by Hobein:—

Specific gravity	0·945
Saponification value	203·8
Iodine value	145·6

Chemistry of the Fats.

The following report taken from the *Journ. Soc. Chem. Industry*, gives the results of an examination of the seeds by M. Tortelli and R. Ruggeri. L'Orosi (23, 289--97—Chem Centr, 1900, 2 [26], 1295). The array of constants however evidently applies to the endosperm oil.

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CHEMISTRY OF THE FATS. Tortelli and Ruggeri's Analysis.

"The seeds of **Stillingia sebifera** contain 41·2 per cent. of fat, of which 22·0 per cent. occurs as tallow in the capsules, and 19·2 per cent, as oil in the kernels. In the following table are given the constants ascertained by the authors for **Stillingia** oil obtained by cold pressing and by extraction with ether. Specific gravity of the oil, 0·9432 at 15°C., 0·9370 at 27°C., 0·8737 at 100°C.

Saponification number (mgrms KOH)	210·4
Acid value (calculated to oleic acid)	6·15
Hübl's (Relative) iodine number	160·6
Absolute rise of temperature (Maumené)	136·5°
Relative rise of temperature, compared with water	267°
Solubility of the oil in absolute alcohol	4·89 per 1,000
Refractive index (Zeiss-Wollny) (t = 35° C)	75°
Rotatory power (200 mm. tube, t = 16° C)	−18·6°
Solidification point of insoluble fatty acids	12·2° C
Melting point of insoluble fatty acids	14·5° C
Iodine number of insoluble fatty acids	161·9
Iodine number (absolute) of liquid fatty acids	178·1
Saponification number of insoluble fatty acids	214·2
Molecular weight of insoluble fatty acids	274·1
Acid value of acetylated fatty acids	195·6
Saponification number of acetylated fatty acids	224·3
Acetyl value of fatty acids	28·7
Hehner value	94·4
Reichert value (for 5 grms)	0·93
Unsaponifiable matter	1·45 per cent.
Absorption of oxygen	12·20 „ „

In carrying out the Maumené test, Jean's Thermelæometer was used. The oil was diluted with twice its volume of a colourless mineral oil, and a maximum value of 65·5° obtained; that is, an absolute rise of temperature of 3 (65·5-20) = 136·5°. For the determination of the iodine values see M. Tortelli and R. Ruggeri. L'Orosi 23, 109-122, Chem. Centr. 1900-2 [10] 598. The drying power of the oil was ascertained by Livache's method. The oil does not appear to give any of the characteristic colour reactions."

The results of these experiments show that **Stillingia** oil approaches linseed oil in character, but it is distinguished from the latter by its strong specific (lævorotatory) action on polarised light. The peculiar odour is said to be due to propionic acid.

Allied Linseed Oi.

With regard to the actual component parts of vegetable tallow it has been asserted that it consists of tripalmitin or of palmitin and olein. The most recent investigator, J. Klimont, (*Monatsh. f. Chem.*, 1903, 24, [6] 408) doubting the accepted statements about its composition, has made experiments with the object of isolating the mixed glycerides. The fat used for this purpose was obtained from the

Uses, and Composition. (*D. Hooper.*) SAPIUM sebiferum.

CHEMISTRY OF THE FATS. Klimont's Analysis.

seeds by hot expression. It dissolved completely in ether and hot alcohol, but was less soluble in cold alcohol. It had the following characteristics:—Melting point 36·4, iodine value 27·6, saponification value 203·5, and acid value 14·2.

After the removal of free fatty acids, the fat was extracted with acetone, and the extract filtered from the crystals that first deposited. The crystals subsequently formed melted at 32·2; and, after recrystallisation, at 29·2. On saponification and liberation of the fatty acids, the substance yielded palmitic acid (m. p. 61·8°) and oleic acid with iodine value 81·3. Its elementary composition, iodine value (29·8), and saponification value (202·6) showed that it consisted of a mixed glyceride, oleo-dipalmitin, $C_3H_5(C_{16}H_{31}O_2)_2C_{18}H_{33}O_2$. The fat also contained a very small amount of a substance of higher melting point, probably tripalmitin.

Admixture suspected.

Lewkowitsch in his "Oils, Fats and Waxes" says that the commercial vegetable tallow represents a harder material than the fat extracted from the seeds by means of solvents, and expresses the opinion that the commercial article consists of a mixture of fats obtained from different species or even different families.* That substances with quite a different nature than those determined by the above constants is placed upon the market as vegetable tallow is shown by an analysis recently made by two Italian chemists C. E. Lay and G. Musciacco (*Journ. Soc. Chem. Industry*; 1903, p. 1005). The experimenters found a sample of vegetable tallow to be optically inactive and therefore free from **Stillingia** fat. The other suspicious constants were:—Specific gravity at 15° C·9816; melting point 52·5°; melting point of fatty acids, 55°; acid value, 22·5; saponification value, 231; Hübl's iodine value, 19; absolute iodine value, 97·04.

An analysis of oil-cake.

Before dismissing the references to the chemistry of the fat of the Chinese Tallow Tree it will be of interest to quote an analysis made of the oil-cake, forwarded lately from the Kangra Valley, and examined in the Economic Laboratory of the Indian Museum:—

Moisture	9·15
Oil	10·86
Albuminoids	13·12
Carbohydrates	21·79
Fibre	41·43
Ash	3·65
	100·00
Nitrogen	2·10
Phosphoric acid	·72
Sand	1·05

* Tenkawang fat obtained from Borneo and the Straits Settlements is yielded by species of **Shorea** and **Hopea** see E. M. Holmes, *Pharm. Journ.*, 1883, 401, and 1887, 901.

SAPIUM sebiferum. — **Chinese or Vegetable Tallow : its Preparation, etc.**

CHEMISTRY OF THE FATS.

Compared with castor cake, mustard cake and other poonacs, this material furnishes a poor manure for ordinary crops. It would only be of service to the land in the neighbourhood, and would not pay to export to a distance. It contains elements of plant food which should not be destroyed. The seeds of some species of **Sapium** are poisonous to fish on account of the presence of an acrid substance resembling saponin. The oil-cake therefore is quite unsuitable for human consumption. As already noticed, it is used in China as fuel, and on account of its slow combustion it is used for chafing dishes in the winter season.

Oil-cake.

Commerce.

Chinese exports.

The export of vegetable tallow from Wu-chang the next district west of Kiu-Kiang in China, amounted in the year 1889 to 517 tons valued at 12,997 li, or double the exports of 1883 and 1884. Chinkiang, Tientsin and Pekin take most of the tallow exported from this district.

The price in 1874 was eight Mexican dollars per picul or 5 cents per lb. The thin oil or *ting-yu* sells for 3 cents per lb. A large trade is done in this product in the Straits. During the year 1900, for instance, vegetable tallow imported to the Straits Settlements amounted to 52,533⅓ lbs., valued at 7,034 dollars (Mexican), while exports amounted to 91,500 lbs. valued at 37,943 dollars. About 60 per cent. of these imports came from Japan and the remainder from Burma ; all the exports went to Great Britain.

Value.

The exports of vegetable tallow from China were 68,548 piculs in 1895, 20,611 piculs in 1896, 23,490 piculs in 1899, 111,312 piculs in 1901, and 140,680 cwts. in 1902. The price averages 8½ Haikuan taels per picul (Haikuan tael = 2s. 8d.; Picul = 133⅓ lbs). During 1902 a rise of 18 per cent. took place, and 29,000 cwts. more than in 1901 was exported, this is a percentage increase of 274 over the average annual quantity exported during the decade 1892-1901. Short supplies elsewhere are responsible for the price.

The duty on vegetable tallow in Italy as per tariff 309 (*b*) is free ; and tariff 307 shows it to be at the rate of 4 lire per 100 kilos.

Duty.

The United States Customs Board have decided that the white brittle fat of the tallow or wax tree is dutiable as "tallow" at ½ cent per pound, under paragraph 279 of the Tariff Act. The importers claimed it to be free of duty as "vegetable wax," under paragraph 695. An analysis of the article, however, showed it to be a true fat and not a wax.

S. 842-49.

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G. I. C. P. O.—No. 101 R. & A.—28-4-04.—2,500—B. N. D.

THE AGRICULTURAL LEDGER.

1904—No. 3.

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(Mineral and Metallic Series, No. 21.)

THE AGRICULTURAL LEDGER.

1904—No. 3.

IRON.

(IRON ORES.)

[*Dictionary of Economic Products, Vol. IV.*, I. 451-64.]

Other PAPERS that may be consulted:—

The Agricultural Ledger, 1898, No. 12; 1900, No. 15.

On IRON ORES in the JABALPUR DISTRICT, CENTRAL PROVINCES.

A Report by EDWARD P. MARTIN, ESQ., M.INST.C.E., PAST PRESIDENT, IRON *and* STEEL INSTITUTE, VICE-PRESIDENT, I.MECH.C.E., ETC., *and* PROFESSOR HENRY LOUIS, M.A., ASSOC. R.S.M., F.I.C., F.G.S., ETC., PROFESSOR OF MINING *and* LECTURER ON METALLURGY.

Iron-smelting. Indigenous methods and modern processes require different classes of ore.

We investigated carefully all the better known localities in the Jabalpur district, in which iron ore was recorded to occur; the occurrence of ore in these places has been known for a long time, and iron has been made there for centuries by native methods. The fact of ores existing in any given place suitable to the native methods of iron-smelting is no proof, however, that the locality would be equally adapted to modern processes. Apart from the importance of accessibility to a railway line by which coke could be imported, and the products shipped to their market, the two methods demand different conditions in the ores themselves. Thus for native methods a soft ore in powder or in small fragments is best; for modern blast furnace practice a hard, lumpy ore is essential. For native methods the presence of phosphorus or other similar impurity is no drawback, whilst it is fatal to the manufacture of steel by modern acid processes. The amount of ore that could keep the whole of the native furnaces in the Central Provinces busy for the year, would not supply a modern furnace for a single week. All the conditions are thus essentially

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different, and it was necessary for us to investigate these ore deposits with strict reference to their suitability for modern methods.

Agria Hill.—This hill has long been considered as one of the largest iron ore deposits in India. It is situated some 10 miles south-south-east of Sihora Road Station, on the East Indian Railway (759 miles from Calcutta), but the distance to the nearest point on the railway is only about 5 miles over fairly open country. Mr. Mallet states that this hill "appears to be formed entirely of iron ore," and he estimates its contents as equivalent to about fourteen million tons of ore" (*Records, Geological Survey of India*, Volume XVI, Part 2, page 9). We have had this hill thoroughly examined by means of numerous deep cuttings, trenches, and pits. The hill is about ½ mile long, ¼ mile wide and about 130 feet high; its greatest length is in about an east-west line, the slopes on the southern side are very gentle, those on the north being somewhat steeper, while the top is approximately level. This level top consists of a capping of laterite, from 7 to 10 feet in thickness; a considerable portion of this laterite contains so much specular hæmatite that it might almost be described as a breccia of iron ore. The amount of such ferriferous laterite seems to be about three-quarters of a million tons.

Analyses.

The following are analyses of three samples of this laterite:—

	Iron.	Silica.	Sulphur.	Phosphorus.	Moisture.
I	57·58	7·28	0·020	0·125	0·45
II	56·85	8·17	0·020	0·135	0·67
III	45·67	13·90	0·030	0·187	0·69

The last analysis was made on laterite that showed but little included specular ore; the extent to which the latter affects the contents of iron is shown by the two following analyses, in which the specular ore was picked out from a sample of this ferriferous laterite and each part analysed separately:—

	Fe.	Sio$_2$	S.P.	P.	Moisture.
Hæmatitic portion	64·67	3·45	0·190	·098	0·20
Laterite freed from ore	50·95	12·80	0·080	·166	2·87

Phosphorus contents.

It will be observed that the phosphorus contents of the ore as mined, is far above the Bessemer limit, whilst it is rather low, on the other hand, for basic steel making. It is evident that the phosphorus contents are due mainly to the cementing laterite rather than to the original ore. It seems probable that the entire laterite cap is due to the degradation of the strata underlying it.

Ore shales.

Below the laterite capping the hill consists of white, yellow, and pink shales, dipping southwards at angles varying from 20° to 30°; interbedded amongst these is one particular zone 20 to 50 feet thick, which shows a large number of thin beds of soft, fissile micaceous hæmatite, that rarely exceed 2 inches in thickness, and are sometimes

only about ½ inch thick. The shales between these thin seams of hæmatite are probably rich in iron, and the entire zone would yield an ore high enough in iron for smelting purposes, but physically quite unsuitable for blast furnace purposes.

Selected ores.

A certain amount of rather denser ore can be picked out, but this would not exceed one-tenth of the entire mass of the ore shales; even this ore can hardly be looked upon as an ore physically suitable for the use in the modern blast furnace. The following are analyses of these ores:—

Analyses.

	Iron.	Silica.	Sulphur.	Phosphorus.	Moisture.
Ore shales	60·70	7·45	0·019	0·075	0·25
Ore shales	58·40	8·40	0·022	0·081	0·33
Hand picked ore	60·15	5·45	0·019	0·053	0·23

Phosphorus p. c.

It will also be noticed that the percentage of phosphorus is far above Bessemer-limits.

AGRIA-RIDGE ORE.

Agria Ridge.—A short distance to the north of the above hill runs a ridge, commencing at Agria village and continuing westwards for about half a mile, which shows indications of ore; this appears to be the locality of which Mr. Mallet writes that "a large amount of ore is available in the ridge." (*Op. Cit.*, p. 98.) Several trenches were cut across this ridge, and these have shown a bed of schistose hæmatite some 4 or 5 feet thick, dipping to the south at an angle of 50°. The bed does not seem to be constant or continuous, and is obviously useless as a permanent source of ore. A sample of ore from this bed had the following composition:—

Analysis.

Iron	50·07
Silica	31·37
Sulphur	0·036
Phosphorus	0·074
Moisture	0·44

JAULI ORE.

Jauli.—This place has been extensively worked by the native miners; Mr. Mallet says that "the largest iron mine in the district is that near Jauli." The ore deposit occupies an area of undulating ground, about 1,000 yards long by 300 yards wide. Within this area some 60 pits were sunk by us, about one-third of which found ore. The ore consists of a soft ochreous red hæmatite inter-stratified between layers of harder siliceous rock; in places a little schistose specular ore occurs. When the soft ore is picked out from the siliceous bands, it is found to be rich in iron, its richness depending altogether upon the care with which such picking is performed, as is evident from the following analyses of Jauli ore:—

Analyses.

Iron.	Silica.	Sulphur.	Phosphorus.	Moisture.
64·67	3·70	0·017	0·023	0·30
54·64	16·05	0·033	0·200	0·48
63·30	3·37	0·032	0·110	0·33
55·12	17·38	0·030	0·053	0·21

JAULI ORE.

The phosphorus contents are evidently very variable, and in the case of this element picking is of course out of the question. Apart from the practical impossibility of obtaining a steady ore supply from deposits of the character here described, the physical condition of the ore is quite unsuited to blast furnace requirements.

Absence of workable deposits.

This entire district undoubtedly contains considerable quantities of ferruginous material, but the latter is nowhere concentrated into what may be called a workable ore deposit showing the essential characters of steadiness and persistence which are indispensable in a deposit that is to form the basis of an important industry. It is quite possible that in a country where labour is as cheap and as plentiful as it is in India, a sufficient ore supply might be obtained by scattered workings throughout this area to keep iron works fully supplied with ore for a number of years, but, on the other hand, there is no evident and assured supply, such as we consider ought to be secured beyond possibility of doubt before we should be justified in recommending the vast expenditure that large iron works must necessarily entail.

Specular ore.

The laterite with brecciated specular ore is the only ore so far met with that is physically suitable for blast furnace purposes. Although its phosphorus contents are far too high for steel making by the acid process, it would yield a foundry pig-iron of the highest quality, at least equal to the best Scotch iron. It is in every respect far superior to the ore from the ironstone shales of the coal measures now being smelted at Barakur; compared with the latter one, it contains 10 per cent. more iron, only half as much silica, and one-fourth as much phosphorus. Delivered at Barakur its cost would, however, probably be as follows :—

Favourable qualities.

	Rs.	a.
Mining	0	6
Carting to Sihora Road Station	1	8
Railway freight, say	8	0
Cost of ore delivered	9	14

Specular ore v. ironstone shale.

The cost of the ore would thus be three times that of the ore from the coal measures, and although its better quality would cause a considerable saving in the consumption of coke and limestone, would increase the output from the furnace, and would give a far superior product, yet it is very doubtful whether all these advantages could outweigh the greatly enhanced price, as long as an ample supply of ore from the ironstone shales is still obtainable.

These remarks derive some importance from the fact that it would not be easy to select a better locality for the iron works than Barakur, or some similar spot in the same district, the advantages of which have been already pointed out. The only reason that could warrant the carriage of iron ores for so long a distance to the works would lie in the high quality of the ores themselves, and in the case of the Jabalpur ores we have already pointed out that not only does their physical condition unfit them for use in the blast furnace, but their phosphorus contents is also too high to allow them to be used for the manufacture of steel by the acid process. We have therefore come reluctantly to the conclusion that the iron resources of this district, considerable though they may in a sense be held to be, are not such as would warrant the erection of iron and steel works with any prospect of commercial success.

High P. & phosphorus.

Business outlook.

SILONDI ORES.

Silondi-Mansukra.—This district is near the little town of Sihora on the western side of the railway line; it contains certain small deposits of iron ores which are different in every sense from those hitherto described; they consist of a couple of bands or siliceous brown hæmatite, striking about E.-W., and dipping southwards at an angle of about 60° into a low ridge some 600 yards long, rising to a height of about 70 feet above the surrounding plain. One of these bands seems to be about 40 feet thick and the other about 20 feet, but their persistency has not yet been proved. The ore as shown by the subjoined analyses, is of inferior quality, though its physical condition is satisfactory.

Analyses.

	Fe.	Mn.	SiO_2.	S.	P.	Moisture.
Wider band	52·15	0·36	14·70	0·022	0·385	0·10
Narrower band	54·95	0·28	14·55	0·027	0·352	0·27

The deposit is well situated, being about one mile from the railway line over fairly level ground.

Manganiferous ore.

In the same ridge there are also small patches of manganiferous iron ore, a sample of which gave the following analysis :—

Fe.	Mn.	SiO_2.	S.	P.	Moisture.
24·45	21·47	19·60	0·022	0·163	0·80

Prospects unfavourable.

With regard to these Silondi ores, it can only be said that if such a deposit were found close to existing iron works, it might possibly prove worth working, but under actual conditions, its highly siliceous character and the small quantity available deprive it of all value.

Two or three other localities in the vicinity of Sihora Road Station were also examined, but proved to be even more unsatisfactory than the last named.

G. I. C. P. O.—No. 201 R. E. P.—13-5-1904—2,500—E. N. D.

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(Vegetable Product Series, No. 80.)
(Foods and Fodder.)

THE AGRICULTURAL LEDGER.

1904—No. 4.

FICUS SPP.

(FRUIT, BARK, ETC.)

[*Dictionary of Economic Product., Vol. III*, F. 129-252.]

NOTE ON THE CHEMICAL EXAMINATION OF THE FRUITS

By O. REINHERZ,

Some time Curator, Indian Museum, Calcutta, Industrial Section.

FICUS BENGALENSIS.

Ficus bengalensis, *Linn., Fl. Br. Ind., V., 499; Wight Ic. t. 1989; King in Ann. Roy. Bot. Gard., Calcutta, I., Part I., 18, 19, pl. 13, 81[a]; Ind. Kew., I., 958.*

THE BANYAN TREE.

Syn.—F. INDICA, *Linn. in part*; URÓSTIGMA BENGALENSE, *Gasp.*

Vern.—*Bor, bar, ber, bargat*, HIND.; *Bar, but*, BENG.; *Bai*, KOL.; *Baro*, URIYA; *Baro*, SANTAL; *Ranbat*, GARO; *Bot*, ASSAM; *Borhar*, NEPAL; *Kanji*, LEPCHA; *Bor*, MAL (S. P.); *Barelli*, GOND; *Wóra, kurku*, UNITED PROVS.; *Bera, ber, bohir, bohar, bargad* (milky-juice *shir*, the fibres of aerial roots are *rish bargad*), PB.; *Baagat, bar*, PUSHTU; *Phagwari*, HAZARA; *Wur, bur*, SIND; *Wad, vad, war, barghat*, BOMB.; *War, vada*, MAR.; *Ala*, TAM.; *Mari, peddimari (marri)*, TEL.; *Ahlada, alada, ala, alava*, KAN.; *Peralu, peralin*, MALAY; *Pyi-nyoung (pa-nyaung* or *pyi-nyaung)*, BURM.; *Vata*, SANS.

Habitat.—A large evergreen tree, remarkable for the aerial roots which it throws down from the branches, thus expanding itself without limit. It grows in a semi-wild or cultivated state all over India; it is common in the Sub-Himalayan forests from Assam to Peshawar, the forests of Behar, Chota Nagpur, Orissa, the Circars, Central Provinces, Bombay Presidency, and South India. Like the pipal, this tree is considered sacred and Hindus will not cut it.

The fruits, young leaves, the bark and seeds are frequently eaten by the poorer classes, particularly in famine years.

FICUS spp.

Note on the Chemical Examination of the Fruits. (O. Reinhers.)

FICUS BENGALENSIS FRUITING SEASON.

The fruits ripen from March to June according to locality (United Provinces, March-April; Kishengarh, Central India, April-May; Bombay, April-June). From Neemuch, Central India, it is reported that the tree bears fruit twice yearly—in May and December. Each tree yields about 6 maunds (1 maund = 82·3 lbs.), and the quantity that a man can pick up in a day is estimated at 10 seers (1 seer = 2·06 lbs.).

The information which follows has been gleaned from the correspondence conducted in the office of the Reporter on Economic Products to the Government of India.

If leaves eaten.

Bengal.—The fruits, leaves and bark are reported to be eaten all over the Presidency from Mozufferpur in the north to Balasore on the southern coast, and from the Sonthal Perganas to Palamau. In Purneah the tender leaves and bark are eaten, in Beerbhoom the young leaves; the ripe fruits in Bhagulpur, Manbhum, Ranchi, and Saran districts. In Palamau, Chota Nagpur, the fruits are dried, and ground into flour of which bread is made.

United Provinces.—The outer bark of the trunk is, in the Etawah district, ground up fine and made into bread. This has little sustaining power for the report states that those who use it become more feeble daily. In Bara Banki and also in Unao the fruits ripe or sun-dried are made into flour, cooked, and eaten in the form of cakes. The ripe and unripe fruits are also eaten in the following districts:—Azamgarh, Ghazipur, Hamirpur, Muttra, and Sitapur.

Rajputana and Central India.—The dried fruits are pounded, mixed with flour and made into bread in the States of Banswara, Bhopal, Bhurtpur, Dholpur, Jaipur, Jaora, Kishengarh, Marwar. In Banswara the pounded fruit is mixed with flour in the proportion of 2 : 1. The use of the fruit as food is apt to induce constipation, especially if taken in large quantity. In Ajmere-Merwara the inner bark mixed with flour is made into chappátis and eaten. It is not harmful unless partaken of too liberally when it causes disorder of the stomach. The ripe fruits are eaten in Kotah as well as in Tonk, Jhalawar, Alwar, and Baghelkhand.

In Jaora State and Baghelkhand it is reported that there is no trade in the fruits.

Madras.—In the Bellary district the fruits are occasionally eaten in small quantity by children only. The leaves are used for plates. The seeds, juice, and roots are employed as medicine. The wood it is reported finds no use.

The fruit of **Ficus bengalensis**, the common banyan, is consumed during famine times in various parts of India.

It possesses a thick fibrous skin, but as the consumers do not be able to remove it, the fruit was analysed in its original condition.

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FICUS spp.

FICUS BENGALENSIS FRUITS CHEMICAL COMPOSITION.

(1) Composition of a dried specimen of **Ficus bengalensis** (from Perawa)—

Water	11·4
Albuminoids	7·1
Oil	4·0
Carbohydrates	35·2
Fibre	36·8
Ash	5·5
	100·0

(2) A sample of the fresh fruit was gathered in Calcutta.

As the sample was very wet, it was partially dried for analysis. It then contained:

Water	12·9
Albuminoids*	8·1
Oil	6·1
Carbohydrates†	35·5
Fibre	31··
Ash‡	6·4

The alcoholic extract contains a glucoside, a trace of acid, but no appreciable quantities of tannin or alkaloid.

The colouring matter is precipitated from its deep purple alkaline solution as a reddish brown deposit which dries to an almost black powder.

FICUS CUNIA.

Ficus Cunia, *Ham., Fl. Br. Ind., V., 523; Wight Ic. t. 669; King in Ann. Boy. Bot. Card., Calcutta, I., Part II., 101; Ind. Kew., I., 959.*

Syn.—FICUS CONGLOMERATA, *Roxb.*

Vern.—*Khewrau, khumhur, kassa, ghwi khenan, ghui,* HIND.; *Dumbur, jajyadomur,* BENG.; *Riu, ain,* KOL.; *Porok podka,* CHUTIA NAGPUR; *Horpodo,* SANTAL; *Kanhya,* NEPAL; *Sangji,* LEPCHA; *Kanai, palkai, taikrau,* MICHI; *Poroh, ferina, teregam,* MAL (S. P.); *Kunia,* KUMAON; *Kathjular, trumbal, karndol, kuri,* PB.; *Porodumer,* KHARWAR; *Ye-kha-ong,* BURM.; *Jonua, sodoi,* MAGH.

Habitat.—This attractive species of the fig tribe occurs in Bengal, Orissa, and the Circars; it is also found in the Sub-Himalayan tract from the Chenab up to 4,000 feet, and in Burma. The fruit ripens in August-October and is eaten (*Atkinson, Econ. Products of the N.-W. P., Part V., 1883, p. 85*). Mr. Innes reports that the fruit

* Containing nitrogen . . . . . 1·31 per cent.
† Ditto colouring matter . . . . . 7·7
‡ Ditto silica (SiO_2) . . . . . 0·35
‡ Ditto phosphoric acid (P_2O_5) . . . 0·53

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FICUS spp.

FICUS GIBBA FRUITS. CHEMICAL COMPOSITION.

Note on the Chemical Examination

when ripe is eaten uncooked and is rather sweet. The fruit appears to spring from the roots of the tree. The fruit ripens about July. It is considered most edible and is much sought after by bears *(List of Jungle Products used as Famine Foods, 1896-97, p. 10)*.

Bengal.—In the Manbhum district the fruit is cooked with oil and a little salt, and eaten along with rice. Other localities where the fruit is eaten are the Sonthal Perganas and Chota Nagpur (Palamau).

A dried specimen submitted by the Deputy Conservator of Forests, Angul Division, shewed the following composition :—

Water	13·5
Albuminoids*	8·7
Oil	5·7
Carbohydrates†	43·1
Fibre	17·7
Ash‡	11·3
	100·0

The alcoholic extract contains a soluble tannin which gives a green precipitate with ferric chloride.

The colouring matter appears to be identical with that characteristic of the other varieties of Ficus.

FICUS GLOMERATA

Ficus glomerata, *Roxb., Fl. Br. Ind., V., 535; King in Ann. Roy. Bot. Gard., Calcutta, I., Part II., 173-174, pl. 218, 219; Ind. Kew., I., 960.*

Syn.—F. CHITTAGONGA, *Miq.*

Vern.—*Gúlar, parua, lelka, umar, umrdi, tus, dimeri*, HIND.; *Jagya dumar, yajna dumbar*, BENG.; *Lowa, lóa*, KOL; *Iowa, loa*, SANTAL; *Dumer*, CHUTIA NAGPUR; *Dimeri*, URIYA; *Dumri*, NEPAL; *Tchongtag*, LEPCHA; *Dumer*, MAL (S. P.); *Thoja*, GOND; *Alamb*, KURKU; *Dumer*, KHARWAR; *Gúlar, panua, lelka*, UNITED PROVS.; *Kathgúlar, krumbal, rumbal, batbar, paláh, kakammal, dadheri*, PB.; *Ormul*, PUSHTU; *Umbar gular*, C. P.; *Umbar*, BOMB.; *Umbara, atti, rumadi*, MAR.; *Umbar*, GUJ.; *Atti*, TAM.; *Moydi, atti, bodda, paidi, meri, medi*, TEL.; *Kulla-kith, atti mara* (the gum is called *Chandarasa*), KAN.; *Ye-thapan*, BURM.; *Udumbara*, SANS.

Habitat.—This large deciduous tree of the Salt Range and Rajputana extends along the outer Himalaya and Sub-Himalayan tract from Kashmir eastwards to Assam, Khasia Hills and Bengal, Burma,

* Containing nitrogen . . . . . 1·40 per cent.
† Ditto colouring matter . . . . . 9·0
‡ Ditto silica (SiO_2) . . . . . 1·65
‡ Ditto phosphoric acid (P_2O_5) . . . . 1·18

FICUS spp.

FICUS GLOMERATA YIELD OF FRUIT.

of the Fruits. (*O. Reinhers.*)

Central, Western and Southern India. It is said to be one of the best shade trees for coffee. It fruits usually from March to July (*Lisboa*), but the fruits are ripe throughout the year at different times (*Talbot*). In Rohtak, Panjáb, the fruits ripen about the end of May, and in Kishengarh, Central India, from April to July. The leaves, bark and fruit are employed as medicine by native practitioners. The fruit has long been known as a useful famine food. In a good harvest the tree yields about 1½ maunds of fruit (Jaora State). About 12 seers can be collected in a day. It will be seen from the reports below that opinions do not agree as to it possessing deleterious properties.

The following is a summary of reports received from districts where the fruit is eaten :—

Where eaten.

Bengal.—In Bhagulpur the ripe fruits are eaten, also the unripe ones after being boiled. Other districts where people eat the fruits are Dinajpur, Champaran, Gya, Jamtara, Monghyr, Mozufferpur and Ranchi.

United Provinces.—Both bark and fruit are used as food. In Bara Banki the ripe or sun-dried fruit is ground to flour and made into cakes. In Banda and Mirzapur districts the fruit is eaten ripe, also unripe after being boiled. In Fyzabad the dried fruit is pounded, mixed with coarse flour and made into chappátis. In the Muttra and Sitapur, Oudh districts, the fruit is considered constipating. It is eaten raw; a kind of bread being made of the dry pulp. In Lalitpur, Oudh, the bark is pounded and mixed with flour, if possible, before being cooked. In Unao, Oudh, the fruit and bark are prepared as food in various ways, *e.g.*, the unripe fruit is boiled and eaten with salt; it is mixed with flour and made into cakes; the dried fruit pounded and likewise mixed with flour is similarly eaten; while the bark after being cut up fine is dried, pounded, mixed with flour and made into chappátis. Besides the districts named, the fruits are reported to be eaten in Azamgarh, Aligarh, Ghazipur, Hamirpur, Hardoi, Jhansi (effects unhealthy), Fatehpur, and Naini Tal (fruit found in all seasons).

Panjáb.—The use of herbs and barks as famine food is reported to have often caused purging and vomiting. It is even thought that the high death-rate in August 1900 was in part due to the use of such food substitutes (Gurgaon). The tree is generally found by the side of canals and tanks (Rohtak).

Rajputana and Central India.—In Bhopal, Bhurtpur, Jaipur, Jaora, Jhalawar, Kárauli, Kisbengarh, Kotah, Marwar, the ripe fruits are eaten. In times of scarcity the unripe or dry fruits are pounded and eaten with ordinary flour. In Jaipur and Ajmere-Merwara the bark is dried and

FICUS spp.	Note on the Chemical Examination
FICUS GLOMERATA FRUITS, CHEMICAL COMPOSITION.	ground with food-grains. In some cases the flour is mixed with the pounded bark in the proportion of ⅓ flour to ⅔ bark. Reports from the Bhopal Agency, Jaipur, Baghelkhand, and Ajmere-Merwara allude to the harmfulness of these foods. In two other instances, however, the opinion was expressed that they were not injurious. **Madras.**—In Bellary the ripe and unripe fruits are regularly eaten. In famine seasons the fruits are ground to powder, which is mixed with *cholum* (Andropogon Sorghum) or other flour, made into cakes and eaten. The fruit is also eaten in Cuddalore. The unripe fruits are boiled and mixed with salt. Ripe fruits are eaten without preparation. The fruit is generally employed as a vegetable, and as a staple food only during famine. No deleterious effects are said to follow the use of the fruit as reported from other districts.

Water	13·6
Albuminoids*	7·4
Oil	5·6
Carbohydrates†	49·0
Fibre	17·9
Ash‡	6·5

The alcoholic extract contains a trace of soluble tannin which gives a light green precipitate with ferric chloride.

FICUS RELIGIOSA.

Ficus religiosa, *Linn., Fl. Br. Ind., V., 513; Wight Ic. t. 1967; King in Ann. Roy. Bot. Gard., Calcutta, I., 55, 62, pl. 67 A, 84ª; Ind., Kew. I., 963.*

THE PEEPUL TREE.

Syn.—F. AFFINIS, *Grif.*

Vern.—*Pipal*, HIND; *Ashathwa, aswat, asód, asvattha*, BENG.; *Hesar, pipar*, KOL; *Hesak*, SANTAL; *Jasi*, ULIYA; *Bor-tur*, CACHAR; *Pipri*, NEPAL; *Hesa-aru*, S. P.; *Ali*, GOND; *Pipri*, KURKU; *Pipal, bher*, PB.; *Pippal*, PUSHTU; *Pijur*, SIND; *Jári, pimpal, piplo* (SURAT), BOMB.; *Pimpala*, MAR.; *Pipal*, GUJ.; *Pipla, pipli* (= the *fruit*), C. I.; *Avasa Aswartham*, TAM; *Rái, raiya, ragi, rávi* or *kulla rávi*, TEL.; *Rongi, basri, arali, arle, haspath, ragi, aswalta*, KAN.; *Nyaungbaudi, nyoungbaude*, BURM.; *Aswaththamu, asvattha*, SANS.

Habitat.—A large and well-known tree, usually epiphytic, which occurs in the sub-Himalayan forests from the Panjáb eastward, Bengal, Orissa, the Circars, Central India, Burma. Extensively cultivated in most parts of India. It does not throw down aerial roots

* Containing nitrogen
† Ditto colouring matter 0·19 per cent.
‡ Ditto silica 8·5
‡ Ditto phosphoric acid 0·25
‡ Ditto phosphoric acid 0·91

	of the Fruits. (*O. Reinhers.*)
FICUS spp.	
FICUS RELIGIOSA FRUITS AS FAMINE FOOD.	like the banian. It is held sacred by the Hindus, and none will destroy it. The tree fruits during the hot months, and sometimes towards the end of the rainy season (Bombay). In Unao, Oudh, and Kishengarh, Central India, the fruits ripen in Chait—15th March-15th April. A tree yields on an average about 1½ maunds of fruit, and in a day a man can collect about 10 seers (Jaora State, Central India). The ripe fruits are eaten. In times of scarcity, the green fruits are pounded with rice or *bajri* and made into cakes, while the tender buds are eaten as vegetables. The dried bark is pounded and bread made from the flour. It is not very nutritive. The fruit which ripens about June is also eaten uncooked. The leaves, bark and fruit are used in native medicine. The particulars which follow regarding the use of the fruit, etc., as a famine food have been gathered from the correspondence conducted by the office of the Reporter on Economic Products to the Government of India. **Bengal.**—In Palamau the fruit is dried, ground into flour and made into bread. In Manbhum the leaves are cooked with salt and oil as a pot-herb. The fruits are also reported to be eaten in the following localities: Balasore, Bankura, Beerbhoom, Berhampur, Bhagulpur, Champarun, Contai, Dinajpur, Gaya, Manbhum, Midnapur, Monghyr, Mozufferpur, Ranchi. Pipal leaves are eaten in the districts of Balasore, Bankura, Beerbhoom, Dinajpur, Midnapur, Mozufferpur, Purneah, and the Santhal Perganas. In the reports mention is made of the bark being eaten in Purneah, and the young buds in Midnapur. **United Provinces.**—In Bara Banki district a flour is made out of the ripe or sun-dried fruits. This is cooked and eaten in the form of cakes. The same method is practised in Unao with the addition of ordinary flour. The fruits are reported to be eaten in the following districts:—Azamgarh, Ghazipur, Gorakhpur, and Muttra. **Panjáb.**—Ficus religiosa fruits are stated to be used as food in Gujerat. **Rajputana and Central India.**—The ripe and also the unripe fruits are dried, pounded, and cooked as chappátis—Bhopal, Jaipur, Jaora, Kishengarh, Kotah, Marwar. In Banswara, flour is added in the proportion of 1 : 2. Opinions are conflicting as to whether the use of the fruits is injurious. If eaten in moderation it is very possibly harmless. The leaf buds are eaten as vegetables by hill tribes in the Kishengarh State. Other localities where the fruit is reported to be eaten are Ajmere-Merwara, Alwar, Bhurtpur, Bundi, Dholpur, Perawar (Tonk). **Madras.**—In Bellary the fruits are eaten in small quantities by children. It is said to produce diarrhœa. The fruits are consumed

FICUS spp.	Note on the Chemical Examination of the Fruits.

FICUS RELIGIOSA FRUITS, CHEMICAL COMPOSITION.

only in famine years. No bad effects following their use have been observed in Cuddalore and South Arcot.

The fruit of **Ficus religiosa** was consumed in the Khandul district in the famine of 1877-78. A dried specimen from Bundi was analysed and found to contain :—

Water	9·9
Albuminoids *	7·9
Oil	5·3
Carbohydrates †	34·9
Fibre	33·7
Ash ‡	8·3
	100·0

The general characters of the extracts are the same as those of **Ficus bengalensis.**

Note on the colouring matter of **Ficus.**

COLOURING MATTER OF THE FRUITS OF FICUS.

The amount of colouring matter was determined as follows :

The oil-free material was first boiled with dilute acid in the usual way to dissolve out starch, mucilage, etc. On subsequent treatment with dilute alkali a very deep coloured solution was obtained. This was acidified with hydrochloric acid and filtered. The colouring matter that remained in solution was neglected owing to the lack of a suitable solvent for it.

The precipitated matter was well washed and weighed, after drying on a tared filter at 100°C. It was afterwards incinerated and the weight of the ash deducted.

The dark brown powder obtained was soluble in ether and in boiling alcohol, almost insoluble in cold water, and quite insoluble in benzene and petroleum ether.

Its melting point was indefinite.

It dissolved with black colouration in strong sulphuric acid. Water precipitated a purple-black substance from the sulphuric acid solution.

Strong nitric acid dissolved it with formation of a clear red solution, from which a yellow precipitate was obtained on addition of water.

*	Containing nitrogen	1·27 per cent.
†	Ditto colouring matter	7·5
‡	Ditto silica (SiO_2)	1·85
	Ditto phosphoric acid (P_2O_5)	0·69

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G. I. C. P. O.—233 R. E. P.—23-5-1904—2,500—B. N. D.

THE AGRICULTURAL LEDGER.

1904—No. 5.

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THE AGRICULTURAL LEDGER.

1904—No. 5.

SHOREA ROBUSTA.

(THE SÁL TREE.)

[*Dictionary of Economic Products, Vol. VI., Pt. II.*, S. 1656 71.]

THE SEEDS OF **Shorea robusta** AS A FAMINE FOOD.

By O. REINHERZ,

Some time Officiating Curator, Indian Museum, Calcutta, Industrial Sectio

Shorea robusta.—*Gaertn.; Fl. Br. Ind., I., 306: Beddome, Fl. Sylv., t. 4; Ind. Kew., IV., 895.*

THE SÁL TREE.

Syn.—VATICA ROBUSTA, *Steud.*

Vern.—*Sál, sála, salwa, sákku, sakhua, sakher, sakoh* (resin =) *rál, dhúná, dámar*, HIND.; *Sál, shal* (resin =) *rá, dhúná*, (fruit =) *saringa*, BENG.; *Sarjum, sekura*, KOL.; *Sarjom, salai (sál brikshephel)*, SANTÁL; *Sargi*, BHUMIJ; *Śakwa*, KHARWA; *Sekwa*, ORAON; *Bolsal*, GARO; *Sakwa*, NEPAL; *Teturi*, LEPCHA; *Salwa, soringhi*, URIYA; *Sál, sarei, rinjal*, C. P.; *Sál, kándar sákku, koron*, U. P.; *Koroh*, OUDH; *Sál, seral*, (resin =) *ral sard, ral sufed, ral kala, dhúna*, PB.; (resin =) *Kal*, DECCAN; *Sál*, (resin =) *ral, dhúná*, BOMB.; (resin =) *rala, guggilu*, MAR.; (resin =) *Ral*, GUZ.; (resin =) *Kangiliyam*, TAM.; *Gúgal* (resin =) *Guggilamu, guggilam chettu*, TEL.; *Kabbu*, (resin =) *guggala*, KAN.; *Enkhyen*, BURM.; (resin =) *Dammala*, SING., *Sala, śvakarna*, (resin =) *rála, guggilam, koushikaha*, SANS.; *Kaikahr*, ARAB; *Lále-moáb bári*, PERS.

Habitat.—The natural distribution of the *sál* in India is as follows:—Along the foot of the Himalaya from the Assam valley in the East to the Sutlej in the West, and again from the Sonthal Pergunnahs to Vizagapatam, passing through the Eastern districts of Central India.

FRUITING SEASON.

Its seeds are used as a food in many parts of India chiefly in times of scarcity. The dry fruits are collected in the forests in the

SHOREA robusta.

The Seeds of Shorea robusta

FRUITING SEASON.

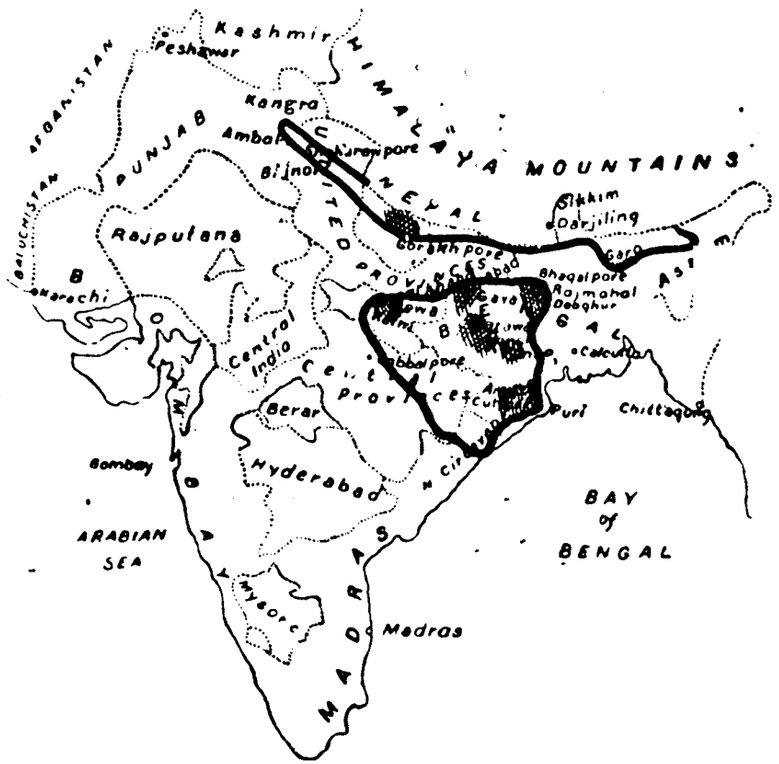
months of May and June, and a man, it is said, can collec
a day. After collection the shells are broken by means
mallet, and the two curiously shaped brown seeds extracte

The following is a summary of information brought to
the office of the Reporter on Economic Products:

Where eaten.

Bengal.—*Sál* seeds are eaten throughout Chota Nagp
Sonthal Pergunnahs, in the district of Gaya to the West and Bhaga

Sketch map showing the distribution of Sál and the area (shaded) over which Sál seeds are eaten.



to the North, in Jalpaiguri and in Orissa. They are generally boiled into a sort of porridge with a little *mahua* (**Bassia latifolia**), and the two eaten together, so that the sweetness of the latter masks the astringency of the former. In Manbhum salt may be the only substance added. In the Ranchi district the seeds are boiled with wood ashes, a most wholesome practice as will be seen. In Bhagalpur the seeds are said to be boiled, then dried and ground

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SHOREA robusta.

as a Famine Food. (*O. Reinhertz.*)

CHEMICAL COMPOSITION.

Cakes are made from this flour, with the addition of flour
olichos biflorus) or *mahua*.
cognised that the raw seeds cause constipation, distension
omen, and much thirst, and owing to the astringent pro-
essed by the seed, it is used to stay diarrhœa in children.

Provinces.—It is eaten in the district of Gorakhpur. The
of preparation is as follows:—The seed is partially dried, then pounded into very coarse meal, dried again, and made into flour. Bread is made from the flour. Owing to the comparative ease with which the seeds can be got, it is a chief famine food, but it is recognised as dangerous and at times even fatal in its effects.

Central India.—The seeds are used with *mahua* just as in Chota Nagpur. They are boiled for 8 to 10 hours before use. In ordinary years the jungle tribes eat *sál* seed even when not hard pressed by famine.

Madras.—Used as a famine food in the Chanda pur district.

The chemical composition of sál seeds.

The analysis which is herewith submitted was carried out on the lines indicated by Professor A. H. Church in his "*Food Grains of India.*" Certain modifications and extensions have to be recorded.

For the extraction of the oil contents of the foods investigated, rectified benzene was used in the place of ether.

Alcoholic extracts of the oil-free materials were made with a spirit of specific gravity 0·85, and were qualitatively examined for tannins and alkaloids.

Sugars, starch, mucilage, etc., were determined by difference and are quoted together as carbohydrates.

The analysis of a specimen of *sál* seeds (from Deoghur) was completed before discovering that an account of the composition of these seeds was given by Professor Church in the work already alluded to. It will be seen that the two analyses are in fairly close accord.

Composition of sál seeds.

	Prof. Church.	The writer.
Water	10·8	10·5
Albuminoids	8·0	8·2
Carbohydrates	62·7	62·1
Oil	14·8	15·4
Fibre	1·2	1·9
Ash	2·3	1·9
"Nutrient ratio"	1 : 12	1 : 12
"Nutrient value"	105	106

Remarks.—The oil contains a small quantity of unsaponifiable residue which smells of turpentine.

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SHOREA robusta.

The Seeds of Shorea robusta as a Famine Food.

CHEMICAL COMPOSITION.

The alcoholic extract is free from alkaloids but contains tannic acid. The dried, oil-free seeds contain a large quantity of colouring matter which is only very slightly soluble in water and in dilute acids, but very readily soluble in alkali. The alkaline solution has a very deep purple colour and a characteristic odour. On addition of acid to this solution, the colouring matter separates as a dark reddish brown, flocculent precipitate which dries to an almost black amorphous powder probably consisting of phlobaphene and allied compounds.

Occurring as it does to the extent of 8 per cent. in the original seeds, this amount should be deducted from the carbohydrates quoted above, the nutrient value becoming thus :—

98 instead of 106

and the nutrient ratio,

1 : 11 instead of 1 : 12

PHLOBAPHENE.

Phlobaphene is a chemical body allied to tannin. It is decomposed by alkalies into protocatechuic acid and some other body.

Both tannins and protocatechuic acid in large quantities are poisonous to man ; and there is considerable presumption that phlobaphene is poisonous like them. The generally reported action of *sál* seeds—upon man—causing indigestion, constipation and ultimately death if taken in quantity is just like the action of acorns wherein the poisonous substance is tannin. There is no doubt that *sál* seeds are a poor food when taken in a raw state.

Regarding acorns there is an old record, generally forgotten, of their effect as food when they were eaten in France in the famine of 1775 : and their poisonous effect on cattle is well known and recognised. *Sál* seed would perhaps be found poisonous to stock were enquiry made.

Beneficial effect of boiling with alkalies.

It was remarked above that alkalies break down tannins and phlobaphene, and that these bodies become soluble in dilute solutions of alkali. By boiling with wood ashes, as recorded, the people of the Ranchi district induce this to occur and the astringent substances rendered soluble are poured off with the waste water.

Experiments kindly made for me by Mr. D. Hooper with powdered *sál* seeds show that when boiled with water containing one thousand part of caustic soda the following changes take place. The fatty matter is saponified and rendered soluble, the starch is destroyed, and one-third the amount of albuminoid matter is dissolved. The boiled liquid therefore contains the oil, starch, tannins, sugar and a portion of the nitrogen present in the seeds. But as only half the weight of the seeds is removed by this treatment and only one-third the amount of albuminoids, a fairly nourishing food is left in an insoluble condition.

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G. I. C. P. O.—No. 232 R. E. P.—2-6-1904.—2,500—B. N. D.

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(Vegetable Product Series, No. 84.)
(Foods and Fodder.)

THE AGRICULTURAL LEDGER.

1904—No. 6.

FAMINE FOODS

[*Dictionary of Economic Products. Vol. III.*, F. 32.]

Other PAPERS that may be consulted:—

The Agricultural Ledger, 1898, No. 19.

PAPERS RELATING TO CERTAIN INDIAN ACCESSORY VEGETABLE FOOD-STUFFS USED IN GREATER QUANTITY WHEN FAMINE PRESSES.

i.—*The Nutritive Value of some Uncultivated Foods used by Bhils during recent Famines, by* D. NOEL PATON, M.D., F.R.C.P., EDIN. *and* JAMES CRAWFORD DUNLOP, M.D., F.R.C.P., EDIN. *(From the Laboratory of the Royal College of Physicians of Edinburgh.*

ii.—*Analyses of Indian Pot-herbs of the Natural Orders Amarantaceæ, Chenopodiaceæ, and Polygonaceæ, by* DAVID HOOPER, F.I.C., F.C.S.

The Nutritive Value of some Uncultivated Foods used by Bhils during recent Famines.

(1)—PRELIMINARY.

ORIGIN OF INQUIRY.

In July 1901 we received from Mr. F. Noel Paton samples of some of the uncultivated foods collected and used by the Bhils during the famine, along with a series of valuable notes stating the mode of use, the quantities found necessary to maintain life, and other essential details. We have thus been afforded an opportunity of investigating the very interesting subject of the quantity and nature of some of the natural vegetable products which were found by the semi-savage Bhils* to be sufficiently nutritious to sustain them through

* Bhils are a tribe numbering over a million of pre-Aryan origin living in the Vindhya, Satpuri and Satmala or Ajanta Hills.—ED.

FAMINE Foods.

ORIGIN OF INQUIRY.

a long period of famine. The investigation may be of interest to the economist in showing the nutritive value of some drought resisting foods, and to the physiologist in affording some further information upon the question of the energy requirements of human beings, and of their powers of digesting and utilising coarse vegetable products.

The samples and notes were originally sent to Mr. Paton in response to an unofficial request to the Government which procured them through Mr. S. M. Barucha, District Deputy-Collector, Panch Mahals, and Mr. F. B. Garda, Famine Officer, Dholka. The samples received numbered 18 in all, Mr. Barucha sending eight and Mr. Garda ten. In the following list we give the native names which were upon the specimens sent to us and also the proper botanical names of the plants, so far as we have been able to ascertain them, the latter having been supplied to us by Mr. Paton from the Indian Government, and kindly revised by the Director of the Royal Botanic Gardens, Kew. The identification of the various specimens has delayed the publication of the analyses.

So far as we are aware the only previous analytic study of foods of this class is that published by Professor Church, who in his "Food-grains of India, 1896, with Supplement, 1901" (Chapman and Hall), refers to some of those now under consideration. When dealing with the composition of these foods we shall have to compare our results with his.

SPECIMENS RECEIVED.

(2)—List of Specimens received.

From Mr. Barucha.

A. *Sent by* Mr. Barucha.

Samo (Panicum colonum).
Podru or *Kherkholu* (Panicum javanicum).
Zinjroo (Indigofera glandulosa).
Mali, or *Manchi*, or *Manebhi* (Eleusine ægyptiaca).
Samlaseru or *Samla Seru* (Panicum, species of).
Kasaiya (Coix Lachryma-Jobi).
Kodri, a husked preparation got from *Samo* or *Podru* or *Samla-seru*.
Katchrq, a wild fruit allied to *Kakri*.

From Mr. Garda.

B. *Sent by* Mr. Garda.

Bil, Root of *Gunderda* (Scirpus grossus, *var.* Kyseor ?).
Ghitola, fruit of *Paena* or *Kumplis* (Nymphæa Lotus, *var.* pubescens).
Kanda Root, root of *Paeni*, or *Ghitola*, or *Kumplis* (Nymphæa Lotus, *var.* pubescens).
Thek Root (Cyperus bulbosus).

FAMINE Foods.

DESCRIPTION AND USES.

Samo (as above).
Ballair, or *Balleriao*, or *Golio* (Panicum, species).
Anchu Manchu or *Anki Manchi* (Eleusine ægyptiaca).
Endoo Pendoo (Panicum, species).
Oru Koru or *Puchadioo* (Panicum, species).
Doda Flowers, pollen grains and anthers of (Dregea volubilis, *Benth.*)

Of the above, we have analysed all the samples with the exception of *Samla-seru*, *Kanda* root, and *Oru Koru*, which appear to be of minor importance as foods.

(3)—Description of the Foods, and their Mode of Use.

Samo, or Grain of Panicum colonum.

Samo (Panicum colonum).—A grain oval in shape with pointed ends. It has a green capsule which is covered by a roughish straw-coloured husk. It is neither very hard nor very gritty. It has a taste somewhat suggestive of oats. Mr. Garda's specimen contained some impurities, mostly bits of grass. Mr. Barucha's specimen was much purer.

Mr. Barucha report.

Mr. Barucha writes:—

"It is found in cultivable fields (especially black soil) that remained uncultivated last year. The *Samo* collected by the Bhil women in fields is half mixed with earth, from which, being a very small grain, it is not separated without a lot of trouble. Pure *Samo* is collected just after the monsoon, when the seed has not yet fallen on the ground. Hundreds of Bhils were seen last year from August to October going from field to field with a basket and a flapper, and filling their baskets with *Samo* got direct from the waving grass by means of the flapper. I send a sample of the flapper; though rudely prepared and of rough materials, it well serves the Bhil's purpose. After October, when the grass was dried up, the *Samo* seeds fell off to the ground, and since then the only mode of collecting the seed was by sweeping it off the ground. As said above, it was half mixed with earth; to clear it the Bhils had first to pour it on the ground from a height of 3 or 4 feet, thus blowing off the chaff; second to pound it with a pestle; and third, to winnow it. The result would be pure *Samo* seed as sent in the sample. Generally out of the quantity collected, about half is the real *Samo*, the other half being earth. This pure *Samo* is then ground, mostly by itself, and sometimes mixed with maize or gram, if available. The flour is then baked in to bread and eaten with either chutney or onions, or some forest fruit or boiled leaves. *Samo* is a soft grass seed, and is therefore considered by the Bhils not to have the same nutritive value as maize. The Bhils, therefore, require a larger quantity of *Samo* than maize to satisfy their hunger, viz., nearly half as much again. I have found that from 1½ to 2 lbs. of maize is daily required for a working man of average health; the *Samo* required by the same man is from 2½ to 3 lbs. *Samo* bread is sweet in taste and much relished by the Bhils,

Papers relating to

DESCRIPTION AND USES.

Samo, or Grain of Panicum colonum.

Mr. Garda's report.

who consider it to have 'cooling properties.' Those who are not used to it get diarrhœa at first, but later on they thrive on it. Within two months of the Bhils commencing to use *Samo*, I was agreeably surprised to see them everywhere fat and strong, there being few traces left of their hard sufferings in the previous year."

Mr. Garda writes :—

"'*Samo*' seed is obtainable about two months after it commences to rain. It is gathered in good quantity (about one maund [=82·3 lbs.] by a strong man), in the beginning, *viz.*, in September and October, by means of an oval-shaped frame-work made of bamboo or wood, with cloth attached to it, and called 'Wanjee' or 'Dhanu.' In November it commences to fall off, and people gather it from the ground and continue to do so till the hot season is over, when about three seers [1 seer =2·06 lbs. Av.] at the most is collected by a strong man. After it is brought home it is exposed to the sun for a couple of days, and then rammed or thrashed. Then the husks are separated. This process is repeated once or twice over, and the grain in its eatable condition is finally separated from the husks, and when 'Chhas' is available. 'Chhas' or 'Rab' (Kanji) is prepared out of it, or the grain is ground and bread prepared out of the flour. *Samo* grows mostly in black soil, and when cheap it can be obtained at two to three maunds a rupee. Out of one maund about 18 seers of grain can be taken out. An adult requires from 1½ to 2 seers of this grain a day for food. Even in years of plenty poor people such as Dheds*, Wagrist, and Shangris resort to it, and high class Hindoos make use of it on the days of fasting. It is better in taste than any other wild grain, and is not found to be so much injurious to the health as others. Those who are accustomed to it have been found to be in good condition, while other people find it producing costiveness and lethargy. *Samo* grass grows more thickly in black soil than in yellow, and is greatly relished by cattle."

Kodri or meal from millets; Sample sent was Kodri from Panicum colonum.

Kodri.—This is husked *Samo*. It is a small hard grain without husk, light in colour, and with few evident impurities.

Mr. Barucha writes :—

"Except *Mali* and *Zinjroo* all other grass-seeds can be made into *Kodri*, as well as bread. *Kodri* is prepared by raking off the husks of *Samo* or *Podru* or *Samla-seru* by roughly grinding it. It is then cooked like rice with water and salt, and eaten with pulse, if any, or chutney. It is called '*Rab*' or '*Ghena*,' a half fluid food much relished by the Bhils. I send a sample of *Kodri* of *Samo*."

Mr. Garda sends no sample.

Amount of daily ration is not stated.

Podru, or Grain of Panicum javanicum

Podru (Panicum javanicum). *Description*.—A grain in all respects very similar to *Samo*.

* Dheds (Dhers) a wild tribe found chiefly in Baroda and Rajputana, where they number over 100,000.—Ed.

†Wagris (Waghris or Vaghris) a wild tribe in Cambay, numbering some 80,000.—Ed.

DESCRIPTION AND USES.

Mr. Barucha writes :—

"'*Podru*' or '*Kharkhadu*,' is found in waste land, compounds, below *babul* trees, and even in forests. It is collected in the same way as *Samo*, and cleaned and prepared similarly. The same quantity is required to satisfy hunger. The only difference between the two is that while *Samo* grows in cultivable fields, '*Podru*' grows in waste land and compounds, and is less sweet in taste."

Mr. Garda sends no sample.

Batterioo or Grain of a third Panicum.

Batterioo, *Battair* or *Golio* (Panicum sp.?).—A yellow grain of elongated shape, some with and some without capsules, mixed with two other grains, the one a brown grain resembling the yellow one in shape, the other a small, almost black seed, with hard resistant punctated capsule and very difficult to break. There are some impurities in the specimen consisting of seeds of other grasses and earthy matter.

Mr. Barucha sends no sample.

Mr. Garda writes :—

"This grass-seed called '*Batterioo*' or '*Golio*' was unknown to the people till the famine appeared; when it was resorted to by the poor people. They commence to collect it from October and continue doing so till the monsoon sets in. In the beginning of the season, the grass is cut and then thrashed, and the grain is collected. As the time goes on the seed falls off the grass, and it is collected by means of sweeping the ground. In the commencement, an adult gathers about 15 seers of the seed while in the latter part of the hot season one is able to get only three or four seers after the dust is separated. The grain is thrashed and the husks separated. Then it is rammed and prepared into '*Ghes*' or '*Rab*' (*Kanji*), or ground into flour and bread is prepared of it. One requires about 2½ seers a day to live upon. In taste it is similar to *Samo* but is not strengthening. However, it is relished by the poor people.

"This *Colio* or *Batterioo* has generally a mixture of other kinds of seeds; the red seeds in it are called '*Damro*' and very small white grain in it called *Charkalioo*. When cheap it can be had two to three maunds a rupee."

Endoo Pendoo or Grain apparently of a fourth Panicum.

Endoo Pendoo (Panicum sp.?).—These seeds closely resemble *Samo*. Of it Mr Garda writes :—

"This seed is collected and made use of in the same way as *Pattair* or *Golio*. An adult requires about 2½ seers (3¾ lbs.) to keep him up. It has the taste of *Golio* and is not strengthening."

Samla-seru or Grain apparently of a fifth Panicum.

Samla-seru (Panicum sp.?).—This specimen consists of small flat oval glistening seeds, of a dark green colour with longitudinal lighter markings, which are easily crushed, and have a peculiar taste. It is contaminated by being mixed with other grains and with earthy particles.

FAMINE Foods.

Papers relating to

DESCRIPTION AND USES.

Mr. Barucha writes:—

"Is a small seed, dark in colour. It resembles the cultivated grain *Samli* just as *Mali* resembles *Bavto*. It is found only in hills and stony upland. It is collected in the same way as *Samo* and prepared by itself into bread which is palatable with milk. The quantity required for satisfying the hunger of a working man is the same as *Samo*, *viz.*, from 2½ to 3 pounds a day. It is, however, not found everywhere like *Samo* and is a rare grass-seed."

Being a rare seed it seemed to us that to analyse it was hardly necessary.

Oroo Koru or Grain apparently of a sixth Panicum.

Oroo Koru or Puchadino (Panicum sp.?).—*Oroo Koru* closely resembles *Samo*. Of it Mr. Garda writes:—

"This wild grain is obtained only in a few villages, from October to the end of summer. It was not known to the people before the famine appeared. One strong man can gather about a maund* a day in the beginning of the season, and about five seers in the hot season when it gets scarce. It is threshed and rammed and husks separated from the grain. From one maund of these seeds only about 10 seers of grain is obtained. It is ground into '*Ghes*' or '*Kab*' (*Kanji*) is prepared from it. It is not strengthening."

We made no analysis of it.

Anchu Manchu or Grain of Eleusine ægyptiaca.

Anchu Manchu (Eleusine ægyptiaca).—A small brown grain like millet seed but rather smaller, hard and gritty. Our sample contains few impurities. Mr. Barucha's specimen is sent under the name of *Mali*.

Mr. Garda writes:—

"This grain appears in October and is obtainable throughout the open season. Before famine time it was unknown to the people. A strong man can collect about 15 seers a day when abundant and about four when it gets scarce. From October to January, people cut the *Anki Manki* grass, thrash it and take out the seed. After January they collect it by means of sweeping the ground when it dwindles off. From black soil, seeds black in colour, and from yellow soil, red in colour, are obtained. The grain is first rammed and then ground, and bread prepared of the flour. An adult requires about 1½ seers a day. It is not good in taste and one finds difficulty in chewing it as it is hard as sand and people have no liking for it. The after effects are bad, it is constipating; the abdomen gets large and hard, and several times the urine of the eater stops. It was resorted to only this year for want of any other eatable grain."

Mali the same as the last.

Mali or *Manebhi* (Eleusine ægyptiaca).—Identical with the last, but with a considerable admixture of another grass seed, which in appearance resembles *Samo*, and a considerable proportion of earth.

* One maund [illegible]

Famine Foods (*D. N. Paton & J. C. Dunlop.*)

FAMINE Foods.

DESCRIPTION AND USES.

Mr. Barucha writes:—

"*Mali* or *Manebhi* is a very small red grass seed found only in *goradu* waste soil. It is collected and cleaned like *Samo*, but has no husks. It is not mixed with any other grass-seed, and it is made into bread, which assumes a reddish hue. It is like the cultivated grain '*Bavto*,' sweet in taste, said to be even sweeter than *Samo*, and strength giving. It is much relished by the Bhils, who call it the best grass-seed for human food, but it is not commonly found like *Samo*. Its growth is only in brown soil, and in small quantities, and cattle moreover are very fond of *Mali* grass. Its grass does not grow more than three or four inches in height, while that of *Samo* and *Podru* goes up to three feet."

Zinjroo or Seed of Indigofera glandulosa.

Zinjroo (Indigofera glandulosa).*—Small, roughly spherical, dark green seeds, mottled with black, and looking not unlike miniature plovers' eggs. They are very hard, and have a bright yellow kernel. It has a characteristic hottish taste.

Mr. Barucha writes:—

"*Zinjroo* is a small, round seed, black and green in colour, and not having husks like *Samo* or *Podru*. While both the latter grow on grass, *Zinjroo* grows on small plants in winter in black soil whether cultivable or waste. It is collected in the same way as maize crop, *i.e.*, cut, stacked, dried, threshed and winnowed. It is ground into flour, but it is so sticky that it has to be mixed with *Samo* before baking into bread. There should be more *Samo* than *Zinjroo* in the mixture, or at least half to half, before good bread is made. While *Samo* and *Podru* are said to be 'cool,' *Zinjroo* is considered by the Bhils to be 'hot.' They do not like it, and fall back on it when there is nothing else to eat in the house. As they say, it is simply for stuffing the belly without relish. Its nutritive qualities are inferior to *Samo*. The quantity required for food is the same, but, as said above, it is seldom, if ever, eaten by itself."

Mr. Garda sends no sample of it.

Kasaiya or Grain of Coix Lachryma-Jobi.

Kasaiya (Coix Lachryma-Jobi).—Elliptical seeds, sharply pointed at one end, olive green to brown in colour, extremely hard, so much so that they cannot be broken between the teeth. Their size is rather larger than ordinary barley. They contain a white kernel of great hardness and of no flavour.

Mr. Barucha writes:—

"*Kasaiya* is a large seed collected from plants or shrubs that look like reeds and grow on banks of *nalas* or streams. The seed is enclosed in a hard shell which has to be broken with a rod or has to be roughly ground. If mixed with *Samo* or Maize it can be turned into bread, but it is mostly cooked like rice. It tastes like wheat, and is considered nutritious. A pound and a half of this *Kasaiya* would suffice for a man

* *Cont.* Agricultural Ledger, 1898, No. 19, pp. 4-5.—Ed.

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per day, but it is generally not used alone, and is not resorted to as long as *Samo* is to be had."

Ghitola or Fruit of Nymphæa Lotus.

Ghitola, Fruit of Poena or Kumplis (Nymphæa Lotus *var.* pubescens).—A poppy-like ovary, filled with small greyish brown seeds, with few impurities. The seeds have no marked taste, and are not very gritty.

Mr. Baruoha sends no sample.

Mr. Garda writes :—

"*Ghitolas* are the fruit of '*Poena*,' or '*Kumplis*,' (big white flowers, smaller than lotus, growing in tanks). The seeds of this fruit are used in ordinary years also as food by the Padharias, and other people living near the Nal-Kantha, and in the interior of the Taluka. It is very often eaten in its raw state when the fruits are green, but when they dry up, the seeds are taken out, ground, and prepared into bread. Some of the people take it in the form of *Kanji*, after boiling it with water. About one seer of this food is sufficient to keep one up. If more is taken it produces cold and cough."

Kanda or the Root of Nymphæa Lotus.

Kanda Root—Poena or Ghitola or Kumplis (Nymphæa Lotus *var.* pubescens).—It consists of a capsule about the size of a pigeon's egg, it is of irregular shape, it has a hard rough woody husk, and at one end has a fringe of fine hair-like processes.

Mr. Garda writes :—

"This *Kanda* is the root of *Poena* or *Ghitola* fruit plant, and is dug out from the Nal tank, and other tanks also. These *Kandas* are baked or boiled with water, and then eaten by poor people with salt. It is better in taste than *Bid*, but has not the same effect as *Bid*."

We made no analysis of Kanda.

Doda Flowers. Dregea volubilis.

Doda Flowers (Dregea volubilis).—Mr. Garda writes :—

"This yellow powder is taken out of '*Doda*,' a kind of flower growing in the village of Durgi and a few other villages in the Dholka Taluka. People make use of it in preparing '*Dhoklas*' (small thick bread). It is not injurious to health. An adult can keep himself up by taking 1½ seers of it a day at the most."

Theek, Root, Root of Cyperus bulbosus.

Mr. Baruoha sends no sample.

Theck Root (Cyperus bulbosus).—These oval seed-like bodies, which are obtained in the manner described by Mr. Garda have the following characters. They are of about the size of barley, with a thin, hard husk of a whity brown colour, which contains a somewhat hard but friable grain. No characteristic taste. In the sample, as received, there was a considerable amount of fine brown meal, which was evidently derived from the breaking up of some of the seeds.

Mr. Baruoha sends no sample.

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Mr Garda writes :—

"'*Theck*' is the root of certain grasses growing near the Nal tank and on salt marsh in the Dholka Taluka. After it is dug out of the ground, the mud is removed from it by washing it. It is then burnt, which process removes the black (thin) husks from over it, and leaves the beautiful grain (as per sample No. 4). In all years and at all times except the monsoon, people in the Nal Kantha are in the habit of digging this root out, as it is greatly prized even by people of superior classes for use on days of fasting. When it is not sold in the Bazars, people grind it into flour and eat it in the form of bread, which is very palatable. Some make use of it in the form of '*Ghes*' or '*Rab*' (*Kanji*). One can collect about five seers of *Theck* a day, and an adult requires from 1½ to 2 seers of it to keep him up. *Theck* has its bad effect too, as it is found costive, and too cold for the constitution. Most of the *Theck* is sold by the diggers for equal amount of wheat or *Bajri*."

Bid Root, Root of Scirpus grossus.

Bid, Root of Gunderda (Scirpus grossus *var.* Kyseor ?).—Masses of what appear to be the brown underground stems of a grass with rootlets adhering, and, in some cases, pieces of the above-ground grass stems.

Mr. Baruoha sends no sample.

Mr. Garda writes :—

"'*Bid*.' It is the root of '*Gunderda*,' a sort of grass, and it is obtainable in any amount in the Nal tank, north-west portion of the Dholka Taluka.

"People commence digging it out as soon as the water in the Nal tank begins to dry up, and continue taking them out till it rains the next season.

"It is found in its raw state, mixed with clay (as per sample No. 1). It is thrashed for removing the clay, the hairy roots are then burnt with their own grass, then they are again thrashed and the roots (as per sample 1A) are collected. This process is repeated again to completely remove the hair on the roots. The roots are then powdered by a hand or grinding machine, and a sort of light yellow flour is sieved out of the powder and bread prepared out of it.

"I submit the refined roots as well as the roots found from the soil in its raw state.

"There are professional eaters of this '*Bid*' root and '*Ghitola*' (sample No. 2) called Padharias, living in some of the villages, *i.e.*, Durgi, Meni, Sial, Donadthal, etc., near the Nal. They live on it for half the year even in ordinary times. The '*Bid*' root was unknown to almost all the people of this Taluka except the Padharias and other people residing on the Nal up to the famine year; when about three-fourths of the villages of the Dholka Taluka and about 200 more of Sanand Viramgam and Dhandhuka and of Katheawad States had to resort to it for the preservation of their poor and cattle. The Padharias require of '*Bid*' food from 1½ to 2 seers per male and about 1¼ to 1½ seer per female to keep them up.

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This food has been seen in their cases, to wonderfully keep up their health and constitutions. But the other people, who resorted to it during the famine, perhaps not knowing the cleaning process, have been seen by me to suffer a good deal by eating it. They have swollen feet and hands, and enlarged abdomens. Some of them died from the effects after the rains; and some managed to live and thrive on *Samo* and other grain seeds.

"On enquiry it appears that one seer of '*Bid*' flour if mixed with half a seer of wheat or barley flour, gives good nourishment to unaccustomed eaters of '*Bid*.'"

Katchra, an unidentified Fruit.

Katchra.—This consists of a seed capsule and seeds resembling that of a poppy-like plant whose identity we do not know. Regarding its use along with grains, Mr. Barucha writes:—

"These grass seeds, coupled with forest produce, which the Bhil well knows how to use, have made a good substitute during the year for the maize, owing to the failure of the harvest. Nearly a dozen varieties of forest produce are consumed by the Bhils, the most common among them being *Katchra*, a wild fruit allied to *Kakri*, red flowers of the Simla tree, *Omra* fruit, *Timerva* fruit, *Pomad*, *Zarakhli*, *Kalli Regari*, *Fang*, and *Nalo*. . . . I send a sample of *Katchra*, the wild fruit which, being dried and stacked, is ordinarily used by the Bhils as a vegetable with bread or rice."

We made no analysis of *Katchra*.

CHEMICAL COMPOSITION.

(4)—Chemical Composition of the Foods.

A.—*Methods of Analysis.*

Methods of Analysis.

The analyses were made under our supervision by Mr. Alfred Patterson, chemical assistant at the Laboratory of the Royal College of Physicians, Edinburgh. All analyses were made in duplicate and only accepted as correct when the two results closely agreed. The methods employed were as follows:—

Sample.

1. *True sample.*—A fairly large sample was carefully ground and thoroughly mixed before a sample for analysis was taken.

Moisture.

2. *Moisture.*—A sample was dried at the temperature of 110° Centigrade until it became of constant weight; the difference between the weights before and after were taken as the amount of water in the sample.

Proteid.

3. *Proteid.*—This was estimated by making a nitrogen determination by Kjeldahl's method and multiplying the result by 6·25. In the case of Zinjroo it was checked in the manner described under that substance.

Fats, Oils.

4. *Fats and Oils.*—These were estimated by means of Sohxlet's method.

Fibre.

5. *Fibre or Cellulose.*—Five grammes were taken and boiled for half an hour with 1·25 per cent. H_2SO_4; the beaker was then filled

FAMINE Foods.

to the top with water, allowed to stand 12 hours and the fluid was siphoned off, the deposit washed and then boiled for half an hour with 1·25 per cent. KHO and washed in the same way. It was then collected on a weighed ash free filter paper, dried at 110° C. and weighed, then ignited and the ash weighed. By subtraction the woody fibre was determined.

Carbohydrates.

7. *Carbohydrates other than Cellulose.*—These were estimated by difference, the weights of all the estimated constitutents were added and the total deducted from the total weight of the sample, the difference being taken as the amount of these carbohydrares.

Digestibility, Proteids.

8. *Digestibility of the Proteids.*—This was tested in *Samo*, *Battairioo* and *Zinjroo* by ascertaining how much of the proteid was undissolved after prolonged peptic digestion. (*See* page 55.)

Carbohydrates.

9. *Digestibility of Carbohydrates.*—This was tested in the same specimens by ascertaining how much of the carbohydrate was converted into glucose by prolonged digestion with taka-diastase. (*See* page 55.)

B.—*Results of Analysis.*

Results of Analysis.

In Table 1, the composition of the various samples analysed is given, and for purposes of comparison the composition of some common cereal foods is added.

Table 1.—*Showing Composition per 100 grammes of famine foods and some cereals.*

Name.	Proteid.	Fat.	Carbohydrate, Soluble.	Carbohydrate, Fibre.	Ash.	Water.	Energy Value.
	Grms.	Grms.	Grms.	Grms.	Grms.	Grms.	Calories.
1. Samo	10·68	5·20	51·16	14·68	7·35	10·93	301
2. Podru	10·50	4·60	42·11	17·02	16·95	8·82	258
3. Kodri	14·00	4·99	63·03	2·84	5·82	9·32	362
4. Battairioo	11·00	3·60	47·89	14·22	12·93	9·46	279
5. Endoo Pendoo	11·81	4·17	46·59	15·02	13·35	9·06	278
6. Anchu Manchu	12·87	2·08	64·03	4·86	4·58	11·58	335
7. Mali	8·44	1·45	38·97	5·71	36·95	8·48	207
8. Zinjroo	36·12	3·09	38·75	10·90	2·99	7·55	341
9. Kasaiya*	18·81	0·2	59·55	1·28	3·4	10·74	378
10. Ghitolas	9·3	·78	66·78	5·81	6·32	10·94	319
11. Doda Flower	14·62	7·60	41·08	23·50	4·50	8·70	299
12. Theck Root	2·27	·58	82·46	1·51	1·58	11·60	353
13. Bid Root†	4·12	1·00	76·18	6·80	3·40	8·50	338
Barley Meal*	10·5	2·2	66·3	6·5	2·6	11·9	335
Oatmeal	16·1	7·2	58·8	·9	1·9	7·3	406
Rice	8·0	·3	78·2	·2	·4	12·3	359
Wheatmeal	13·8	1·95	71·9	·9	1·0	11·4	369

* With husk removed. † Sample 1 A (purified root).

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CHEMICAL COMPOSITION. Results of Analysis.

The above table shows that these famine foods may be arranged in three groups (1) those with proteid more or less in a proportion similar to that in ordinary cereal foods; (2) those with more proteid than ordinary cereal food; and (3) those with less proteid than ordinary cereal food.

1. The first group contains:—

(i) The seeds of the various species of **Panicum**. These closely resemble in composition such a cultivated cereal as barley but differ from it in containing less soluble carbohydrates and more fats, fibre, and ash.

Professor Church writes of the **Panicum colonum** under different names from those reported to us by **Mr. Garda** and **Mr. Barucha**. The names he uses are Shama Millet, **Oplismemus colonus** (*Kunth*), *Shama*, *Sarwak* and *Shamak*. From his description and from his using the name of **Panicum colonum** we have no doubt but that what he writes about is the same as the *Sama* submitted to us. He says:—"This millet, sometimes called 'Wild Rice' or 'Jungle Rice,' is a poor food; it is used, however, in some places where it grows freely (*e.g.* in Champaran) by a considerable number of labourers as a usual article of diet. It is very good fodder-grass." He gives the following analysis of the seeds:—

Water	12·0
Albuminoids (Proteids)	9·6
Starch	74·3
Oil	·6
Fibre	1·5
Ash	2·3

His specimen gave a smaller percentage than ours of proteids, fats, fibre, and ash and a greater amount of carbohydrates. Since these last are calculated by difference the discrepancy between our figures is obviously the result of the higher percentage of the other substances in our specimen. Our specimens were analysed as received by us and the high fibre and ash results are probably due to the persistence of the husk and to a certain admixture with earth due to the mode of collection.

(ii) The seeds of **Eleusine ægyptiaca**, of which two specimens were received, that from **Mr. Garda** being labelled *Anchu Manchu*, and that from Mr. Barucha as *Mali* or *Manchi*. The latter contained a manifest admixture with earth which it was impossible to separate and which accounts for the very large ash. An attempt was made to separate this by blowing, but the ash was only reduced from 36·95 per cent. to 21·04 per cent.

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CHEMICAL COMPOSITION. Results of Analysis.

(iii) The seeds of **Nymphæa lotus**, *Ghitola*, and

(iv) The pollen* of **Dregea volubilis**—*Doda* flower.

In these four foods the proteids vary from 8·4 in *Mali* to 14·62 in *Doda* flower. They have from ·78 to 7·6 per cent. of oil. *Ghitola* is the poorest in fat, having only ·78 per cent., while *Doda* flower is the richest with 7·6 per cent. Soluble carbohydrates are found to be in varying amount; *Ghicola* is the richest with 66·78 per cent.; *Mali*, the poorest, with only 38·97 per cent.

The small proportion of carbohydrates in these foods results in their having an energy-value smaller than that of the ordinary cereals. **Mr. Garda's** specimens of *Anchu Manchu* and *Kodri* alone have an energy-value larger than that of barley meal, which has the smallest energy-value of those ordinary cereals included in the table. Other points of difference between these eight foods and the average cereal are, that they as a class generally contain more fibre, and a large percentage of ash, from 4·58 to 36·95 per cent., while the cereals have from ·4 to 2·6 per cent. This is to be explained by the great admixture of sand and earth particles with many of the grains due to the method in which they are collected.

2. The second group, characterised by being richer in proteid than the ordinary cereals, contains two examples: the seeds of **Indigofera glandulosa**, *Zinjroo* and the seeds of **Coix Lachryma-Jobi**, *Kasaiya*. The former, as will be seen in the table, has no less than 36 per cent. of proteid, an amount three times larger than that found in the average cereals. To determine how much of the nitrogen was in the form of extractives and how much in proteids, 3·27 grms. of *Zinjroo* were repeatedly extracted with alcohol, but only ·067 per cent. of nitrogen was thus dissolved, only 1·1 per cent. of the whole, so that practically all the nitrogen is in the form of proteids. In containing this large proportion of proteid, *Zinjroo* is in composition more like one of the pulses, as peas or lentils, than like a cereal. In addition to being exceptionally rich in proteid, *Zinjroo* contains a fair amount of fat, and a relatively small amount of carbohydrates.

Professor Church writes of *Zinjroo* under the following names:— **Indigofera glandulosa, Indigofera frumentacea**, *Vekhçariyo, Barbed, Gavancha, Malmandi, 'Baragadam, Barapatalu*, and *Broomidapu*. He states:—"The seeds of this species of **Indigofera** greatly resemble in alimentary value those of **Indigofera cordifolia** and **Indigofera linifolia**, but are slightly superior in this respect (*i.e.*, high proteid value) to the former though inferior to the latter. All three kinds, it will be seen, are amongst the most nitrogenous

Cf. Agric. Ledger, 1898, No. 19, pp. 4, 5.

* It cannot be pollen: for to collect a tola's weight of it would take a week.—Ed.

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of all seeds, even amongst the pulses, being excelled only by the lupine." He gives the following analysis :—

Water	8·2
Albuminoids	31·9
Carbohydrates	46·7
Oil	2·2
Fibre	7·8
Ash	3·2

This analysis corresponds closely with ours, except in that we find the proteid value somewhat higher, and the carbohydrate value correspondingly less. With his remark as to the proteid value being exceptional we concur, not knowing any other vegetable food that has so large an amount of proteid in its composition. As already stated we ascertain that only a trivial amount of the nitrogen was in the form of extractive which could be dissolved in alcohol.

Kasaiya.—Our analyses as well as those of Dr. Church show that this is a food specially rich in proteids and fats. When separated from its very hard husk it should form a food of great value, especially as its energy-value is the highest of all the foods studied.

Professor Church writing of this food says :—"Throughout Assam and in the eastern frontier lands of India, this coarse cereal constitutes an important food of the hill tribes, replacing to some extent the millet of Northern and Southern India. . . . The grains of wild kinds are exceedingly hard and are used as beads, those of the cultivated variety are much softer and more easily husked. He gives the following analyses of two varieties :—

Water	13·2	14·8
Albuminoids	18·7	16·6
Starch	58·3	60·1
Oil	5·2	5·8
Fibre	1·5	0·9
Ash	2·1	1·8

3. The third group characterised by being poor in proteid contains two members, *Theck Root* and *Bid Root*. They both contain much less proteid than any of the other foods included in the table, they both have only a small amount of fat, and both have a large amount of soluble carbohydrate. They both more nearly resemble in composition dessicated potato or other dried bulbs than they do cereals.

Special Characteristics.

C.—*Special Characteristics of certain of these Foods.*

In the reports of Mr. Barucha and Mr. Garda certain special characteristics of some of these foods are noted, many of them having distinct pharmacological actions. The principle of these are noted.

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The grains of the different species of **Panicum**, as well as *Doda* flower all appear to be free of any toxic action.

While according to **Mr. Barucha** the seeds of **Eleusine ægyptiaca**, *Mali* are harmless, and amongst the most valued of the grains, **Mr. Garda** reports of the same plant as *Anchu Manchu* that the taste is not good, that it is so bad that even after grinding and baking it is difficult to masticate, that it is constipating and produces flatulence, and that its use is sometimes followed by suppression of urine. Such a description is suggestive of distinct toxic action.

Zinjroo.—**Mr. Barucha** reports that alone it cannot be used for making bread, that it is reported by the Bhils to be "heating" and that it "stuffs the belly without relish." These properties may be ascribed to its composition. In Zinjroo carbohydrates are to proteid as 1 to 1, while in oatmeal they are as 4 to 1, and in wheatmeal nearly as 6 to 1.

Theck Root.—**Mr. Garda** reports that "*Theck* Root has its bad effects as it is too costive and too cold." These two ill-effects can both be explained by reference to its composition. The costive action may be due to its apparently containing very little indigestible matter, the small amount of proteid and the small amount of fibre warranting that opinion. Its being reported to be "too cold" may be ascribed to its small proteid value, for the deficiency of proteid would almost certainly lead to a poor condition of the general nutrition, and that would in popular language be described as being "too cold."

Bid Root.—**Mr. Garda** reports that some natives habitually live on it for about six months of the year and thrive on it, while those natives who used it for a first time during the recent famine suffered a good deal, getting swollen feet and hands and even ultimately dying of the evil effects. **Mr. Garda** attributes this difference to the more skilful preparation in the hands of the habitual *Bid* eater. The root when found is covered by hairs, and it is to them that **Mr. Garda** attributes the toxic actions. Another explanation is suggested by a study of its composition, and that is, that the ill-effects are due to chronic proteid starvation. *Bid* contains a very small quantity of proteid, and, were a man restricted to its use, it is probable that the want of an efficient supply of proteid would result in a general lowering of nutrition. The absence of evil effects in habitual *Bid* eaters will be referred to later.

Ghitola.—**Mr. Garda** reports that the use of these seeds as a food is limited to one seer *per diem* as more "produces cold and cough." This description by **Mr. Garda** is suggestive that *Ghitola* has a distinct toxic action which generally resembles that of the iodides. To what this is due we have not investigated. It is noteworthy because this toxic action prevents *Ghitola* being used in sufficient quantity to supply a full day's ration.

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CHEMICAL COMPOSITION. Daily ration value.

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(5)—The Value of the Daily Ration of some of the Foods.

Mr. Garda and Mr. Barucha state how much of certain of these foods is required by a man *per diem*, and on their statements we construct the tables which are given below. We cannot hold ourselves responsible for the accuracy of those observers as to the daily ration, and we think it right to point out that there are considerable differences between their estimations. For instance, both observers write regarding *Samo*; the one assesses the daily ration at 2½-3 lbs. (1,022-1,363 grammes), the other at 1½-2 seers (700-933 grammes). Further, Mr. Barucha's estimates are all higher than Mr. Garda's. Mr. Barucha expresses quantity in pounds, Mr. Garda in seers. We might have ascribed this discrepancy to our having mistaken the value of the seer referred to, had we not official information that the seer under question was the weight of 40 rupees, which is 1 lb. 3 oz. Troy, or 466·5 grammes, or rather more than 1 lb. Avoirdupois.

Another and even greater difficulty in discussing the results shown in the tables is to formulate a standard for comparison. Such a standard should be based on what is known to be the food requirement of the particular class of people under consideration. A knowledge of European and American dietaries, however, is of some service in this respect. We know that the labourer in Europe or America, doing moderate work, requires a diet containing about 118 grammes of proteid, and yielding 3,500 Calories of energy, to properly nourish him. We know that a food requirement varies with the size of the individual, with work, and, to some extent, with climatic surroundings. Now the Bhils are smaller than the average European labourer; in famine time they are presumably not working hard, and they are living in a warmer climate, hence it is safe to assume that their standard of requirement is less than that of the European labourer. Taking the average Bhil man at 20 per cent. lighter than the European, 120 *versus* 145 lbs., the energy-value of his standard diet will be 20 per cent. less than 3,500 Calories, *i.e.*, 2,800 Calories. Assuming that his work is essentially light, the study of American diets shows that a further 20 per cent. may be deducted, further reducing the standard to 2,240 Calories.

If the proteid in the diet is to bear the same relation to the energy value as it does in the European labourer's diet we conclude that the Bhil's daily requirement of proteid is 77 grammes. The following information given us by a tea planter in Ceylon throws light upon the question. He states that the coolies average about 120 lbs. in weight, and that the allowance of rice on which they live is 64 lbs. a month, *i.e.*, 29 kilos, or, roughly, 1 kilo a day. According to our informant they do not eat the whole of this, but exchange some for Chilis and other flavouring ingredients. One kilo of rice

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CHEMICAL COMPOSITION. Daily ration value.

daily contains—proteids 80 grammes, fat 3 grammes, carbohydrate 790 grammes, and yields 3,595 Calories of energy. Upon this the coolies are capable of doing very hard work day after day such as carrying a weight of 60 lbs. for 30 miles a day.

But the digestibility of the food is a factor which must be taken into consideration in fixing a standard of requirement. Hence the mere fact that these foods are purely vegetable necessitates that the supply of energy should be in excess of that required in a mixed diet. But vegetable foods vary in their digestibility, even when cooked in the same way, and in deciding on the value of these famine foods as a source of energy it was necessary to compare their availability with that of some well-known cereal. The cereal selected was wheat, and with this, three of the more important foods were compared *Samo*, *Zinjroo* and *Batterioo*.

The method of testing the digestibility was as follows: 5 grammes of the food, finely triturated in a mortar, were taken and boiled for 30 minutes with 300 c.c. of water, allowed to cool and then 10 c.c. of liquor pepticus and 0·2 per cent. hydrochloric acid were added and the mixture kept at a temperature of 38° centigrade for four hours. After this, the mixture was made alkaline by the addition of carbonate of sodium and 5 grammes of taka-diastase added, and then again kept at a temperature of 38° centigrade for 3 hours. During the course of digestion the mixture was, by a mechanical means, kept in constant agitation. After these digestions the undigested proteid in the insoluble residue was estimated by determining the nitrogen by Kjeldahl's method, and from it the digested proteid was estimated by difference. The digested carbohydrate was estimated from the amount of glucose found to exist in the filtrate. For comparison we applied these methods to wheatmeal. The results are shewn in Table 2.

Table 2.—*Relative Digestibility of Wheat, Samo, Batterioo and Zinjroo.*

	Proteid.		Carbohydrate.	
	Per cent. in Food.	Per cent. Digested.	Per cent. in Food.	Per cent. Digested.
Wheat	10·18	84	71·0	45
Samo	10·68	33	51·2	26
Batterioo	11·90	34	47·89	30
Zinjroo	36·12	83	38·75	28

The close correspondence in the results with the two very similar grains, *Samo* and *Batterioo*, vouches for the accuracy of this method for comparative purposes.

Taking the percentage of proteids and carbohydrates in these substances, and the amount digested in these experiments, it appears that the availability of the proteids and carbohydrates after such a uniform digestion may be represented as follows:—

Available proteids and carbohydrates in 100 parts of—

	Proteids.	Carbohydrates.
Wheat	8·5	31·9
Samo	3·5	13·3
Batterioo	4·4	14·4
Zinjroo	29·9	10·9

The *relative* available energy may be calculated from the above table so far as proteids and carbohydrates are concerned.

Wheat	166
Samo	69
Batterioo	77
Zinjroo	167

As a source of available energy from these constituents *Zinjroo* may be considered equal to wheat, while the two grains of **Panicum** are of less than half the value.

The lowness of the available energy of *Samo* is supported by the statement of Mr. Barucha that 2½ to 3 lbs. of *Samo*, with a theoretical energy value of 3,086 to 4,116 (mean 3,601) Calories is required by men who can subsist on 1½ to 2 lbs. of maize, yielding from 2,467 to 3,290 (mean 2,878) Calories.

Another factor affecting the availability of such food is that excessive use of a single cereal seems to lower its digestibility. One of us, when investigating the feeding of prisoners in Scottish prisons, found that, when oatmeal was used in moderate amount it was readily digested but when moderation was exceeded the digestibility was greatly reduced. (*See* Dunlop on Prison Dietaries, Laboratory Reports of the Royal College of Physicians, Edinburgh, Volume VIII, 1900, also as Parliamentary Report, C 9,514, 1899.)

In taking 7·7 grammes of proteid and 2,240 Calories of energy as probably about the minimum requisite for the famine diet of Bhils, we intend to imply that such a diet is the smallest which will theoretically keep a man under the particular circumstances and doing essentially light labour in proper nutrition. But in taking the standard we do not allow for the probable indigestibility of these foods used by themselves, and we are not surprised to find, that of many of these foods the amount which has by experience been found necessary is considerably above our standard.

In tables 3 and 4 we show the food values of the daily rations of these foods. From them we exclude those foods the use of which is restricted by toxic action.

TABLE 3.—*Showing Food Value of Daily Rations of non-toxic Foods.*

Seed.	Authority.	Lbs. or Seers.	Grammes.	Proteid.	Fat.	Carbohydrate.	Calories.
Samo	Garda	1½ seers	700	74·4	36·4	358·1	2,107
,,	,,	2 ,,	933	99·6	48·5	477·3	2,808
,,	,, mean	1½ ,,	816	87·1	42·5	417·7	2,452
,,	Barucha	2½ lbs.	1,022	09·1	53·1	522·8	3,086
,,	,,	3 ,,	1,363	145·5	70·9	697·3	4,116
,,	,, mean	2½ ,,	1,187	127·3	62·0	610·1	3,601
Podru	,,	2½ ,,	1,022	107·3	47·0	430·1	2,640
,,	,,	3 ,,	1,363	143·1	62·7	573·9	3,522
,,	,, mean	2½ ,,	1,187	125·2	54·8	502·0	3,080
Batterioo	Garda	2½ seers	1,166	138·7	42·0	558·4	3,248
Doda Flowers	,,	1½ ,,	700	102·3	53·2	287·6	2,094
Theck Root	,,	1½ ,,	700	15·9	4·1	577·2	2,469
,,	,,	2 ,,	933	21·2	5·4	769·3	3,291
,,	,, mean	1½ ,,	816	18·5	4·7	623·3	2,380
Bid Root	,, male	1½ ,,	700	28·8	7·0	533·3	2,385
,,	,, ,,	2 ,,	933	38·4	9·3	710·7	3,158
,,	,, mean	1½ ,,	816	33·6	8·1	622·1	2,771
,,	,, female	1½ ,,	583	24·0	5·8	444·0	1,975
,,	,, ,,	1½ ,,	700	28·8	7·0	583·3	2,385
,,	,, mean	1½ ,,	641	26·4	6·4	488·7	2,179
Kasaiya	Barucha	1½ lbs.	681	128·0	42·0	405·2	2,574
Endoo Pendoo	Garda	2½ seers	1,166	138·7	48·6	543·3	3,246

In the above tables the difference between daily requirement as estimated by Mr. Barucha and as estimated by Mr. Garda is very evident. The average of Mr. Barucha's estimates of all of these is worth 121 grammes of proteid and 3,340 Calories of energy, that of Mr. Garda's 71·7 grammes of proteid and 2,568 Calories.

FAMINE Foods.

CHEMICAL COMPOSITION. Daily ration value.

Papers relating to

Mr. Garda's estimates being the more comprehensive are taken first. We consider them *seriatim*.

1. *Samo*.—Average ration 816 grammes, Proteid 87·1, Fat 42·5, Carbohydrate 417·7, Calories 2,452. The value of the daily ration of this food very closely corresponds with what, on hypothetical grounds, we have stated as a probable standard. Were *Samo* as easily digested as other cereals, it seems that the mean daily ration as estimated by Mr. Garda, *viz.*, 1¾ seers or 816 grammes, might be sufficient to keep a small man doing essentially light work in proper nutrition. The energy value of the ration is somewhat above that of the standard but the consideration of the relatively small availability of *Samo* renders it probable that the ration of *Samo* is to be regarded rather as just sufficient to maintain life than to support even light labour.

2. *Batterioo*.—Ration 1,166 grammes, Proteid 138·7, Fat 42·0, Carbohydrate 558·4, Calories 3,248. The value of this ration of this food is very considerably larger than both our standard and the value of the *Samo* ration. Why this should be so is not evident from chemical analysis. A 2½-seer ration of this food has a food value of about 33 per cent. more than that of the daily ration of *Samo*. The bulk of the diet is so great that in all probability the full ration of 2½ seers, 1,166 grammes could not be used.

3. *Endoo Pendoo*.—Average ration 1,166 grammes, Proteid 138·7, Fat 48·6, Carbohydrate 543·3, Calories 3,211. In all particulars this closely resembles the ration of *Batterioo*.

4. *Theck Root*.—Ration 816 grammes, Proteid 18·5, Fat 4·7, Carbohydrate 623, Calories 2,880. Mr. Garda assumes the daily ration as the same as for *Samo*, namely, 1¾ to 2 seers. Chemical analysis, however, shows that it compares unfavourably with *Samo* because it contains only a very small percentage of proteid. The proteid value of Mr. Garda's daily ration is 80 per cent. less than our standard of 77 grammes and it cannot be considered as a satisfactory food when taken alone. A note in Mr. Garda's statement regarding this food shows that it is not found very satisfactory, for, he says, that it is found "too cold for the constitution". From the composition of *Theck*, we conclude that it is ill-adapted for use as a single food, because were the ration increased to the full eating powers of a man, even then the proteid allowance would be so small as to be decidedly insufficient. *Theck*, however, is a food possessed of large energy value, and if used in combination with some proteid rich food, as, for instance, one of the pulses, or *Zinjroo*, or *Kasaiya*, it is an excellent basis for a diet.

5. *Bid Root*.—Ration 816 grammes, Proteid 35·6, Fat 8·1, Carbohydrate 622·1, Calories 2,771. This food resembles *Theck* in

FAMINE Foods.

CHEMICAL COMPOSITION. Daily ration value.

having a small proteid value and a large energy value, it, however, differs from *Theck* in that its proteid value is not so extremely small. We had no hesitation in asserting that the proteid value of *Theck* root was so small as to prevent its use as an efficient single food. In *Bid* the proteid ration is 50 per cent. below the standard, so that it too is unsuitable as a single food, but like *Theck* if combined with a proteid rich food it would make an excellent basis of a diet.

There are two interesting points regarding the daily ration of *Bid* mentioned in Mr. Garda's report, the one a comparison of the male and female requirements, the other the fact of the existence of persons who annually live on this food for a great part of the year. The proportion which the food requirement of a woman bears to that of a man is a matter which has been carefully studied by Dr. Atwater of the United States Board of Agriculture, and he has assessed it as 8 to 10, or, in other words, that a proper ration for a woman is four-fifths of that of a man. Now it is certainly of interest to note that Mr. Garda had from quite independent observation assessed these rations in the same proportion, or at all events in as nearly the same proportion as his weights permit of, for he rightly does not commit himself to small fractions of the seer. This observation is of special value in enabling us to place confidence in Mr. Garda's other observations.

The other special point mentioned was the existence of habitual *Bid* eaters. Mr. Garda's statement (*vide* page 9) appears to indicate that the use of *Bid* by these people is often combined with the use of other foods, *e.g.*, *ghitola*, wheat, barley, all of which have greater proteid values. However, Mr. Garda certainly indicates that *Bid* can be, and is, used as a single food for long periods without apparent harm. If this is so, it is a matter of scientific importance, as it affords a good observation of how small the daily allowance of proteid can be reduced without causing much, if any, harm, and if properly corroborated it would be accepted by physiologists as a valuable indication of the requisite minium daily proteid allowance for health.

6. *Doda Flower*.—Ration 700 grammes, Proteid 102·3, Fat 53·2, Carbohydrate 287·6, Calories 2,094. Of the non-toxic foods Mr. Garda selects this as being capable of nourishing a man properly with the smallest ration. Factors which may explain this special value of *Doda* Flower as a food are the high percentages of proteid and fat which it contains. The actual proteid value of the ration is in excess of our hypothetical standard, while its energy-value approximates to that standard, being only 7 per cent. below. That Mr. Garda is able to report that so small a ration can properly nourish a man, and that we find that that small ration very nearly satisfies our hypothetical standards, are sufficient to warrant the opinion that *Doda* Flower is an excellent food.

Three of Mr. Barucha's daily rations are included in Tables 3 and 4, these are the rations of *Samo* and *Podru* and *Kasaiya*. His estimations are higher than those of Mr. Garda. In writing of *Samo* he estimates the daily ration as fully 40 per cent. higher than Mr. Garda does, and his estimate shows a diet of about 50 per cent. higher than our standard. Similarly with *Podru*, his daily ration is found to have a food value much in excess of the average of Mr. Garda's estimates and much in excess of our standards. We do not pretend to be able to explain this discrepancy, but it is possible that Mr. Barucha has made his estimate of the amount of these foods the people will eat if they can get them, while Mr. Garda in most cases has estimated the amount they are able to subsist on during a period of famine.

In the case of *Kasaiya* his estimate is not so high and approaches more to our standard. From the proportion of the various constituents it appears to us essentially a valuable food, and the fact that it must be completely freed from the hard husk before it is used, probably renders it easily digestible and largely available.

TABLE 4.—*Showing Food Value of Daily Rations of certain Foods the use of which appears to be limited by their toxic properties.*

Food.	Authority.	Ration. Seers.	Ration. Grms.	Proteid.	Fat.	Carbo-hydrate.	Calories.
Ghitola . .	Garda .	1 seer .	466	43·3	3·6	311·1	1,486
Anchu Manchu	,, .	1½ seers .	700	90·1	14·6	448·2	2,342

7. *Ghitola*.—The ration, as limited by the toxic action of the food, is too small for proper nutrition. Both the proteid and energy-values are less than our standard, and less than those of the rations of non-toxic foods such as *Samo* and *Doda* Flower. Consequently *Ghitola*, as a food, is of more limited value than others included in this report.

8. *Anchu Manchu*.—From chemical analysis it would appear that the ration of this food is ample. The apparent food value exceeds that of our standard and that of other foods. Its possible toxic effects may make it an undesirable food but in the light of what Mr. Barucha says of it under the name of *Mali*, in all probability this is of little moment.

9. *Zinjroo*.—As this is seldom, if ever, eaten alone it is unnecessary to report on it as a single food. It should, however, form a most valuable addition to some of the other foods in which the proteids are

small in amount and not readily digestible, since we find that its proteids are as fully digested as those of wheat.

10. *Kodri*.—The food value of *Kodri* still remains for consideration. Our reason for excluding it from tables 3 and 4, is that neither of the reporters, Mr. Garda nor Mr. Barucha, have stated its daily ration. This being so, all we can do is to state what, in our opinion, should be the minimum allowance.

It differs from the other foods submitted in not being a single grain, but a preparation that can be made from other grains *Mali* and *Zinjroo* excepted. The sample submitted was made from *Samo*, and was, in fact, *Samo* without part of the husk. The result of this manufacture is to increase both the proteid and energy values, and consequently an efficient diet can be got from a smaller ration of *Kodri* than from *Samo*. Calculation shows that a diet of 670 grammes (about 1½ lbs. or rather less than 1½ seers) will yield 94 grammes of proteid and 2,425 calories of energy, and thus be fully equivalent to a daily ration of 816 grammes of *Samo*.

(6)—General Conclusions.

1. Many of these food-stuffs appear to be well adapted for human food, and of these *Samo*, *Batterioo*, *Doda* Flower, *Kasaiya*, *Podru*, and *Kodri* appear to be the best.

2. *Ghitola*, *Anchu Manchu*, and *Zinjroo* have a more limited use as toxic properties have been ascribed to them.

3. *Bid* and *Theck* root, from their poverty in proteid, are not well adapted for use as single foods.

4. A daily ration of 1 lb. 13 oz. Avoirdupois, or 1¾ seers or 816 grammes of the more nutritious foods, should theoretically be sufficient to maintain a small man of about 120 lbs. weight, doing light work and living in a warm climate.

5. The daily ration may be reduced to 1 lb. 9 ozs. or 1½ seers or 700 grammes when *Doda* Flower, *Kodri*, or *Kasaiya* are the foods used.

Analyses of Indian pot-herbs of the Natural Orders Amarantaceæ, Chenopodiaceæ and Polygonaceæ.

By David Hooper, F.I.C., F.C.S.

Restriction of inquiry.

The present Ledger deals with esculent plants, either cultivated or wild, belonging to the Natural Orders of the Amaranth (AMARANTACEÆ), the Goosefoots (CHENOPODIACEÆ), and the Knotweeds (POLYGONACEÆ).

Composition.

About twenty-eight plants have been submitted to chemical examination and their analyses are tabulated at the end of the article. It will be noticed that pot-herbs of the best quality contain large proportions of nitrogenous material, a high percentage of ash and phosphoric acid, and a low amount of crude fibre. The figures for silica include sand, and when they are high, they usually indicate the presence of mechanically attached soil, as it was impossible in some cases to remove this before analysis. The figures returned as fat refer to the ether extract of the plants and include chlorophyll, wax and sometimes resin. The carbohydrates include starch, sugar, and; in the case of Polygonums, a considerable amount of tannin. The albuminoid matter or crude protein is calculated from the amount of nitrogen obtained by the Kjeldhal method of determination.

Effect of cooking.

Since spinach and other green plants are as a rule cooked before they are eaten, an experiment was made with samples of the green and red *ság* of the Calcutta market to ascertain the change in the composition produced by boiling. On referring to the table of analyses it will be seen that weight for weight the dried matter of the boiled vegetable is equally, if not more, nutritious than the dried matter of the uncooked vegetable. The albuminoids are very similar and the phosphoric acid is only slightly reduced in amount. It would seem that the sugar of the soluble carbohydrates and a certain amount of saline matter are removed by the operations of boiling and straining, and the balance of the albuminoids is maintained by the major portion coagulating and remaining behind with the other insoluble constituents.

In arranging these green stuffs according to their composition it will be noticed that they fall under three heads.

FAMINE Foods.

POT-HERBS.

First quality.

The first includes the more useful pot-herbs with over 20 per cent. of crude protein, over 1 per cent. of phosphoric acid and a low yield of fibre. These are—

Spinacia oleracea.
Amarantus (all species but **spinosus**).
Basella alba.
Chenopodium album.

Second quality.

The second class includes those plants yielding in a dried state from 15 to 20 per cent. of crude protein, less than 1 per cent. of phosphoric acid, and a fibre content of usually over 15 per cent. They are—

Alternanthera sessilis.
Beta vulgaris.
Atriplex sp.
Digera arvensis.
Polygonum sp.

Third quality.

The third class consists of coarser famine foods with less than 15 per cent. of crude protein and a large amount of fibre or mineral matter, such as—

Calligonum, Celosia, Haloxylon and **Suæda.**

Salt-worts.

To this class belong the Salt-worts, an order of plants growing in arid regions and affording the only available fodder for camels in the cold season. Many of the Salt-worts are also so rich in alkaline salts that they are burnt in certain districts of the Panjâb and the ash constitutes barilla or *sajji-matti*. Several of these plants are used as famine food as it is found that the operation of boiling removes a large quantity of the saline matter and leaves a palatable and nutritious food which is resorted to by poorer inhabitants of the districts.

In recording the results of the analyses it should be noticed that the percentage of water is that found in the fresh plant, while the figures for all the other constituents are those calculated on the absolutely dried and powdered vegetable. The results are thus more readily comparable than by showing the composition on the fresh or partly dried plants containing a variable amount of water.

Before commenting on the plants in the following paragraphs it is necessary to state that the present is an instalment of an extensive enquiry into famine foods now being undertaken by the Reporter on Economic Products to the Government of India.

FAMINE Foods.

INDIAN SPINACH.

Ærua spp.

Ærua javanica, *Juss.*

Ærua lanata, *Juss.*

Vern.—*Chaya*, BENG.; *Bhui*, RAJ.; *Bui, jari*, SIND; *Bui-kallan* (flowers as sold in bazars), PB.; *Kul-ke-jar, khul*, DUK.; *Aom-i, spirke, sassai*, TRANS-INDUS; *Kapur-madhura*, MAR.; *Sirru-Pulay-vayr*, TAM.; *Pinde-conda, Pindi-chetter*, TEL.; *Astmabayda*, SANS.

These are small weeds common everywhere in the plains, ascending to 3,000 feet in altitude. The leafy shoots of the young plants are used in curry, and the whole plant is occasionally resorted to as a famine food.

Alternanthera sessilis.

Alternanthera sessilis, *R. Br.*

Vern.—*Salanchi-sak, gamudi sag, chakai saranch, phol saranchi, muti* or *moti sag, gathni* or *girni sag*, BENG.; *Madanaganti, pounnaganti*, TEL.; *Poonanghennay kirai*, TAM.; *Honogone soppu*, KAN.; *Mokunu-wanna*, SINGH.

Throughout hotter India and Ceylon, in damp places.

This plant has been sent as a famine food from several districts of Bengal where the leaves are largely eaten after being cooked. In Ceylon the leaves are consumed as a vegetable specially by mothers with the object of increasing the flow of milk.

Arthrocnemum indicum.

Arthrocnemum indicum, *Moq.*

A plant of the salt-marshes used as a vegetable. Fryer who visited Bombay in 1694, called it "Samphire."

Amarantus gangeticus.

Amarantus gangeticus, *Linn.*

INDIAN SPINACH.

Vern.—*Lál-ság*, HIND.; *Dengo* or *dengua-ság, ranga* or *konkarung-ság* (Red variety), *Notia* or *notay-ság* (Green variety), BENG.; *Ranga sak*, ASS.; *Arak, gandhari*, SANTAL; *Lal-sag, chulai*, U. PROV.; *Lalru, chalai, chaulai*, RAJ.; *Bathua*, PB.; *Math* or *mathla, gotala matala, ran math, harawi*, BOMB.; *Koi-thorti-kora*, TEL.

This plant is cultivated as a pot-herb throughout India and is sold in the chief bazars at all seasons of the year. The red and green varieties are called "spinach" by Europeans, and are an excellent substitute for the spinach of Europe. There is no uniform opinion as to the merits of the two *ságs*, some natives consider the red to be better than the green, and others consider the green to be far superior to the red. They are similar in chemical composition.

In times of scarcity the fruits are eaten in Ajmir-Merwara, and even the stems are consumed in Bharpur. In different districts in Bombay it is the custom to partake of this pot-herb after it is boiled

The generic name is said to be derived from the Malabar or Tamil name of the plant; it is sometimes called the Malabar Nightshade. It is cultivated in almost every part of India, especially in Lower Bengal and Assam. Scarcely a village exists in Bengal where a hedge-row covered with this favourite pot-herb may not be seen. The succulent and mucilaginous leaves and stems are made into a curry by all classes. Several doctors have spoken of the wholesome nature of the vegetable and consider it one of the best greens (*sâgs*) of the country.

The juice of the leaves which is demulcent and cooling is a popular application to allay the heat and itching of urticaria arising from dyspepsia. The boiled leaves are also used as a poultice.

Beta vulgaris, *Moq.*

THE BEET, *Swiss*; CHARD, *Eng.*

Vern.—*Palak*, HIND.; *Palak, bit palang* or *palang sag*, BENG.; *Palanki*, SANS.

This is the *Palang* of Assam, which, according to Dr. G. A. Grierson, is a name usually applied to spinach. Dr. Aitchison says the Afghans are very fond of this vegetable.

Calligonum polygonoides, *Linn.*

Vern.—*Phog, phok, phogla, phogalli* (flowers) *firni* (root), *Ikasu*, RAJ., PB., and SIND; *Falanja, berwaja, tatuke*, TRANS-INDUS and AFGHANISTAN.

A slow growing shrub of the arid zone of Sind, the Panjáb, and Rajputana, distributed into Afghanistan and Western Asia. The branches are leafless, and the small pink flowers are succeeded in May by the small fruit. The *phog* bushes growing on the sandy crests of the hills in Muzuffergarh district act as a sand-binder by means of their roots.

This plant in times of scarcity affords sustenance to numerous of the poor inhabitants of Bikanir and other parts of Rajputana. Specimens have been sent from Jaipur, Jodhpur, Bikanir, Kishengarh, and Jaisalmer. The smooth stems and branches, the abortive flowers and the small succulent fruits are eaten as food. The flowers are either made into bread or are cooked with *ghi* or cocoanut oil.

The young shoots of the *phog* are relished as a fodder by goats and camels.

The soil at the roots of *phog* bushes is used in the Panjáb Doab to fertilise well lands. One thousand and six hundred donkey loads are applied to the acre. One rupee is given for 80 donkey loads of 50 pounds' weight.

Celosia cristata, *Linn.*

Vern.—*Kokan, pi a-murghka, lal-murghka*, HIND.; *Lal-murga* (*the red form*), *huldi-murga* (*the yellow form*), BENG.; *Garka*, BOMB.; *Sirmoli*, U. PROV.; *Keidu*, ALI RAJPUR, C. I.; *Mawal, taji khoros, bostán afras, kanju, dhura-dru*, PB.; *Mawal*, KASHMIR; *Punnee-keeray*, TAM.; *Erra-kodi-ulta-totakura, kodi-juttu-tota-kura, garati ak*, TEL.; *Kyet-monk*, BURM.

This is cultivated as an ornamental plant in the plains and on the Himalayas. It grows in Kashmir at 5,000 feet elevation.

The plant, as well as the allied species **C. argentea**, *Linn.*, is grown as a pot-herb and used in times of scarcity. It has been sent as a famine food from Hamirpur in the United Provinces, Panch Mahals in Bombay and from the Madras Presidency, where the leaves and young shoots are eaten as greens.

The seeds are demulcent and are considered to be efficacious in cough and diarrhœa.

Chenopodium album, *Linn.*

THE WHITE GOOSEFOOT.

Vern.—*Bathú-sag, bethuá-sak, chandan-betú, chakai*, BENG.-HIND.; *Kandrabe* or *kalu bethu* or *kanta lathe*, SIKKIM; *Palang, tirrhye, aghu, aru, jilmil*, ASS.; *Bathua, bathu, jauság, chulai, lúnak*, PB. PLAINS; *Irr*, CHENAB VALLEY; *Em*, LADAK; *Bethuwa, charai, jau ság, bhátwa*, U. PROV.; *Bhatua arak*, SANTAL; and *Kharttua sag*, HIND. in SANTAL PERGANAS; *Chakwit, chil*, BOMB.; *Jhil*, SIND; *Chilbabra*, ALI-RAJPUR, C. I.; *Khuljeh-ke-baji*, DUK.; *Parupu kire* TAM.; *Pappu kura*, TEL.; *Vastuk*, SANT.; *Kulf*, ARAB. The English names are Lambs quarters, Pigweed and Goosefoot.

Common throughout the tropic and temperate Himalaya from Kashmir and Sikkim, ascending to 12,000 feet above the sea, and in Tibet to 14,000 feet. General in the plains from the Panjáb to Bengal, Western and Southern India. Wild and cultivated.

Voigt describes three forms of this plant: (α) **album** proper, *chandan betu*, of Bengal; (β) **viride**, the *lettu shak*, entirely green; and (γ) **purpureum**, the *lal bethi*, a form "with the angles of the stem and branches of a fine purple colour; leaves and the mealy panicles somewhat reddish."

Stewart refers to a form of this plant from the Panjáb which he considers to be equal to **C. Quinoa**. The leaves are eaten as a pot-herb in the valley of the Sutlej, but the plant is chiefly cultivated for its grain, which is considered better than buckwheat.

FAMINE Foods.

POT-HERBS.

Chenopodium album.

Oil of *chulai* mentioned by Baden Powell is not now known, but the vegetable of that name is in Lahore referred to C. album.

It is cultivated as a food by the hill tribes on the higher Western Himalayas, in the Naga Hills and in other parts of India. It grows in the rains and sometimes attains a height of six feet. The wild plant is regularly collected and eaten as a pot-herb. It has been sent as a famine food from Monghyr, Mirzapur, Dholpur, Alwar, Udaipur, Poona and Ahmednagar where both the leaves and seeds are eaten. It is said not to be cultivated in the United Provinces, but the leaves of the wild plant are eaten by the poorer classes.

As will be noticed from the analysis, the leaves and small shoots are exceedingly rich in mineral matter including potash salts and phosphoric acid, and the nitrogenous material is fairly high.

The seeds ripen in October and are regularly collected for food from the cultivated plants. The seeds, also, of C. ficifolium are used in the North-West Himalaya for making a kind of bread.

Chenopodium ambrosioides.

Chenopodium ambrosioides, *Linn.*

SWEET PIGWEED. MEXICAN TEA.

Vern.—*Herba Santa Maria*, BRAZIL; *Culen*, CHILI.

This American plant is now completely domesticated in many parts of India, such as Bengal, Sylhet, the Deccan, and Coimbatore.

This plant possesses tonic and antispasmodic properties and enjoys the European reputation as a useful remedy in nervous affections, particularly chorea, and for pectoral complaints. It is also said to be used as a substitute for C. anthelminticum having in a milder degree the anthelmintic properties of that plant. An infusion or tea of the plant is the usual form in which it is administered.

The medicinal use of the herb does not appear to be recognised by the natives of India. Analysis made of one of the plants growing near Calcutta shows that, while it is not so rich in ash and albuminoids as the White Goosefoot, it contains an essential oil of a pleasant mint-like odour and a bitter principle.

Digera arvensis, *Forsk.*

Vern.—*Luta mahawria, gunjatiya*, BENG.; *Kari gandhari*, SANTAL.; *Das*, BIJNOR; *Tartara, kundra, tandala, leswa*, PB.; *Gar-tundula*, PUSHTO; *Tandala*, SIND; *Getan, kunjur, kunjari, kunjira, kunjra, kundru*, BOMB.; *Lahutwa, lahuswali, lesua sag, leswa, halunjara, lalra, labre, Alinjra, lolharu*, RAJ.; *Chenchali kura, chanchali kura*, TEL.; *Akoi goraji*, KAN.

FAMINE Foods.

POT-HERBS.

A small herb of the plains of Bengal and North-West India, South Deccan, Koncan, Mysore and the Carnatic, West Peshawar and the Salt Range. Distributed on the one side through Burma to Ceylon, and on the other to Baluchistan, Afghanistan, Arabia and Africa.

The weed is generally used as a pot-herb. The leaves are made into curries, or the whole plant is boiled with water and spiced with salt and chillies.

The plant as well as the seeds have been sent as a *famine food* from Alwar, Dholpur, Jaipur, Bhartpur, Ajmir-Merwara, Jodhpur, Udaipur and Bikanir in Rajputana and from Nasik in Bombay.

It is used as fodder in South Baluchistan and therefore serves *for* beast as well as man in times of scarcity.

Haloxylon salicornicum.

Lana shrub.

Haloxylon salicornicum, *Bunge.*

Vern.—*Lana*, RAJ., PB.; *Mether, dati*, JHANG., PB.

This shrub, one of the salt-worts, is a low growing plant of Rajputana and the Panjáb. The Lana Thal *is* the great grazing ground for which the Doab of the Panjáb is celebrated. Thousands of camels come from all parts to feed on this herbage during the winter months.

As a famine food the young branches have been sent from Jaisalmer and Rajputana.

This is the ordinary lana plant of the North-West and yields sodium carbonate. The sample from Jaisalmir afforded 14·1 per cent. of ash, about half of which consisted of sodium and potassium carbonates.

Polygonum barbatum.

Polygonum barbatum, *Linn.*

Vern.—*Bekh-unjubas*, BENG.; *Nani*, PB.; *Atalari*, TAM.; *Konda-malle, niru-gannera*, TEL.; *Velluta modela mukku*, MALAY.

The plant is used as a food in curries in parts of Bengal. Balfour remarks that cattle eat it greedily.

Polygonum glabrum.

Polygonum glabrum, *Willd.*

Vern.—*Sauri arak, jioti*, SANTAL; *Larboma, bih agni, bih langani Bonka*, BALARAMPUR, OUDH; *Patharua*, ASS.; *Rakta rohida*, BOMB.; *Aatlaria*, TAM.; *Scheranna mudela mucca*, MALAY.

The fruits are parched and made into a kind of *sattu* in Balarampur.

Campbell states that the plant is eaten as a pot-herb in Chutia Nagpur, a custom which, according to Darrah, obtains in Assam.

The latter author states that the leaves and young shoots are always, when eaten, cooked with other vegetables. They are pungent in flavour and are used only in small quantities.

Polygonum plebeium, *R. Br.*

Vern.—*Chimtee* or *chemiti sag, dubia sag, jalos, pitra, ketha, mechheta-sag, chakai madranga sag*, BENG.; *Raniphul, merie arak*, SANTAL; *Machic'i, choti machhaichhis*, UNITED PROV.

The plant is common in Mysore and the Karnatic; occurs also in Bengal, Chutia Nagpur and Bombay.

The leaves have been received as famine food from Pakur, Ranchi, Manbhum, Monghyr, Balasore and Mirzapur. The plant is used as a pot-herb in the Santhal Parganahs.

Polygonum stagninum, *Ham.*

Vern.—*Ratooti sag*, BENGAL.

Used as a pot-herb in times of scarcity.

Rumex sp.

In addition to the Knotweeds certain docks are used as sags. **Rumex vesicarius**, *Linn.*, (*Sukha sak*, Assam; *suka kora*, Rajamundry). Sudras or low caste people boil the leaves and use them as a food. **Rumex maritimus** (*Bans pata*) is also employed.

Salsola fœtida, *Del.*

Vern.—*Illa-kura*, TEL.; *Moti lane, gora lane*, PB.; *Shora, shoraj*, PUSHTU; *Laman*, SIND.

This is one of the salt-worts which does not appear to be touched by grazing animals on account of its richness in saline matter. It grows near Delhi in the dry weather and always looks fresh, but its taste is very saltish. *Lana sajji matti* is made from it.

Aitchison remarks that a quantity of manna is secreted on the leaves of this plant, which is collected by Baluchi camel drivers and used for food.

Spinacea oleracea, *Linn.*

THE SPINACH.

Vern.—*Palak, pálaí, palánki*, BENG.

This is a typical pot-herb of Europe and the United States. It is most probably a native of Persia. The plant has been introduced into India by the Muhammadans, and is now cultivated in many parts of the country. The African Moors brought it to Spain and its use gradually spread to other parts of Europe. Aitchison in his Botany of the Afghan Delimitation Commission remarks that it grows profusely in the vicinity of Simkoh in the Badghis, and is collected as a pot-herb by the natives. Spinach is much valued by Muhammadans on account of its cooling and emollient properties, and a decoction of the plant is prescribed in febrile affections. The herb is considered one of the most digestible and wholesome vegetables. It is cultivated at Saharanpur, United Provinces, and in many other parts of India.

Besides a large quantity of mucilage and albuminous matter Dr. Dymock says spinach contains a large proportion of nitrates, that the water in which it has been boiled may be used for making touch-paper. We have not been able to confirm this statement in regard to any of the Indian pot-herbs although potassium nitrate has been detected in **Amarantus gangeticus**. The analysis of spinach given in the table is the mean percentage composition of three samples recorded by König. It will be noticed that the nitrogen is higher than in any of the herbs examined:

Suæda maritima, *Dumont.*

Syn.—SUÆDA INDICA. *Willd.*

Vern.—*Vellakora, kodee-kasseeray-kura*, TEL.; *Kayey-kasseeray-Keray*, TAM.; *Lani*, PB.

The plant grows in salt-marshes of Bengal, Bombay and Madras and is widely distributed in Europe, Africa and America. It is universally eaten and is an essential article of food during famine. The weed is saltish and purgative, but these properties are largely removed by boiling with water.

The sample of this salt-wort was obtained from Port Canning (Matla) in the Sandriban, and it was found that one quarter of the dried plant consisted of sodium chloride or common salt with between 3 and 4 per cent. of magnesium chloride.

It is said that *sajji-matti* is not made from this plant in Lahore. As the analysis shows that most of the ash is composed of common salt it would be unsuitable as a source of *sajji-matti* which is a material always associated with strongly alkaline properties.

FAMINE FOODS.

Papers relating to Famine Foods.

	Water.	Fat.	Albumenoids.	Carbohydrates.	Fibre.	Ash.	Nitrogen.	Phosphoric acid.	Silicates.
Aerua javanica	...	3·15	20·12	36·10	18·15	22·48	3·22	·70	6·33
Alternanthera sessilis	70·40	3·65	16·35	47·59	11·47	20·54	2·60	·52	6·16
Amarantus gangeticus (green) April	90·6	4·30	27·61	36·26	7·85	23·98	4·42	1·47	3·53
Amarantus gangeticus (green) November	82·60	4·50	25·72	36·84	11·89	21·05	4·12	1·35	3·20
Amarantus gangeticus (green) November, boiled	...	5·24	23·59	41·30	13·05	16·82	3·77	1·33	2·07
Amarantus gangeticus (red) April	91·0	5·34	25·46	34·71	6·96	27·53	4·07	1·36	1·97
Amarantus gangeticus (red) November	84·5	3·77	24·75	38·50	11·55	22·03	3·96	1·53	1·57
Amarantus gangeticus (red) November, boiled	...	4·65	27·41	36·48	12·08	19·38	4·39	1·33	1·76
Amarantus gangeticus (red), (older)	...	5·46	21·56	34·51	14·51	23·95	3·77	1·12	2·38
Amarantus polygamus	53·30	3·45	21·77	39·02	10·36	25·40	3·48	1·52	6·90
,, spinosus	52·10	3·21	19·43	38·35	19·81	20·20	3·11	1·13	1·50
,, viridis	...	3·76	26·36	38·12	10·04	22·72	4·06	1·09	2·84
Atriplex nummularia	75·00	2·20	16·24	42·84	7·24	31·28	2·59	...	...
,, pamparum	71·79	2·41	19·75	34·81	22·26	20·77	3·16	...	...
,, semibaccata	75·00	1·54	15·72	40·60	22·32	19·72	2·51	...	...
Basella alba	92·00	6·87	20·42	32·90	11·55	28·27	3·27	1·32	6·70
Beta vulgaris	...	5·75	13·92	45·55	17·85	16·93	2·23	·50	·86
Calligonum polygonoides	...	...	12·03	...	...	11·10	1·92	·38	·38
Celosia cristata	...	1·76	12·29	41·42	31·99	12·54	1·97	·41	·70
Chenopodium album	78·00	4·53	22·14	40·22	7·60	25·51	3·54	1·35	2·00
,, ambrosioides	...	7·08	15·90	44·07	13·60	19·35	2·54	·71	5·47
Digera arvensis	...	2·82	17·24	41·43	20·83	17·68	2·76	·73	1·84
Euphorbia salicornioides	...	...	11·12	...	...	15·21	1·78	·13	·21
Polygonum barbatum	...	2·10	15·68	50·44	20·71	11·07	2·51	·45	1·41
,, plebeium	69·36	2·95	17·38	50·37	10·15	13·15	2·78	·61	3·27
,, stagninum	76·82	3·16	18·28	40·00	15·05	23·51	2·92	·48	11·72
Spinacia oleracea	88·47	5·03	30·17	38·50	8·07	18·13	4·64	...	...
Suaeda maritima	83·70	2·58	11·10	38·80	10·17	37·15	1·77	·55	1·89

F. 32.

G.I.C.P.C.—No. 880 R. F. P.—6-5-1904.—2,500—C. M.

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(Wax, animal.)

THE AGRICULTURAL LEDGER.

1904—No. 7.

INDIAN BEES'-WAX.

(APIS DORSATA, etc.)

(Dictionary of Economic Products, Vol. I., B. 392-415.)

Other DICTIONARY article that may be consulted:

Honey and Bees'-wax, *Vol. IV.*, H. 341-359.

AN ACCOUNT OF THE SOURCES, PREPARATION, TRADE AND COMPOSITION OF THE BEES'-WAX OF BRITISH INDIA.

By DAVID HOOPER, F.C.S., F.I.C.

INTRODUCTION.

An enquiry into the subject of Indian bees'-wax was instituted by the Reporter on Economic Products to the Government of India in 1893. The following letter from the Officiating Reporter addressed to the Inspector General of Forests, (No. 339, dated Calcutta, 16th October 1893) will explain the circumstance under which the investigation was undertaken:—

"At the request of the Secretary of State, insect-waxes (*viz.*, bees'-wax and white insect wax) have been included among the products of which detailed collections are to be made, and hand-books written, in connection with the Imperial Institute; and I should be very grateful for any assistance in carrying out the enquiry which can be rendered through the medium of the Forest Department."

After referring to the exports of bees'-wax during the five years 1885-1892, and the countries to which it was exported, the letter continues—

"Bees'-wax is said to be brought to Calcutta from the Sundarbans, Western Bengal, Orissa, Behár, North-Western Provinces, Assam, and

An Account of the Sources, Preparation, Trade and Composition

INTRODUCTION.

Nepal. The best qualities are reported to come from Orissa, Western Bengal, Sylhet, and Nepal.

"I should be very grateful for specimens, if possible, of the bees (preserved in alcohol) and of wax (about 10 lbs.) from different localities, and for any information which may be obtainable under the following heads:—

1. By whom the combs are collected.
2. Place of collection.
3. Method of collection (*e.g.*, from hollow tree [redacted], crevices of rocks, etc.).
4. Abundance of supply.
5. Extent of export of wax.
6. Method of preparation of wax. (In some places the combs raised in villages are said to contain a large quantity of sticks, moss, leaves, etc., which are easily removed by stirring powdered borax with the molten wax.)
7. Price of combs with honey, and of the wax.
8. Whether bees are domesticated."

This letter was circulated by the Inspector General of Forests to the Governments of Madras, Bombay, Bengal, North-Western Provinces and the Panjáb, to the Chief Commissioners of the Central Provinces, Burma, Assam, Coorg, and Ajmir, and to the Chief Officials of Hyderabad, Port Blair, and Baluchistán. The Conservators of Forests in these Provinces were instructed to furnish specimens and information to the Indian Museum. During 1894 and 1895 a ready response was made to the circular by all the Forest Officers concerned, and a considerable amount of information became available on the subject of Indian bees and the economic value of their products.

The present number of the *Agricultural Ledger* is accordingly prepared from official documents in the office of the Reporter on Economic Products, and an opportunity has been taken to make the subject more complete by submitting to chemical examination some of the various samples of bees'-wax collected in different districts and deposited in the Industrial Section of the Indian Museum

The species of bees described in this report were, when possible, identified by **Major A. Alcock, F.R.S.**, and **Mr. E. C. Cotes** of the Indian Museum, and this opportunity is taken to thank these officers for their courtesy in this respect.

After describing the peculiarities of the bees, the centres of the wax and honey trade in India are discussed in the following pages, the methods of preparing the wax and its local uses are referred to, and finally a report is made on the character and composition of the various denominations of bees'-wax of the country.

THE INDIAN HONEY-BEES.

Apis dorsata, *Fabr.*

THE HILL BEE.

Apis dorsa

Vern.—*Vowra*, HIND.; *Khago, bheer mohury*, BENG.; *Lywai*, ASSAM; *Dangara, dingar, sarang, bhural, mahal*, U. PROV.; *Bhavra, bhor, mohal, bhawura, mahook*, CENTRAL PROV.; *Mahal*, PB.. *Age, aghya, agya, bhawar, bhammar, bramuar, konge, konege, ghangal, katámbé, hejjen, togri*, BOMB.; *Tagara, heddajenuhula*, KAN.; *Peddapera, kondaténiga, pedda egalu, perai-egalu*, TEL.; *Periathem, malai teni, perumthene*, TAM.; *Pyagyi*, BURM.; *Bambera*, CINGH. Bees are commonly called *Shahd-ki-makhi* (Hind.), or *modhu makhi* (Bengal), meaning the "honey fly."

This bee is found all over India, but not at great height above sea level. It is said to be found at 2,000 feet or more in Bhután and 3,000 feet in the Shán hills, but may justly be termed a tropical insect indigenous to the plains.

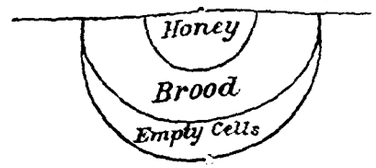
Descriptio

A. dorsata is the largest Indian honey-bee. It is about one inch long, marked with yellow or light brown stripes, and has thirteen rows of bristles forming the pollen basket. It builds cells to the number of 4½ to the inch. The combs are built exclusively in the open, on the underside of the branches of large trees, in caves or under overhanging rocks, and in old buildings. Dr. Forel says this bee seems to have a great liking for the buildings of old Mogul Emperors, as it is found in the mosques of Fatehpur, Síkri, Secundra and Delhi. It is very partial to the *Semul* tree (**Bombax malabaricum**), *Anjan* (**Terminalia Arjuna**), *Bar* (**T. belerica**), *Pipal* (**Ficus religiosa**) and **Mangifera indica**. In Burma it attaches itself to the *Kanyin* (**Dipterocarpus lævis**), *Thitpok* (**Dalbergia purpurea**) and *Letpan* (**Bombax malabaricum**).

Size of comt

The combs are three to five feet long and two feet or more deep. The brood comb or lower portion containing the larvæ is about 1½ inches thick, the upper portion or store comb is much thicker and contains the honey. Some of the combs weigh about half a maund, others are too heavy to be carried by one man. An average comb gives from 10 to 20 lbs. of honey and from 2 to 3 lbs. of wax.

A diagrammatic sketch of the comb of **A. dorsata** is represented below—



THE INDIAN HONEY-BEES.

Apis dorsata.

The reasons against any attempt to cultivate this species in a hive are—(1) The bee builds naturally in the open. (2) It builds normally only one comb, so that the honey cannot be removed without removing the brood also. (3) Although it builds a very large comb, this comb is not so great in cubic capacity, normally as the combs built by a stock of **A. mellifica** which is readily cultivated and the habits of which are well understood. (4) It is only found in a tropical climate, and in this respect differs from **A. mellifica** and **A. indica**, the most productive varieties of which are indigenous to localities having more or less severe winters.

This large bee when disturbed attacks men and animals and it has a reputation of being a vicious insect, but unless disturbed it does not attack, and can be handled by some of the measures usually employed by bee-keepers.

Apis indica.

Apis indica, *Fabr.*

♂. THE TREE BEE.

Vern.—*Satpada*, HIND.; *Mohury*, BENG.; *Aira, doar, khera, door*, U. PROV.; *Doyer*, PB.; *Sadhi, satde, sateri, sative, satar, satree* MAR.; *Kol*, BOMB.; *Sathpuria, satha*, CENTRAL PROV.; *Tudir-jen, tudri-jen, tudabi nona*, KAN.; *Aduku theni, kosumtheni*, TAM.; *Thorrá egdlu, pullaténiga*, TEL.; *Pya aung*, BURM.; *Lehej*, ADEN.

Description.

The bees of this species agree with **A mellifica** in having nine rows of bristles to the pollen baskets, and in the division of the anterior wings, relative position of the eyes, in building drone comb, and in the drones being widely different to the workers in shape. In fact, as described by entomologists, they differ from the European honey-bee mainly in size and colour, being smaller and darker. The size is about ½ inch, and with black and brown stripes on the lower half of the body.

This bee builds cells to the number of 5½ to 6 to the linear inch. The Bhutan variety builds larger cells, and more comb, and is not so prone to sting than the varieties met with in the plains. This kind, therefore, has offered advantages to Europeans living in hill-stations to cultivate and hive them successfully. The bee of the plains is considered to be economically worthless for purposes of cultivation.

Habitat.

Apis indica, as distinct from **A. dorsata**, frequently chooses hollow trees to build in where it has necessarily to submit to the presence of other insects. It has even been known to share its dwelling with a nest of wasps. It also builds in empty white-ant hills. **Colonel Bingham** has remarked that in Burma, where the houses are built chiefly of wood, he had more than once seen a house rendered

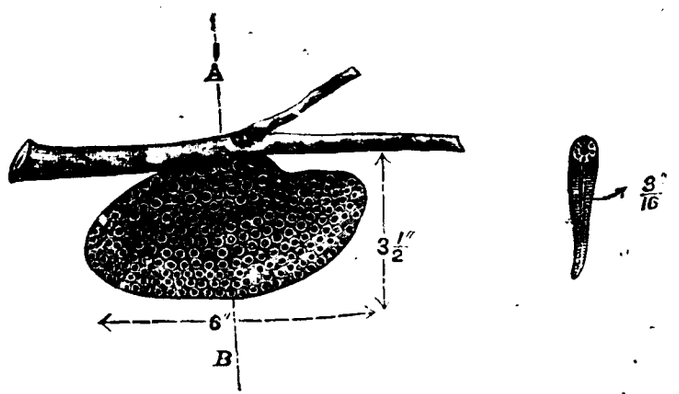
THE INDIAN HONEY-BEES.

Apis indica.

uninhabitable by a swarm of **A. indica** taking possession of the hollows under the wooden stair cases or between the outer walls when these were built.

In the cold weather these bees build their combs in hollow or decayed trees, and the combs are made in layers, one on top of another, often to the number of seven, hence the vernacular name *Sathpuria* or *Satha*. The appearance of an average specimen of one of these nests is illustrated below :—

In the hot weather the combs are built on the branches of trees, and are of the size of a hand or larger. A sketch of one of these combs from Hoshangábád is given below :—



Among a number of *Sateri* bees collected in Belgaum and sent to **Major Alcock** for identification, a fly named **Eristalis arvorum**

BEES. An Account of the Sources, Preparation, Trade and Composition

THE INDIAN HONEY-BEES.

was detected. This resembled the bee so closely as to defy detection by a casual observer.

Apis florea.

Apis florea, *Fabr.*

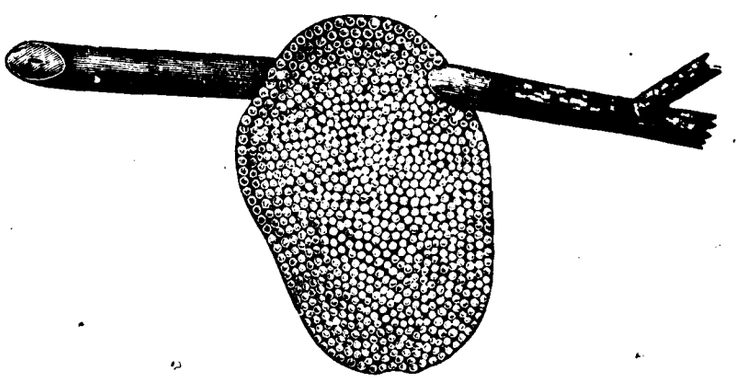
THE FLOWER BEE.

Vern.—*Kátyál*, MAR.; *Sopelia, lamai*, C.P.; *Tudbi, sinya*, BOMB.; *Kol-jen, dubal-jen, kombujenuhula*, KAN.; *Kombuthem, oletheni, shirutheni*, TAM.; *Thodi-pera, pullu egalu, dsuntiteniga*, TEL.; *Cheruténica*, MAL.; *Yin-pya, thit-kaung-byah*, BURM.; *Pushpalit*, SANS.

Description.

This is the smallest species of **Apis** found in India, and is a particularly common bee in the Bombay Presidency. It is very constant in colour, size and shape, being about ¼ inch (8 mm.) in length or somewhat larger than an ordinary house fly. Its worker cells are nine to the inch, and its drone cells about six; the drone is relatively to the worker much larger than the European honey-bee, and has a thick thumb-like projection on the metatarse of the posterior legs. This drone differs also in some other structural respects from that of **A. mellifica.** It is regarded as a stingless bee.

Like **A. dorsata,** this species builds in the open a single comb, and is only found in the plains. Its comb is usually built attached to a branch in the manner shown in the following illustration:—



Habit.

It commonly builds in bushes of a thorny nature, but sometimes under the cornices of houses and inside buildings. The comb is about the size of a duck's egg, at other times it may be as large as a man's hand, or it may be greatly extended and in part duplicated. Another peculiarity about the comb is that it is looped round the bough instead of entirely depending from the lower side as in **A. dorsata.** Near Mandalay combs have been found on bamboos and shrubs of the **Acacia** tribe as *Tanoung* (**Acacia leucophlœa**)

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of the Bees'-wax of British India. (*D. Hooper.*) BEES.

THE INDIAN HONEY-BEES.

Apis florea.

Cutch (**A. Catechu**), *Nantonkiang* (**A. Farnesiana**), and *Soo-yet* (**A. pennata**). The Morhi bee, probably the species under discussion, is found in desolate forests of West Khandesh, where a bush *Khavi* (**Strobilanthes ciliatus**) grows in abundance. The combs are raised in the shrubs when in flower. The bee is about the size of the common house fly and produces good honey.

A. florea is not nearly so plentiful in Burma as are the other two species. **Colonel Bingham** has seen very few nests. One was built in a cane bush not more than a few inches from the ground; another under the eaves of the roof of a forest bungalow.

The honey is small in quantity, and that of the small combs built in the open air is commonly very thin, but that found in large sheltered combs is very superior. The honey and wax of this species are not of commercial importance; they are often collected but seldom offered for sale. With regard to the wax it will be noticed that there is a slight variation in the composition of samples, although the average results correspond with the wax of **A. dorsata** and **A. indica.**

THE DAMMAR BEE. Melipona.

Melipona (Trigona) spp.

Vern:—*Kúnti, kóte, poyé, nasari, pove*, BOMB.; *Bhinkwa, bhumkua, bhungaira*, UNITED PROV.; *Bankua*, PB.; *Misri, misri-jiga, nasri-jen, sollejenuhula*, KAN.; *Kota, kuntali, lokhra*, CENTRAL PROV.; *Nasri theni, kosutteni*, TAM.; *Musuruténiga, Musari egalu*, TEL.; *Moye byah*, BURM.

Several species of these minute, stingless bees occur in India and Burma. They are about one-eighth of an inch long, and are sometimes called the "Mosquito bee" and "Dammar bee."

They build their combs in the walls of houses, in holes in the ground, and in hollows of trees. The entrance to the hive is generally projecting like the mouth of a bugle made of a soft sticky wax. When the nests are small the wax is not regularly collected, but from large combs the peculiar black sticky wax said to resemble chewed resin or cobbler's wax is used for many purposes.

In the Central Provinces the wax of the *Kota* bee is sold at the low rate of 2 to 4 annas a seer, because it is darker in colour and more sticky than ordinary yellow bees'-wax.

Honey.

The honey of these bees is often tainted with a peculiar odour and bitterish and acid taste, and has a considerable reputation in many parts of India for its medicinal properties. In Nellore the honey is regarded as intoxicating.

Wax.

In Burma the dammar-bees are of some importance in yielding a peculiar resinous wax known as *Pwé-nyet*, and a note by **Colonel Bingham** on the subject may be read in this connection with some interest.

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THE DAMMAR BEE. Melipona.

"The dammar-bees as the species of this genus are sometimes called, are widely spread, being plentiful in South America and in the Oriental region. All the species known to me build their nests in hollows of trees, crevices among rocks, sometimes in holes in stone walls. **Horne** (*Trans. Zool. Soc.* vii, p. 185) gives an interesting account of the finding of the nest of **Melipona (Trigona) ruficornis,** *Smith*, and states that the hollow in which it was built was coated all over with a layer of black wax, and that the cells, containing a dark honey of excellent flavour, were globular in shape, pendent side by side from the roof. In 'Science Gossip' for 1866, p. 198, the **Rev. C. S. P. Parish**, then chaplain of Moulmein, gives an excellent description of the nest of **Melipona (Trigona) læviceps,** *Smith*, a fairly common species in Burma. He mentions the extraordinary trumpet-shaped structure of resinous wax, which very often forms the entrance to the nests of the dammar-bees, projecting from the hole in the tree for a foot or more. The resinous product collected and used by the bees in making their nests is called 'Pwé-nyet' by the Burmese, and after boiling in water and mixing with earth-oil or petroleum is largely used for the caulking of boats. The right of collecting 'Pwé-nyet' is sold by the Local Government in Burma and Tenasserim yearly, and forms one of the sources of revenue under 'Minor Forest Products' (*in Blanford, Fauna of Brit. Ind., Hymenoptera*, I. 560).

Pwe-nyet.

Conf. p. 99.

For further information on Pwé-nyet, **Rev. C. S. Parish's** "Letter on the tree which produces Pwai-nyet" may be consulted, which will be found in *Journ. Agri. Hort. Soc. of India*, X. 103-105. Proc. 56.

In Trinidad, species of **Trigona** were observed to carry off the rubber fluid from the stems of **Castilloa elastica,** and the gum-resinous exudation of the **Garcinias,** as a sort of ready made wax for their nests. In some cases they actually cut the bark to cause a flow of the desired fluids.

PREPARATION OF WAX.

PREPARATION OF THE WAX.

The preparation of bees'-wax is a very simple operation and requires no skilled labour. In fact, it is almost invariably performed by the jungle tribes who collect the honey and combs from the trees and rocks. The season for making wax is usually the hot weather, and lasts from April to the middle of June.

As we have noticed in an earlier part of the paper the comb consists of two parts, the upper portion containing the honey, and the lower portion bearing the eggs or brood. The upper part affords a clean white wax, while the lower produces a dirty and coloured substance. As a rule the whole of the combs are detached from

the branches and are not separated before being melted. They are first divested of the honey and are squeezed by hand until it is all removed. The comb is then washed in cold water to remove all soluble matter, it is then placed in a brass, iron or earthenware pot or cauldron, half filled with water, and warmed on an open fire. As the wax melts it rises to the surface of the hot water, and the impurities sink to the bottom. The impurities consist of the larvæ, dead insects, twigs, leaves, grass, chips of wood. The pot is then removed from the fire and after being allowed to cool, the wax is taken out and made into cakes or balls. If the wax still contains impurities it is remelted and strained through a piece of coarse cloth or blanket (*kambli*), and the melted wax received in a pan or plate containing cold water.

PREPARATION OF WAX.

Methods of clarifying.

In a few districts some peculiar methods are adopted to purify or clarify the wax. For instance, in Betul, Central Provinces, the wax is put into a jar of liquid cow-dung for one night, it is then washed and again heated and strained through cloth. This operation is supposed to make the wax very clear. In the Nellore district, Madras, when the melted wax has reached its boiling point, a handful of Tamarind leaves is thrown into the vessel; this addition is said to precipitate all the foreign matter and furnish a very pure product. Salt is sometimes used in the water in which the wax is boiled, but, as a rule, no chemicals such as borax are employed in the clarifying process.

Artificial colouring.

Then to give the finished wax a golden yellow colour it is mixed with *Haldi* or turmeric, the powdered root of **Curcuma longa.** It is surprising how universally the artificial colouring with turmeric is practised. In Bombay and Madras and throughout Burma this colouring agent is frequently added at the last stage of manufacture.

Bleaching.

The bleaching of wax does not appear to be attempted by the native tribes, although the conditions in India are so suitable. If exposed to the sun in thin layers for a week, most forms of bees'-wax will become completely bleached. White wax is not appreciated in the native markets, so turmeric is employed to improve on the natural pale colour and enhance its commercial value.

Moulding.

Yellow wax is sold in various shapes according to the district. In Nimár and Ganjam it is made into round balls of about half a pound or one pound in weight. The Madras market prefers wax in the form of cakes of one foot in diameter and 1 or 1½ inch in thickness. In the Kurnool district the wax is moulded in blocks of two feet in diameter by 6 to 9 inches in thickness, or the size of a "ten pound wedding cake." The moulds for these cakes are usually pits dug in the ground lined with liquid cow-dung, and are constantly used for this purpose in many districts in Bombay and

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PREPARATION OF WAX.

Madras. The largest blocks of wax on the market are those made in the Lower Chindwin Division, Burma, where they are moulded into masses of 8 viss (29·2 lbs.) each.

Moulding.

If for export to Bombay, the collectors in South Kanara strain the melted wax into square wooden boxes. In Burma hollow bamboos are utilized for melting and moulding bees'-wax into cylindrical blocks; either the clarified melted wax is poured into a bamboo joint and allowed to solidify, or, as in the Kátha Division, it is prepared in the bamboo. The Conservator of Forests, Kátha, thus describes the process. A joint of a large bamboo is cut so as to have one end closed. In this a little water is placed, on top of this a thin layer of strips of split bamboo, and wax above this; the whole is then put on the fire. The steam causes the wax to melt and run through the filter and collect at the bottom. When cold, the bamboo is split up, and a mass of pure wax is found in the interior.

Adulteration.

It does not appear that any systematic adulteration is practised by those who prepare bees'-wax for the local Indian markets. In one district in the Panjáb it is said that after cooling the strained wax, one-eighth of its weight of oil of *til* (**Sesamum indicum**) is added before it is made into lumps for the market. The addition of oil would render the wax more plastic and perhaps give it a consistence suitable for local requirements.

Most of the samples collected for the Indian Museum were fairly clean, but a large proportion would have been greatly improved with a second remelting and straining. Very few districts supply refined bees'-wax, and when it is refined by the *baniyas* in large towns opportunities are given for adulteration which are occasionally not neglected. In the collection of samples to hand from Indian districts it will be seen that the most flagrantly adulterated bees'-wax comes from Bombay where it is supposed to have been imported from European sources.

CENTRES OF TRADE Bengal.

CENTRES OF TRADE.

BENGAL.—In the Sundarbans, where large quantities of honey and wax are collected through the Forest Department, the combs are taken by a class of Badgis called Moulays or honey-men. Other tribes in Bengal engaged in the trade are the Bharias, Khunjurs and Natuas.

The supply is not large in Singbhum but the industry is capable of great development. It has been estimated that from 3 to 10 maunds of wax could be collected from a range of 150 square miles in this division. It is sold at the rate of 3 to 4 annas per pound by the villagers, while the bazar men sell it for 8 annas per pound or more.

of the Bees'-wax of British India. (*D. Hooper.*) BEES.

CENTRES OF TRADE. Bengal.

The amount and value of wax removed by purchasers for the past two years were as follows:—1901-02, 622 maunds valued at ₹2,510, and in 1902-03, 755 maunds at ₹3,023. This shows a decided increase, most of the revenue being derived from the reserved forests.

With regard to honey and wax in the Chittagong district, a report on bees of this locality will be found in the *Indian Forester*, Vol. X. (1884), p. 560.

In Bhután, Nepal and Tibet wax is collected on a large scale and brought into Bengal for sale. It is usually obtainable in the cold season when it is sold in the local markets at an average rate of 5 annas per pound. 315 maunds of wax valued at ₹13,266 were brought from Bhután to Buxár in 1893-94, and was purchased by Marwaris who sent it to Calcutta. This was not an exceptional year, but the figures are quoted to indicate the extent of the trade in this quarter. The price ranges from ₹50 to ₹47 per maund for the raw wax which is clarified and boiled down into large circular cakes for export.

Calcutta prices.

With regard to the price of bees'-wax in Calcutta, the Secretary of the Bengal Chamber of Commerce reported in 1896 that this article was comparatively scarce. It commanded a price ranging from ₹50 to ₹75 per maund. Pure bees'-wax realized from ₹65 to ₹75, and mixed and rough descriptions from ₹50 to ₹62 per maund. It is in great request in the Straits and Java.

More recent information on prices of bees'-wax in Calcutta is quoted from the market reports for April 1904: "₹53 to ₹61 for raw wax, ₹59 to ₹62 for locally refined. The demand for Europe is very limited. Fair demand for Singapore and the Straits."

Calcutta wax merchants.

The following list of firms selling wax in Calcutta was drawn up by the Secretary of the Bengal Chamber of Commerce in 1896:—

Modhusundum Rampersum Bhobuturum Nundy.
Denonath Mookerjee.
Odhor Narain Roy and Nilmoney Roy.
Madhub Chunder Daw.
Dhun Mudhun Shaw.
Megho Shaw.

The buyers and shippers, and more important dealers are—
Messrs. J. E. D. Ezra & Co., Meyers Bros. & Co., S. Manasseh & Co., Ebrahim Solomon & Co., Cama Ramjee & Co., Goculdoss Hunsraj, Chetram Chutterbhuj.

ASSAM.—Most of the wax of this province comes from the hills beyond the frontier, and very little is produced locally.

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CENTRES OF TRADE. Assam.

Two species of bee are found in Assam, called *Lywai* and *Ngap*. The former is larger than the other and is probably referable to **Apis dorsata.** It builds its hives in inaccessible rocky precipices, and the comb is often half a maund in weight. The *Ngap* or **A. indica** is the smaller bee, not larger than the ordinary house fly, and exists in the jungle.

In the neighbourhood of Cherrapunji, the Khasia villagers (*Wár*) collect honey and wax. Bees are domesticated to a small extent on these hills, and in other places the *Ngap* bee is hived by building a frame in the hollow of a tree trunk about 3½ feet in circumference, and encouraging a swarm.

Sylhet.

Merchants from Sylhet purchase all the wax from the Khasia Hills, but statistics of annual exports are not available. The wax is only of fair quality, and some consignments are of such low value that they realize only 2 annas per pound.

United Provinces.

UNITED PROVINCES.—The right of collecting honey and wax in these provinces is leased annually by auction sale to contractors. There is no particular class of men who make the collection a profession, but those having an inclination and skill in the work take it up as a livelihood. About 50 years ago much honey was collected and brought for sale especially at Petwaghar, Kumaon; the wax was also an article of trade. In the Dehra Dun Division collectors come from Saháranpur. In the neighbouring Kheri Division wax is collected by Kúchbandhias, Nutts and Pásís; the first two castes are rope-makers, and the last chowkidars and small cultivators.

Dehra Dun.

Formerly the honey and wax used to be collected from all the forests of the Dun Division, but of late the work has been confined to those in the Eastern Dun. The receipts from this source have also declined in recent years which shows that the supply is not so abundant. One of the causes of the decline in trade is the prohibition to carry torches or light fires in fire-protected areas. The export of wax consequently does not amount to more than a few maunds, the selling price of which is 8 annas per pound.

Kheri.

In the Kheri Division honey and wax are gathered in the forests near running streams. Two men are needed to collect; one enveloped in a blanket climbs the tree to which the comb of the Sarang bee (**Apis dorsata**) is attached, provided with a knife and an earthen pot. The other man, also wrapped in a blanket, ignites a bundle of grass and leaves and passes it to the man on the tree who smokes the bees away from the comb, cuts it from the branch, and places it in the pot. The average revenue from the honey and wax contracts in Kheri for five years ending 1893 was R1,392. The average price of wax is 8 annas per pound, and it is supposed that the contractors make at least 50 per cent. profit.

CENTRES OF TRADE. United Provinces.

In Saháranpur yellow bees'-wax from the comb of the **A. dorsata** is sold at 11 annas per pound, the annual trade amounts to several thousand rupees. A white wax imported from Bombay is sold in small quantities at 9 annas per pound.

Central Provinces.

CENTRAL PROVINCES.—The Commissioner of Settlements and Agriculture writing in 1896 says:—"The honey and wax industry is not developed to its full capacity. The minor forests are stated to be capable of yielding at least 500 maunds of honey and 100 maunds of wax a year, but nothing like this quantity is collected. In the Chadgarh tract of this district bees are so common that it is impossible to beat for wild animals in the forest."

Nimar.

As in other provinces, jungle tribes extract the produce from these forests and prepare honey and wax for local consumption and export. In Nimár the wild tribes, Bhíls Kúrkus, Dhanuks, and Náháls are the collectors. In some of the reserves no honey is collected although the supply is abundant. Ratgarh hill is described in the Administration Report as "a perfect hive of bees' nests." The bees identified in this district were the large kind (**Apis dorsata**), and a small kind living in hollow trunks of trees (**A. florea**).

Panjab.

Hoshangaoa.

About 50 or 60 years ago the collection of honey in Hoshangábád was solely in the hands of the Gonds and Náháls, but lately some enterprising Mahomedans have taken to it as a means of support. The first man who learnt the art and taught it to his co-religionists was a camel driver attached to a European officer's camp. The Mahomedan collectors, being less inured to jungle life, attack the bee-hives in the day time, being afraid of the reptiles and wild beasts that inhabit the forests at night. The Gond collector of honey, called a Bharia or Mavasi, invests his calling with an air of mystery by observing dietary rules before attacking the comb. It requires five or six persons to accomplish the perilous task of removing the combs from lofty and precipitous crags. The most courageous is he who with a smoking torch in his arm-pit has to climb a lofty tree or rock, or suspend himself in the air in a net or basket with the aid of two ropes—one tied round his chest and the other held in the hand for support—in order to ransack the well-guarded hives, and cut away the best portions. The torch is made of a few dry sticks of wood and green leaves, and is called a *taranga* or *bota*. The Náháls, Gonds, and Kúrkús, who work at night, consider the combs to contain more honey on a dark night than when there is a moon. The comb weighs on an average 5 seers and gives ½ seer of wax and 3 seers of honey. The Gonds and Kúrkús occasionally collect honey as food for themselves and families. The Mahomedans who are professional collectors, and numbered 15 in 1894, pay visits to Bhopál where no

CENTRES OF TRADE. Central Provinces.

restrictions regarding fires exist. In addition to the wax gathered in the district quantities are imported from Nimár and Betúl; on the other hand wax is exported to Bombay and Surát. The trade is, however, limited and the Mahomedans, the largest workers in Hoshangábád, earn only R200 a year.

Betul.

In Betúl the honey and wax is collected by Gonds and Kúrkús, but no reliable statistics can be given regarding the value of the exports. The combs are afforded by the **Apis dorsata** or Bhowar bee, building in large trees as the **Bombax, Terminalia** and Pipal. Fort Bhowargarh is supposed to have taken its name from the fact of these bees building their combs along its precipices. Combs are found all over the district and the supply is abundant.

Chhindwara.

In Chhindwárá there are three honey-producing bees:—(1) *Bhor* (**A. dorsata**); (2) *Maharose*, similar in colour but of smaller size; (3) *Kothie*, a small bee of an ash colour. The combs of the two former are collected by experienced Gonds, Kúrkús and Bhurias. The supply of combs is limited and the wax is used locally.

United Provinces.

About 500 lbs. of wax are taken out of the Government forests in the Nagpur-Wardha Division by Gonds, Pardhans and Gooras. The greater portion is consumed locally. One Forest Officer gives his opinion that Wardha is the best district in the Province for honey and wax. **Apis dorsata** and **A. florea** have been sent from Nagpur, their combs are found in trees growing near river banks.

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In the Chanda district it is estimated that the total annual yield of these products from Government forests alone amounts to 1,000 seers of honey and 300 seers of wax.

Damoh.

In Damoh, forest products, including wax and honey, are collected by Rowats, Sours, Gonds, Konders, Bhomias, Kheroas, Bherias, Kots and Bhils. It is estimated that 1,500 to 2,600 combs are gathered annually, and 4 or 5 maunds of wax exported.

Mandla.

There are two seasons for collecting honey in the Mandla district, *viz.*, April and May, and November and December. Baigas and Gonds gather the combs which belong to four bees called Mohras, Kanis, Kuteas, and Bhanwars.

Jabalpur.

Jabalpur district contains very few bees' nests, probably on account of the scarcity of water in the neighbourhood.

Raipur.

In Ráipur, collections of combs are made by Kharwars and Binjhwars, those of **Apis dorsata** and **A. florea** affording the largest quantity of honey and wax.

Sambalpur.

Sambalpur combs are collected by Kols, Konds, and Gonds, wild tribes living in and around the jungle. The principal localities affording honey and wax are the Bamra forest, Rehra Khol, the Gad Laising Zemindary, Ráigarh and Borasamber.

CENTRES OF TRADE. Central Provinces.

A rough estimate of the outturn of bees'-wax from these places is given in the Annual Report of the Forest Department. Bamra 50, Rehra Khol 40, Gad Laising 20, Ráigarh 40, Borasamber 30, total maunds 180. The wax is not consumed locally but is exported, probably to Cuttack and Calcutta.

The following are the rates for wax about 10 years ago in different districts of the Central Provinces:—

		As.	
Ráipur.	White Wax	10	per pound.
	Yellow "	8	" "
	Dark coloured	6	" "
Nagpur, Nimár and Chhindwárá		4	" "
Hoshangábád		6—10	" "
Sambalpur		12	" "
Betúl		5	" "
N. Circle, about		8	" "
Barra bees'-wax (**Apis dorsata**)		3—6	" "
Kota bees'-wax (**Trigona sp.**)		1—2	" "

Panjab.

PANJAB.—In the Hazárá district the domestication of bees seems to be confined to the higher parts of the district, in the valleys of the Kanhar and Siran, where it is practised by the Sayads and their tenants; the villagers adjoining the forests of the Dungagalli range also capture and domesticate bees.

In the Jhelum, Chamba, Kángra, Kúlu and Bashahr Divisions it is reported that the zamindars themselves are in the habit of keeping bees. It would appear from the figures given below that in Bashahr and Chamba only is the practice carried on to any large extent.

Where collected.

Place of collection.—This is generally in the forests from hollow trees and crevices in rocks. In Hazárá "Swarms are easily captured in spring and removed from hollow trees to the zamindars' houses in bags smeared with honey and paste"—Bee-keeping here is, however, "entirely resorted to for the honey."

In Chamba swarms are obtained by putting "hives made of hollowed logs of some species of **Rhus** in selected spots in the jungles, or by attracting swarms to hollows left in the walls of the houses."

In Kángra the bees are kept in "hives formed of mud and boxes in the walls of the houses, or hives built on the branches of trees."

Much the same is reported from Kúlu, Bashahr and Simla.

Collection.

Method of collection.—Generally the honey and wax is obtained by smoking out the bees which are driven alternately to opposite ends of the hive "whilst combs or parts of the one comb are removed at either end." Occasionally, as in Kángra, zamindars wait till the bees have abandoned a hive in a hollow tree, the branch containing it is then cut down. In Hazárá the operation of removing the honey is

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Panjab.

Trade.

carried out in November. In Kúlu it is done twice a year in July and October, and this is also the case in Chamba where the seasons are May or June, and September or October.

Abundance of supply and extent of export.—Hazárá.—As noted above, bee-keeping is here only carried on for the sake of the honey. There is no trade in wax. It is, however, to a small extent purchased by shop-keepers in the Gallis. Hives contain from 20 to 40 lbs. of honey and 2 to 4 lbs. of wax—It is estimated that not more than 120 lbs. is exported annually to Rawalpindi.

Jhelum.—Wax occurs only in very small quantities; there is no export.

Chamba.—Nearly all the honey which is collected is sold to traders from Kángra and elsewhere, the quantity exported is believed to be about 1,6-3 cwt. and 100 cwt., for honey and wax respectively.

Kángra.—Apparently 2 or 3 maunds of wax are used locally in forming moulds for brass work, etc., while 6-7 maunds are exported.

Kúlu.—There is no regular trade in the wax, and the zamindars often use it themselves; the export may be taken at between 2 and 3 maunds. The quantity taken from one hive varies from 6 seers downwards.

Bashahr.—The annual outturn of wax from all sources is about 20,000 lbs., and nearly all this is disposed of at the Rampur Fair, and finds its way to the plains.

Simla.—The supply is very limited, there is no regular trade.

Ambála.—Very small supply of honey, and export *nil*. Wax is not prepared and the honey even is not sold.

Multán.—Very small supply and no export.

Fresh honey-comb yields some 5 per cent. of wax and 90 per cent. of honey.

The wax is sometimes obtained by skimming the surface or dipping into the mixture a cold lota. Another description of the method is as follows:—

The honey is first strained through a sieve, the remaining part is then boiled and strained through a cloth when the cleared wax collects on the top of the water, when cooled, it is taken off and formed into pieces weighing 2 lbs.

Prices.

Price.—In Hazárá the gallis wax is sold at 3-5 lbs per R1.

Jhelum.—Combs are not sold, but pure wax fetches 1 lb. per rupee. or 1½ lb. per R1 when adulterated with fat.

Chamba.—Wax 1¼ to 1½ seers per rupee, about 10 annas per pound.

Kángra.—There is no honey sold in this Division. Wax is valued at from 1½ to 2 seers per rupee, or 5⅓ annas to 4 annas per lb.

Kúlu.—Wax 1 to 1½ seers per rupee, or 6 to 8 annas per pound.

CENTRES OF TRADE.

Panjab.

Bashahr.—4 lbs. per rupee for wax, or 4 annas per pound.

The bees appear to be domesticated in most hill districts, such as Simla, Bashahr, Kúlu, Kángra, and Hazárá. It, however, appears that in most places the bees are captured in the forest and endeavours have been made to make them remain in the hives prepared for them.

The following information is available regarding the kinds of bees found in the Panjáb:—

Varieties of bee.

In Hazárá a little brown bee (probably a variety of **A. indica**) is the one most commonly domesticated.

In Chamba there are 3 varieties said to be domesticated:—

(*a*) "Paruu" which is the best domesticated variety and gives the best honey.

(*b*) "Dharoou," rather more savage, and honey not quite so good.

(*c*) "Thamoon," very savage, honey moderate, and builds only a conical or cylindrical comb.

In Kángra two kinds of bees are distinguished, "Bhanour" and "Darola." Both are wild. The latter is to a certain extent cultivated by the zamindars in the hill villages; it keeps apparently exclusively to the high hills. The former appears not to be abundant and keeps continually moving, staying on the hills during the hot weather and migrating to the forests in the valley at the commencement of the rains.

Kashmir.

KASHMIR.—The bee of Kashmir (*manchtilr*) is almost domiciled; it is a little smaller than that of Europe, though a little larger than the domesticated bee of Kumaon. Nearly every farmer has provision in his house for hiving these bees, consisting of small hives, often to the number of ten, built in the upper portion of the walls. About the end of September or the beginning of October is the best time for taking the honey, which is used largely in place of sugar for mixing with food or preserving fruits.

Rajputana.

RAJPUTÁNA.—In Ajmere-Merwara combs are collected by the Bhils who obtain the contract from the Forest Department, paying a certain amount in cash for the honey and a certain amount of wax fixed at the time of the contract. It is collected from Todgarh, Dewari, Ammer, Baojari and Mandlan ranges, often from huge precipices. The supply of wax is not abundant, about 1½ maunds only, of which the contractors take half as the cost of collecting.

Baluchistan.

BALUCHISTÁN.—Efforts to collect samples and information concerning bees and bees'-wax in this province have been fruitless; nothing could be gained in the jurisdiction by the Deputy Conservator of Forests. This statement is substantiated by a note in a recent number of the *Journ. Nat. Hist. Soc. Bombay* (Vol. XV. No. 2360).

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Baluchistan. Major C. G. Nurse, of Quetta, writes:—"The Apidæ are numerous, both in species and individuals, but I have never come across a specimen of the true honey-bee (Apis) (in Baluchistán) though three species occur in India."

SIND.—No samples also were received from Sind and Karáchi.

Kuram Valley. *KURAM VALLEY.*—Dr. J. E. T. Aitchison remarks:—"In every village near the hills in this country bees are largely kept by the people, honey and wax being important articles of traffic. Honey is used in place of sugar which is very expensive."

Bombay. *BOMBAY.*—Visitors to the caves of Elephanta and Salsette are often disturbed by the bees that frequent the roofs of those historic monuments, and those arriving from England early become acquainted with the fact that honey and wax are not wanting in India.

Forest officers in various districts of the Presidency have contributed useful information on the kinds of bees peculiar to the districts and the trade in honey and wax.

Panch Mahals. Commencing with the Panch Mahals we are informed that three kinds of bees are known in this division; the large or *Bhammar* bee (**Apis dorsata**), the common kind (**A. florea**) building under railway bridges, and the smallest or *Kunti* bee, a species of **Trigona**. The honey and wax are collected over most of the division, but the crop is greatest in the two eastern talukas, Dohad and Jhalod. Wild tribes, such as Bhils and Náikdás, collect the produce of the bees. Men carry long poles with a bundle of dry grass at one end. After climbing a tree they cover themselves with blankets and kindling the grass, sweep the bees off the comb with it; they then cut off the combs from the branches and lower them to the ground. When nests occur in hollow trees the bees are smoked out and the honey and wax removed by hand. The supply is plentiful, and the gathering of wax forms one of the means of support for the jungle tribes in the hot weather. About 100 maunds or 4,000 lbs. of wax are exported every year, and the value is from ₹25 to ₹30 per maund of 40 lbs. The bazar rate is about 10 annas per pound.

West Khandesh. The forests of West Khandesh produce five kinds of bees of which the Bhawar bee (**A. dorsata**), as usual, is the largest honey and wax producer. The other bees occurring in this division are:—

Kotya (**Trigona**); size of black ants raising combs in the hollows of trees.

Mohri (**A. indica**) found in the hollows of trees and rocks.

Zinya or common bee smaller than cattle flies and harmless; combs contain much honey and a whitish wax.

Sondya, white bees, somewhat larger than ants. They raise combs in small branches of trees and in crevices of the earth

of the Bees'-wax of British India. (*D. Hooper.*) BEES.

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and store up honey in the hot season, April and May. The honey is white.

Bombay. The Sátpurá ranges, *viz.*, Shirpur, Shahade and Akrain, export wax in abundance, which is brought in for sale by the Bhils and other wild tribes. The export is about 10 maunds annually. The wax sells locally for 8 annas per pound.

East Khandesh. In East Khandesh honey and wax are collected by Bhils, Náháls, Tadvís and other hill tribes inhabiting the Sátpurás. The products are only sufficient for local consumption and there is no export trade. The three bees known in the division are the *Sadhe* (**A. indica**), *Age* (**A. dorsata**) and the *Koli* bee (**Trigona sp.**).

Sholapur. Honey and wax are not obtained in large quantity in the Sholápur division on account of the scarcity of trees and wild flowers. The combs are collected by low caste Kunbís, Mahars and Mangs, but wax is not exported.

Satara. In Sátára combs are collected by fishers (Kolís), shepherds (Dhángars) farmers (Kunbís and Kamoses). A fair supply of honey and wax may be obtained in Jáoli, Mahábleshwar, Patara and Spirada ranges, and in the western part of Sátára and Wái. About four kundis (of 560 lbs.) are exported annually. A single comb will sometimes fill 10 or 15 bottles with honey, and supposing one bottle to be worth three annas, the whole costs ₹2-8 or ₹3. Wax is valued at one-quarter the price of the honey.

Ratnagiri. There are three kinds of bees met with at Ratnágiri which produce only sufficient honey and wax for local requirements. The honey combs are formed by the *Kalambe* or *Aghya* (**A. dorsata**) found in inaccessible rocks or on branches of tall trees; the *Kalyal* (**A. florea**) found in small trees or bushes; and the *Poyé* (**Trigona**) lodged in hollow tree trunks or burrows of ant-hills. The honey and wax are collected by Kunbís or the labouring class, as at Kolába, but there is no export of wax from the division. The local price is 4 annas a seer of 28 tolahs.

Kanara. Kánara, for purposes of Forest administration, is divided into a Northern, Southern, and Central Circle, and in each of these divisions there are large supplies of wax collected and sent to Bombay.

The combs are not gathered in Kánara by any particular class of people, and anyone may collect outside of forest limits. The right to collect honey and wax inside forest limits is farmed out to contractors and sold yearly to the highest bidder. In the Northern Division, the *Konge* bee (**A. dorsata**) supplies large quantities of combs. Expert climbers ascend the trees at night, and with smouldering torches drive off the bees and remove the comb in baskets. The following sums were received in 1894 for collecting comb in the jungles:—Supa

CENTRES OF TRADE.

Bombay.

range, R500; Haliyábrange, R75; and Kárwár range, R50. The wax averages R14 per maund, and is principally purchased by Goanese for making wax candles.

Kanara.

In the Central Division, Kánara, the supply of wax is derived chiefly from Yellapur and Mundgod, Yellapur producing 2,250 lbs. and Mundgod 750 lbs., or an annual outturn of about 3,000 lbs. Wax is sold by the collector for R275 to R290 per *kandi* of 560 lbs. and is purchased by Goanese. Inferior portions left by straining are sold at a low price. A peculiar fact has been noticed in this division, that the honey is always at its best when the *Karvi* (**Strobilanthes ciliatus,** *Nees*) is in flower. This interesting fact confirms the belief in the virtue of this tribe of plants in affording a superior food for Indian bees.

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The four talukas of Sirsi, Siddapur, Kumta and Honawar in the Southern Division, Kánara, are largely used by honey and wax contractors. The values of the contracts for three years ending 1893-94 were—

	1891-92.	1892-93.	1893-94.
	R	R	R
Sirsi . . .	1,571	865	1,340
Siddapur . . .	157	122	139
Honawar . .	48	73	64

The contractor, while keeping a little for local sales, sends most of the wax to Bombay in square wooden boxes. The price is very low, being only 3 or 4 annas a seer of two pounds. There is such a ready sale for the wax that very little trouble is taken to preserve the honey.

Belgaum.

The seasons for collecting wax in Belgaum are May and November. There are four kinds of bees met with in the district, **A. dorsata, A. indica, A. florea** and a **Trigona**; but the bulk of the wax comes from the combs of the **A. dorsata**, which is known by the Marathi name *Konegi*. The combs are collected by the village people, principally Mhars, Kunbís and shepherds, those of the *Konegi* bee are only collected at night, at which time the bees are less inclined to use their stings. The supply of wax in this district is not large, amounting in all to about 50 or 60 maunds (28 lbs. each). Most of the wax is exported to Goa and Bombay; the market price in Belgaum ruling at from R15 to R20 per maund.

Dharwar.

In Dhárwár combs are collected by Lamanis and Hale Paiks, and the wax is made up into balls. The amount collected annually is 60 maunds valued at R10 per maund. It is estimated that R300 worth of wax is annually exported from the division.

Experiments in apiculture have been attempted in the hill-stations of Bombay, but as far as can be ascertained, with no very signal success. The only bee which can be said to be domesticated is the *Nasri-jen* of Kánara (a species of **Trigona**), the honey of which has a peculiar taste and is prized for its medicinal properties.

CENTRES OF TRADE.

Berar.

BERAR.—Reports on the collection of honey and wax in the Hyderabad Assigned Districts have been received from Wún, Básim and Ellichpur through Mr. Cecil Bagshaw, the Conservator of Forests. The abundance of supply depends to a great extent on climatic conditions; a dry season being responsible for a large yield, while a heavy rainfall prevents the formation of combs. The industry is in the hands of the Kúrkús or country people, and the Gonds, Kolams, Banjárás and other wild tribes. The collection of the *Agya* combs (**A. dorsata**) is very troublesome and is only performed at night time. A man clad in a blanket climbs up one of the trees (which are very lofty, such as the *Bar, Pipul* or *Anjan*) and, with a torch in his hand, burns and disperses the bees. The collectors usually rub themselves over with some kind of ointment prepared from herbs, the composition of which is known only to the Gonds and Kolams, and is said to be sting-proof.

Trade.

The extent of the export of wax cannot be even approximately given as some is collected in forests belonging to Izardars; moreover, no records are kept, as from certain forest lands, head loads are allowed to be removed free of duty. Pusád Taluk in Básim gives a fair yield, and as much as R1,000 to R1,500 worth is reported to be sold annually in the bazars. Collections are also made in the forests of the Melghát, Ellichpur, and in Mangrúl and Wún, but the exports, if any, are of no commercial importance. The bazar price of wax in Ellichpur is 4 annas per pound which is very low.

The bees from the Wún district have been identified as **Apis dorsata** and **A. florea**; those from the Básim district as **A. dorsata, A. florea** and **Trigona sp.**; and those from Ellichpur as **A. dorsata** (*Agia* bees) and **A. indica** (*Koti* bees).

Madras.

MADRAS.—This Presidency supplies large quantities of wax and honey for local and export purposes at very moderate rates, and in many districts the trade is capable of great expansion. The hilly regions from Ganjam to Tinnevelly on the Eastern Coast, and the Western Ghats of South Kánara and Malabar are the abodes of wild bees of the **Apis** family whose combs are annually gathered by the hill tribes.

In Ganjam and Vizagapatam the Konds recognise four different kinds of bees known by the Uriya names of—

(*a*) *Bhaga mohu*, a large sized bee (**Apis dorsata**).
(*b*) *Satlapuri mohu*, building its comb in 7 layers (**A. indica**).
(*c*) *Binchina mohu*, with a comb like a fan.
(*d*) *Nikiti mohu*, a very small bee.

The honey and wax are collected by the Konds and a class of men called Benias, who almost live in the forest and are expert

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Madras.

climbers of precipitous rocks and lofty trees. From Gúmsúr from 600 to 700 lbs. of wax are annually exported, and a large quantity in addition is brought down from the hills. The local price is 6 to 7 annas per pound. The estimated annual outturn of wax in Kondasemtha and Kristurdesrepeta is about 800 maunds, which sells at the average rate of R17 per maund.

In the Pálakonda range of Vizagapatam professional honey gatherers belong to the Savaras, Jotoahas and a tribe called Nakkalus.

Godavari.

The Godávari and Kistná districts afford honey and wax more than sufficient in amount for local requirements. It is collected by Gottehs and Kays. Wax is one of the principal products of Peddapuram in Godávari, and in the Kistná district it is procured from Satterapalle, Palnád, Vinukonda and Bandar. A collector in the last named district is let down the rocks with a basket lined with wax, a knife, brushwood and a light. When he reaches a comb he cuts away the underpart containing the larvæ, which can usually be done at night without disturbing the bees; he then lights the brushwood to drive the bees out and cuts off the upper portion of the comb and puts it in the wax-lined basket. At Vinukonda wax sells for R12 the maund of 25 lbs., but there is no great supply as the quantities collected are mostly consumed locally.

Kurnool.

Kurnool.—Large collections of honey and wax are made on the Nellamalái Hills in Kurnool. The hillmen of the Chenchu tribe are the collectors of these products, and this has been their recognised caste occupation from time immemorial. It is strange that this class of people, otherwise most cowardly and apathetic, have the courage to venture into these apparently inaccessible and dangerous places. The estimated quantity of wax exported from Sirvel taluk is about 200 maunds, this is brought to the market from Muttanal and Chruvu. In 1894 Sirvel exported 5,000 lbs. of wax valued at 4 annas per pound, and Nandyál 250 lbs. at 8 annas. The whole is sold to Bombay and Madras merchants. Very little honey or wax is collected in the Verramalai Hills.

Bellary.

Bellary affords wax in the Ráyadrug and Sandúr zamindaries. The combs are collected by Boyas and Bedars from Government leased forests, the Raja's forest at Sandúr, and from reserve forests near Ráyadrug. The combs occur in crevices of over-hanging rocks. It has been observed in this district that when the Tamarind tree flowers profusely a large yield of honey is always obtained. About 20 maunds of wax are exported each year from the Ráyadrug reserve, selling at the low price of R3-12 per maund.

Cuddapah.—Wax is collected by the hill tribes, Chenchus and Yánadís, from the combs of the **Apis dorsata** found in crevices

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of cliffs and on the trunks of trees. Men are lowered from the rocks with lighted torches and collect the combs in baskets. 150 maunds of wax are annually exported from this district, and is chiefly sent to the Madras markets where it sells for R15 to R20 per maund.

Nellore.

The Yánadís and Muthuragus are the expert comb collectors of the Nellore district, and the localities are the Veligondahs (a part of the Eastern Ghâts) and to some extent the island of Srîharikota. When the hives are built on precipitous rocks, a drop made partly of bamboo and partly of *Jurvi* (**Ficus Tsiela**) fibre is let down the cliffs after securing one end of it to a tree or staple. One of the party then descends by the drop, and for his safety a rope is passed under his arms. He carries with him a leather bag, a torch made up of whisks of grass, and a stout stick. On getting in line with the combs he lashes himself to the drop, lights the torch to drive away the bees, and removes the combs, which are handed up to those of the party waiting above the cliffs. Statistics as to the quantity collected are not available, but about 20 maunds or 500 lbs. of wax are annually exported. The price is R3-5-4 per maund which the middlemen sell at the rate of R12 to R16. The bees from this district were thus identified:—

Perai Tenai Egalu	.	**Apis dorsata.**
Thorri Tenai Egalu	.	**A. indica.**
Pulla Tenai Egalu	.	**A. florea.**
Mussan Tenai Egalu	.	**Trigona sp.**

North Arcot.

In North Arcot combs are collected by Irulas or Yánadís all over the hill forests. The combs are reached by means of a ladder made of the *Zidda thiga* creeper suspended from the rock; combs are collected chiefly for their wax which is largely exported to Madras, Vellore and Vaniyambadi. The combs are said to yield ½ viss of wax and 1 viss of honey. The wax is sold for 12 annas a viss locally, and in Madras at R2-8 a viss. (1 Viss = 3·65 lbs. Av.)

Trichinopoly.

Honey and wax are collected in the mountainous and thick jungles of Trichinopoly such as those of Pachamálais, the Marnagapuri, the Kolavur hills, and the Musiri range, where wax is obtained in some abundance. Wax is also one of the principal products of the Pachamálai hills. The combs are collected from large trees, and from species of **Euphorbia.** The Catholic missionaries of Trichinopoly have tried to domesticate certain kinds of indigenous bees, but, as far as can be ascertained, with only indifferent results.

There is a limited industry in honey and wax in Tinnevelly, where hill-men and coolies collect combs near the foot of the hills. There is no means of knowing the extent of supply as the right to collect is leased out to contractors who extract other minor produce

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from the forests. The price of the wax varies from ₹14 to R16 per maund. Madura affords limited supplies of honey and wax from the Saduragi and Varshanad hills.

Coimbatore.

Coimbatore is a large centre of the wax trade in South India as the hills on the north, south, and west are the homes of innumerable bees. In South Coimbatore combs are collected by Irulars, Maduvars, and Kaders in the forests of Tunacadavu, Pollachi, Udamalpet, Metupolyam and Bolampati ranges. The collection of the honey combs is a dangerous occupation. A hill man with a torch in his hand and a number of bamboo tubes suspended from his shoulders descends by means of ropes or creepers to the vicinity of the comb. The sight of the torch drives away the bees, and he proceeds to fill the bamboos with the comb, and then ascends to the top of the rock. 200 maunds of wax are collected annually and sells for R7 per maund.

The hill men on the eastern side of Mangapatti domesticate bees to a small extent. The contrivances to hive them are small mud houses a foot square, or earthen chatties or pots placed mouth downwards with a few holes made in the bottom.

Nilgiris.

In North Coimbatore Sholagars, a wild tribe, collect combs from rocky crevices. These combs are much larger than those found on trees and are supposed to contain twice as much wax in proportion to the honey. Kollegal and Bhavání ranges furnish about 125 maunds of wax a year which is all exported.

On the Nilgiri Hills the aboriginal tribes of Todas, Badagas and Karumbas are adepts at collecting and preparing honey and wax for the market. On these hills the combs of **Apis dorsata** are found at an elevation of 5,000 feet, and these combs are collected by Jain Karumbers and Sholagars. The supply of honey varies according to the nature of the season, and is especially plentiful and of good quality when **Strobilanthes Wightianus, S. Kunthianus** and other species are in flower. These plants clothe the hillsides with blossom in certain places once every few years.

Malabar.

In North Malabar combs are collected by Jain (honey) Karumbers in the Kudracote and Begur reserves. The **Apis dorsata**, building on trees, supplies large quantities of wax and honey. About 170 lbs. of wax are collected annually from the above reserves; it is sold at Marantoddy and taken to Tellicherri and Mysore.

The three bees found in South Malabar are—**A. dorsata, A. indica** and **A. florea**. The combs are collected by a wild tribe called Naikers. Sometimes the combs of the first named bee are so large that one cannot be carried by a single person. They are removed from the rocks by night when there is no moon. A man is let down the rock by a rope or rattan, and with a torch in his hand, he drives away the bees. He then removes the combs which are

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placed in baskets and carried up by another rope. About 25 maunds of wax can be exported from the district annually.

South Kánara.

South Kánara.—The hill tribes gather honey and wax from the rocky spurs of the Western Ghâts. Coondapoor taluk furnishes 40 maunds a year, Udipi 50 maunds, Mangalore 5, Upninangadi 7, and Kásaragod 20.

The quantity of wax exported ten years ago was—

	1891-92.	1892-93.	1893-94.
Cwts.	200	84	75
Rupees	15,922	6,802	6,116

Rupees 5 to R20 a maund are the prices between which it fluctuates in the district.

The following were the prices for bees'-wax in the Madras Presidency in 1894:—

	Per pound. a.	p.
Nallamaláis, Kurnool	1	4
North Arcot	1	8
Nellore	2	2
Waltair, Northern Circle	2	4
South Coimbatore	4	6
South Kánara	3	2 to 12 8
Ganjam	6	0 to 7 0
North Malabar	8	0
Tinnevelly	9	0 to 10 9
Vizagapatam (average)	11	0
South Malabar	12	0
Cuddapah (at Madras)	9	6 to 12 8

Middle men or Chetties purchase wax from the jungle tribes of Arcot, Kurnool and Nellore and resell at twice and three times the price at large towns. The Madras maund is the usual weight by which wax is sold, this is equivalent to the weight of 1,000 tolas or rupees, or 25 pounds. The prices at South Kánara annas 3-2 to 12-8 is equal to R5 to R20 per maund.

Burm

BURMA.—Honey and bees'-wax are collected in Upper and Lower Chindwin, Kátha, Mandalay, Pyinmána, Minbu and Tenasserim. The season for taking the combs and selling the products is from March to May. The Chins at this time of the year are particularly energetic in collecting over the large tract of country at the foot of their hills. The Chins have an interesting custom with regard to the

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gathering of the combs. In some villages each man has a recognised claim to collect over a certain locality; this claim he has inherited from his ancestors, and on his death, the privilege descends to one of his children.

Species of Bee.

The bees of Burma are of four kinds. The *Pya gyi* **(Apis dorsata)** is the largest, about an inch long, blue black on the dorsal surface with yellowish sides. The combs are found on huge forest trees and occasionally in crevices of rocks. The combs sometimes weigh from 25 to 30 viss, or on an average 15 to 20 viss; one of these will yield from 5 to 10 lbs. of honey and 1 to 1½ lbs. of wax.

The *Pya-aung* is a medium-sized bee building chiefly in the hollows of trees.

The *Yin pya* or **Apis florea** is the smallest kind, and builds small combs in bamboos and bushes which yield only ¼ to ½ lb. of wax each.

The *Pya gyi* is the most important, as the honey of the other bees is often tainted and the wax very dark in colour. In the season a party of wax-gatherers consisting of three men, one being an expert climber, proceed to the forests. The bees are stupified or driven off by means of smoking torches, and the hives are then cut off and lowered by ropes to the men below. The smoke of a Burmese cheroot is sufficient to drive off the bees from a small comb. The Karens ascend trees for the purpose of obtaining honey by means of bamboo spikes driven into the wood. When combs are found on the sides of steep cliffs and limestone rocks in the hills, the collector, suspended by a rope-swing, knocks off the whole of the combs with a pole and they fall to the bottom of the hill. Bees are much more plentiful when the **Strobilanthes** (*panthinbin*) is in flower, an event which happens about every six years.

Collection.

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A curious ceremony is performed in the Kabaw valley, Upper Chindwin District, by certain associated villagers when the flowering takes place. The villagers build bamboo hives near their villages, and after having made offerings to their *Nats* (wood demons, Dryads) they, after having themselves gone through a complicated ritual accompanied with songs sung in the Kudu dialect of the Shán language, invite the bees to swarm, the Sháns at the same time make as much noise as possible by striking tortoise-shells with a stick made from a fresh-water cat-fish (dried in the sun till it is like a bone, *Nga-yan*). They then leave the hives, visiting them every now and then to see if bees have swarmed, and going through the rite again on any sign of a swarm. If swarming follows, they eat the resulting honey. This festival coincides with the flowering cycle of the *Moyan*, a species of **Strobilanthes**, shrubs of which genus are known to blossom at regular intervals in hilly regions of Southern India as well as Burma.

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CENTRES OF TRADE.

Burma.

A considerable and expanding trade in bees'-wax is carried on in the Upper Chindwin Division; the duty returns for the two years, 1892-93 and 1893-94, being 1,636¼ viss and 3,541 viss, respectively. These amounts of revenue were paid at Kindat. The honey is of poor quality, and is only used by the Burmans, but the wax collected by the Chins is brought for sale to the Kabaw Valley and to several riverside villages on the upper reaches of the Chindwin up to Kanti.

The trade is in the hands of Burmans and Chinese who pay R1 to R1-8 to the Chins for the wax. The value at Kindat being R2 per viss and the Government duty 12½ per cent. *ad valorem*, so it will be seen that there is a wide margin for profit in wax transactions.

Lower Chindwin.

In Lower Chindwin Maukadaw is the centre of the honey and wax industry. The supply is abundant, and if communications were better in the Mahamyaing Forest, there is no doubt that trade could be greatly developed. The three bees peculiar to this Division are the *Pya-gyi* **(A. dorsata)**, the *Yin-pya*, which makes a comb with a smaller proportion of wax, and the small dammar-bee producing the black substance called Pwe-nyet.

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Some of the largest combs of the **Apis dorsata** yield about 50 viss of wax. The annual outturn of wax is said to be between 2,000 and 3,000 viss.

Eastern Circle.

In the Eastern Circle, Upper Burma, wax is a minor forest product obtained from Bhamo, Kátha, Mandalay and Pyinmána. In 1893-94 the total amount obtained by license was 573 viss valued at R126, an improvement on the previous year which was given as 250 viss valued at R50. These figures do not give the whole of the amount extracted from the forests, as some of the licenses are purchased in kind. For instance in Kátha there were 10 licenses issued in 1892, 28 in 1893, and 22 in 1894, and reckoning 30 viss of wax for each license, a very fair estimate may be obtained of the amount extracted by each license holder.

Western Circle.

In the Western Circle honey and wax are gathered in Upper Chindwin and Minbu; in the former division, in 1893-94, 187 licenses brought in 4,437 viss valued at R935, and in the latter division 5 licenses gave 500 viss valued at R10. The total yield of the Circle for the year returned a considerable increase over that of 1892-93, which was returned at 2,036 viss valued at R460.

The right to collect bees'-wax and honey in the forests in Tenasserim is sold by public auction yearly. The following table gives the amount realized during the five years :—

1888-89.	1889-90.	1890-91.	1891-92.	1892-93.
R	R	R	R	R
1,286	895	545	1,105	1,085

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Burma.

Tenasserim.

The price of bees'-wax in Lower Chindwin, Pyinmana and Katha is R2-8 per viss of 3·65 lbs., or 10·9 annas per lb. This is the rate in the jungle, in the towns it is 50 per cent. higher.

In Tenasserim the price fluctuates from R2 to R5 per viss (8¾ annas to R1-5-11 per lb.) as shown by the market rates in the following townships: Yé R5, Wagaru R2, Zaya R4, Ataran R2-8 to R3, East Salween R2. The markets are not supplied from local collections, but the wax is imported from Moulmein. In 1893-94, 22 cwt. of wax valued at R1,976 was exported from Mergui on the Tenasserim coast.

There are no records of any successful domestication of bees in Burma. The Kachins are said to have domesticated some forms of the wild bee, and in some of the hills experiments were made with the stingless bee (*A. florea?*), but it was found to give so little honey that the trials were abandoned.

EXPORTS FROM INDIA.

The following is the quantity of bees'-wax exported from the whole of India to foreign countries during the past twenty-four years :—

	Cwt.	R
1878-79	3,311	2,66,644
1880-81	6,592	5,45,110
1885-86	5,635	4,11,127
1887-88	5,989	4,61,605
1888-89	4,573	3,45,911
1889-90	4,222	3,05,499
1890-91	6,514	4,73,630
1891-92	5,814	4,47,375
1892-93	4,667	3,68,261
1893-94	5,816	4,90,874
1894-95	7,487	7,05,247
1895-96	5,882	5,64,715
1896-97	3,142	2,76,190
1897-98	3,537	2,80,806
1898-99	4,846	3,89,379
1899-1900	5,787	4,64,172
1900-01	5,059	4,26,917
1901-02	4,139	3,64,179
1902-03	4,481	3,84,753

Exports from	Cwts.
Bengal	3,020
Bombay	762
Madras	427
Burma	230
Sind	42
	4,481

To	Cwts.
Straits	2,062
United Kingdom	1,313
Germany	534
Ceylon	312
France	176
United States	67
Java, Belgium, Mauritius, etc.	17
	4,481

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BEES. — of the Bees'-wax of British India. (*D. Hooper.*)

USES OF WAX.

THE USES OF WAX.

Bees'-wax is known in India under the following vernacular names :—

Mém, HIND., BENG., DEC., PERS.; *Sinth*, KASH.; *Mena*, MAR., KAN.; *Min*, GUZ.; *Moshukkin, méllugé*, TAM.; *Mainam, minum*, TEL.; *Meshuka, lelin*, MALAY.; *Phayonè*, BURM.; *Madhujam, sikthá*, SANS.; *Shamʿ*, ARAB.; *Itti*, CINGH.

Compared with the amount exported wax has only a limited use in the country, but for many years it has regularly been employed in minor industries. Tavernier in his "Travels," Vol. II., p. 413, says: "Wax is cheap throughout India and is easily bleached, every religious house always has a large supply of wax tapers on account of the festivals when numbers are lighted before the grand altar and in all the chapels. Even the least of the Dutch sailors had 30 or 40 of the tapers for his share, and some of them had some as thick as the thigh."

A considerable amount of wax from the Western Coast is sent to Goa annually to be made into candles for burning in the churches during religious services, and in Burma thousands of wax candles illuminate the pagodas during Buddhist ceremonies.

In the Central Provinces it is used by Chipas for stamping patterns on cloth. And in Burma it makes wax-resist patterns for dyeing silk. In North Arcot it enters into the preparation of wax cloth.

The Kasarars and Lonars (metal-workers) use wax for making impressions and moulds of images and for other purposes.

Wax is one of the ingredients for preparing artificial flowers.

In medicine white and yellow wax enter largely into the manufacture of ointments and plasters. Under the name of Cera flava (yellow wax) and Cera alba (white wax) it is official in all the Pharmacopœias.

CHEMICAL EXAMINATION.

CHEMICAL EXAMINATION OF THE WAX.

Bees'-wax is chiefly a mixture of cerotic acid and myricin or myricyl palmitate. In smaller quantities there occur also melissic acid in the free state, and myricyl alcohol and ceryl alcohol. Small quantities of unsaturated fatty acid and hydrocarbons have also been found. Schwalb has isolated two hydrocarbons, heptocosane melting at 60·5 and hentriacontane melting at 67°C.

The ratio of free acid, regarded as cerotic acid, and myricin, has been found by Hubl and Hehner in a number of well-agreeing experiments as 14 : 86.

Bees'-wax is almost insoluble in cold alcohol, but boiling alcohol dissolves from it the bulk of cerotic acid and a small quantity of

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CHEMICAL EXAMINATION.

myricin. An alcoholic solution is acid in reaction. On cooling a hot alcoholic solution of wax cerotic acid separates out in the form of thin needles so completely that the solution does not become turbid on mixing with water, a slight opalescence only appearing.

Warm ether dissolves bees'-wax with facility; chloroform dissolves it in the cold, leaving behind any impurities.

Bees'-wax is frequently adulterated in the European markets. The usual adulterants are water, mineral matters (yellow ochre, gypsum, etc.), flour and starch, tallow, stearic acid, Japan wax, carnauba wax, resin, paraffin wax or cerasin. The mineral and vegetable structures may be detected with the microscope or some simple methods, but the identification of foreign fats and waxes requires a more intimate acquaintance with the chemical character and constituents of the wax.

The constants of European bees'-wax as given by Lewkowitsch in "Chemical Analysis of Oils, Fats and Waxes" are arranged below:—

		Mean.
Melting point	61·5°— 65°	63·2°
Acid value	16·8 — 21·2	19
Ether value	71·8 — 76·1	73·9
Saponification value	87·8 —107·0	97·4
Iodine value	7·9 — 11	9·4

These numbers apply to the wax secreted by bees of different species, such, for instance, as that of **Apis mellifica**, *Linn.*, and **A. ligustica**, *Spinola*, showing the practical identity of samples from different zoological sources. In testing samples from different countries, provided they are genuine and unadulterated, the results accord substantially with the above figures.

Adulterants.

In order to compare the numbers or constants with those of other materials used for adulterating bees'-wax the following table is appended:—

	Melting point.	Acid value.	Ether value.	Saponification value.
Japan wax	54°	20	200	220
Carnauba wax	84°	4	75	79
Chinese wax	81°	trace	63	63
Tallow	45°	4	176	180
Stearic acid	71°	195	...	195
Rosin	100°	140	20	160
Paraffin or Cerasin	44—61°	...	...	...
Pure wax	63°	20	75	95

CHEMICAL EXAMINATION.

According to this table the lowering of the acid and saponification values of a sample would indicate the presence of paraffin wax, and a higher value than the normal would show possible adulteration with stearic acid, tallow or Japan wax. Mixtures, however, may be made of these materials which resemble bees'-wax in so many particulars that it would be difficult to detect the sophistication by ordinary methods of analysis.

Regarding the bees'-wax of Indian origin it does not appear that authentic samples have been subjected to any systematic examination, although it readily finds markets in different parts of the world and realises fair prices when carefully refined. In a paper by G. Buchner on "The Analysis of Bees'-wax" abstracted in the *Journ. Soc. Chem. Industry*, 1901, a short notice is given of a particular kind of Indian wax. Under the name of "Ghedda wax" the author states:—

Ghedda Wax.

"This is a very plastic, aromatic wax derived from British India. It gives very abnormal figures, and the author has frequently met with a sample giving results such as—Acid value 5·33, Ether value 88·35, and Saponification value 93·68."

With the object of making a fuller enquiry into the subject and to test the relative values of a series of waxes from different parts of India the samples in the Indian Museum were examined. These specimens had been sent in answer to the circular letter sent by the Reporter on Economic Products, and a large number of the waxes had been prepared from the combs of bees which were entomologically identified. In the accompanying list is set forth the registration number, locality of collection, appearance of the sample and, when possible, the origin of the wax.

List of samples.

Reg. No.	District.	Origin of wax.	Colour of wax.
280	Panjáb	.....	Dirty white.
284	Madras	.....	Clean white.
285	,,	.....	Whitish.
286	Poona, Bombay	.....	Dirty white.
287	Birbhum, Bengal	.....	White.
308	Simla, Panjab	.....	Light yellow.
309	Jessore, Bengal	.....	Brownish, dirty.
310	Burma	.....	Dirty white.
318	Poona, Bombay	.....	Ditto.
327	Madras	.....	Light brown.
328	,,	.....	Light brown, dirty.
339	Birbhum, Bengal	.....	Dirty white.
1459	Andaman Islands	.....	Black.
4608	Ráipur, Central Provinces	Apis dorsata	Dull white.
4610	,, ,, ,,	,, florea	Brownish, dirty.

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CHEMICAL EXAMINATION. List of samples.	Reg. No.	District.	Origin of wax.	Colour of wax.
	4614	Ráipur, Central Provinces	Trigona sp.	Black.
	4616	Nagpur, " "	Apis florea	Ditto.
	4624	Nimár, " "	" "	Ditto.
	4630	Cuddapah, Madras	" dorsata	Yellowish white.
	4743	Godhra, Bombay	.....	Light brown.
	4744	Panch Mahals, Bombay	Apis florea	Dirty white.
	4745	Jhalad Taluq, Bombay	" "	Whitish.
	4755	Sundarbans, Bengal	Apis dorsata	Dirty white.
	4756	" "	" "	Whitish.
	4760	Damoh, Central Provinces	" indica	Dull white.
	4761	" " "	*Kóte* (Trigona)	Black.
	4762	Jabalpur, Central Provinces	.....	Whitish.
	4765	Nilgiris, Madras	Apis indica	Light brown.
	4785	S. Coimbatore, Madras	" dorsata (pure)	White clean.
	4803	Chaibassa, Bengal	" dorsata	Very impure.
	4832	Dhárwár, Bombay	" florea	Dull, whitish.
	4874	Sirsi, Kánara, Bombay	Trigona sp.	Brownish black.
	4912	Dehra Dun, United Provinces	Apis dorsata	Dull white.
	4916	" " "	" "	Dirty white.
	4963	South Malabar, Madras	" "	Light yellow brown.
	4968	North " "	" "	Light brown.
	5031 and 5035	Nellore, " "	" indica	Dull white.
	5047	Sambalpur, Central Provinces	" dorsata	Whitish.
	5049	" " "	Trigona sp.	Black.
	5051	Chhindwára, Central Provinces	Apis dorsata	Light brown.
	5053	" " "	" florea	Black.
	5137	Trichinopoly, Madras	.....	Dull white.
	5199	Bashahr, Panjáb	.....	Light brown.
	5613	South Kánara, Madras	Apis florea	Brown.
	5616	Coondapore, "	Trigona sp.	Black.
	5617	South Kánara, "	Thodijiga bees	Light brown.
	5720	East Khándesh, Bombay	Apis dorsata	Brownish.
	5726	" " "	Trigona sp.	Light yellowish brown.
	5746	Hazára, Panjáb	Apis dorsata	Brown.
	5760	Coimbatore, Madras	" "	White clean.
	5768	" "	Koorbuthan bees	Yellow brown.
	5774	" "	Apis indica	Very light brown.
	5777	" "	" dorsata	Dull white.
	5780	Madras	" "	Yellowish white.
	6009	Mussoorie, United Provinces	" sp. (Autumn.)	Dull white.

B. 392-415.

of the Bees'-wax of British India. (*D. Hooper.*)

Reg. No.	District.	Origin of wax.	Colour of wax.
6138	Gurdáspur, Panjáb	Apis dorsata	Light brown dirty.
6141	" "	" indica	Brownish.
6241	Dehra Dun, United Provinces	" dorsata	Soapy colour.
6244	" " "	" indica	Yellowish.
6308	Sooligarh, Central Provinces	" dorsata	Dirty white.
6529	Rawalpindi, Panjab	" indica	White.
6653	Almora	" dorsata	Dirty white.
17949	Sundarbans, Bengal	Refined	Ditto.
21061	Saháranpur, United Provinces	Apis dorsata	Yellowish.
21062	" " "	Refined	White.

In the following tables the results of the examinations are classified according to the origin of the specimens. Figures are given for the melting point, acid value, saponification value, ether value and iodine value.

Melting point.—This was taken by means of a glass capillary tube suspended in water by the side of a Centigrade thermometer. The temperature was read off immediately the melting wax rose in the tube.

Acid value.—This was determined by heating the wax in boiling alcohol and noting the amount of alcoholic potash required to neutralise the free acids, using phenol-phthalein as an indicator.

Saponification value.—The amount of caustic potash (K H O) required to saponify a weighed quantity of the wax, after boiling for three hours in an inverted condensor.

Ether value.—This figure is arrived at by subtracting the acid value from the saponification value.

Iodine value.—Hübl's method of estimation by means of an alcoholic solution of iodine and mercuric chloride was employed. The iodine solution was allowed to act for 12 hours.

The Specific Gravity was only determined in a few selected samples. While English bees'-wax had a density of 0·960, three samples of Indian wax varied between 0·953 and 0·964. The **Trigona** wax like that of the adulterated samples had a higher gravity, *viz.*, 0·980 to 1·000, and therefore scarcely floated in water.

When much dirt was present the sample was dissolved in chloroform to remove impurities, and the analysis was conducted on the clarified portion.

B. 392-415.

Analyses of Bees'-wax.

Reg. No.	Melting point.	Acid value.	Ether value.	Saponification value.	Iodine value.	Remarks.
			Bees'-wax samples (origin not stated).			
280	66°	7·4	87·8	95·2	8·2	
284	61·5°	10·2	87·8	98·0	6·5	
285	62·2°	8·8	87·2	96·0	5·1	
286	66°	10·8	87·8	98·6	4·9	
287	62·2°0	11·5	83·0	94·5	4·5	
309	68°	11·1	80·4	91·5	7·2	
310	68°	13·2	74·8	88·0	2·3	
318	63·5°	8·3	84·7	93·0	4·0	
327	62°	7·2	84·3	91·5	6·6	
328	62·5°	7·2	80·8	88·0	4·5	
4339	62°	8·3	93·7	102·0	5·1	
4743	63°	8·1	89·4	97·5	7·1	
4745	63°	7·3	85·2	92·5	5·9	
4762	61·5°	7·4	97·6	105·0	5·7	
5137	61·5°	7·3	92·7	100·0	5·7	
5199	66·5°	5·2	80·2	85·4	10·7	
5617	65°	9·5	136·1	145·6	5·9	
5726	62°	10·4	87·5	97·9	8·8	
5768	64°	5·8	92·8	98·0	8·5	
6009	69°	6·1	83·9	90·0	9·7	
Average	63·9°	8·5	88·9	97·4	6·3	
Maximum	69°	13·2	136·1	145·6	10·7	
Minimum	61·5°	5·2	74·8	85·4	2·3	
			Apis florea.			
4610	63·2°	6·1	85·9	92·0	9·0	
4744	64°	7·7	80·8	88·5	11·4	
4832	68°	6·7	123·8	130·5	7·7	7·9 per cent. insoluble.
5053	63°	8·4	84·0	92·4	6·0	3·6 per cent. insoluble.
5613	63°	8·9	103·7	112·6	6·0	Impure.
Average	64·2°	7·5	95·6	103·2	8·0	
Maximum	68°	8·9	123·8	130·5	11·4	
Minimum	63°	6·1	80·8	88·5	6·6	

Analysis of samples of Bees'-wax.

Reg. No.	Melting point.	Acid value.	Ether value.	Saponification value.	Iodine value.	Remarks.
			Apis dorsata.			
4608	62°	7·2	97·8	105·0	5·2	
4630	62°	9·1	80·9	90·0	6·2	
4755	63°	10·2	87·3	97·5	4·8	
4756	64°	7·3	87·7	95·0	5·0	
4785	62·5°	4·4	90·7	95·1	5·2	
4803	61°					Very impure.
4912	67°	7·7	84·3	92·0	7·8	
4916	63°	6·6	91·0	97·7	8·3	
4963	63°	6·6	93·4	100·0	6·9	
4968	62·5°	7·4	97·5	104·9	6·7	
5047	62°	7·2	90·4	97·6	6·1	
5051	60°	5·9	91·7	97·6	6·9	
5720	66·5°	6·1	69·5	75·6	9·0	4·5 per cent. insoluble
5746	66·5°	8·2	91·8	100·0	9·9	10·5 per cent. insoluble.
5766	64°	5·2	95·6	100·8	5·7	
5777	61·5°	5·9	89·3	95·2	5·9	
5780	62·5°	7·3	90·7	98·0	5·3	
6138	62°	7·4	92·8	100·2	7·6	7·5 per cent. insoluble.
6241	61°	8·3	81·7	90·0	9·0	
6308	64°	6·6	94·2	100·8	5·9	
6653	62°	6·1	85·1	91·2	7·3	
21061	63°	5·8	86·6	92·4	8·0	
17946	61°	8·1	92·7	100·8	5·2	
Average	63·1°	7·0	89·4	96·2	6·7	
Maximum	67°	10·2	97·8	105·0	9·9	
Minimum	60°	4·4	69·5	75·6	4·8	
			Apis indica.			
4760	62°	6·6	95·9	102·5	6·9	
4765	64°	5·8	94·2	100·0	5·3	
5031 / 5035	63°	7·3	85·4	92·7	9·2	
5774	63°	7·3	93·0	100·3	5·7	
6141	63·5°	5·0	85·0	90·0	8·5	
6244	64°	8·8	84·0	92·8	8·9	
Average	63·25°	6·8	89·6	96·2	7·4	
Maximum	64°	8·8	95·9	102·5	9·2	
Minimum	62°	5·0	84·0	90·0	5·3	

BEES.

An Account of the Sources, Preparation, Trade and Composition

CHEMICAL EXAMINATION.

ANALYSES.

Analyses of Bees'-wax.

	Reg. No.	Melting point.	Acid value.	Ether value.	Saponification value.	Iodine value.	Remarks.
Trigona sp.				**Trigona sp.**			
	1459	72°	18·5	55·2	73·7	47·6	
	4614	68°	20·9	94·9	115·8	48·3	3·1 per cent. insoluble.
	4616	76°	21·7	128·3	150·0	30·2	
	4624	70°	22·9	56·9	79·8	42·9	6·3 per cent. insoluble.
	4761	69°	20·8	74·4	95·2	48·0	
	4874	72°	22·8	100·2	123·0	49·6	22·6 per cent. insoluble.
	5049	66°	22·7	123·9	145·7	48·2	
	5616	71·5°	16·1	84·0	100·1	39·1	4·5 per cent. insoluble.
	Average	70·5°	20·8	89·6	110·4	42·2	
	Maximum	76°	22·9	128·3	150·0	49·6	
	Minimum	66°	16·1	55·2	73·7	30·2	
Adulterated Wax.				*Adulterated Wax.*			
	308	44°	42·3	143·5	185·8	5·7	
	6529	43°	36·6	162·9	199·5	3·8	
	21062	44°	27·7	165·6	193·3	7·1	
English Wax.				*English Bees'-wax.*			
		65°	20·15	77·05	97·20	9·99	

In studying these tables of analyses two very interesting facts will be revealed. The first is the lower acid value of Indian bees'-wax; this indicates a different ratio between the cerotic acid and myricitin compared with that of waxes from other parts of the world, and the second is the uniformity in composition of the secretion of the three kinds of Indian bees representing the **Apis** family. The appearance of the wax from the three species gives no clue to the origin, and although there are two or three somewhat abnormal deviations from the average on account of the high saponification value and the wide range of the iodine value, there is very little, if any, suspicion of adulteration. The wax from the combs of **Apis dorsata, A. indica** and **A. florea** is, therefore,

BEES.

CHEMICAL EXAMINATION.

practically identical in composition, and a combination of the wax of one species with that of another cannot be regarded as a fraudulent admixture. It must be admitted, however, that the **Apis dorsata,** because of the much larger comb it manufactures, is the chief source of the bees'-wax of the country.

Trigona Wax.

The wax of the **Trigonæ** has quite a different character and composition compared with that of the true bees. The blackish colour, sticky consistence, and higher melting point, acid and iodine values readily distinguish it. These features at once separate it from ordinary bees'-wax, although, according to some of the forest collectors, the origin of wax of this nature was attributed to **A. florea.** From descriptions of the Propolis or resinous wax used in the hives of domesticated bees it would seem that the secretion of species of **Trigona** is very similar. An analysis of this material by **Greshoff** and **Sach** (*Pharm. Weekblad.* 47,933), however, showed that it consists of a mixture of 84 parts of resin, 12 parts of wax with 4 parts of an impurity insoluble in alcohol. The resin melted at 60° and the wax at 66°.

Propolis.

As before mentioned, the honey of the comb has a peculiar flavour and is valued by some tribes for its medicinal properties.

Among these specimens were three purchased in the bazars of Simla, Rawalpindi and Saháranpur which were decidedly adulterated or were foreign substitutions. They were called "refined wax" and differed in appearance from ordinary white wax in resembling white bar soap. In some respects it had a great resemblance to Japan wax. The specific gravity was high and the melting point much lower than bees'-wax, and on ascertaining the acid and saponification values it was found that the figures were double those of genuine wax. On applying **Fehling's** test, as recommended by **Röttger,** a precipitate resembling stearic acid separated from the diluted solution. Enquiries as to the origin of the refined wax from Saháranpur resulted in tracing it to Bombay where it was probably imported from Europe.

Adulteration.

It is satisfactory to record that out of 64 samples collected from different parts of India only 3 were really adulterated, or less than 5 per cent. of the total, and there is no evidence that the sophisticated wax was a native product or was manufactured in the country.

From the above review of the existing information we may draw the following conclusions:—

Conclusions.

1. Indian bees'-wax is derived from three species of bees: **Apis dorsata, A. indica and A. florea,** but chiefly from **A. dorsata.**
2. The wax separated from the combs of the three species of bee are substantially identical in composition, and is rarely mixed for fraudulent purposes.

CHEMICAL EXAMINATION. Conclusions.

3. Indian bees'-wax differs analytically from that of Europe chiefly in its lower acid value.
4. Indian bees'-wax is procurable in large quantities, and the trade, which has remained almost stationary for the past twenty years, is capable of great expansion.

With regard to the last conclusion it may be said that much attention has been given of late to the subject of apiculture in the West Indies with very successful results. During the ten years from 1888 to 1898 the value of bees'-wax exported has increased from £4,823 to £10,389. Some share of this increase is no doubt due to the intelligent action of the Jamaica Agricultural Society in employing experts to make periodical visits to the country districts and to encouraging a better system of caring for the bees and recovering honey and wax. Another feature of success is the high class quality of the wax sent to the London market and the consequently good prices realized.

In India the industry is in the hands of almost wild tribes and the wax is refined by very primitive methods without any special regard to appearances. There is therefore in this country vast opportunities of improvement. The sources of supply might be visited and a study made of better methods for *collecting* the combs and preparing the wax for the market by more economical processes. Spasmodic attempts have been made in different districts to domesticate the bees, but no really satisfactory results can be shown. A closer acquaintance with the habits of the wild bees and the flowers they frequent is urgently required, and an earnest enterprise in this direction is almost sure to meet with success.

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AGENTS.

IN BRITAIN.

Messrs.	Messrs.
E. A. Arnold, 37, Bedford Street, Strand, London, W. C.	Kegan Paul, Trench, Trübner & Co., Charing Cross Road, London, W. C.
Constable & Co., 2, Whitehall Gardens, London, S. W.	Bernard Quaritch, 15, Piccadilly, London, E.
P. S. King and Son, 2 & 4, Great Smith Street, London, Westminster, S. W.	Williams and Norgate, Oxford.
	Deighton Bell & Co., Cambridge.

ON THE CONTINENT.

Messrs.	Messrs.
R. Friedländer & Sohn, Carlstrasse 11, Berlin, N. W.	Karl W. Hiersemann, Leipzig.
Otto Harrassowitz, Leipzig.	Ernest Leroux, 28, Rue Bonaparte, Paris.
	Martinus Nijhoff, The Hague.

IN INDIA.

Messrs.	Messrs.
Thacker, Spink & Co., Calcutta and Simla.	Superintendent, American Baptist Mission Press, Rangoon.
Newman & Co., Calcutta.	Rai Sahib M. Gulab Singh & Sons, Mufid-i-Am Press, Lahore.
R. Cambray & Co., Calcutta.	A. J. Combridge & Co., Bombay.
S. K. Lahiri & Co., Calcutta.	Radhabai Atmaram Sagoon, Bombay.
Thacker & Co., Ld., Bombay.	D. B. Taraporevala Sons & Co., Bombay.
V. Kalyanarama Aiyar & Co., Madras.	
Higginbothan & Co., Madras.	

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MARSDENIA TENACISSIMA.

(RÁJMAHÁL HEMP.)

[*Dictionary of Economic Products, Vol. V.*, M, 299-301.]

PAPERS RELATING TO FIBRE OF **Marsdenia tenacissima**.

i. *Report upon the Fibre by* PROFESSOR WYNDHAM R. DUNSTAN, F.R.S., *Director Imperial Institute, London.*

ii. *A note upon the use of* Marsdenia *in the Rájmahál Hills, by* I. H. BURKILL, *Officiating Reporter on Economic Products to the Government of India.*

PROFESSOR DUNSTAN'S REPORT.

A report upon the Fibre of Marsdenia tenacissima *by* PROFESSOR WYNDHAM R. DUNSTAN.

A sample of the fibre of **Marsdenia tenacissima**, shown at the Colonial and Indian Exhibition of 1886, was examined by Messrs. Cross and Bevan, who reported that it was of excellent quality, and that in point of fineness and durability it ranked next to Rhea fibre (*Report on Indian Fibres*, page 33).

History of enquiry.

Since it appeared desirable to investigate more fully the properties and possible applications of this fibre, the Imperial Institute requested the Reporter on Economic Products (F. S. No. 28) to procure a sample for this purpose. Considerable difficulty was experienced in India in collecting an authentic specimen of the fibre, but a sample (Reg. No. 16080) was eventually forwarded and is described in a letter from the Officiating Reporter on Economic Products, dated the 15th May 1902, (1046—94 F. S.). It is stated that the plant is fairly abundant in the Rájmahál Hills, but that the process of extracting the fibre is both tedious and laborious, being mainly carried on by hand-stripping.

PROFESSOR DUNSTAN'S REPORT.

The sample consisted of a very strong, fairly white fibre with a staple of an average length of 12-13 inches. The results of its chemical examination in the Scientific and Technical Department of the Imperial Institute are given below, and those of Messrs. Cross and Bevan, obtained from the former sample.

Analyses compared.

	Sample 16080.	Cross and Bevan.
	Per cent.	Per cent.
Moisture	7·7	4·5
Ash	1·5	1·5
a—Hydrolysis loss	7·8	6·2
b— Ditto "	8·9	10·1
Mercerising "	4·9	4·6
Acid purification "	3·5	0·8
Nitration gain	53·9	31·0
Cellulose	91·5	88·3
Length of ultimate fibre	10—30 mm.	5—20 mm.

The fibre contains little or no lignocellulose; this is shown especially by the absence of colour in the nitration product and by the fact that when the chlorinated product, obtained in the course of the estimation of cellulose, is treated with sodium sulphite no red coloration is produced. It is exceptionally resistant to the action of alkali as is indicated by the comparatively small losses sustained on hydrolysis and mercerising. The remarkable quality of this fibre is shown also by the unusually high percentage of cellulose and by the large increase of weight on nitration.

The present specimen is seen to be of better quality than that examined by Messrs. Cross and Bevan; it is richer in cellulose and shows a much larger increase of weight on nitration, whilst the average length of the ultimate fibre is also somewhat greater.

Representative specimens of this fibre have been submitted to two leading firms of fibre brokers for commercial valuation. One firm reports that the fibre, although short, is of great strength and therefore likely to be of value. It is suggested that sample bales should be sent for trial. The other firm reports that the fibre is very strong but harsh. It is too short for machine spinning and consequently could only be utilised as tow. The sample is said to be worth from £15 to £18 per ton (of a length of 12-15 inches); if, however, the fibre could be sent of a length of 30-50 inches, its value would probably be from £35 to £40 per ton.

Valuation in London market.

From the foregoing report, it is seen that the fibre is one which might be of importance, whilst the chemical examination shows that it possesses properties which are considerably above the average of those of ordinary fibres. The question arises, therefore, whether

experiments in cultivating the plant should be undertaken as it is understood to be of comparatively rare occurrence in India, and also whether the fibre could be successfully treated by machinery.

POSSIBILITY OF USE IN EUROPE.

MARSDENIA IN THE RÁJMAHÁL HILLS. Introductory.

A note upon the use of Marsdenia *in the Rájmahál hills by* I. H. Burkill.

Sir Frederick Abel, the late Director of the Imperial Institute, having been interested by the article on **Marsdenia** in the Dictionary of Economic Product, in 1894, asked that samples of the fibre might be collected for chemical examination. The fibre was collected, and the result of that proposed examination is now before the reader in the report by Professor Dunstan, printed above. The fibre was collected in the Rájmahál hills, Bengal, by the late Deputy Conservator of Forests, Santál Parganas, H. D. D. French, Esq., who spared himself no pains in the search for the right stuff. It is melancholy to think that I had written to him, requesting that he would write this note, on the very day of his death. Nothing new has been published regarding **Marsdenia tenacissima** since 1891, when the article on it in the *Dictionary of Economic Products* appeared: and much of the information which I have briefly to give here, was collected by Mr. French.

VERNACULAR NAME.

When Sir Frederick Abel opened the enquiry we did not possess the vernacular name by which the Santáls of the Rájmahál hills know it. Royle had called it the *Jiti* fibre. Enquiry was therefore made for *Jiti*, and for *Chiti*—a name used about Palamau and referred to **Marsdenia tenacissima**, but Mr. French did not find the names to be known. He, however, discovered that another fibre plant, *viz.*, **Spatholobus Roxburghii** passes under the not altogether dissimilar name of *Chunti* in the Paharia Sooria dialect. This plant is in Santáli the *Chihut*, and its fibre, when extracted, is called by the Paharias *Orre*.

Distinctive names of Spatholobus Roxburghii.

When the vernacular name had failed Mr. French sought for the plant wanted by its descriptions, and he was successful so that in May 1900, he reported that the Santáli name of the **Marsdenia** is *Konat* and the Mal Paharia name is *Kona* (this "n" being sounded like n in the French word "bon"). He added that "The Santáls use it as follows—for fish-lines, for fixing feathers and arrow heads to their arrows, sometimes for bow-strings, and for ornamental arm-tassels dyed black with the fruit of **Terminalia Chebula**. The Paharias use it for stringing their bead neck-laces, for fishing-lines, bow-strings, etc. In this locality (within twenty miles of Dumka), it is not as far as I am able to ascertain, brought to the bazaars for sale."

FIBRE NOW EMPLOYED BY SANTÁLS AND PAHARIAS OF THE RÁJMAHÁL HILLS.

About the beginning of May the plant comes into new leaf, it flowers in September-October. After the rains is the time when the

USES.

PREPARATION OF FIBRE.

Stem cut into short lengths.

Reason for so doing.

fibre is prepared. The method of preparing the fibre has been described in the Dictionary of Economic Products. To this description I find a little to add in regard to the practice of cutting the stems into short sections before peeling it and scraping the bark with the thumb nail. What I have to say explains the methods of the Santális as reasonable.

If an attempt be made to strip by hand from the stem a ribband containing the fibre, the ribband will be found to break at each node. The length of the fibre thus becomes limited by the length of the internodes and they run ordinary to about 15-20 inches in length. The breakage is due to two causes:—primarily to the greater depth in the cortex at which the fibres lie as they pass the node and to some formation of cork above them under the scars of the leaves when they have fallen, and of the stipules also, and secondarily to the ramification at the nodes of the fibres themselves.

The fibres are little round strands of some 50-80 bast cells whose lumen is nearly filled up. They are not added to in the growth of the plant so that they are no larger in a 3-year old stem than in a 1-year old stem. Throughout the internodes the strands are perfectly parallel, but at the node two or three may draw together unite and divide up again.

As the fibres are not added to in growth, those from a first year shoot are, we may believe, as good as those from a third year shoot.

It is possible to get out the fibres without breaking them at the node by cutting or by scraping the firmer cortex from above them at the nodes, as I have proved by experiment on stems kindly obtained for me by Mr. J. S. Baker, Officiating Deputy Conservator of Forests, Santál Parganas, but a weak spot remains. The practice of the Santáls therefore seems reasonable.

COST OF FIBRE REPORTED TO BE EXCESSIVE.

The cost of preparing the fibres was found by Mr. French to be excessive.

In June, 1902, Mr. French sent to me fishing-lines, bow-strings and amulets made of this fibre. They may be seen in the Economic Gallery of the Indian Museum. He also sent at the same time the fibre reported on by Professor Dunstan.

Most of the fibre sent was made from lengths of stem about 10 inches long, but bow-strings are made of lengths of the stem nearly three feet long picked out in the forest with great care.

USES, thread utilised for bead chains.

The bead chains are made on thread which is very thin, corresponding to No. 40 (Kerr & Co. N. M. T. extra six cord) of the cotton thread scale of European manufactures. And an amulet is made of twisted thread of the same thickness. The fishing-line is well made, but coarse for the purpose.

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ALTINGIA EXCELSA.

(BURMESE STORAX.)

[*Dictionary of Economic Products, Vol. I. A.*, 892-96.]

Other DICTIONARY articles that may be consulted:

Liquidambar orientalis, Vol. V., L. 455-58.

The PROPERTIES of *Nan-ta-yok* or BURMESE STORAX.

By David Hooper, F.C.S.

INTRODUCTION.

The fragrant balsam, known as Nan-ta-yōk and used in Burma in ancient times as an incense and for medicinal purposes, has recently been enquired into by the Reporter on Economic Products, and specimens deposited in the Indian Museum. When this material became available, the Reporter put the information of his gathering into my hands for the purpose of a report. The tree yielding the balsam grows in Burma and Assam, and it seems desirable to extract the secretion and endeavour to introduce it into commerce as a substitute for the valuable storax of Asia Minor which is regularly imported into Bombay, and employed, principally as a perfume, in India, Malaya and China. It grows also in Java and yields there the balsam as in Burma, and its composition and properties have been recently investigated. The information to hand is here brought into one view with that to be found in the article by Sir George Watt in his *Dictionary of the Economic Products of India*.

ALTINGIA excelsa.

The Properties of Nan-ta-yok

BURMESE STORAX.

Altingia excelsa, *Noronha*; *Fl. Br. Ind.*, *II.*, *429*; *Ind. Kew.*, *I.*, *96*; HAMAMELIDACEÆ.

Syn.—LIQUIDAMBAR ALTINGIA, *Blume*; SEDGWICKIA CERASIFOLIA, *Griff.*

Vern.—*Jutili*, ASSAM; *Nan-ta-yok*, *nan-ta-yu*, BURM.; *Rasa mála*, MALAY.

The tree was named by C. Noronha, a Spanish botanist and traveller, in honour of A. W. Alting, Governor of the Dutch Indies.

Habitat.

Habitat.—A magnificent tree of the tropical evergreen forests of the Indian Archipelago, Burma, Assam and Bhutan; abundant in the Tenasserim province of Burma. In South Tenasserim it is scattered over the division in fairly large quantities, especially in the Kaleinoung and Heinze reserves, on the Kaullaing and Nanpayok *choungs* (or streams) as well as in the Palaw and Tenasserim townships. The Nanpayok is a considerable stream in the province of Mergui which Dr. Mason states derives its name from this tree in consequence of its growing so thickly on its banks. Kurz states that it occurs also in the Kachin (Khakyen) Hills.

Burma.

Assam.

It, known as *Jutili*, is one of the principal timber trees in Upper Assam, and is taller than the **Mesua ferrea** with which it is often associated. It is very abundant on the plains near Muttock and occurs on the Mishmi Hills. Griffith who named the tree **Sedgwickia cerasifolia** (*in Asiatic Researches*, Vol. XIX, 1836, 99) found it growing between Debrumukh and Rangagurrah. He describes it as "A lofty and aromatic tree", and says that its light greyish bark holds or exudes sparingly a gum-resin with an odour of pepper.* The exudation has not been collected in Assam, and it has not been observed by recent explorers.

Distribution.

The tree is one of the most important timber trees of Java, growing in the western part of the Island. According to Miquel it is found in the mountainous regions of the Sunda Archipelago, New Guinea, Cochin China, and in Yunnan in China.

It is a leaf-shedding tree and reaches 150 to 180 feet in height, with a clean stem of 80 to 100 feet, and a girth of 15 to 20 feet. The wood is very hard, close-grained, with a somewhat balsamic odour. It is said that from the fruits and from the knots of the stem, a softish resin collects which burns freely and emits a strong odour of Gum Benjamin or Benzoin.

Balsamic Resin.

Balsamic Resin.— This tree is of interest because of its being the source of a resin similar to Storax or Styrax of European Commerce. Storax is obtained from a tree of the same Natural Order named

* "Gummi-resinam piperaceo-aromaticam parcam continente vel effœta."

ALTINGIA excelsa.

or Burmese Storax. (*D. Hooper.*)

BALSAMIC RESIN.

Liquidambar orientalis, *Miller*, growing in Asia Minor. Storax is imported into Bombay from the Red Sea ports and is used in medicine by Muhammadans and Hindus; it is also said to have been carried into China by Arab traders since the Ming Dynasty, A. D. 1368-1628. Three kinds of resin are described in Arabic and Persian works, *viz.*,—1st, that which exudes naturally; 2nd, that which is obtained by pressing the bark; and 3rd, that which is obtained by boiling it. The bark of the tree is fragrant and is supposed to be the drug which was formerly known by the name of **Cortex Thymiamatis**.

American Storax.

Another styrax-yielding tree is the **Liquidambar styraciflua**, *Linn.*, the Sweet Gum tree of North America. The balsam obtained from this species has a similar composition to that of the official storax, and has been gathered to a considerable extent in the United States for the preparation of chewing gum.

Rasamala of Java.

The resin of **Altingia excelsa** is the *Rasamala* of the Javanese and Malays, and this name is supposed by some to be the origin of *Rosa Mallas* and *Rosa Malœs*, the names for Storax occurring in the statistics of the early European traders. Dr. Dymock, however, considered this supposition to be incorrect as the only Rosa Malœs known in Bombay is that imported from Europe, and the Burmese Storax seems to be quite unknown in India. Moreover, the name would appear to be of European origin and has been applied to Liquid Storax incorrectly through the confusion of that substance with Honey dew or Manna collected from trees, the *Drosomeli* of the Greeks and the *Ros melleus* of the middle ages. We have on the one hand the evidence that Rosa Mallas was an alias of Liquid Styrax of the Levant in 1708 when Mr. Petiver read a note on the subject before the Royal Society of London, and on the other hand Rasamala has for over three centuries been used in the Straits. Whether these are corruptions of the same term applied to a different substance, are points not yet decided. The author of the Makhzan says:—Rasimilius is a Greek name for a kind of incense called in Arabic *Dukhán-el-dam*, and in Hindi *Ast loban* or Western Frankincense. Storax is imported into Bombay to the extent of three or four cwt. every year and is valued at about Rs. 44 per cwt. The usual trade name is *Silaras*. Its chief uses are as an incense and as a stimulant expectorant like the Balsam of Peru, Tolu and Benzoin.

Drosomeli.

urmese Storax.

Burmese Storax is at present little known and our knowledge of its preparation and uses is very scanty. Tradition says that in former times when the Burmese court resided at Pagan or Ava, and before English perfumes were introduced into the Burmese markets, a regular trade was carried on in "Nanpayok Oil," and it was used both medicinally and as a perfume. Dr. Mason

BALSAMIC RESIN.

the author of "Burma and its People," searched the reports of **Dr. Helfer** for information about the tree, but without success. It was brought to notice by a Catholic priest, a resident of Rangoon, who introduced it in a Burmese medical treatise that was lithographed by **Colonel Burney**. This gentleman, however, seems to have confused the tree with the one that produces Balsam of Peru (**Myroxylon Pereiræ**, *Klotzsch*) which belongs to quite a different Natural Order.

Previous notices.

Dr. E. J. Waring, in *Pharmacopœia of India*, page 88, refers to two varieties of the resin met with in Burma, one pellucid, fragrant and of a light yellowish colour, obtained by simple incision of the bark; the other, thick, dark, opaque, of a highly terebinthinate odour, obtained by boring holes in the stem and the application of fire around the trunk of the tree. Samples of these two varieties were sent to the Madras Drug Committee in 1851. In an analysis of the resin by **Marquart**, quoted by **Dr. Jonathan Pereira**, it was found to contain a volatile oil somewhat like styrol, and a substance similar to styracin. The Editor of the *Pharmacopœia of India* instituted some trials with it as an expectorant, but with no satisfactory results; he came to the concusion that it was of little value as a medicinal agent.

Recent collections.

To bring the enquiry from 1868 to more modern times, the Reporter on Economic Products in 1899 received from **Mr. F. B. Manson**, Officiating Conservator of Forests, Tenasserim, three small samples of products of **Altingia excelsa**. These consisted of a fragrant oil, a crystalline fatty substance, and a black resin having a strong odour of cinnamon. Further samples were asked for, and some larger quantities of the yellow crystalline fat and the black storax-like resin were forwarded in 1901. With the latter consignment the Forest Officer sent the following particulars respecting the mode of collection. Balsamic gum or oil only oozes out of certain Nantayôk trees, and from injuries caused by insects, or where branches have fallen off and decay has set in. In the dry weather four trees were tapped in the same manner as the *Kanyin* (**Dipterocarpus turbinatus**) when the oleo-resin or wood-oil is required, but only one of the trees responded in giving the fragrant oil. A white resinous substance exuded from the fresh wounds in Palaw, but near old wounds a black resinous substance remained adhering to the bark which could only be removed with portions of this attached. The white, honey-like exudation apparently becomes converted on exposure to a dark coloured resin. The quantity found to exude from the trees was so very small that it was considered hardly worth while to collect it, unless a price commensurate with the labour were asked for the resin. After making a further trial two years afterwards, the Conservator of the district reported that the products were difficult to obtain, the inhabitants in the jungles very few, and tha all the trees do not respond to the attempts made to extract the storax.

BALSAMIC RESIN.

In Java the tree known as Rasamala (**Altingia excelsa**) yields by incisions in the trunk an odourous resin, but the exudation issues very slowly and in small quantity. In tracing the references to Rasamala in Dutch works it is clear that in Java and the Malayan islands the name *rasamala* is given to different products. Taking the notices in chronological order it is interesting to review the opinions expressed on the nature of the fragrant substances met with under this name.

Java and Malaya.

Rumphius

Rumphius (*Herbarium Amboiense*, II, 57) describes under the name of "*Caju Rasamala*" or "*Lignum Papuanum*", the wood of a tree. He says the tree has been referred to the same as that which produces gum elemi, but proceeds "no gum or resin exudes, neither in the wood of the tree is any peculiar odour observed." He also remarks that it is brought from that part of new Guinea where Massoy bark is sold.

Blume.

Subsequently **Blume** referred to Lignum Papuanum as a synonym of the wood of **Liquidambar Altingiana**, and **Hasskarl** identified Rasmala or Rosmala with the same tree.

Noronha.

Noronha (1827) in describing the plant admits that it is Rasamala in the Malay language, "which in herbals is known by the name of styrax." He observed that an oil exuded from the stem, first having the consistence and colour of honey, but afterwards turning white in the fissures of the bark and then appearing translucent and crystalline and forming into drops which do not adhere to the bark. **Noronha** alludes to the styrax odour being greater in the roots, and to the stem of the tree being covered with ferns and epiphytic plants; these two observations are not confirmed by subsequent writers.

Junghuhn.

Junghuhn (1850) described rasamala as an exceedingly pleasant smelling resin which runs like honey out of the bark, soon becoming hard on exposure to the air, and filling up cavities in the bark. These masses are to be found in the upper part of the stem and have to be obtained by felling the tree.

Wiggers.

Wiggers writing in 1865 asserted that he had not succeeded in obtaining any balsam from the huge stems of the tree, and declared it was a mistake to say that oriental storax was obtainable from it.

De Vrij.

Dr. De Vrij, who resided in Java from 1857 to 1863, collected a hard resin in flat angular pieces, of a light yellow or amber colour, and transparent. The resin was brittle, with a shining glassy fracture, tasteless and odourless.

In Javanese medicine very heterogeneous substances are employed as rasamala. When of sufficient fragrance it is used as benzoin for incense, but it is not regularly collected and placed on the market.

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The Properties of Nan-ta-yok

BALSAMIC RESIN.

Professor A. Tschirch and Dr. L. van Itallie, in 1901, examined three samples from Java; two of them were identical, consisting of loosely adherent pieces, faintly dusty, of a light yellow colour and glassy fracture, crumbling to powder when chewed. These are designated as "*rasamala bodas*" (= white), and are derived from an **Altingia** tree with white wood. The third sample consisted of a conglomeration of brown resinous pieces, and was designated *rasamala beurum* (= red), derived from a tree having red wood; but both trees, according to Greshoff, were identical with **Altingia excelsa**. The tree is abundant and very accessible in certain parts of Java, and it might be worth while to make experiments to obtain the exudation in a manner similar to that practised in the collection of storax.

Liquid Benzoin.

A substance of the nature of the liquid balsam of **Altingia** is described by **Hanbury** in his Notes on Chinese Materia Medica, under the name of *Shuy-gan-scih-heang*, literally "Liquid Benzoin." He says "the drug is a dark brown, semi-fluid resin, having an extremely fragrant odour of storax. It is met with in small globular wooden shells, apparently the pericarp of some fruit, about $1\frac{1}{4}$ inch in diameter, closed with wax. Its origin is very obscure. The Chinese assert that they import it from the Straits, or, in other words, by way of the Indian Archipelago; but I have not been able to trace it either there or in Siam. It is curious, moreover, that this fragrant resin even to the shell inclosing it, is extremely like that kind of balsam of Peru which was brought to Europe long ago in the capsules of a **Lecythis**, and naturally supposed to be a product of South America. The Liquid Benzoin is very expensive, a single shell, holding perhaps half an ounce, being worth four dollars, or 20*s*."

Chemical composition.

Chemical composition.—Oriental storax is a mixture of free cinnamic acid, vanillin, styrol, styracin, cinnamic acid—ethyl ester, cinnamic acid—phenolpropyl ester, and storesinol, partly in the free state and partly as cinnamic acid ester. Storesinol has the composition C_{16} H_{26} O_2, and melts at 156°—157°; it is isomeric with the benzoresinol, isolated from benzoin, which melts at 272°C.

The composition of American Storax deviates so insignificantly from Oriental Storax that they may regard as identical.

MM. A. Tschirch and L. van Itallie who investigated these balsamic substances in 1901 (*Arch. d. Pharm.* (Sept. 17, 1901) 239 No. 7·506), discovered that notwithstanding the close botanical relationship between storax and rasamala resin they are widely different in composition. It was acknowledged, however, that possibly this difference is due to the various modes of collection. The authors used a light yellow variety for their examination. The two samples melted respectively at 65° and 80°C., this difference being probably due to the variable quantity of volatile oil contained

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or Burmese Storax. (*D. Hooper.*)

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in them. The odour is very aromatic, reminding of cinnamon, pepper and turpentine. The solubilities are as follows: partially in alcohol, methyl-alcohol, carbon disulphide and glacial acetic acid; almost completely in ether, acetic ether, chloroform and benzol; nearly insoluble in acetone and soda solution. The only constituents that have been determined with certainty are: cinnamic acid, benzaldehyde and cinnamic aldehyde. The alcoholic solution contained tannic acid, probably derived from the bark of the tree.

CHEMICAL COMPOSITION.

The two aromatic exudations from South Tenasserim will be described separately.

Soft white Balsam.

The soft white crystalline balsam.—In a fresh state this secretion resembled honey in colour and consistence, but after two years it became white and crystalline, and possessed a delightful fragrance of styrol. It melted on the surface of mercury to a clear liquid at 41°C. Heated on a water-bath until it lost weight the volatile constituents, chiefly essential oil, amounted to 7·65 per cent. The following constants were determined: acid value, 24·96; ester value, 174·39; saponification value, 199·35; iodine value, 57·3. Upon examining the soluble extract resulting from the acid determination, no free cinnamic acid was detected, but the alkali had combined with 8·3 of a light yellow resin.

The process of saponification revealed the interesting fact that about half the balsam consisted of an ester compound of cinnamic acid. The product of the action of alcoholic potash was evaporated to dryness, dissolved in water, and agitated with ether. The ether removed a yellowish fluid body neutral in reaction. On decomposing the salt with sulphuric acid and again agitating with ether a compound was removed which afforded 37 per cent. of cinnamic acid calculated on the original balsam. The tendency of the action of potash on cinnamic acid is to convert it into benzoic acid, but the product of saponification was shown to be the former acid from its melting point, degree of acidity and the peculiar reaction when treated with nitric acid.

Dark brow Balsam.

The dark brown solid balsam.—This was in fragrant, resinous masses, varying from dark brown to black, externally hard, yielding a brown powder, some portions were soft and sticky within, odour strong and pleasant, that of cinnamon predominating. The resins were mixed with portions of bark, wood and sand. Two samples clarified by means of alcohol gave:—

	1	2
Pure resins	53·72	54·70
Organic impurities	19·09	28·05
Inorganic impurities	22·24	10·67
Volatile oil and loss	4·95	6·58
	100·00	100·00

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CHEMICAL COMPOSITION.

The purified resin had a clear amber colour and the fragrant odour of the crude Nantayôk balsam and melted at 68°C. It was soluble in chloroform, carbon disulphide and benzol, partly in acetic ether, and only slightly in petroleum ether.

The following constants were obtained on the second sample of resin which had been obtained from the Zinba forest, Tenasserim :—

	Crude resins.	Pure resins.
Acid value	52·48	76·80
Ether value	77·62	53·64
Saponification value	130·10	130·44
Iodine value	41·07	51·68

On comparing the values determined by alcoholic potash there is seen to be a great difference between the soft white crystalline balsam and the dark brown solid variety. The latter contained a trace of free cinnamic acid, and only 9·7 per cent. of the acid in combination as an ester.

Cinnamic acid.

These experiments show that the soft white crystalline substance derived from the Nantayôk tree and exuding from the bark with a honey-like consistence is a valuable perfume and a rich natural source of cinnamic acid. The brown resin has the peculiar fragrance of storax and is not without value as a perfume and incense. Compared with genuine storax from the Bombay Medical Stores, the Burmese products possess a sweeter aroma. Both balsams evolve the odour of benzaldehyde when heated with potassium bichromate and sulphuric acid.

The point of some importance is to determine how these samples of Nantayôk resin or balsam differ from true oriental storax. Dr. K. Dieterich proposed in 1898 (*Pharmaceut. Centralblatt.*) a scheme for the examination of crude and refined storax. Calculating on the dried drug, he ruled that not more than 2·5 per cent. should be insoluble in alcohol, and found that samples of authentic origin possessed acid numbers of 87·62 to 95·81, ester numbers of 49·84 to 109·83, and saponification numbers of 145·82 to 199·14. According to this scheme of analysis the brown resinous balsam would be excluded from the category of true oriental storax, and the soft crystalline balsam only resembles it in regard to the saponification value.

I am thus able to confirm the results of Tschirch & van Itallie in showing that Nantayôk resin, like rasamala resin of Java, has a different constitution to true storax of Asia Minor. At the same time the products of **Altingia excelsa** are rich in aromatic compounds which recommend them for more than local use, and their collection by Forest Officers might profitably be extended in Burma and Assam.

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MANIHOT UTILISSIMA.

(CASSAVA, TAPIOCA, MANIOC.)

[*Dictionary of Economic Products, Vol. V.*, M. 216-30.]

Other PAPERS that may be consulted :

The Agricultural Ledger, 1897, No. 4 ; 1900, No. 15.

THE TAPIOCA PLANT: ITS HISTORY, CULTIVATION AND USES. A REVIEW OF EXISTING INFORMATION.

By J. H. BURKILL, *Officiating Reporter on Economic Products to the Government of India.*

INTRODUCTORY.

Manihot utilissima is an American plant which has been cultivated for such ages that the wild parent is no longer recognisable. Under the selection of man it has been broken up into many races, some of which have roots poisonous when raw, while others have had the poison largely eliminated from the fleshy edible inner part of the root. The plants with little or no poison in the flesh of the raw roots have a distinctive name in Brazil, *viz.*, *Aipi*, and are our sweet cassava ; while *mandiocca* or *maniba* is the esculent root of both sweet and bitter cassava. Besides differing in the way in which they contain poison, the races differ in precocity, and in yield and in the way in which they resist the evil effects of water standing on the land or waterlogging, and in their demands in temperature.

Cultivated races.

Sagot, in the *Bulletin de la Société de Botanique de France* XVIII, 1871, p. 347, says that when he travelled in Surinam there were 10-12 races cultivated in that little French Colony ; Tracy, in the *United States Department of Agriculture. Farmers' Bulletin*, No. 167, 1903, p. 7, asserts that Brazil contains 40-50 races ; there are several in the West Indies and four (*teste* Tracy) in the Southern United States. Robert Thomson (see *Agricultural Ledger*, 1900, No. 15, p. 163) says that there are many varieties in Colombia, some of which grow where the rainfall is only 14-16 inches per annum, and some where it exceeds 200 : and some of which grow in the sub-tropical belt of the mountains, and others in the hot valleys. Réunion and Mauritius, islands which received **Manihot** first a century and a half ago, have now in them several races, and Madagascar has four.

THE BRINGING OF MANIHOT TO INDIA.

Very early the Portuguese, who colonised Brazil and carried on a big slave traffic between Africa and America, brought **Manihot** to the Old World where they established it with ground-nuts and other American

MANIHOT utilissima.

The Tapioca Plant: its History,

HABITAT.

produce. We have reason to believe, though there exists no absolute proof for the view, that they also brought the **Manihot** to their Indian possessions and established it at Goa, whence its cultivation spread.

A.D. 1786. A fresh introduction of the plant into the East Indies occurred in 1786 when Ceylon received it through Mauritius. It was brought to Calcutta and Serampur from South America in 1794. **Bennett** in his *Ceylon and its Capabilities* claims that about 1820 he brought the plant into Ceylon. That would seem to be a second introduction, or possibly as the Portuguese may have grown it there even a third introduction to the island. **A.D. 1840.** A third introduction to the mainland of India occurred in about 1840 when it was again brought to Calcutta—this time direct from the West Indies. Burma probably received the plant from the Straits Settlements in part, in part from Calcutta or Madras *vid* Arakan.

How far the divergences which may now be found between races in India, are due to the introduction of different races on these occasions and how far to selection in India it is impossible to say: and it would be unwise to assume that any of the races now to be found in India have exactly the same agricultural value, the same food value or the same industrial value as races which have been the subject of experiment in other parts of the world.

Where grown in India. **Manihot** is grown in Assam and Bengal in gardens, in parts of Nepal, in the United Provinces "luxuriantly" (*teste* **Atkinson** in *Economic Products of the North-Western Provinces*, Part V, Allahabad, 1883, pp. 22 and 23) but to my knowledge quite rarely (*vide* letter from the Superintendent of the Royal Botanic Gardens, Shibpur, in the *Agricultural Ledger* No. 4 of 1897, p. 10). It is grown all down the East Coast to Cape Comorin and up the West Coast at least as far as Goa in gardens, and in Travancore and at Pondicherry and Cuddalore, at least, in fields. In Burma it is grown here and there throughout the Province, but chiefly in the south. Chinamen are the chief cultivators of it at Tavoy. The roots are eaten cooked. I have seen it in the Northern Shán States and on the Siamese Frontier. It is only to be found in gardens and never in fields. In the Federated Malay States it is a field crop.

Assam. Aracan. Assam and Bengal as well as the Arakan coast used to grow **Manihot** before about 1840 when the Calcutta gardens distributed the fresh strain from the West Indies. The new strain was found in Assam, as regards appearance, to be almost identical with the old strain and to be "not distinguished by the natives" (*Major Jenkins in Journ. Agri.-Horticultural Soc. India*, N. S., VII., 1850, p. 238). There do not seem to be any two recognised kinds in Assam at the present date, but only a single strain of the sweet cassava plant.

Bengal. The same strain is the Bengal plant. However, that the bitter has been tried is indicated by **Mr. A. C. Hartless** in "*Indian Gardening*," August 4, 1898. The cassava root is sold cooked in October and

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November in the bazars of Sikkim. The Bengal stock, after the last famine, was sent to many remote parts of India by the **Agri.-Horticultural Society** (*vide Report, Dept. Land Records and Agriculture, Bengal*, for 1898-99, p. 34). Whether it was established in Cutch, Meywar and Sind by these efforts, is not known.

RACES. Sikkim. The race of our plant to be found at Rajamandry, Madras, Pondicherry, Cuddalore, etc., is one only as far as I can judge; but a comparative study in the field is necessary to determine the point. **Sir George Watt** and **M. Poulain**, President of the Chamber of Commerce, Pondicherry, both call it sweet cassava; but they—the former in a note in my office, the latter in the *Journal d'Agriculture Tropicale*, II, 1902, p. 12,—say that at Cuddalore and Pondicherry it is always sold cooked. It is sold in Madras fresh, and I have obtained it from the bazars with the sandy soil in which it had been grown adhering to it. "From Pondicherry and Cuddalore," says **Sir George Watt**, "the cultivation of **Manihot** extends through Tanjore practically to Tinnevelly and Travancore." **Dr. Shortt**, author of a *Manual of Indian Agriculture*, and others, formerly grew a kind of the bitter cassava plant in the Shevaroy Hills. **Mr. J. Cameron**, of Bangalore, tells me that there are two races in Mysore, distinguished by the colour of their stems—the one reddish, the other green. When we reach Travancore we find no longer one or two but instead many races, to tabulate which from **Mr. A. M. Sawyer's** statement in the *Indian Forester*, XXI, 1895, p. 290, is all I can do, until a further study of them has been made.

Madras. **Mysore.** **Travancore.**

	Height of plant.	Average weight of root.	Age at maturity.
Class I.—**Avians** or easily boilable kinds—	Feet.	lbs.	Months.
1. Pacha avian	12	15	12
2. Chini or Vellari avian	...	10	6
3. Chovalay avian	..	10	12
4. Curry avian	4	12	12
5. Chana avian	8	8	...
6. Chenkomban		(like No. 2).	
7. Neduvenganden	...	4	...
Class II.—Maravans or dark races—			
8. Olley Karim Maravan		10	12
9. Nedunali-kian Karim Maravan	...	...	...
10. Aria Maravan	20	20—25	15
11. Kathelay Marachini	...	...	...
12. Kcota Maravan	2-2½	...	...
13. Ellavurti Kappa		(like No. 10).	
14. Ananakkum Kappa	4	small	...
15. Vellay Marachini	25	...	...
16. Olaven	3	small	...
17. Kili Vakay	10	12	...

Their cultivation according to the *Madras Manual of Administration*, 1885, II., p. 135, extended very rapidly in Travancore just before 1885.

The roots are there often cut into slices boiled and dried in the sun, and kept for future use.

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RACES.

Mr. Mollison, in a note communicated to me, states that when tried together at Cawnpore a selected Travancore race proved itself superior to the Tanjore race.

Ceylon.

Exactly how many races Ceylon has is not known, three or four are cultivated in the Botanic Gardens of that Island (*vide* Macmillan in *Indian Gardening and Planting*, 20th December. 1900).

FURTHER INTRODUCTION OF NEW RACES

Recently again the Government of India has imported new races which are under experimental cultivation at Poona. These are **Manihots** originally from Colombia but had been grown for some years in Jamaica before India received them. The sender is Mr. R. Thomson,—to whose interest and energy their acclimatisation in the West Indies is due. The names of the races which have so far been successfully grown at Poona I cannot ascertain.

Having established a stock, these plants will be tried in various parts of India.

VERNACULAR NAMES.

When introduced into India **Manihot** got new names, none of which retain any indication of foreign origin unless it be "*Manupendalum*" and most of which are easily translateable. They are as follows:—

In Sikkim the Lepchas call it *Tungtu-bok* [*i.e.*, yam with Simul (*Bombax*) leaves], the Nepalese *Simul-torul* (the name has the same meaning), the Bhutias *Sha-Shingken*.

In Assam and Bengal—*Simul-álu*, *Simla álu*, and *Hemálu álu* (*i.e.*, the yam with Simul leaves), and also *Roti-álu* (bread yam) or *Gach álu* (tree potato) or *Kathalu*. The Garos call it *Thabalchi*.

In the United Provinces at Pertabgarh it is called *Maida-darakht* (meaning Flour tree), at Lucknow a few know it as *Aluga* (potato tree), *Shafat alu* (white yam) and *Chikna aru* (sticky yam); at Cawnpore it has been called *Simul alu* as in Bengal.

In Burma it is *Tan-u* and *Pulu-penang myouk* (Penang island yam) and *Themban myouk* (ship-yam) *Kalaw-pinan myouk*, a name received from Pegu, is a corrupt form of *Pulu Penang* or *Pilawpinan-myouk*.

On the East Coast it is *Kara pendalum*, *i.e.*, stick yam—sometimes the distinctive *Kara* may be dropped and the roots may be sold as *pendalum* which means "yam," or *Manupendalum*.

In the South part of the Madras Presidency it is *Kuchu-valli Kilangu* or *Mara valli Kilangu* (white stick yam) or *Al-valli Kilangu*, by misapplication; also *Savari-kattai* quite locally.

On the Malabar Coast it is *Mara-chini* (stick sweet potato) and *Kappa Kilangu* (ship yam).

In the above pages I have reviewed what we know about the plant in India and told the races that are present for any purposes to which we can put them; now it is necessary to indicate what might be done with them.

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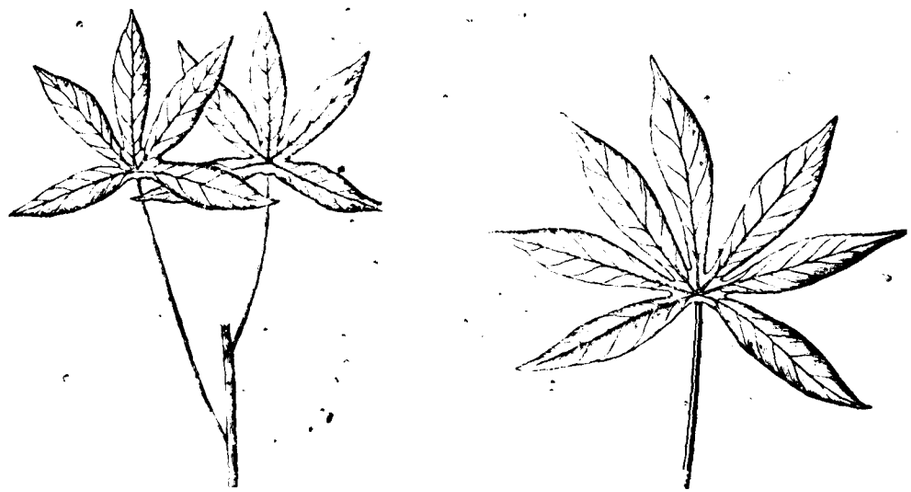
Description of the plant.

APPEARANCE OF THE PLANT.

Manihot utilissima is an undershrub with the growth of a castor oil plant but more rigid. Its stems are moderately thick, for the most part straight and with a large pith. Its leaves are as broad as long, cut nearly to the base into 3, 5, 7, 9 and 11 fingers, 5, 7 and 9 being the commoner numbers. The fingers may vary considerably in breadth. Their colour is a deep green above and a lighter green below, with short hairs, only when quite young. The flowers which are but seldom produced stand in short panicles among the leaves; there are both male and female flowers on the same panicle, the former smaller than the latter. The male flowers are situated above

FIG. 1. FIG. 1A.



Leaves of **Manihot utilissima** from Tavoy and Sibsagar.

the female flowers. They are purplish green outside, reddish green within, with five perianth lobes, and with ten stamens sometimes longer, sometimes shorter than the lobes. The female flowers have the same five perianth lobes but longer, and within them the green ovary with its stigmas. The seeds are elliptic, black, shining, with a thick fleshy seed stalk. The roots are swollen, with a red brown or blackish brown skin and white or yellow flesh loaded with starch, and they contain more or less prussic or hydrocyanic acid either in the skin only or throughout the substance.

It is these roots freed from the poison in them that constitute the great economic value of the plant.

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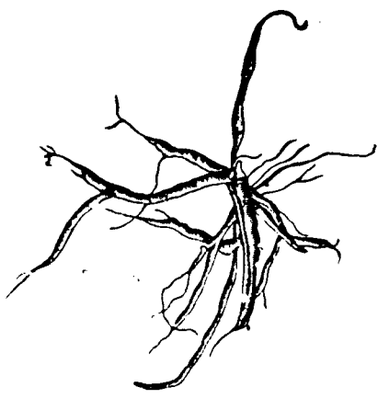
MANIHOT utilissima.

APPEARANCE OF THE PLANT.

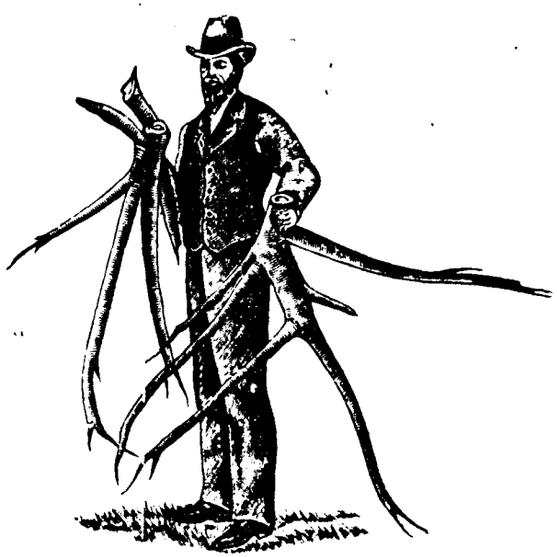
When the young plant reaches a height of some five feet they are as drawn in figure 2 and later may grow to the size represented in figure 3.

FIG. 2.



Small root (after Tracy).

FIG. 3.



Very large roots from the United States (after Tracy).

APPEARANCE OF THE PLANT.

Naked Eye Differences between sweet and bitter.

Races of the sweet cassava are more hardy than the bitter, but yield less in weight of roots. The tubers are smaller in these hardy races and often lighter in the colour of both skin and flesh. Semler (*Tropische Agricultur* II, 1900, p. 769) says that the leaves stand straight out from the stem or depend, while in bitter cassava they grow upwards. Dûss says in his *Flore de la Martinique* that the sweet cassava plant is more erect, its stem is not angular, its petioles are yellowish green and never brown or black as are those of the bitter cassava plant: that there are at the base of the petiole two winged stipules which in bitter cassava are only represented by traces or by a process like a prickle with a broad base: that its leaves are a little larger, less slender and less pointed in the lobes and that its fruits are without wings and slightly angular at the summit.

Probably these differences given by Semler and Dûss may hold good in particular localities, but they most likely do not hold good in any broad way.

NATURE OF THE ROOT.

The **Manihot** stores up large quantities of starch in its roots and guards it with more or less prussic acid. The greater part of this prussic acid may be in the bark of the root and the interior so free from it as to be safely eaten raw—this is in sweet cassava—or the prussic acid may occur all through the root and then we have bitter cassava.

Prussic Acid.

There are degrees of poisonousness. The most poisonous roots seem to be those with yellow fleshed and rather fibrous tubers. Death is very rapid from eating them uncooked, but their bitterness ought to warn the eater that they should be avoided. In the countries where much of the root is grown, cases of poisoning are occasional. The recognition of the nature of the poisonous principle was made long ago; but the recognition that sweet cassava may hold the same has only come about of relatively recent years. Sagot in 1871 (*l.c.* p. 349) wrote that he doubted if any kind were absolutely free from the poison. Francis in 1877 (*The Analyst*, April 1877) demonstrated the presence of prussic acid (HCN) in West Indian Sweet Cassava. These are his figures:—

	Sweet Manihot.	Bitter Manihot.
Maximum	·0238	·0442
Mean	·0168	·0275
Minimum	·0113	·0133

Carmody in the *Trinidad Agricultural Society's Proceedings* (copied in the *Trinidad Bulletin of Miscellaneous Information*, 1901, p. 319) gives the results of a further examination, in which using

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a slightly different method of analysis he was able to find in sweet cassava.

	Prussic acid per cent.
Maximum	·019
Mean	·010
Minimum	·005

Carmody, however, has gone beyond **Francis** and he shows that in West Indian Sweet Cassava it is the skin which contains the greater part of the poison, while in bitter cassava the poison is distributed more evenly through the root. His figures are published in a place little accessible to workers in India and for that reason are reprinted here *in extenso*.

CARMODY'S ESTIMATIONS.

"The following are some of the results obtained from fairly representative samples of sweet cassava:—

Inner part HCN per cent.	Skin and outer cortical layer. HCN per cent.	Inner part. HCN per cent.	Skin and outer cortical layer. HCN per cent.
0·006	0·033	0·004	0·024
0·003	0·014	0·010	0·030
0·015	0·033	0·004	0·042
0·008	0·031	0·005	0·038
0·011	0·020	0·003	0·034
0·08	0·032		

With bitter cassava the following results were obtained from representative samples:—

Inner part HCN per cent.	Skin and outer cortical layer HCN per cent.	Inner part HCN per cent.	Skin and outer cortical layer HCN per cent.
0·031	0·024	0·017	0·019
0·034	0·012*	0·019	0·020
0·021	0·025	0·016	0·024
0·037	0·014*	0·017	0·020
0·030	0·025	0·013	0·016
0·14	0·033	0·032	0·056

The general conclusions to be drawn from these results are:—

(1) that in sweet cassava the prussic acid is not uniformly distributed throughout the tuber and that in bitter cassava it is uniformly distributed, or nearly so; and

(2) that this affords an analytical means of distinguishing between sweet and bitter cassava."

* Exceptional.

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It has probably been noticed by the reader that **Carmody** contrived to extract less prussic acid than **Francis**—a result, he thinks, due to some influence of season on the plant, which unfortunately cannot be gone into here.

AN INDIAN ANALYSIS.

Dr. J. W. Leather, analysing roots from Goalpara, Assam, found in them ·015 per cent. of prussic acid.

Prussic acid ready formed and capable of being formed.

A certain amount of prussic acid exists in the root ready formed; and there exists with it also the formative materials for the production of a further amount, so that though a soaking or boiling in water may remove what is present, there is in the roots the possibility of more appearing to replace some of what is lost.

Carmody shows that how feeling unwell may result from the eating of cooked cassava by reason of this happening. He writes—

"It is shown in my experiments that whilst a first boiling removes a certain amount of hydrocyanic acid—all in fact that exists ready formed in the tuber—a second addition of water and subsequent boiling removes a further portion. It would appear from this that cassava in a person's stomach would also develop an amount of prussic acid ..... The total quantity would, however, be far below the minimum fatal dose and would only be expected to produce those unpleasant results occasionally reported."

Symptoms of poisoning.

Symptoms of cassava poisoning are violent pains in the stomach and then collapse. The treatment is to make the sufferer vomit and do everything to keep up circulation and most especially respiration.

Reason for cooking before sale.

The preventive measure to be taken is good cooking. Boiling removes the prussic acid to such an extent that the root is harmless or never fatal. Roasting removes all the prussic acid. It seems to me, however, that in India cassava is sold cooked more because cooking preserves the tuber than because it renders it innocuous.

The prussic acid in the roots has no commercial value.

Poisoning in the West Indies.

West Indian statistics shew that most of the cases of cassava poisoning occur among undercared-for children who eat the bitter root despite its taste, and in towns where it is due to careless preparation of food (*W. Indian Dept. of Agri. Leaflet* No 7, p. 3, and *Hart* in *Trinidad Bulletin of Miscellaneous Information*, 1901, p. 323).

There has never been known a case of poisoning in Florida. Unfortunately I cannot find analyses of the roots of Florida plants which tell the amount of prussic acid in them. But I do not suppose them to be free altogether from it though probably very like the Colombian plants of which analyses follow. In Colombia these races are held quite harmless.

How much of the tuber is bark.

The bark makes up in the West Indies one-fifth by weight of the whole tuberous root.

Analyses showing prussic acid and starch etc.

More than one-half of the weight of the fresh root is due to water and about one-third or less is due to starch. The following are the figures of analyses by **H. H. Cousins** of roots of Colombian races

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grown by Mr. R. Thomson in Jamaica at Half Way Tree. The figures are in the order of starch content and are taken from the *Bulletin of the Dept. of Agri., Jamaica*, 1903, p. 37.

Name of race.	Moisture.	Starch.	Solids not starch.	Prussic acid.
Governor Hemming	57·17	36·50	6·33	0·0018
Cabesa Dura	54·69	35·40	9·99	0·0010
Negrita (sample No. 1)	55·10	34·80	10·10	0·0019
Helada (sample No. 1)	55·41	34·30	10·29	0·0007
Paloma	57·78	34·30	7·92	0·0017
Blancita	54·22	33·80	11·98	0·0009
Pacho (sample No. 1) a hill race	59·61	33·33	7·06	0·0029
Cajon Amarilla	56·11	33·30	10·59	0·0030
Negrita (No. 2)	59·31	31·10	9·59	0·0010
Helada (No. 2)	50·93	29·90	13·17	0·0019
Negrita (No. 3)	61·43	27·70	10·87	0·0020
Cenaguera	67·21	25·00	7·79	0·0014
Montera	71·42	25·00	3·58	0·0009
Negrita (No. 4)	60·57	23·90	15·53	0·0035
Pacho (No. 2)	58·57	22·30	19·13	0·0022
Pacho (No. 3)	72·28	22·10	5·62	0·0010
Pacho (No. 4)	64·19	19·30	16·50	0·0010

Analyses by Archbold.

Archbold as a result of over 100 analyses of roots from Jamaica found an average of 26·23 per cent. of dry starch to be present. The root further contained 4 per cent. of sugar. He gives the following figures:—

	Water.	Protein.	Fat.	Resins, Alkaloids.	Amides and sugar.	Crude fibre.	Starch.	Ash.	Potash.	Phosphoric acid.
Fresh root	66·745	0·855	0·188	0·115	5·650	1·685	24·075	0·740	0·300	0·080
Dried root	5·170	2·455	0·525	0·325	16·090	4·800	68·530	2·105	0·860	0·255

Analyses by Wiley.

The next table gives analyses made by the United States Department of Agriculture on dry roots.

	Moisture.	Ether extract.	Crude fibre.	Pentosan.	Starch.	Protein.	Ash.	Etc.
Florida	5·47	·37	4·05	3·09	57·60	3·42	1·47	24·53
Florida	5·11	·50	6·53	2·93	67·20	3·16	1·50	13·01
Alabama	7·05	·49	6·06	2·43	62·19	2·37	3·04	16·37
Mississippi	5·59	·26	3·76	2·06	70·13	2·98	1·75	13·67
Average	5·76	·42	5·08	2·63	64·28	2·98	1·96	16·89

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Analyses by Francis.

Francis' analyses of Cassava gave results as follows:—

	Moisture.	Sugar.	Starch.	Fibre.	Mineral salts.	Albumen, etc.
Sweet Cassava	58·73	·81	33·38	2·04	·71	4·33
Bitter Cassava	62·07	2·67	29·39	2·01	·59	3·27

Analyses of Flesh and bark.

Wiley analysed roots from Florida separating the bark from the interior with these results:—

	Peeled root.	Bark of root.
Moisture	61·39	61·30
Ether extract	·17	·66
Albuminoids	·64	2·29
Starch	30·98	...
Fibre	·88	3·83
Ash	·51	2·02
Undetermined	5·52	29·90

It will be noticed that the bark contained no starch.

DO EXTERNAL CONDITIONS DETERMINE THE AMOUNT OF PRUSSIC ACID PRESENT.

Dr. Maingay of Malacca has in the *Journal of the Agri.-Horticultural Society of India*, I, New Series, 1869, p. 191, the following sentences:—

"It is adduced by all classes of cultivators with whom I have conversed on the subject that in planting from cuttings they must on no account be inverted. If by an accident this occurs the resulting tubers do not belong to the variety described as the sweet but to that to which in the West Indies I imagine the term "Bitter Cassava" has been applied. . . . With a view to test the accuracy of the popular belief I have planted six cuttings in the usual manner and six inverted. I fear my stay in my present appointment will not be sufficiently long to enable me to lay the result before the Society."

Curious as the statement reads there is not material to laugh at in it, because experiments have indicated that circumstances unfavourable to the plant do increase the amount of prussic acid present. I quote the following paragraph from the *Queensland Agricultural Journal*, XII, 1903, p. 131.

"It is indicated (by Dr. Maxwell) that the difference of sweetness and bitterness may be due to the conditions of soil and climate in which the Cassava plants are grown. This opinion of Dr. Maxwell is most conclusively borne out by the recorded experience of a Cassava planter in Jamaica who in reference to very particular enquiry regarding experiences with Cassava in that island has reported as follows:—

"Soil has a great effect on Cassava as I have seen sweet Cassava turn quite bitter on some lands; the variety called Mexico (which is

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very productive) being especially apt to change in this way. The change is generally produced by planting on a free level soil after growing on stony hilly land . . . Our bitter Cassava if planted in Central America turns to sweet."

Sawyer (*Indian Forester*, Vol. XXI, 1895, p. 291) tells us that the roots grown in Travancore in the rainy season are nicer to eat and "more wholesome" than those grown in the dry weather.

Age does not increase the prussic acid.

Carmody (*Trinidad Bulletin of Miscellaneous Information*, 1901, p. 322) says that there are no grounds for the common belief that sweet Cassava contains more prussic acid the older it is.

Uses.

USES.

The root of **Manihot** yields the following four important preparations:—

Starchy Foods.

Couac.
Cassava meal.
Brazilian arrowroot.
Tapioca.

It yields also the sauce cassareep and the Brazilian fermented drink piwarri. Couac is the coarsest roughest meal. Cassava meal is a finer preparation. Brazilian arrowroot is starch washed out of the root and Tapioca is the same slightly torrefied.

Sauce.

Cassareep is made from the juice by boiling it down to the consistency of molasses; and piwarri is made by the Indian women who chew the root and spit it out into bowls to ferment.

Fermented drink.

Uses of leaves.

The leaves of some races of **Manihot** are eaten as a vegetable, this is specially so in Java: and cattle seem to eat them readily without harm. But the leaves of some races are reported as being poisonous to cattle. In India a variety of insects more or less omnivorous (and therefore not specialised to digest the poison) are ready to attack the plant (vide *Shortt's Manual of Indian Agriculture*, 1885, p. 309).

Preparation of Food products in Brazil.

In making any of the four first named preparations the preliminary act is the peeling of the root and the second its disintegration. There are two processes in use in Brazil by which this is done—

(i) the interior edible part of the root is rasped on a board with metal points or on a large nutmeg grater or on a wheel with points: **Neuville** in the *Journal d'Agriculture Tropicale*, 1903, p. 324, describes a rude grater still in use furnished only with bits of broken pottery or glass or quartz by way of teeth. The raspings are left for twenty-four hours to ferment on a mat or cloth and are thrown damp into a bag made of rushes or canvas to have the juice squeezed out of them.

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(ii) the roots are thrown into water; peeled or not peeled, and left for some days until they are soft and somewhat slightly fermented. They are then easily crushed. If they have not been peeled before soaking the rind is removed by hand before they are crushed.

In the Brazils the expressions *farinha secca* and *farinha d'aqua* are used for the meal or flour resulting from the different ways of making it. The manufacture of *farinha secca* and *farinha d'aqua* is described in the *Diplomatic and Consular Reports*, Misc. series, 547, 1901, p. 10, and elsewhere.

Subsequent operations turn the root into couac, cassava meal, Brazilian arrowroot or Tapioca.

For couac is to be made the bag is compressed, generally by being hung on a weight pulling upon it below, and after the juice has run off the raspings or crumbs are turned out, dried somewhat, then sifted and finally made quite dry. It seems that if not made quite dry the meal will not keep.

If cassava meal is wanted, probably the d'aqua process is used. It is the last operation and after compression of the bag as in making couac. Dr. Peckolt the last pounding is well done and the particles sifted until a *cultural* desirable degree of fineness is attained. The meal is also more scientifically dried over a fire with stirring.

"There is a yellow couac in Brazil said by **Neuville** to be greatly valued, and so much so that an imitation of it is made dyed with **Curcuma**.

The manufacture of arrowroot in Brazil.

For the making of Brazilian arrowroot the wet process (No. ii) is preferable for we want to wash out starch and to remove the cell walls, etc. The tubers are, therefore, well macerated, crushed and the starch removed by the use of plenty of water from which it is allowed to settle.

The making of starch in Brazil has received a good deal of attention; and what with the making of Cassava starch or Brazilian arrowroot in Sao Paulo and elsewhere, and the making of starch in the province of Santa Catherina from **Maranta** the country has a large business.

The Tapioca Industry of Brazil.

The tapioca industry of Brazil is centred in the provinces of Bahia, Minas, Santa Catharina and Rio de Janeiro. Further north there is a cassava meal industry but no tapioca industry. I do not know when it took its origin. In the middle of the last century the exports from Brazil were very considerable. In 1871, according to **Simmonds** (*Tropical Agriculture*, 1877, p. 351) they were valued at £26,050, three-fifths of which went to Great Britain. The export subsequently decreased: but again increased till in the last decade it stood again at about the same value, while more than

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formerly is consumed in the country. The best Rio tapioca fetches the highest price in the European market. In making tapioca the starch is won as described, and dried up to a certain point, whereupon it is transferred to hot iron plates, and with gentle stirring is made quite dry. The heat of the iron plates, about 100° C., makes the wet starch granules to crack and stick together into little pellets or flakes and in these forms it comes into the market.

The Tapioca Industry of Straits Settlements.

The tapioca industry of the Straits Settlements has had a good deal more than half a century of success chiefly in the hands of Chinamen. **Maingay** in the *Journal of the Agri.-Horticultural Society of India*, N. S., Vol. I., 1869, p. 135, has given a brief r - tion of it. At the time when he wrote, Chinamen easily ob' :d grants of Government forest land at a very low rental, the ide .he Government being to bring this land under permanent cultivation. The lessees cleared off the forests and planted tapioca. Fc three years they continued cropping the land and then the soil being worn out, managed to transfer it to other parties who finding it no longer fertile let it go back to scrub and so ultimately to forest. **Maingay** wrote strongly upon the mischief being done.

The tubers produced weighed from 10 to 25 lbs. at the end of eighteen months when they were dug. Taken out of the soil they were first scraped and then well washed either by hand or in a rotatory drum. Next they were crushed between rollers and the pulp shaken up with water, the water strained through muslin and left for the starch in it to subside; eight or nine times after this it was washed with a view to getting it white and finally it underwent a bleaching in the sun in heaps.

Pearl tapioca was made from it by taking small quantities of the starch at a time slightly moistening it and placing it in a cradle-shaped frame lined with canvas wherein it was given a rotatory movement and granulated. The granules were next dried in the sun for a time and finally slightly torrefied by being stirred round in a hot shallow iron pan. The average amount of the export of tapioca from the Straits Settlements for the years 1862-1870 was 32,908 cwts. and value £41,453 (or R62,17,195 at the present rate of exchange).

In the five succeeding years it increased to an annual value of £73,713 (*vide* **Simmonds**, *Tropical Agriculture*, 1877, p. 352).

Since **Maingay's** time the process of **Manihot** cultivation has not materially changed, but the fields have got further and further away from the coast towns in the continued search for rich land on which to grow it. A race with yellowish-green stems is preferred to the one with reddish stem.

Factories are never far from the fields; but no longer is the trade so exclusively in the hands of Chinamen as it was formerly. As

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formerly, some of the factories have machinery for washing the roots; and some wash by hand. After washing the roots are crushed and the crushed material passes with water into a gauze bag. The stream of water running through it carries the starch forward through a long channel into masonry tanks. The stuff held back is turned down another broad channel and kept for fattening pigs. When the starch in the masonry basins has completely subsided, the water above is run off, the powder is dug out into big tubs and stirred up with perfectly clean water and allowed to subside. The process is repeated as often as is necessary until the starch is quite clean.

At this point the processes for the making of pearl and of flake tapioca diverge.

Pearl tapioca is made by taking the damp half-dried blocks of starch breaking them up and in a cloth by a jerking backwards and forwards movement making the meal to form into pellets. The jerking requires skill and upon the way in which it is done the size of the pearl depends. By means of sieves the pearls are afterwards graded and then torrefied in big ovens on hot plates.

Flake tapioca is made by taking the starch slightly damp and putting a thin layer on the hot plates stirring gently until it is torrefied enough.

The refuse sells at 6-8 dollars the cartload. (**Schlechter** in *Tropenpflanzer*, 1901, pp. 323-324.)

The export of pearl tapioca from Singapore in 1903 was 316,800 cwt. and in flake or flower 209,300 cwt.

Chinamen with no capital have devised a modified form of the "d'aqua" method, and succeed in making a coarse article. The process has just been described by **A. L. De Mornay** in the *Agricultural Bulletin* of the Straits and Federated Malay States, III, 1904, p. 133. **De Mornay's** note is as follows:—

"The smaller Chinese growers, not having the sufficient capital to erect steam machinery to work off their crops, discovered a method some thirteen years ago, of producing an inferior Tapioca flour, or, more correctly speaking, meal, by means of rotting the tubers in water instead of disintegration and thus avoiding the necessity of motive power.

A hole or shallow well of suitable size in proportion to the extent of crop to be treated, is dug in the ground at a spot of sufficiently low level to ensure the water remaining stagnant and not draining away. The hole is then charged full of unwashed tubers, care being taken that all are entirely submerged, and there left for 4 to 7 days. The time they take to rot depends to some extent on the weather (a low temperature retarding putrefaction) and partly on the

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degree of foulness the water may have reached according to the length of time, the same hole may have been previously employed for the purpose. A new hole with pure water, taking a considerable longer time to accomplish putrefaction.

When it is found that decomposition is sufficiently advanced to mash the tubers to a pulp between the hand, they are removed from the hole and placed in a large tub into which a man enters and treads them out to as fine a pulp as possible.

A basket of about ¼ inch mesh is placed in a separate tub, and the pulp is poured into this and stirred till the greater part passes through the meshes of the basket, leaving only the woody and imperfectly rotted portions of the root. Water is frequently poured on the pulp to assist in straining the basket. When the desired quantity of pulp has thus been treated, the basket is withdrawn and the pulp left for 24 hours to precipitate. When it has settled, as well as its fibrous nature will permit of, the water is baled out of the tub and skimmed off the flour as much as possible.

Ordinary gunnies (sacks) are then tied to sticks driven into the ground in a triangular position, and the pulpy mass removed from the tub and thrown into the sacks, where it is left to drain. In this way the water drains out of the pulp, and becomes of sufficient consistency to be removed from the sacks, separated into pieces, and spread over a cement space to dry in the sun. Whilst drying, the lumps are broken smaller, and when comparatively dry, are trodden out and finally sifted through bamboo sieves of about ¼ inch mesh, and packed for the market.

The proportion of so-called "Flour" obtainable from the tuber may be calculated at 27 to 32 per cent.

Cassava Starch Industry of the United States

The tapioca industry of the United States is quite a new one. In 1888 it did not exist; only in Florida certain planters were in the habit of making their own starch from the root. In 1894 Wiley (*U. S. Dept., Agri. Division of Chemistry, Bulletin* No. 44), reported upon the plant, concluding that—

"Cassava can be cultivated with safety and profit in the greater part of the Peninsula of Florida, and probably also in Southern Alabama, Mississippi, Louisiana and Texas; it will yield with fair treatment on the sandy soils from 4 to 5 tons (8,960-11,200 lbs.) per acre.

"It will give when properly manufactured 20-25 per cent. of the weight of the fresh root in starch of high grade.

"An excellent article of tapioca can be prepared from the starch.

"Glucose can be prepared directly from the starch and more profitably from the pulp of the peeled root.

"The plant furnishes an excellent human food and cattle food, deficient, however, in nitrogen. It would make a well-balanced ration for cattle with one-fourth of cotton seed oil cake."

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Cassava Starch industry of the United States.

In the same year according to Tracy (*Farmer's Bulletin* No. 167, p. 7), cassava starch seems first to have become an article of trade. At that date business men familiar with the manufacture of corn starch from maize, turned their attention at once to the cassava plant. A factory was established at the town of De Land and another in the next year at Lake Mary. New races of the plant were imported, but the importation not succeeding, they have fallen back upon the already established races (*vide* p. 123 above) and the factories now both grow and buy from farmers roots for their purpose. "Both factories," says Tracy, "appear to be profitable business enterprises and it now seems probable that others will be erected in the near future. Up to the present time these factories have confined their operations to the manufacture of starch only, no attempt having been made to produce tapioca, glucose or other products. None of the starch made at the factories has been offered in the retail market, all being sold to cotton factories where it is used in making sizing for various classes of goods...".

To the farmer, who sells to the factory as a rate which the factory owners maintain is the maximum possible price permitted by the competition with other starches, the crop is, says Tracy, in his concluding remarks, "not more than ordinarily profitable except when grown on unusually favourable soil" and where the cost of carting to the mill is little. But the factories are largely increasing their acreage on their own adjacent lands.

Method of manufacture.

Robert Thomson in a Report made to the Government of Jamaica (*Report on the Cultivation of Pineapples and other Products in Florida*, 1901, p. 11), says that the Lake Mary factory was then operating for 4 months in the year and crushing 40-50 tons of roots per diem.

Dr. G. Archbold in the *Journal of the Society of Chemical Industry*, XXII., 1903, p. 65, describes the machinery and process which he devised for use in the better of the Florida factories. It is a modification of the manipulation carried on in making potato-starch and is able to extract 25 per cent. of the root as starch, whereas the potato-starch machinery unmodified did not extract more than 20 per cent. of the weight of the root. The process is automatic and continuous and the plant can work 100 tons in a 10-hour day. To the delivery of the starch it takes three days.

1. The roots are washed in an inclined trough with an Archimedean screw conveyor such as is used in the beet sugar industry.

2. The roots are rasped in an upright cylinder such as is used for rasping beets.

3. The pulped root falls into a separator meeting an upward current of water of such strength that it carries the lighter starch grains upwards with it and through a wire gauze diaphragm, while

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the heavier cellulose shreds pack at the bottom and are subsequently discharged by an automatic arrangement.

4. The impure starch milk at a density of 30° Brix runs by a pipe of uniform diameter down the centre of a cone, and as it finds more space in ascending again in the cone outside the pipe, the velocity of the current is lost and the starch ceases to be carried upwards by it against gravity. There are two of these cones, seven feet high, with a door at the bottom through which the part of the liquid holding starch is withdrawn.

5. The starch milk is next treated with alkali and pumped up to a higher level to the regulators. Regulators are tanks with agitators where, by the addition of water, the starch milk is brought to the required consistency.

6. It then goes to shakers such as are used in the maize-starch industry.

7. There follows a washing which is almost a repetition of process No. 4, the water removing the rest of the impurities. The starch may be withdrawn from the cone from below with whatever small amount of water is desired and is pumped into a boxing tank (store tank for the next process) of Cypress wood provided with agitators to keep the granules in suspension.

8. The thick milk is run into moulding boxes with perforated bottoms and muslin lining and by means of a vacuum chamber 75 per cent. of water is removed.

9. The blocks that come out of the moulding boxes are cut up into cubes wrapped in paper and set in a kiln to dry.

It is claimed by Dr. Archbold that there is none of the loss of starch from discoloration which has been practically inevitable in the potato starch industry.

The pulp left behind at stage No. 3 is not wasted but it is to be used for the making of glucose in exactly the same way as maize refuse is. It is to be pumped into a vat with a copper worm and be raised to boiling point with water and hydrochloric acid. Then run into a closed copper convertor where it is subjected to pressure of 30 lbs. per square inch for ten minutes or thereabouts. During the period of compression rapid chemical tests are done to ascertain if the conversion is complete. When complete the stuff is run off, neutralised, filtered through charcoal, evaporated down to a certain extent, filtered again, further evaporated, cooled and put into vessels. The refuse left behind at operations 3 and 6 of the starch extraction, and on the filters in the manufacture of glucose goes to the making up of an animal feed.

INDUSTRY IN THE WEST INDIES.

A company has been formed under the name of the "Jamaica Cassava Development Company" to produce starch in Jamaica

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upon the same lines as the Florida factories. Its capital is £10,000, and there is a factory now at Longville, capable of turning out 150 tons of starch per annum (*vide The Agricultural News, Barbados*, 1903, p. 134, and 1904, p. 161). To make a mill in Dominica is also proposed. The making of Cassava cakes for the American market has been suggested. These are cakes to be made of the meal and put up in tins.

INDUSTRY IN THE WEST INDIES.

In Martinique small proprietors have mills moved by bullocks or by water-power for rasping the cassava roots and means for making starch or cassava meal; actual cultivators grow the crop and bring it to the mill on the metayer system whereby the profits are divided (**Dulien** *in Journal d' Agri. Trop.* 1903, p. 413).

INDUSTRIES ELSEWHERE

Portuguese West Africa makes some cassava meal and so do the Cape Verde Islands. In the British Colonies of West Africa, Cassava meal is the staple prison food.

Mauritius and Réunion have tried tapioca manufacture and so has New Caledonia. Apparently want of capital has held the industry back in all these places.

FUTURE OF CASSAVA STARCH.

Dr. George Archbold in the *Journal of the Society of Chemical Industry*, XXII., 1903, p. 63, puts cassava starch forward as a product of the future destined to replace maize or corn starch. "At the present time the demand for maize and other cereals is advancing their value, so that in the near future they will not be available for the manufacture of starch. The manufacture of starch from maize was introduced into America over sixty years ago by **Thomas Kingsford** who established the Oswego Starch Factory. The superior quality of the product soon created such a demand for "corn starch" that other factories were erected in different States and to-day all are owned by the trust known as the Corn Product Company. Maize starch has its own characteristics which distinguish it from other starches. If a cheaper raw material be suggested (to take the place of maize) for the production of starch and allied products, it must yield them of the same quality. In the plant commonly known as cassava we have such a raw material."

FOOD VALUE OF PRODUCTS OF MANIHOT.

As food, couac and cassava meal differ from Brazilian arrowroot and Tapioca chiefly in the amount of cellulose present. The difference can be well shown by citing the following analyses by **Balland** of samples sent to the Paris Exhibition of 1900 (*Journal de Pharmacie et de Chimie*, 1903, 1st April and 15th May).

It will be observed that to make them keep, almost all the samples of couac and cassava meal have undergone more desiccation than the samples of Brazilian arrowroot and tapioca. It will also be observed that some of the American starches and tapioca still had a little cellulose in them: and that the washing of the latter reduces

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FOOD VALUE OF MANIHOT PRODUCTS.

the small amount of nitrogenous material present and the ash, but not fats, while the percentage of starch is hardly increased.

	Water.	Nitrogenous material.	Fats.	Starch.	Cellulose.	Ash.
Couac and Cassava meal:—						
from Ivory Coast	9·80	1·11	0·25	85·39	2·45	1·00
„ Dahomey	9·50	2·68	0·25	83·62	2·65	1·30
„ Guiana (white)	9·00	1·26	0·20	85·09	2·25	1·30
„ „ (yellow)	10·70	2·05	0·25	83·10	2·60	1·30
„ Martinique	8·80	0·30	0·20	86·85	2·35	1·50
„ „	10·10	0·45	0·40	86·30	1·25	1·50
„ New Caledonia	7·00	2·37	0·85	84·73	3·25	1·80
„ Cape Verde Islands	12·20	1·38	0·15	83·77	2·30	0·20
„ „ „ „	10·80	1·69	0·10	81·06	3·25	0·10
Arrowroot (Starch):—						
from the Guianas	13·50	1·84	0·55	83·16	0·00	0·40
„ „ „	11·80	0·70	0·40	86·36	0·00	0·50
„ Cochin China	15·80	0·44	0·22	83·84	0·00	0·20
„ Madagascar	15·80	0·84	0·20	82·96	0·00	0·20
„ Réunion	14·50	0·44	0·10	84·06	0·00	0·30
„ the Soudan	11·20	0·30	0·25	87·65	0·00	0·30
„ Ceylon	13·50	1·08	0·20	85·02	0·00	0·20
„ Guatemala	13·70	0·46	0·30	84·09	0·75	0·70
Tapioca:—						
from Cayenne	14·90	1·38	0·45	82·87	0·20	0·20
„ „	14·10	0·77	0·45	84·43	0·10	0·15
„ Martinique	9·30	0·30	0·45	88·95	0·00	1·00
„ New Caledonia	13·80	0·45	0·15	85·20	0·00	0·40
„ „ „	13·60	0·30	0·25	85·60	0·00	0·25
„ „ „	12·50	0·70	0·25	86·35	0·00	0·20
„ Réunion	10·60	1·68	0·40	86·82	0·00	0·50

CASSAVA AS A CATTLE FOOD.

It has been mentioned that the waste from Tapioca factories in the Straits Settlements is sold for feeding pigs and that a cattle food can be made from the refuse of starch factories in America. We now

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CASSAVA AS A CATTLE FOOD.

proceed to the use of the whole root for fattening stock. It is to be mentioned that cassava has long been grown in Mauritius as a food for stock, but the only part of the world where a large business of this nature is carried on is Florida.

Before Wiley wrote his article on cassava in 1894 (see *U. S. Dept. Agri. Division of Chemistry, Bull.*, No. 44), the roots were irregularly in local use in Florida and elsewhere for feeding cattle, pigs, poultry, etc. But, after the winter of 1894-95 had largely destroyed the Florida orange orchards, when the farmers took to stock raising and fattening, the cassava plant attracted immediate attention. Now 95 per cent. of the cassava grown in the United States is grown to feed stock (see Tracy, *U. S. Dept. Agric. Farmers' Bulletin*, No. 167, 1903, p. 35), "All kinds of stock eat it with relish and thrive upon it much better than when confined to any dry feed."

"Being so highly carbonaceous in its composition it is commonly fed in combination with bran, cotton seed meal or other nitrogenous grain feed and, when judiciously used, it is one of the most inexpensive feeds which can be grown. It is less watery than sweet potatoes (**Ipomœa Batatas**) or potatoes or turnips, while its yield is fully twice as great. One hundred bushels of sweet potatoes per acre is a fair crop, but it weighs only 3 tons, while from 5 to 6 tons of cassava could be grown on the same ground with less expense. As the roots are always fed in a fresh condition, they furnish an excellent substitute for winter pasture, and so do much to keep animals in good condition through the season of dry feed. When the crop can be grown successfully it can be made to take the place of a silo, as the feed is much more nutritious than silage, and can be used economically when one has too few animals to make a silo profitable. In nearly all cases the roots are fed as fast as they are dug, as they never fail to keep in good condition so long as they are left undisturbed in the ground where they have been grown. The roots are so smooth that if they are dug when the soil is dry they need no washing or cleaning before being fed, and no special preparation beyond cutting them into small pieces before feeding them to cattle."

Professor Tracy continues on page 24 to show that stock does very well on cassava. As to the method of feeding, it is best done by crushing or chopping the root up before giving it to the animals.

Pigs are more often fattened on cassava than cattle; and for poultry it is very largely used.

The Lake Mary starch factory in Florida finds a ready sale for the factory waste dried as a cattle food. It is not an ideal food owing to want of proteids, but may well be mixed with other nitrogenous food. This factory waste must be dried at once or it turns sour. Technically it is called bitty.

CASSAVA AS A CATTLE FOOD.

Factory waste ought always to be a safe cattle food owing to the working that it has had; but we do not know how far it is safe out of the United States to give fresh cassava to cattle. Under the conditions of and with the races grown in Florida, cattle can be fed on the fresh chopped roots, but as a general rule means should be taken to get rid of the prussic acid by washing or better cooking before animals are allowed to touch the roots.

YIELD PER ACRE.

Yield per acre.

Satisfactorily attested yields in North America with sweet cassava, per acre.

	lbs.
1. On poor light worn soil (Tracy)	4,480—5,600
2. On average soils (Tracy)	11,200—15,680
3. On the very best soil, unusual yields (Tracy)	22,400—33,600
4. In Mississippi, manured with 200 lbs. bone meal (Tracy)	20,160
5. In Alabama, on excellent soil (Tracy)	28,000
6. In Florida, unmanured (H. E. Stockbridge)	7,420
7. In Florida, manured heavily with acid phosphate, cotton-seed meal, kainit (H. E. Stockbridge)	12,979
8. Average crop round Lake Mary factory, Florida (Thomson)	20,160.

References.—*1–5.* Tracy in *U. S. Dept. Agri. Farmer's Bulletin*, No. 167, 1903, p. 21. *6 and 7. U. S. Dept. Agri. Experiment Station Records*, XI., 1900, p. 334. *8.* R. Thomson *Report on the Cultivation of Pineapples in other Products of Florida*, Kingston, Jamaica, 1901, p. 11.

Yields, per acre, in Tropical America which may be accepted.

	lbs.
St. Lucia, red-stemmed race (Dulien in *Journ. d' Agri. Trop.* II., 160)	8,400
St. Lucia, white-stemmed (Dulien in *Journ. d' Agri. Trop.* II., 160)	13,440
Paraguay (Semler, *Tropische Agricultur*)	13,379
Jamaica, bitter cassava, not irrigated (*Journ. Jamaica Agri. Soc.*, 1899)	19,054
Jamaica, bitter cassava, irrigated (*Journ. Jamaica Agri. Soc.*, 1899)	32,664

Yield in Africa which may be accepted.

	lbs.
Soudan, (Vilbouchevitch in *Journ. d' Agri. Trop.*, II., p. 160)	13,597

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YIELD PER ACRE.

Yields in the East which may be accepted as correct, per acre.

	lbs.
1. Pondicherry (Poulain)	2,423—4,846
2. Madras	10,880
3. Cochin China (Paris *ex* Vilbouchevitch)	10,703—16,055
4. Madagascar, without manure (*ex* Vilbouchevitch)	12,754
5. Madagascar, manured (*ex* Vilbouchevitch)	25,866
6. Madagascar frequent range (Jumelle)	13,379—44,597
7. Réunion (Jumelle)	22,298—26,758
8. Ceylon (Watt)	22,400
9. New Caledonia (Semler)	22,622
10. Andaman Islands	24,200
11. Java (van Gorkom)	13,333
12. Do. do.	27,428

References.—1. in *Journ. d' Agri. Trop.* II., 1902, p. 14; 2. *Madras Agri. Dept. Rep.*, 1879, p. 44; 3. in *Journ. d' Agri. Trop.* II., 1902, p. 299; 4 and 5. *Rapport de la Commission indigene*, 1898, quoted by Jumelle in his *Cultures Coloniales, Plantes alimentaires*, p. 57; 6 and 7. Jumelle loc. cit.; 8. *Dict. Econ. Prod.*; 9. Semler, *Tropische Agricultur*, II., p. 766; 10. *Administration Report of the Andamans Islands*, 1885-86, p. 53; 11 and 12. *De Oost indische Cultures*, Supplement, p. 275.

Statements which are not accepted, per acre.

	lbs.
Calcutta (Mukerjee in *Englishman* of 28th July 1898)	38,150
New South Wales (*Agricultural Gazette, New South Wales*, II., 381)	22,400—44,800
British North Borneo (*British North Borneo Herald* quoted in *Produce World*, 14th February 1896)	93,333
Annam (*The Planter*, Calcutta, 11th November 1899)	35,677
Florida (Semler, *Tropische Agricultur*)	66,895
New Caledonia (Jumelle, *Cultures Coloniales*, l. c.)	37,461
Brazil (Jumelle, *Cultures Coloniales*, l. c.)	89,194
Guatemala (Niederlein, *La Yuca*, 1896)	160,550—26
Florida (Jumelle, *Cultures Coloniales*, l.c.)	
Demerara (A. M. and J. Ferguson in *All about Aloe and Ramie Fibres*, etc., 1890)	

CULTIVATION.

Cultivation.

Propagation.

Propagation is done by means of cuttings and has been so carried on for ages. Some of the kinds of Manioc rarely flower and

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seed. Sagot says that he never, to his recollection, saw the sweet cassava or camanioc flowering in South America; and sweet cassava flowers very rarely indeed in India. Sagot goes on to say that a certain "Father Labat affirms that Manioc plants raised from seed give but poor roots. May we believe that stock raised from seed remains as vines do, for many years puny and backward, until after several successive propagations by cuttings they attain their proper vigour and height?"

Fortunately it is the easiest to grow from cuttings. When the roots are dug, the stems are to be kept for cuttings. The way in which they have to be treated depends entirely on whether any cold is likely to be experienced or not: for they are sure to be cut down by the slightest frost. If frost is likely to occur they must be buried in straw or wrapped in straw and put in a shed. But if no frost is likely to occur and the land for them can be got ready at once, they are to be cut up into short lengths and planted. If the land is not ready and the air moist, there is only moderate harm done by leaving the whole stems in a shady moist place as they are; or in drier air the ends of the stems whole may be pushed into the earth in a shady moist place where they will root and grow slowly for a time until required.

Guarding against frost

G. A. Gammie in a note sent to me says that the natives of the Darjeeling District carelessly leave the stems lying about the ground for months until the advent of the monsoon and that they take no harm.

Planting the cuttings.

Upon planting out the fields these branches are cut into lengths of four to eight inches and set in the ground at an angle of 45° with half their lengths in the soil. Rarely they fail to grow; but usually cuttings will be numerous enough to allow of two being set together along the lines at every four feet, so that if one fails there may yet be no gap in the crop. The lines should be 4 to 5 feet apart. The middle parts of the stem, not too old nor too young, generally grow most readily, a plant will yield a hundred cuttings or more.

Water.

Frost is fatal to all races of Manihot; any cold that kills Tomatoes kills them. During the first two months of the plant's growth it requires a moderate supply of water, after which many of the races are fairly resistant to drought though retarded by it.

Soil.

The soil should be rich and light. If references be made to page 144 above and to the first three figures of the tabular statement, the effect of poverty of soil on the yield is obvious. The one thing most against the cultivation of the plant is its enormous demand for available plant food. All the tropics over it has been a great crop for light virgin forest soil. In Florida it is best grown on land

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cleared from pine forest in rolling country, in Brazil on clearings, in West Africa on clearings; and in the Straits Settlements the crops are getting further and further away from the original centres as the land gets worked out. In India it is the same, too, clearings are made and it is planted in Travancore and Sikkim.

The soil of gardens always richer than that of fields is in many other places the only soil in which it is planted. Soils with very much humus in them are not good as they caused the tops to grow at the expense of the roots, and soils which want drainage are most unsuited. Ideal soils are the soils which grow sweet potatoes well.

Irrigation.

Irrigation in India is generally given about Pondicherry and a little in Travancore but hardly elsewhere.

On the flat or not.

Cultivation in Florida and most other places is on the flat, in the French West Indies it is sometimes on low ridges, and in St. Lucia on low mounds like a tortoise back (Dulien in *Journ. d'Agric. Trop.* II., p. 160).

Weeding.

No very special cultivation is required after the crop is planted out except to keep the soil free from weeds. When the plants have grown up a little they cast shade enough to do this for themselves.

Cost.

The cost of cultivation is no more than that of cotton. When

Harvesting.

the crop is ready for the harvest dig only as it is required for the tubers soon begin to rot when out of the soil. Two or three days are enough to cause a blackening unless great care be taken. Very many of the roots sold raw in the Madras bazaars are sold with rotting commencing. I believe that they are sold cooked in Pondicherry and Cuddalore more to prevent the rotting than to remove the poison.

Maturity.

The time at which the crop is mature depends on the race grown. It may be seven or eight months, or even six months in one Travancore race, or it may be eighteen or more. In the Madras Presidency with irrigation the crop is planted in December or January but without irrigation in the end of July or beginning of August. The roots come to the markets from the irrigated lands in November. Sawyer tells us (*Indian Forester*, XXI., 1895, p. 291) that the Malayalam cultivator of Travancore puts in his cuttings in October or November, but if the rains be late he digs the crop up immature and plants again if he can irrigate with copious irrigation at the end of March. There must be for each race a period when most profitably to harvest it, to grow it beyond which is to get possibly a little heavier crop, but a monetary gain not as heavy as the land should give. The optimum periods of these races need to be ascertained by direct experiment, for we do not know them. Probably, however, for most races it is at twelve months. The loss of

Times of planting and harvest in India.

Roots left in the soil.

CULTIVATION.

roots in the soil in digging is great if the soil be heavy, but if the roots be small and the land light there is no cause for losing a single tuber. In Mauritius, Réunion and some of the smaller West Indian islands Cassava crops are planted to alternate with sugarcane in the place of a fallow. As both crops take a great deal out of the soil, manure must be given liberally. The practice has existed for a considerable time in the first named British Colony. Cassava without manure would do much better after a leguminous crop,—a method of rotation practised in the United States.

Alternative.

In some countries maize or an unirrigated rice are grown between the Cassava plants, and return a small yield.

M. 216-30.

(472)

G. I. C. P. O.—No. 1384 R. E. P.—26-8-1904—2,500—P. M. H.

THE

AGRICULTURAL LEDGER.

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(Oils and Oil-seeds.)

THE AGRICULTURAL LEDGER.

1904—No. 11.

CARTHAMUS TINCTORIUS

(SAFFLOWER).

[*Dictionary of Economic Products, Vol. II., C. 637—80.*]

Other DICTIONARY articles that may be consulted:

Carthamus Oxyacantha, Vol. II., C. 633; *also*

The Agricultural Ledger, 1899, No. 12; 1901, No. 12.

A digest of the correspondence conducted by the office of the Reporter on Economic Products to the Government of India.

By REGINALD ABBEY-YATES.

INTRODUCTORY.

The following pages deal mainly, if not altogether, with safflower as it exists in cultivation. They are as the title above states a digest of unpublished information from the files of the office of the Reporter on Economic Products: very little information borrowed from books has been added to it. Regarding wild safflower (**Carthamus Oxyacantha**) the reader should consult *The Agricultural Ledger*, No. 12 of 1901. It may here be added that the oil of safflower has been dealt with as an edible oil in *The Agricultural Ledger*, No. 12 of 1899, in which will be found Professor Wyndham R. Dunstan's valuable Report on Edible Oils used in India.

Carthamus tinctorius, *Linn., Fl. Br. Ind. III., 386; Ind. Kew.* [*I.* 445.

THE SAFFLOWER.

Vern.—*Kusum, kásumba, kar* (the seed), *barre*, HIND.; *Kusum, kusam phul, kajirah, darhua* (the oil), *kushi* (thorny), *murai* or *mundo* (thornless variety), BENG.; *Ga'áp machú*, MANIPUR; *Kúsam, kúrtum, kushumbha, ma. sufir, karar* (*khar, tolian*=seed), PB.; *Barre, kar*, UNITED PROV.; *Bundi*, RAJ; *Kusumba, kurdai*, BOMB.; *Kusumbo* (*kabri*=the seed), GUJ.; *Kurdi, kavarhi, kasdi, sadhi* (oil plant), *kardai*, MAR.; *Kusumba*, CUTCH; *Powári-jo-bij, kardai, kurtum* (seed), *khoinbo* (the plant), SIND; *Khardi* (oil), *kasar* (thorny), *kusum* (smooth variety), C. P.; *Karad*, DEC.; *Sendurgam, kushumbá, kushumba-virai, sendurkun*, TAM.; *gnisikha, kushumbá-vittu-lu*, TEL.; *Kusanhe* (or *kusambi*), *kusumi* AN.; *Hetoo, su, hsú-wine, supán, subán*, BURM.; *Qurtum, girtum* *sfar*, ARAB.; *Kashirah muasfir, kasak dánah*, PERS.; *Kusur* *kamalottara, kushumbha*, SANS.; *Kurtim*, EGYPT.

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CARTHAMUS tinctorius. **A digest of the correspondence conducted by the office of the**

BENGAL. Muzaffarpur.

Two forms of the plant are met with in Muzaffarpur, Bengal, (*a*) the thorny variety known as *kuthi*; (*b*) the thornless kind called *murdi*. The first named is believed to flower earlier than the other. The flowers usually appear from the 1st of January to the 15th February. Seeds are collected in March and April. The seat of the safflower industry is Hajipur. The area at present under cultivation, however, is stated to be only one-tenth of what it was some years ago. Safflower is a crop of the cold weather, it is generally sown about the middle of October, and is usually preceded by a bhadoi crop. But when grown with opium, the land is left fallow till September. The time of sowing depends upon the amount of moisture in the land.

Subsidiary crop.

Safflower is now cultivated as subsidiary to the following crops: potato, mustard, opium, barley, wheat, linseed, and gram. Opium and safflower are said to be particularly suited to each other.

Cultivation.

Soil.—While it is reported that the plant can be grown on all soils, it is said to prefer a sandy loam, or a light soil with an admixture of sand and clay. Safflower is generally cultivated on irrigated land. A purely sandy soil is not desirable.

Manure.—No special manure is used for this crop. Opium lands are often manured with cowdung and ashes.

Ploughing.—The number of ploughings varies according to the nature of the soil; usually six ploughings suffice.

Sowing.—When cultivated as an independent crop, it is sown broadcast at the rate of 10 seers per acre; raised as auxiliary to other crops, the seeds are sown on small banks thrown up with the shovel, about an inch above the water channel. In this case between 5 and 6 seers of seed to an acre are allowed.

Irrigation.—Safflower lands are usually irrigated by means of water channels from wells.

Thinning the crop.—The plants are ordinarily grown a cubit apart. When the growth is too thick, the young plants are thinned out. On the other hand, the tops of the plants are often broken off to induce a bushy growth.

Picking the flowers.

Picking the florets.—In small holdings, this work is generally done by women and children; for a large area a picker is usually employed. The florets are plucked or nipped off with the hand. The picker receives 1 flowerhead for every 16 flowerheads gathered. He is sometimes paid in corn, in which case he receives half the weight of the flowers he collects; for collecting 5 seers of florets, he thus gets as his share 2½ seers of maize or like crop. Delay in gathering the florets until red by exposure to the sun is said to weaken the dye. Moreover, when the florets are allowed to get crisp by heat, the pod does not afford any further supply. If care be taken, three successive supplies of florets can be obtained. Picking is generally done every three days.

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BENGAL.

Weather.—A good shower before the time of flowering is generally very beneficial to the crop; heavy rains at this season are disastrous, and if followed by cloudy weather are said to favour the spread of an insect pest called *lahi*. A west wind is believed to improve the quality of the dye.

Diseases.

Insect pests.—The plant is liable to be attacked by *lahi*. These, as already stated, are thought to be induced by foggy weather. They cripple the plants and prevent the growth of flowers.

Cost of cultivation.

Cost of cultivation.—As an independent crop per acre—

	₹	a.	p.
Rent of land per acre	12	0	0
Cesses	0	12	0
Six ploughings @ 10 annas	3	12	0
10 seers of seed	1	4	0
Hoeing each 4 annas	1	0	0
	18	12	0

To this must be added the cost of picking florets and collecting seed.

Yield.

Yield.—Average outturn per acre—

	lb
Flower crop	80
Seed crop	1,000

Prices.

Prices.—Safflower has largely retrograded in price. While formerly sold at 4 lbs. per rupee, the average price at present is one rupee for 12 lbs. The average value of seed is 20 lbs. per rupee. The price of safflower rises early in those months in which marriages are largely celebrated.

Cultivators consider that a constant ratio exists between the two crops of flower and seed of 1:16. Thus if the flower crop be a chittack ($\frac{1}{16}$ of a seer) a seed crop of one seer will be expected. (*Mr. Bhupendra Nath Gupta, Assistant Settlement Officer.*)

Dacca.

Safflower was at one time a very important crop of the Dacca district. Of the 8,448 maunds of safflower dye, valued at ₹2,90,655-8-6, that passed the Calcutta Custom House in 1824-25 it is estimated that two-thirds were grown in the vicinity of Dacca . . . The industry declined with the introduction of aniline dyes. Some few villages in the Nawabgunge thana are now the principal places where safflower is still grown to any extent. . . . As was the case formerly the village of Patharghata produces the dye of the best quality. . . . (*Report on Agriculture and Statistics of the Dacca district, by Mr. A. C. Sen, C.S., 1889.*)

The reader may here consult pages 292 to 295 of *Handbook of Indian Agriculture*, by Mr. N. G. Mukherjee regarding safflower in Bengal.

CARTHAMUS tinctorius.

A digest of the correspondence conducted by the office of the Reporter on Economic Products. (*Reginald Abbey-Yates.*)

UNITED PROVINCES.

Cultivation.

Cultivation.—In the Western districts of the United Provinces, *e.g.*, Meerut, Muzafarnagar, Aligarh, etc., safflower is commonly raised as a fodder crop and fed to cattle before the plants begin to flower. In Cawnpur, Jalaun, and Jhansi, it is cultivated as a dye crop.

Varieties.—There are two kinds, the one thorny, the other without thorns. The latter is grown mainly for the dye and the former for its seeds from which oil is extracted. Safflower is seldom sown as an independent crop. It is usually grown along with wheat, barley, gram, and other cereals, also with vegetables, such as radish, carrots, etc. When raised with vegetables, it is generally sown broadcast, but when grown along with cereals it is sown on the borders of fields, and by the side of *barhas* or irrigation channels.

Soil.—A stiff clayey soil together with high manuring and careful hoeing and weeding are desirable. The crop is thinly sown, to provide room between the rows for weeding. The quantity of seed per acre of the two varieties of safflower (the thorny and the thornless) when sown alone is 6 and 15 seers, respectively. When grown along with other cereals only 2 or 3 seers of seed per acre, respectively, are employed.

Prices.

Price.—The price of the seeds of the thorny and the thornless varieties is R2-6 and R2- per maund (82·3 lb) respectively (*note furnished by the Director of Land Records*).

In response to an inquiry for recent figures showing cropped area under Safflower, the Director of Land Records and Agriculture, United Provinces (letter No. 1607—VIII-64, dated 14th April 1904) states that as safflower (**Carthamus tinctorius**) does not form a separate heading in the annual crop returns, the area under this crop for 1901-02 or 1902-03 cannot be furnished. The Director further remarks it is very rare to find this crop grown by itself: practically all of it is sown in lines in wheat and gram fields.

CENTRAL PROVINCES.

The safflower dye industry was formerly one of some importance in the Central Provinces, but latterly has been almost killed by the large imports of cheap aniline dyes. In the Nagpur and Wardha districts a little safflower is still grown. In Chhindwara cultivation of the dye plant has almost entirely ceased, while in Seoni it no longer exists.

Cultivation.

Soil.—Safflower is grown in black or brown soil suited for wheat: it thrives best in fields which from their proximity to the village receive a considerable supply of manure. Sometimes the fields intended for safflower are first well manured with cow dung. As a rule the crop is not irrigated. Safflower is generally cultivated as a subsidiary crop to gram, linseed or castor and in most cases along the borders of fields.

Two kinds of safflower are grown (1) the *kusum*, possessing a smooth leaf, and (2) the *kasar*, a thorny plant with a rough leaf.

CENTRAL PROVINCES.

The *kasar* is cultivated for its oil alone. The *kusum* is grown both on account of the dye and of the oil. The seed is sown towards the end of the monsoon, and the plant begins to flower after a couple of months. An excessive or a deficient amount of moisture proves very injurious to safflower—hence in a wet year it is grown in high and in a dry year in low lying or irrigated ground.

Plucking.

Plucking.—The flowers are picked at intervals of three days in the early or late cold weather according as the plant was sown in September or December or at some time between these months. The flowers are gathered early in the morning as they suffer much damage if exposed to the midday glare after picking.

The cost of cultivation of safflower is estimated at about R12 per acre. At the present low prices the gross profits are only about R15 an acre as against R25 gained a few years back. The prospects of the industry are thus far from encouraging.

Area.

Area under cultivation.—This is shown in the following table. The figures for 1903-04 have been kindly furnished by the Commissioner of Settlements and Agriculture, Central Provinces (letter No. 3326—163, dated the 8th July 1904.

Statement showing the acreage under Safflower during 1894-95 and 1895-96 in each district of the Central Provinces.

District.	1894-95.			1903-04.		
	Rough leafed (oil plant).	Smooth leafed (dye plant)	Total.	Rough leafed (oil plant)	Smooth leafed (dye plant)	Total.
1	2	3	4	5	6	7
	Acres.	Acres.	Acres.	Acres.	Acres.	Acres.
Saugor	15'07	...	15'07	'10	'20	'30
Damoh			Not produced.			
Jabalpur			Ditto.			
Mandla	227'03	...	227'03	97'59	...	97'59
Seoni	430'73	...	430'73	424'15	...	424'15
Narsinghpur	...	15'03	15'03	'61	'08	'69
Hoshangabad	Not grown for some years.			3'32	...	3'32
Nimar	0'10	...	0'10	'23	'52	'75
Betul	56'88	...	56'88	60'27	..	60'27
Chhindwara	...	224'35	224'35	120'01	25'08	145'09
Wardha	21'33	3'27	24'60	10'42	46'02	56'44
Nagpur	...	127'53	127'53	8'34	...	8'34
Chanda			Not produced.			
Bhandara	71'46	0'96	72'42	68'85	'15	69'00
Balaghat		Not grown.		75'40	....	75'40
Raipur	241'36	914'14	1,155'50	893'66	1'96	895'62
Bilaspur	8,234'00	...	8,234'00	8,687'00	...	8,687'00
Sambalpur	1,232'32	...	1,232'32	1,880'09	...	1,880'09
Total	10,550'28	1,285'28	11,815'56	12,333'04	74'01	12,407'05

CARTHAMUS tinctorius.

A digest of the correspondence conducted by the office of the

PANJAB. Hoshiarpur.

From Hoshiarpur, Panjáb, it is reported that the area under cultivated *kasumba* (Carthamus tinctorius) has diminished considerably since the introduction of aniline dyes. These may be said to have driven the indigenous product quite out of the market. It is noted on page 186 of Volume II, Dictionary of Economic Products, published in 1889, that the area under cultivated safflower in the Gurshankar Tahsil of this district was 6,722 acres. The figures of 1895-96 for this same tahsil show an area under *kasumba* of 1,624 acres only, or less than a quarter of what it was fourteen years previously.

Cultivation.

Kasumba is sown broadcast as a subsidiary crop, along with wheat, gram, barley, and *masar*. It is sometimes raised as an independent crop. The plant prefers a light sandy soil, especially in the hilly slopes. In the plains a land well ploughed is considered best.

No irrigation is required nor does the land receive any special preparation. A single weeding in the month of December is considered sufficient. The winter rains of December and January do the crop no harm, but subsequent rains are liable to damage the flowers. The custom prevalent in Bengal of snipping off the central bud with a view to bring about a more bushy growth is quite unknown in this district. The flowering begins about the last week of March, and is fairly established towards the middle of April. Each flower head is picked three times, the second pickings having the greatest value as they contain the most colour. Plucking is done on alternate days.

Hoshiarpur.

Insect Pests.—The plant is attacked by an insect known locally as *tela*, which also does damage to mangoes and sugarcane.

Cultivation.—In 1895 the total area under cultivation in each tahsil and for the district was reported to be as under—

	Acres.
Hoshiarpur	80
Garhshankar	1,624
Dasuya	5
Una	690
	2,399

The following figures recently received show that the cropped area under safflower in the Hoshiarpur district has still further receded :—

Total area under safflower (Carthamus tinctorius) *in the Hoshiarpur district during the year 1902-03.*

Tahsil.	Area sown in acres.
Hoshiarpur	8
Dasuya	...
Garhshankar	504
Una	146
	658

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CARTHAMUS tinctorius.

PANJAB.

Yield per acre of cultivated *kasumba*—	R	a.	p.
Flowers 16 seers at 4 seers per rupee	4	0	0
Seed 3 maunds at R2-6-9 a maund say	7	4	0
TOTAL	11	4	0

Deducting half as cultivator's share, the owner's share is R5-10 and with R1-8 further deducted for revenue, a net income of R4-2-0 per acre is arrived at (*Mr. Kesho Das, Revenue Assistant*).

Ambala.

About Ambála the crop is sown in September at the rate of 13 lbs. to the acre. The plant flowers in the beginning of April. The flowers are plucked by hand in such a manner as not to interfere with the seeds which remain in the pods. About 15 or 20 days after the removal of the flowers, the seeds are gathered, and if not perfectly dry, they are placed in the sun. The yield of flowers for dye per acre is 78 lbs. and of seed 5 cwt. 16 lbs. The same plants yield both dye and oil (*Deputy Commissioner, Ambála*).

SIND.

In Sind safflower is sown in October, November and reaped in March. The land is first ploughed three or four times, it is then harrowed and the safflower seed sown like wheat. When the crop grows up and bears pods, the flowers are plucked with the fingers. The process of plucking is carried out thrice.

Only one cultivated form of the plant is recognised locally. It was formerly grown for the oil and also for the dye, but since the introduction of cheap European dyes, it has ceased to be cultivated to any extent. The yield of oil seed per acre is from 30 to 40 seers. The price per cwt. of seed is R10-4. In 1895 the production was reported to be small and local: in 1902 the cultivation is stated to have been *nil.*, *conf.* p. 158.

Conf. p. 158.

BOMBAY.

Two forms are cultivated in the Bombay Presidency—(*a*) the yellow flowered thorny variety of the Deccan, grown only for its oil-seed; (*b*) a less spiny or nearly spineless form, with reddish orange flowers cultivated in Gujerát as a dye and also for its seed.

Cultivation.

The dye plant is grown almost exclusively in the rich alluvial soils of Northern Gujerát, and on similar land in the Baroda territory. The fields intended for this crop are fallowed very carefully during the monsoon, and are liberally manured. It may be questioned whether the careful tillage does not develop the red dye matter in the flowers, and it is quite possible that the Gujerát plant, owing to this high cultivation, has become less spiny.

The plant in Gujerát or the Deccan grows to a height of about 18 inches to 2 feet. It is usual to nip off the leading shoot from each

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BOMBAY. Cultivation.

plant to encourage lateral branches and the formation of a larger number of flower heads.

In Gujerát the name *kabri* is given to the seed. The crop is called *kasumbi*, and the petals prepared for dye *kasumba*. In the Deccan the Maráthi name *kardai* is given to the seed or the crop.

In the year 1895 safflower stood first amongst the oilseed crops of the Presidency with an area of over 500,000 acres annually. The chief centres of cultivation are Sholapur, Ahmednagar, Poona, Bijapur, and Belgaum. As a dye plant it is grown sparingly in the Karnatak as well as in Gujerát. In the Deccan safflower does best in black soil. It is almost always grown as a row crop with rabi *jowari* (**Andropogon Sorghum**) dry crop, wheat or gram (**Cicer arietinum**). It often occupies the headlands of cereal fields as a protection because cattle do not care to trespass through it on account of the thorns or spines. As a subordinate crop with *jowari* or wheat, three adjacent rows of safflower alternate with 12, 15, or 18 rows of the principal crop.

The rows of the principal and subordinate crop are the same distance apart, *viz.*, about 12 to 14 inches. The seed is drilled in September or early in October; 5 lbs. *jowari* and 1 to 1½ lbs. of safflower is an ordinary seed rate. The crop will succeed best if the field has been carefully prepared during the monsoon, but it is exceptional to plough black land in the Deccan oftener than once in three years. If the field is not ploughed, the heavy hairow is used once or twice before the rains, and once a month during the monsoon up to September. No manure is ordinarily applied. The crop may be once bullock-hoed, but if the field has been well harrowed during the monsoon, weeds are not likely to appear in the rabi season and weeding is not required. If rain falls after sowing, the surface soil should, as soon as it dries, be stirred by the bullock hoe. Safflower ripens in March. The crop is ready for harvest when the plants turn yellow. It is reaped or uprooted and lies in small loose heaps in the field for a few days. The seed is then separated with a flail or long bent stick. It is difficult to give even approximately the outturn of oil seed from a row crop. The result of a crop-test taken in the Ahmednagar district in 1890-91 is tabulated below, and is nearly average :—

	Jowari.	Safflower.
	lbs.	lbs.
Seed rate per acre	4	1
Outturn per acre grain and seed	664	96
Value per rupee	55	43

Reporter on Economic Products. (*Reginald Abbey-Yates.*)

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pecial test taken in 1895 resulted as under. The crop was a row crop with *jowari*. Three consecutive rows of safflower as usual grew together. The distance between the rows was accurately calculated and checked by measuring the distance between the coulters of the drill used. Each strip of safflower was held to occupy an area of three times the distance between the rows or the coulters of the seed drill. The crop from more than an acre of ground (according to the above data) was tested and yielded 464 lbs. per acre. The seed was worth at the rate of one rupee per 35 lbs. (*Mr. James Mollison.*)

For further particulars regarding the plant as it occurs in the Bombay Presidency the reader may consult Mr. J. Mollison's *Textbook of Indian Agriculture*, 1901. Vol. III., pages 98 to 101.

Baroda State. Petlad Taluka.

Soil.—In Baroda safflower is grown on both clay and sandy soil; a medium loam is considered the best. Safflower is a rabi crop, and is best raised on land that has been fallowed during the monsoon. It matters little what crop has been cultivated in the previous year, but after safflower, kodra and cotton (usually *kahnami*, *i.e.*, the cotton of the Kahnam—the black soil district round Broach) or *chino* (**Panicum miliaceum**) and cotton are always grown. During the monsoon, land intended for safflower is ploughed and harrowed frequently. It is ploughed eight times with the light two bullock plough of Gujerát (*hal*) and harrowed four times. But this of course depends on the season, and on the opportunities the cultivator has for working the land. The object of the cultivator is to make the soil soak up as much rain water as possible during the monsoon, but the field at seed time should be smooth, friable, and comparatively dry near the surface. The seed is sown by drill in the end of September or the beginning of October, whenever the ryat thinks that the rains have ceased. The rows are about 18 inches apart. About 15 lbs. of seed are required to sow an acre and with the safflower 1 lbs. of castor-seed is usually mixed. Safflower seed should not be buried more than two inches deep. Before sowing, the land gets 15 to 20 cartloads of cattledung per acre, or failing this sheep are folded on the land instead. When it can be had sheepdung is considered the best. Should rain fall after sowing, the land is bullock-hoed, otherwise no after cultivation is required. (*Note by Mr. B. C. Shah.*)

From the annual report of the Department of Land Records and Agriculture, Bombay Presidency, for 1901-02 we learn that there was an aggregate increase . . . in safflower of 48 per cent. [in the area cropped] . . . still in very large defect of the acreage

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Extent of cultivation.

in ordinary years. The extent to which the safflower plant is cultivated in the several districts is shown by these figures :—

	District.	Dye crop (*Kasumba*). Area in acres.	Seed crop (*Kardai*). Area in acres.
A.	Bombay Presidency Proper—		
Gujerát	Ahmedabad	1,362	981
	Kaira	1,646	828
	Pánch Mahál	...	...
	Broach	3	...
	Surát	...	...
Deccan	Khandesh	3	1,492
	Násik	...	10,096
	Ahmednagar	...	88,094
	Poona	...	48,159
	Sholapur	...	72,721
	Sátára	...	15,492
Karnatak	Belgaum	...	29,102
	Bijápur	...	48,952
	Dharwar	...	38,461
Konkan	Thána	...	...
	Kolaba	...	6
	Ratnágiri	...	...
	Kánara	...	
	TOTAL	3,014	354,384
B.	Sind cultivation	*nil.*	*nil.*

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Baroda.

Cloudy * weather during growth and moderate cold are in Baroda said to favour flowering and seeding, but frost is very injurious. Harvest begins in January and continues throughout February, the flowers being picked every fourth or fifth day. More than a dozen pickings are made during the monsoon. The flowers are collected in the early morning (picking must cease before 10 A.M.). In the evening the flowers gathered in the morning are roughly pounded in a mortar and sifted to prevent them from adhering to each other. The sieve is a charpoy (bedstead) covered with a network of string. On the 2nd and 3rd days the pounding and sifting processes are repeated. On the fourth day the flowers are thoroughly dried by being spread out in the sun. They are once more pounded and placed in a sack ready for use. Occasionally they are moistened with sesamum oil before being stored, but the practice is not recommended. From the first to the sixth picking, the quality of the flowers improves, after that the quality falls off, the colour of the petals becoming less bright.

After the petals have all been picked, the plant is allowed to become dead ripe, the crop is then cut and the seeds are separated by beating on a wooden board.

* "This is very doubtful. I should rather say cloudy weather was harmful"—J. Mollison.

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BOMBAY.

Baroda.

The seed harvest usually takes place in the beginning of March. A very good crop is expected to yield 1,600 lbs. of seed and 150 lbs. of dry (four times this quantity of fresh) flowers per acre.

Gujerat.

The safflower crop in Gujerát is, however, liable to injury from many causes. Rain after sowing is practically fatal. It is not often that a full crop is harvested. The following figures obtained from results on the Nadiad Experimental Farm may be taken as average :—

Outturn of seed per acre.	Outturn of dry flowers per acre.
lbs.	lbs.
973	113

Seed sells at 33 to 40 lbs. per rupee, and dry flowers at 7 to 8 lbs. per rupee. The produce is mostly exported, but a small amount of both the oil and the dye is prepared locally. (*Mr. B. C. Shah, Agricultural Officer.*)

MADRAS.

In a recent letter, Dis. No. 461, dated the 18th April 1904, the Deputy Director of Agriculture, Madras, states :—"The crop is grown to some extent in the Bellary and Kurnool districts as a late crop on black cotton soil, but I never saw a field of safflower, though occasionally when the sorghum, amongst which it is usually sown, fails or is poor, the safflower makes a fair show. The crop is most generally grown in narrow strips along the margins of the fields as an obstacle to cattle straying off roads and paths among the sorghum crops. . . . . The total crop is, I believe, unimportant, though besides the localities mentioned, safflower plants may be seen in many parts of the country."

BURMA.

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Leaves of **Carthamus** are eaten largely as a vegetable in Burma, and may be readily bought in the bazaars in January and February.

Minbu. Thayetmyo.

The Deputy Commissioner of Minbu reports about 3 acres cultivated in his district. The plant flowers in March.

In Thayetmyo one variety only is stated to be grown for purely local consumption and that to a small extent.

Henzada.

From Henzada it is learned that only one variety is cultivated during the cold season. In this district the safflower plant cannot be transplanted : this has been tried. The flowers are used for extracting a red dye.

Kyaukse.

One variety only is cultivated in Kyaukse and that for its leaves. The area under safflower is infinitesimal. The seed is generally sown broadcast in October and November, and the seed for the next year's use is gathered in February and March. The Burmans never at any time crushed the seed for oil. Formerly, before imported dyes became cheap, a dye used to be extracted from the flowers, and the area under safflower was much larger. The practice of extracting a dye from the flowers, it is reported, has now entirely ceased in this district.

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BURMA.

Northern Division.

In the Northern Division the cultivation of safflower is limited to garden plots near a few towns and is infinitesimal in amount with the exception of Mandalay where, however, it is not grown to any extent.

Central Division.

Central Division. Cultivated only in the Ava Sub-Division, Sagaing district, the annual outturn in good years being about 25 baskets (225 gallons).

The Oil.

BENGAL.

Dumraon.

Yield.—In Dumraon, Bengal, the best kind of seed yields 30 per cent. of oil.

Uses.—It is employed by the inhabitants as a lamp-oil. It is also applied as a preservative to leather buckets used for drawing water from wells. A bucket so treated will last, it is said, over a year; moreover it is stated that rats will not touch it.

Dry Hot Extraction of oil.—An ordinary sized earthen vessel is puddled all over with mud to the thickness of about ½" and well dried in the sun. The seed is then put in the vessel, and the latter placed upon the "oven." The vessel is then covered with cowdung cakes which are now set on fire. The oil falls through a hole at the bottom of the vessel into a smaller vessel placed below in the middle of the "oven" to receive it.

Muzaffarpur.

The seed is known in the Muzaffarpur as *Barrè*, and the oil as *Barrè ka tel*. The oil may be extracted cold and dry in the following way. The husks are carefully removed by pounding the seed in a mortar. The seeds are then crushed in an ordinary oil mill. Four seers of seeds will give two seers of unhusked material and one seer of oil. The oil-cake constitutes a good cattle fodder.

Or else the oil which is then locally called *jerna-tel*, may be obtained thus :—

The husks of the seed are not removed as in the cold dry process. A hole is dug and a vessel put into it to receive the oil. Above this is placed an earthen jar full of unhusked seeds. On the mouth of the jar is placed an earthen cup or plate secured with mud paste (*chikna matti*). A hole is now bored in the centre of the cup. Pieces of wood or cowdung cakes are strewn over the bulb of the inverted jar and set fire to. If the jar is very full, oil begins to drip in a few minutes. The yield of oil by this process is greater than that by cold method, being 10 chittacks of oil per 2 seers of seed. Yield by ordinary method 7 or 8 chittacks of oil per 2 seers of seed.

Calcutta.

A sample of safflower seed oil prepared by a Calcutta firm was examined by Mr. D. Hooper, Curator, Indian Museum, Industrial Section, who reported as follows :—"The oil has a specific gravity of ·9224 at 15° C, a yellow colour and possesses pronounced drying

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properties. It readily saponifies with alkalis, forming a fairly good soap, and the free fatty acids have some of the characters of linoleic acid obtained from linseed. The oil-cake retains 11·55 per cent. of the natural oil and is not contaminated with any earthy impurity. The nitrogen amounts to 3·19 per cent. which is equivalent to 19·94 per cent. of albuminoids. This is not a very rich oil-cake, and the large proportion of fibrous matter is liable to detract from its value as a feeding substance for stock. It would, however, form a useful manure for many indigenous crops."

BENGAL.

UNITED PROVINCES.

In the United Provinces the outturn of oil-seed per acre of the thorny and the thornless varieties is given at 5 and 4 maunds respectively. The yield of oil from the two varieties if extracted by the ordinary cold dry method is 20 and 22 per cent., respectively. This method of extraction consists in the removal of the husk and the pressing of the kernels in a mill. The hot dry process is not known in these Provinces.

CENTRAL PROVINCES.

Central Provinces.—The oil is extracted from the seeds which are gathered in the case of the *kusum* from the same plant of which the flowers have been collected for the dye. The *kasur* variety of safflower yields more seed than the *kusum* and the seed of the former contains more oil than that of the latter in the proportion of 5 to 4. The oil is extracted by either the dry cold or the dry hot method. The oil expressed by the dry cold method is used for culinary purposes as well as for lamps. Before expression the safflower seed is usually mixed with the *jagni* (**Guizotia abyssinica**) seed, which yields about 30 per cent. weight in oil as against 20 per cent. in the case of safflower. The oil extracted by the dry hot method is used to lubricate the axles of carts and as a salve for sores on cattle.

PANJAB. Hoshiarpur.

In the Hoshiarpur district of the Panjáb the oil is usually expressed just after the rains—September and October—when the husk is damp and can be easily separated from the seed. Very little oil is extracted in a pure state. It is the practice to mix the seed with rape seed and extract the oil for burning purposes. In this way the cake finds a use; the pure cake is valueless as fodder, and if given to milch cattle, it dries up their milk. The oil cannot be used alone for culinary purposes. The only form in which it is offered for sale is when as an adulterant in *ghi*; it has no smell and hence cannot be distinguished from that article. Food prepared in pure oil of *kasumba* is considered indigestible.

Ambala.

In Ambála the oil is extracted by the hot dry process; the yield is equal to ⅛ of the weight of the seeds including husk. The seed

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PANJAB.

SIND.

BOMBAY.

sells at R2-10-8 per cwt. and the oil at 10 lbs. per rupee or annas 14-6 per gallon.

Sind.—The yield of oil to ascertained weight of seed by cold dry expression—the only process adopted in Sind—is 20 seers of oil to 4½ maunds of seed.

Practice in Bombay.—Oil is expressed (without heat) either in the common country wooden mill or in a stone mill. In either case the pressure is applied by a pestle working in a mortar. The seed pressed in the wooden mill is previously husked and sifted in the same way as in Gujerát, whilst in the stone mill the unhusked seed or fruit is used. Water is added to the half crushed seed in either mill, the object being to facilitate the separation of the cake. Oil flows from the stone mill into a receiver as the pressing proceeds. In both mills the cake consolidates by the action of the revolving pestle into a thick layer against the sides of the mortar, and is removed in pieces by means of a short crow-bar. In the wooden mill the oil sinks to the bottom of the mortar, and is removed by soaking it up in a mop and squeezing out the oil with the hand. The results by each process were as under :—

	Weight of unhusked seed.	Water added to half crushed seed.	Oil.	Cake.	Loss.
	lbs.	lbs.	lbs.	lbs.	lbs.
Stone mill	266	20	53	228	5

	Weight of unhusked seed.	Weight of kernels.	Water added.	Oil.	Cake.	Loss.
	lbs.	lbs. oz.	oz.	lbs. oz.	lbs. oz.	lbs. oz.
Wooden mill	44	26 12	8	9 8	15 0	2 12

Baroda State.

Petlad Taluka.

In the Baroda State (Petlad Taluka) cold pressure only is employed. In obtaining the oil the seeds (fruits) are bruised between mill stones set wide apart to remove the husks which are sifted from the kernels by hand by means of the "sup" (scoop). Oil is expressed from the cleaned seed, and sells at about 6 to 8 seers per rupee.

The following results were obtained in expressing oil from the seed of the dye-plant—in a test made at Poona from seed obtained from Karied ;—

Weight of unhusked seed.	Water added to half crushed seed.	Cake obtained.	Oil obtained.	Loss.	Remarks.
lbs. oz.	lbs. oz.	lbs. oz.	lbs. oz.	lbs. oz.	
10 0	14 4	96 14	13 0	4 0	The low percentage of oil is striking if comparison be made with that from the seed of the oilplant of the Deccan.

(*Note by Mr. B. C. Shah, Agricultural Officer.*)

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BOMBAY.

In submitting the following analyses of Deccan safflower seed and cake the Agricultural Chemist to the Government of India made these remarks :—

"Columns 2, 3 and 4 in Statement I. exhibit the composition of the seed and of the two sorts of cake (decorticated and undecorticated) at the time the analysis was made.

Both samples of cake dried very considerably before they were analysed and I have therefore calculated from the analysis, what the composition was at the time the seed was crushed. These are exhibited in columns 5 and 6.

If from these analyses and the figures relating to the experiment supplied to me by Mr. Mollison the actual weights of oil in the cake be calculated, the figures in Statement II. are obtained and there was apparently a very considerable loss of oil experienced during the experiments. Of course when operating on small quantities losses such as this are generally unavoidable, but in the case of the experiment with undecorticated seed in which 266 lbs. of seed was crushed I should not have expected it to be so great. Mr. Mollison intimated to me in his demi-official letter of 7th May 1895 that he would later send samples of the Gujerát seed and cake, and I shall feel much interested to see what the results are and to know if the apparent loss of oil can be accounted for in any way."

STATEMENT I.

	Composition at time of analysis, Safflower cake.			Composition at time of crushing Safflower cake.	
	Safflower seed.	Undecorticated.	Decorticated.	Undecorticated.	Decorticated.
1	2	3	4	5	6
Moisture	7·49	8·79	8·49	22·47	22·13
Oil	31·84	9·84	9·80	8·36	8·44
Albuminoids	13·31	16·06	32·75	13·65	27·86
Carbohydrates	15·66	27·23	21·19	23·15	17·94
Woody fibres	26·31	33·83	20·17	28·76	17·76
Ash	2·39	4·25	7·60	3·61	6·47
Nitrogen	2·13	2·57	5·24	2·18	4·47
Sand	None.	0·95	4·00	·81	3·40

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ANALYSIS BY DR. LEATHER.

STATEMENT II.

	Undecorticated.	Decorticated.	
	lbs.	lbs.	oz.
Total oil in seed	85	14	0
Oil extracted	53	9	8
Oil in cake	19	1	4
Loss	13	3	4

Analysis of Safflower seed and Safflower Cake from the Gujerat Plant.

	332 Safflower seed.	333 Safflower cake.
	%	%
Water	7·92	23·88
Oil	28·85	7·68
Albuminoids	12·25	11·94
Carbohydrates, etc.	17·39	22·30
Woody fibre	31·11	31·12
Mineral Matter	2·48	3·08
	100·00	100·00
Nitrogen	1·96	1·91
Sand	·35	·42

BENGAL.

Dye.

In Bengal the mode of preparing the dye is very simple. After collection the florets are placed in a *denra* (basket), and left to dry in the shade. Exposure to a strong sun greatly weakens the dye. When sufficiently dry they are deposited in an earthen jar. Should the collection be large, the florets are usually kept in a *kothi* (a reservoir made of mud). When required for dyeing, the florets are placed in a mortar, *okhi*, and pounded, being freely sprinkled with water during the process. When sufficiently bruised, the florets are put in a cloth suspended on four poles, water is then poured on them until the yellow is removed. This stage is locally known as "*piri giryou*" (freeing the dye stuff from the yellow). Another process. On the florets being gathered in, they are bruised in a mortar or rubbed between the palms. They are then put in a *denra* (basket) and water is applied to them till the soluble yellow is removed. They are next rolled up and placed between leaves of the castor oil plant in the form of cakes. On the following day the flower cakes are opened out on a *chitai* (mat) to be dried. When they are sufficiently

BENGAL.

dry, they are preserved in an earthen jar or *kothi*. Sometimes the yellow is removed simply by squeezing the florets (previously sprinkled with water) with the hands. This process of removing the yellow is repeated at the time of dyeing the fabric. After the yellow has been carefully removed, the florets are rubbed between the palms with *saji* (Potassium Carbonate). In the case of a large collection, the florets are usually again ground in a mortar along with *saji* (2 chittacks of *saji* to one seer of safflower). Or, the florets and the *saji* are trampled under foot to mix them completely. The *saji* is generally prepared from the ashes of plantain stems or from the ashes of *târ* palm or *khajar* (date palm) leaves. After the *saji* has been thoroughly mixed with the flowers, the latter are strained through a cloth. Three strainings are generally taken. The first is for dyeing crimson red, the second for obtaining a lighter colour, and the third for a lighter still. Into the three mixings which are kept in three separate vessels, acid is put. Tamarind, lemon, mango, *dâhi* (curded milk) are employed. In some localities the 2nd and 3rd strainings are not acidulated. To a seer of strained material, 4 chittacks of tamarind and mango are allowed.

A large number of colours is produced with safflower as their basis. Again different shades of red are produced simply by regulating the period of immersion in the strainings. The principal colours produced from safflower are (1) *lal* (red) or *ekranga* obtained by dipping the fabric in the 3rd, 2nd, and 1st straining. (2) *gulabi* (pink) by immersing the cloth in the 3rd and 2nd straining only. (3) *baigni* (purple) is produced by first dyeing the fabric in indigo and then in safflower. (4) *surmai* (antimony black) is obtained by dipping first in indigo and then in safflower, (5) *badami* (almond colour) is produced by treating the fabric first with a preparation of *singhra* (**Nyctanthes Arbor-tristis**) and then safflower dye. (6) *kesarya* (saffron yellow) is got by immersing the cloth in a preparation of *dhawa* (**Anogeissus latifolia**) and thereafter in safflower dye. (7) *narangi* (orange yellow) is produced by dipping the fabric first in the yellow and then in the red dye of the safflower. (8) *champa* (orange) a ground colour is first given by turmeric, the fabric is then dyed with the red dye of safflower.

As with indigo much depends upon the care taken in preparing the dye stuff and in dyeing the fabric. The superiority of Tirhut or Bengal indigo over North-Western Provinces indigo is due perhaps more to the greater care bestowed upon preparation than to soil or atmosphere. It is believed that the older the safflower, the better colour will it afford.

The passages which follow deal with the safflower industry as practised in Behar, Bhagalpur, Dinajpur and Purnea in the earlier part.

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of the last century They are taken from *Montgomery Martin's History, Antiquities, Topography and Statistics of Eastern India*, 3 volumes, London, 1838.

Behar and Patna.

Kusum or safflower is cultivated to a considerable extent; 1,500 bighas are sown with this alone, and a great deal is scattered through other crops, especially in rows round poppies and round vegetables for the kitchen. [*Behar and Patna Districts in Martin's Eastern India*, I., p. 292.]

Bhagalpur.

The dyers in most parts of the district [Bhagalpur] are chiefly employed to dye the clothes of those who attend marriage parties, that are exceedingly numerous; and during the three months which the ceremonies last, the dyers make very high wages; but at other times they have little employment. They dye chiefly with the safflower, with which they give two colours, *kusami*, a bright pomegranate red, and *golabi*, a pale but fine red like the rose; and each colour is of two different shades. . . . As the dyeing cotton with safflower, and the other flowers is much practised at Mungger [Monghyr], I shall give an account of the processes as they were performed before me. The safflower, Carthamus tinctorius, or *kusum*, is in most demand.

In order to dye the pomegranate red (*sorukh* or *kusami*), for three turbans 40 cubits long by 1 wide, take of the flowers 3 sers (84 S. W.)* or 6 lbs. 7⅓ oz., value Re. 1; of impure carbonate of soda (*sají*), 6 chhataks, almost 13 oz., value ½ anná; of turmeric 1 chhatak 2⅛ oz., value ¾ anna; of any vegetable acid, lime-juice, mango, or tamarind, to the value of ¼ anna. Wash the flowers on a cloth strained with six pots of water, each containing about 15 sers (32 lbs. 5⅓ oz.) until the water comes off clear. This water is called *pili*, and is used in dyeing green with turmeric and indigo. In about an hour after, wash the same flowers with another six pots of water. This water is called *dohol*, and is of no use. Then squeeze the water from the flowers, add the soda, and rub them together.

Then place them on the strainer, and with 1 or 1¼ pot of water wash out the colour, which is called *sahab*, and is the proper dye. In this dip the three turbans, and knead them in the dye. Then take out the cloth, and add the turmeric and acid; then put in the cloth again, and having soaked it, wring, and dry it in the shade. The same operation is repeated with fresh flowers on the two following days. If the colour is wanted lighter, a little more water is added to the *sahab*; and if a bad cheap colour is wanted, give the cloth only one or two dips instead of three.

* Sicca weight. Thus 84 S. W. implies that in the locality mentioned the seer in use weighed 84 tolas.

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The best *golabi* or rose colour is given thus. After having extracted the *sahab* colour as above, the dyer adds to the same flowers another pot of water, which extracts a colour called *Pachuya*, that dyes four turbans of the same size. They are first dipped in the dye, then taken out and an acid added, and then dipped again and dried in the sun. Each turban brings to the dyer 2 annas, and the acid costs ¾. A paler rose colour is given by taking ¼ ser of the *sahab* colour, adding 5 sers of water, and using this dye as the other. The dyeing three turbans of a bright pomegranate brings the dyer R4-8 as. and the four turbans of a rose colour brings 8 annas, in all R5. The cost is R3-6¾ annas.

Naranggi, or orange colour and *surd*, or yellow, may be given either with the flowers of the *Singgarhar* or of the *Tunyd*, both nearly of the same quality, and used in the same manner; but each turban requires 4 chhataks (8⅔ oz.) of the former, while 6 chhataks (13 oz.) of the latter are necessary. The flowers are boiled in 3 sers (each 2 lbs. 2½ oz.) of water to 2 sers. When cooled, add 1½ ser of the *sahab* colour, prepared as above from safflower, and 1 ser of water. In this dip the cloth, wring it, add some vegetable acid, and soak the turban in the mixture for 24 minutes; then wring and dry it in the shade. This makes an orange of different shades according to the quantity of cold water added. Each turban pays for dyeing 4 annas. The yellow colour is given in the same manner, only that no *sahab* is added, and that in place of acid 1 chhatak of alum, worth ½ anna, is employed. The flowers are boiled with 4 sers of water to 3 sers. If a light yellow is wanted, a little cold water is added to the dye when cool. *Martin's Eastern India*, II., 267-269.

Dinajpur.

Plants cultivated for dyeing.—The plants cultivated in the fields of this district (Dinájpur) for producing dyes are two, indigo and safflower. The last is of little or no importance, and a few drills of it are occasionally put amongst cotton, as I have already mentioned, or a small bed is sown in a garden, chiefly on account of its leaves, which are used as a green. The safflower is chiefly used at Maldeh, and the greater part is imported from other districts. The natives here do not eat the seed. *Martin's Eastern India*, II., p. 866.

Mal eh.

Two colours are given with safflower (Carthamus tinctorius), and are called *kusum* and *goldbi*. The *golabi* is a fine rose-red, but is not a fixed colour. For one skein of silk take 10 S. W.* of safflower, dry it and reduce it to powder; then add 1 S. W. of impure carbonate of soda (*sajimati*), and rub them with the hands for about 12

Dinajpur.

* Here the expression S. W. is employed to indicate tolas (1 tola = ·41 oz. Ad.).

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minutes. Then put them on a cloth strainer, and allow 40 S. W. of water to drain through them. In this water steep the silk a whole day, and wash it. Then put it into an infusion of tamarinds, which is prepared thus. Take 5 S. W. of ripe tamarinds freed from the shell, and having rubbed them well with 20 S. W. of water, strain this for use. In this infusion the silk is kept between 48 and 72 minutes, and is then dried in the shade. The *kusum* colour is better fixed, but is not such a fine red; still, however, it is a beautiful colour. The only differences in the process are that 30 S. W. of safflower are used, and that ¼ S.W. of alum, and S.W. of lime-juice are added to the infusion of tamarinds. *Dinajpur in Martin's Eastern India*, II., p. 965.

Kusum as a dye for cotton. The third colour called *kusum* is not well fixed; but is a bright beautiful light red, like the pomegranate flower. For 20 S.W. of cotton thread take 1¼ ser of dry safflower, powder it on a cloth, and wash it, until the yellow colour is entirely separated. Then add by degrees 15 S. W. of impure carbonate of soda (*sajimati*) and rub them together for an hour, until they become scarlet. Then put them on the strainer, and filter water slowly through them, until all the colour is carried away, and keep this infusion of safflower. At the same time put 60 S.W. of tamarinds freed from the pod, into 2 sers of water, rub them and strain the infusion. Mix the infusions, and divide them into two equal parts. Put the thread into one part for an hour, then wring it, and put it in the remaining half of the infusions for three hours. Then wash, and dry in the shade. *Martin's Eastern India*, II., 969-970.

In this district (Purniya-Purneah) safflower (*Kusum*) is an object of some little more importance than towards the east. It is never sown by itself, so that no estimate can well be formed of the expense attending its cultivation. The collecting the flowers does no injury to the seed, as they are pulled off while naturally separating from the young fruit. The oil is always extracted by the farmer, and the seed does not therefore come to market, so that in the tables, I have calculated the produce by the value of the oil. The seed is put into an earthen pot, which has a hole in the bottom, and is placed over another that is sunk in the ground. A cover is then put over the mouth of the pot containing the seed, and a fire is kindled over and around it. As this burns, the oil falls into the pot below. It is therefore an empyreumatic oil, and is fit only for the lamp of the poor. The seed here is never eaten. *Martin's Eastern India*, III., 257—258.

The Carthamus or *kusum* is a very common green, and is sown in fields to a considerable extent. It gives the flowers as a dye, the

oil, without its growth being [illegible] is a valuable plant. *Paraguay-* [illegible] XII., p. 237.

In the United Provinces as well as in Bengal (see p. 151), safflower is much used for dyeing wedding apparel. The *kusum* dye has been nearly driven out of the market by aniline dyes. The flower as prepared by cultivators for the dye market is sold in Cawnpur at R15 to R30 per maund (82·3 lbs.). The colouring matter dissolves in alkaline water and can be easily extracted from the flower. The *kusum* colour gradually fades away and does not last long.

Safflower dyeing in the Central Provinces is described thus. The flowers are first pounded with a pestle in a wooden mortar. The pulpy mass resulting is then squeezed by hand into small round balls, dried, and is then sold to the dyers. The dyers again pound these balls, and after steeping them in a little water, knead them under their feet for several hours. The mixture is then placed in an outstretched cloth and cold water poured on it until the water running off loses its yellow tinge. The pulp remaining is then mixed with the ashes of burnt plants, generally those of the *jagin* and *sajji*, the mixture resulting is similarly placed on a cloth and water poured on it. The red liquid which after a time flows off from the mixture is the safflower dye. It is collected in three separate vessels, the liquid contained in the first of which possesses the deepest tinge, and is the most valuable.

In the Karnal district of the Panjab *kardi* or safflower is usually sown very sparsely with gram or on the edges of the fields, seldom by itself. Only small quantities are sown. The soil requires little preparation and no further care. When the flowers open, the women pick out the petals; three days later they repeat the operation; and again a third time after the same interval. If hired they take a quarter of the picking as their wages. The petals are bruised the same day in a mortar, rolled between the hands, and pressed slightly into a cake. Next day they are rolled again, and then spread in the sun for two days to dry, or still better, one day in the sun and two days in the shade. One seer of petals will give a quarter of a seer of dry dye. Any delay in the preparation injures the dye.

The dry dye is called *kasumbh*, and is the yellowish red colour with which the clothes of the village women are ordinarily dyed. The dyer (*rangar*) has the cloth and dye brought to him, retains one-fifth of the dye as a perquisite, and is also paid for his trouble. A bitter oil is expressed from the seeds which is used for burning only. Forty seers of seeds will give 3½ seers of oil. (*Gazetteer of the Karnal District*, 1890, p. 208.)

CENTRAL PROVINCES.

In the Central Provinces the oil extracted by the dry hot method is employed as a salve for sores on cattle.

SIND.

The seed is employed as a cooling medicine (*thadhol*); it is sometimes boiled and made into gruel. The oil is considered a mild purgative.

Food.

BENGAL. Conf. p. 168.

The young plant when still green is much used in Bengal as a pot herb. The white substance in the seed ground and boiled in water is said to be largely eaten by the poorer classes as a substitute for thick milk, notwithstanding that it generally brings on indigestion. The oil is much used for cooking. It is largely employed by the less well-to-do in marriage ceremonies for preparing *puris* (cakes) fried with *kusum* oil or clarified butter.

UNITED PROVINCES.

In the United Provinces the tender leaves are cooked and eaten as a vegetable. The seed when parched is eaten along with parched gram or with dried *mahwa* flowers. The two dried separately and then pounded together are made into balls (*laddoos*) and eaten by the poorer class.

CENTRAL PROVINCES.

The oil expressed by the dry cold method is reported to be used in the Central Provinces for culinary purposes, as well as for lamps.

PANJAB. Simla Hill States.

The poorer classes in Mahlog, Simla Hill States, mix safflower oil with *ghi* and use it in the manufacture of sweetmeats.

Hoshiarpur.

From Hoshiarpur it is reported that pure *kasumba* oil is used to adulterate *ghi* for the preparation of sweetmeats in large trade centres, such as Amritsar and Lahore. The oil cannot be used alone for culinary purposes; it is employed to adulterate *ghi*, having no smell. In the Western districts of the Panjáb, bruised *kasumba* seed is eaten.

BOMBAY.

In Bengal safflower, sesamum and groundnut seeds are often ground together and furnish the sweet oil of the bazars. Pure safflower oil is extensively used in adulterating *ghi* and sesamum oil. It is worth in the Deccan 8 lbs. per rupee.

BURMA. Conf. p. 159.

The tender leaves are used as a vegetable in most of the districts of Burma under the name of *hsu-wine-ywet*. The leaves are boiled and eaten as a sort of spinach. They are also used in curries.

Fodder.

BENGAL. Dumraon.

In Bengal (Dumraon) the oil cake resulting from the cold dry process is fed to cattle and is said to be fattening.

Cattle must be accustomed to the cake before they eat it with relish. It has this advantage over other edible oil cakes, that it keeps free of mould and good for a long time and, moreover, is usually cheaper.

UNITED PROVINCES.

A report from the United Provinces states that the whole plant before flowering is cut and given to cattle.

PANJAB. Hoshiarpur.

The following particulars relate to the Hoshiarpur district, Panjáb. By mixing the seed with rape seed and then expressing the oil, the oil cake becomes useful as fodder. Pure Carthamus oil cake is not employed for the purpose—if given to milch cattle it is said to dry up their milk.

BOMBAY.

In Bombay it is said that the cake from husked seed contains an appreciable percentage of husk. The latter is coarse and fibrous. An undue proportion of husk makes the cake more or less unsuitable for cattle food. If safflower cake is good, *i.e.*, if it contains a small percentage of husk, it is recognised in the Deccan as one of the very best and cheapest of foods for milch cattle. Cattle have to get accustomed to safflower cake before they eat it greedily. It has an advantage over the edible oil cakes in that it keeps free of mould and good for months, and can therefore be bought in seasons when it is cheap and then stored. In outstations in the Bombay Presidency, good cake can be had when cheap at the rate of 80 lbs. per rupee; it ordinarily costs one rupee for 60 lbs. in Poona.

Fuel.

BENGAL.

In Bengal the dry stalks are commonly used as fuel. The cold dry pressed oil is employed for lighting purposes.

UNITED PROVINCES.

The dry stem easily takes fire and is used in the United Provinces for making matches. It is cut into small pieces of equal length, these are dipped at one end in liquified sulphur, and kept ready for use. The wood of the plant is so combustible that if two dry stems be rubbed together fire is produced.

Insecticide.

SIND.

In Bengal the dried plants are stated to be kept by the people in their houses to destroy bugs.

Domestic and Sacred.

BENGAL.

The colour is considered by the Hindus of Bengal as particularly auspicious and sacred. It is perpetually in request at religious ceremonies. The orthodox Hindu (in Behar) will not allow his son or daughter to wear any apparel at the wedding ceremony which is dyed with European dyestuffs. It is believed the priest would lose half the respect of his people if he did not exercise sufficient discretion in choosing the dye for his *chaddar* (sheet) or *mureh* (head dress). Hence it will be seen that religious rather than economic considerations have saved the safflower industry from complete extinction.

THE

AGRICULTURAL LEDGER.

1904—No. 12.

AGENTS.

In Britain.

Messrs.
E. A. Arnold, 37, Bedford Street, Strand, London, W. C.
Constable & Co., 2, Whitehall Gardens, London, S. W.
P. S. King and Son, 2 & 4, Great Smith Street, London, Westminster, S. W.

Messrs.
Kegan Paul, Trench, Trübner & Co. Charing Cross Road, London, W. C.
Bernard Quaritch, 15, Piccadilly, London, E.
Williams and Norgate, Oxford.
Deighton Bell & Co., Cambridge.

On the Continent.

Messrs.
R. Friedländer & Sohn, Carlstrasse 11, Berlin, N. W.
Otto Harrassowitz, Leipzig.

Messrs.
Karl W. Hiersemann, Leipzig.
Ernest Leroux, 28, Rue Bonaparte, Paris.
Martinus Nijhoff, The Hague.

In India.

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Newman & Co., Calcutta.
R. Cambray & Co., Calcutta.
S. K. Lahiri & Co., Calcutta.
Thacker & Co., Ld., Bombay.
V. Kalyanarama Aiyar & Co., Madras.
Higginbothan & Co., Madras.
G. A. Natesan & Co., Madras.

Messrs.
Superintendent, American Baptist Mission Press, Rangoon.
Rai Sahib M. Gulab Singh & Sons, Mufid-i-Am Press, Lahore.
A. J. Combridge & Co., Bombay.
Radhabai Atmaram Sagoon, Bombay.
O. B. Taraporevala Sons & Co., Bombay.
N. B. Mathur, Superintendent, Nazair-kanun-Hind Press, Allahabad.

(Vegetable Product Series. No. 87.)
(Dyes and Tans.)

THE AGRICULTURAL LEDGER.

1904—No. 12.

BIXA ORELLANA.

THE ANNATTO-DYE PLANT.

[*Dictionary of Economic Products. Vol. I, B. 523-38.*]

ANNATTO DYE.

A Review of existing information. By I. H. Burkill, *Officiating Reporter on Economic Products to the Government of India.*

Bixa Orellana. *Linn.: Fl. Br. Ind., I., 190; Ind. Kew., I., 309.*

The Annatto or Arnotto Dye.

Vern.—*Latkan, latkhan, watkana,* Hind., Beng.: *Kong khombi,* Santal; *Jarat, jalandhar,* Ass.: *Gultas,* Uriya: *Pomasi,* Chittagong: *Reipom, urei-rom,* Manipur: *Shāk-sandūki-jhār,* Duk.: *kisri, kesari, kesuri, sendri* or *shendri,* Mar.: *Jāpāra-chettu, jafra-vittulu-chettu, kurungu-munji-vittulu-chettu,* Tel.: *Jāpira-maram, jāpira-virai-maram, kurungu-munjit-varai-maram,* Tam.: *Kappa-manjala, rangamali, rangamali-kannu* (the fruit), Kan.: *Thitka,* Burm.

Habitat.—Annatto or Arnatto is a dye obtained from the coating of the seed of an American shrub or small tree known as **Bixa Orellana**. It is a plant easily cultivated, is not very exacting in the matter of soil, and has been taken to nearly every country of the Tropics. The flowers are showy, sometimes white, sometimes pink; and often it is grown as an ornamental plant in gardens. Swampy ground it does not like, and the least frost is prejudicial: otherwise, the plant is ready to accommodate itself to most conditions found within the Tropics where the rainfall is 50-60 inches.

The plant grows to a height of 12-15 feet.

BIXA Orellana.

Annatto.

HABITAT.

The leaves are heart-shaped, sharp at the end, and even at the sides rather like those of the common lilac of gardens in England. The flowers are borne at the ends of the branches in a loose bunch and are large, regular and showy. The pods are rather urn-shaped in general outline, laterally compressed and slightly beaked above; they are covered with weak prickles. At full maturity they crack open from the beak downwards, along the two edges and expose the seeds. The Annatto harvest begins when two or three of the pods of a bunch are gaping slightly: then is the time to cut off the whole and to take them to any suitable place for shelling out the seeds. These seeds are either dried carefully in the sun and sent into the market as they are, or else the dye is prepared from them by one of the processes to be described.

Cultivation.

CULTIVATION.

The cultivation of **Bixa** is very simple; and the bush has few enemies. The first return comes in the second year.

Seeds from which the dye may have been washed are sown at the beginning of the rains about 7-8 feet apart in prepared soil. Two or three seeds may be put into each hole and ultimately the weaker seedlings eliminated, or else the seedlings may be grown in a nursery and planted out at the distance named. On the fattest lands the intermediate plants may ultimately have to be removed, so that the bushes may stand 15 feet apart. As the young plants come up a little shade is given either by placing large leaves over them to protect them during the heat of the day, or by putting mats over them. When they are a foot high they may be considered to be established and need no further shade. Weeding is necessary until by their own growth they so cover the ground as to keep weeds down. Pruning is desirable to make the plant bushy; for the flowers are borne on the ends of the branches.

Annatto plants make good hedges and may be used for wind breaks for other kinds of cultivation.

YIELD.

The yield per acre is set down at $6\frac{1}{2}$ to $7\frac{1}{2}$ maunds of seeds and as 9-10 seers of seed will give one seer of the prepared dye, it is 26 to 30 seers of dye. The first full crop may be set down at 5 cwts. (4 mds.) of seed per acre; the subsequent crops increasing.

The parts of India with rainfall suited to its cultivation are Lower Bengal, Dacca, Mymensingh, almost all Assam, the hill regions over Orissa, the Burmese coast, and North Burma, the coast south of Bombay and the lower hills of Southern India.

Of Ceylon the greater part of the island is suited to its cultivation, and an extensive plantation under European supervision exists at Matale.

Annatto. *(I. H. Burkill.)*

BIXA Orellana.

CULTIVATION.

Except for the coast south of Bombay, I have evidence that the plant already exists in all parts of India suited to it; but the pink-flowered form seems to be the better kind and it is not always the one already growing.

The Dye.

THE DYE.

The outermost coat of the seed is the part which contains the dye. The dye principle is a chemical body known as Bixin, isolated as glistening red crystals and examined by **Zwick** (*Chem. Zeitung Repert.* 24, page 66) in 1900 who ascribes to it the formula $C_{28} H_{34} O_5$. His results agree with and complete the earlier ones of **Etti**.

The percentage of Bixin present in the seed coat is not very large and may be considerably less in commercial annattos because of the admixture in them of parts of the seed—often the whole seed ground up—and of substances added in manufacture.

There are recorded, however, no recent analyses of the seed coat which might be quoted for the sake of obtaining a standard.

Uses.

When **Columbus** discovered America, Annatto dye was used by the fierce Caribs as war paint. They called it Roucou—a name still used by the French. It is now employed chiefly to colour butter and cheese, in pharmacy for colouring some ointments and to a less extent as a dye for silk, calico, wool, sheep-skins, feathers, wax, ivory, bone, etc., and in the paint industry. The commonest tints which it is used to give are yellows—such yellows are the primrose and cowslip yellows of butter and cheese, but it can also be made to give reds. The Caribs used to make their faces and bodies crimson with it.

The markets for it now are chiefly in Europe and North America, and the chief countries supplying it are Brazil, French Guiana or Cayenne, the French West Indies, and to a less extent the British West Indies. Ceylon and Madras also send a small quantity of seed to Europe.

KINDS IN THE MARKET.

The prepared dye enters the market in several forms, the chief of which are the following:—

(1) as rather hard, reddish, oily, homogeneous rolls or cakes smelling somewhat like urine:—origin French Guiana (Cayenne);

(2) similar rolls or cakes, but rather granular:—origin West Indies;

(3) brown rolls with a pleasant smell:—origin Brazil.

The annatto of Cayenne obtains the highest price; and in France it may, sold in bulk, touch at times, 200 francs per 100 kilos. The less valuable kinds sell at much lower prices down even to 30 francs per 100 kilos. An average price in Germany seems to be about 80 marks per 100 kilos.

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Annatto.

PRICES OF THE DYE.

The seeds have sold in Europe during the last years at 2¾ to 4 pence per lb.

These rates translated into Indian currency and calculated per seer are—

	₹	a.	p.
For best Cayenne annatto in France per seer .	1	3	0
„ inferior annatto „ „ .	0	3	0
„ average annatto in Germany „ .	0	9	6
„ seeds in London	0 5 6 to 0	8	0

These prices bear out the remark made by **Dr. H. A. Alford Nicholls** in his excellent *Text-book of Tropical Agriculture* (London, 1892), page 248: "The purer the dye is sent to the markets, the higher will be the prices obtained for it; and unless a fine article be prepared *it is better* to ship the dried seeds, from which the dye is extracted in England and the United States."

PREPARATION OF GOOD ANNATTO.

The preparation of annatto in any form is quite a simple one. The better stuff is made in the following way:—

The seeds, taken out of the capsules, are placed in a receptacle; and hot water is poured over them until they are well covered: they are then stirred for a considerable time until the colouring matter has been washed off. That done, the liquor and seeds are separated by straining through any suitable material. The former carries with it all that is of value, and is set to stand so that the dye may fall to the bottom; the latter are thrown away. When all the dye has settled, the supernatant water is poured off as far as possible, and the fine residue placed in the shade where the rest of the water may evaporate without the aid of artificial heat. As soon as the mass is dry enough to be kneaded, it is moulded by hand into rolls or cakes and these are put by until they are perfectly hard. When moulded they are wrapped in clean leaves, plantain or banana, and when dry they are packed in layers in boxes.

Brazil sends into the European market annatto in the form of rolls, but the dye is not always prepared with requisite care. The rolls weigh 50—100 grammes (4·3—8·6 tolas), and are brownish on the outside and a reddish green inside. The market knows the shape under the names of flag and roll annatto. The cakes are chiefly made in Cayenne and are called cake annatto.

The preparation proceeds for cake annatto as for roll annatto until the point is reached at which the roll annatto is moulded by hand; when instead it is cut into squares with a knife and left wrapped in clean leaves to get its last drying.

IMPROVEMENTS.

An improvement upon this process is given by **Semler** in his *Tropische Agricultur, II* (Berlin, 1900), p. 636. He says: Pour hot water over the seeds and stir as usual: then let the mass soak for

BIXA Orellana.

Annatto. (*I. H. Burkill.*)

PREPARATION OF THE DYE.
a. standing.
b no heat.
c. precipitation chemically

some days; filter off the seeds, let stand for a whole week, and afterwards pour off the supernatant water and dry.

Another suggested improvement is to use cold water and no heat in drying.

A third improvement is, use a 2 per cent. solution of soda instead of pure water for pouring on to the seeds, and to throw down the dye afterwards by adding dilute hydrochloric or sulphuric acid.

This last suggestion from a chemical standpoint is a sound one, and would seem to be in use among the manufacturers who in Europe prepare annatto from the imported seeds.

PREPARATION OF INFERIOR ANNATTO.

The preparation of an inferior annatto is thus done in Guadeloupe and the French West Indian islands.

The dry seeds are crushed between rollers and the fine powder resulting, which consists in chief part of seeds and in small part of the useful seed coat, is thrown into water and allowed to settle after which the surface water is run off: the sediment is then boiled, with the lower water only, for four or five hours. After the boiling as much water as possible is squeezed out by means of boards and the remaining paste is packed into casks in layers with plantain leaves between them. This paste must be kept moist or it will deteriorate.

As of course the stuff so prepared contains a large percentage of useless matter it fetches the low prices recorded above.

ANNATTO AS A PIGMENT.

Annatto for the paint industry.—A specially high-priced annatto is thus prepared: the Indians of Guiana dip their hands in oil and with them wet rub the fresh annatto seeds and get a sticky mass which has to be scraped off. This mass is dried like the ordinary preparation and like it comes into the market wrapped in plantain leaves. There is but a very small demand for such material and its only use in Europe is in the paint industry. It comes into the market in little irregular shining red lumps. Gum and other substances of plant-origin may have been mixed in it as the natives like it so in order to smear their bodies with it not by way of ornament but, so it is said, to keep away mosquitoes.

ANNATTO IN BUTTER AND CHEESE.

There is a supposition that a little annatto added to butter and cheese has a preservative effect, but this is very doubtful. The adding of it is rather merely to give it a colour which somehow in the English mind is associated with butter. The amount added is very small, for ·03—·08 per cent. of a good preparation of annatto is all that is required to give the desired tint. Moreover, the annatto gives no taste and no smell to the butter. Nevertheless, it is said that annatto is in the Spanish Americas added to cocoa not to give it a colour but to give it a certain flavour. This fact as Semler remarks stands unreconciled to the statement that in putting annatto

THE DYE.

butter we are doing nothing to alter the flavour.

BIXA Orellana.

CHEMISTRY OF COMMERCIAL ANNATTO.

Annatto.

Nearly twenty years ago Lawson reported in the *Pharmaceutical Journal and Transactions* (1885-86, page 645) upon ten samples of annatto which he had obtained in England—two Nos. 4 and 7 direct from manufacturers and the rest from dealers. Since his report no particular attention has been directed to the commercial product, and therefore we cannot cite more recent analyses.

He had five samples of red rolls which on analysis did not differ very much. The description reads as if they were flag annatto from Cayenne or the French West Indies.

The figures which he gives are as follows :—

	No. 1.	No. 2.	No. 3.	No. 6.	No. 5.
Moisture	21·75	21·60	20·39	18·28	18·00
Colouring matter	3·00	2·90	1·00	1·80	3·00
Extractive	57·29	59·53	65·00	65·67	58·40
Soluble ash, mostly common salt	13·20	12·57	7·50	11·75	10·0
Insoluble ash	4·76	3·00	6·11	2·05	10·6

No. 6 was dirty, full of hairs and foreign matter, and No. 5 gave out a disagreeable odour on ignition.

Lawson remarks the high percentage of soluble ash present. In most cases it consisted of common salt which he thinks was added as a preservative and because the presence of salt heightens the colour.

He had three samples of cake annatto bought from dealers, and one, No. 7, obtained from a manufacturer. His analyses gave the following result :—

	No. 7.	No. 9.	No. 10.	No. 8.
Moisture	15·71	19·33	22·50	38·18
Colouring resin	5·40	5·90	9·20	12·00
Extractive	26·89	23·77	23·50	20·82
Soluble ash	18·50	15·00	13·80	20·00
Insoluble ash	33·50	36·00	26·00	9·00

The figures are very unlike those for roll annatto in containing more colouring matter, less extractive and a large quantity of insoluble ash chiefly potassium carbonate.

Mr. Lawson also obtained a paste from a manufacturer and analysed it with the following result :—

	No. 4.
Moisture	69·73
Colouring resin	8·80
Extractive	19·47
Soluble ash almost all NaCl	2·00
Insoluble ash	...

BIXA Orellana.

CHEMISTRY OF COMMERCIAL ANNATTO

This paste he got put to a practical test and ½ oz. coloured 60 lb. of butter satisfactorily. It was the only really satisfactory preparation among the ten which he examined. As it was very moist it is necessary in order to compare it with the others to recalculate the figures to what they would be were some 20 per cent. of water only present, whereas nearly 70 per cent. was present. Remove 50 per cent. of water from No. 4 and we get 17·60 resin, 38·94 extractive, and 4·00 ash. No single sample in the whole series comes up to this in percentage of resin. All the rolls are far inferior; they have had added to them a good deal of salt, in itself not injurious. The first three of the cakes, Nos. 7, 9 and 10, have had added to them a lot of chalky matter. Remove the ash from them and the other figures recalculated would not be unlike those of the best sample (Lawson's No. 4).

Thorpe, *Dictionary of Applied Chemistry*, vol. 1, 1898, p. 174, quotes an analysis by Winter Blyth of a good annatto, wherein 28·8 per cent. of resin was found, 22·5 per cent. of ash, 24·5 per cent. of extractive matter, and 24 per cent. of water.

The conclusions are that all the red rolls contained far less colouring matter than they might and had had common salt added to them; that the cakes had got chalk or some very similar unnecessary substance in them, and that few of the preparations marketed, at least at the date at which Lawson wrote, were really good.

More recent writers, *e.g.*, Chevallier and Baudrimont, in their *Dictionnaire des Altérations et Falsifications des Substances Alimentaires, Médicamenteuses et Commerciales*, Paris, 1897, II, p. 239, speak of the extent of adulteration but without giving recent figures which I can quote. They give directions for the testing of commercial samples by estimating the ash first and then testing the tinctorial properties by the side of a standard sample.

Lawson alleges his belief that a great deal of adulteration by turmeric was going on, but he does not prove it.

Production of Annatto in India.

ANNATTO IN INDIA Two varieties

All that can be said about the introduction of annatto into India will be found in the pages of the Dictionary of Economic Products. There are two forms of the plant in this country, the one with pink flowers and red pods, the other with white flowers and green pods. In 1895 Sir George Watt instituted an enquiry as to where these two forms occur in India and how. The results of this enquiry are now to be given. Wild, the white flowered plant may be found in the districts of Murshidabad, Midnapur (Ghatal), and Raniganj, in Bengal. It also occurs about Calcutta and some places in the 24-Perganas. The colour of the flowers of the plant grown in Dacca, Chittagong

BIXA **Orellana.**

Annatto

DYEING.

Ghatal. In the sub-division of Ghatal the same process is used. Alum is sometimes used as a mordant.

Cachar. In Cachar the process is essentially the same, but the mordants are different. Lemon-juice, ash-water, and tamarinds or the fruit of **Garcinia pedunculata** are used. It is agreed that the dye is rather fleeting. It is cotton cloths which are here dyed.

Jorhat. In Jorhat the process in common use is as follows. The seeds are first boiled in a vessel in which plantain ashes have been mixed with water. As soon as the mixture reaches boiling point, the cloth to be dyed is immersed in it, and allowed to boil for about a minute. The vessel with the cloth still in it, is then taken off the fire, and the contents allowed to cool. The cloth is lastly taken out and dried; and a yellow dye results. The colour, however, is fleeting, and its tint varies according to the mordant used. The leaves of the *bhomrati* (**Symplocos grandiflora** or **S. spicata**) are also used as a mordant to produce a yellow dye with or without another mordant (**W. A. M. Duncan,** *Monograph on Dyes and Dyeing in Assam*, page 14).

Ash-water is prepared in Assam in the following way:—The trunk of a plantain tree or its root is split into pieces, dried in the sun, and then burnt to ashes. The ash thus produced is put by for future use. When required a quantity of ash is put into a thick basket and pressed down by the hand until fairly firm; then water is poured gently over it and allowed to percolate very gradually into a vessel placed underneath. The liquor is called *kharoni*.

Nowgong. Raipur. Sambalpur. In the Nowgong district the seeds are pounded before water is poured on to them. Also in the Raipur and Sambalpur districts of the Central Provinces the seed is pounded in a mortar before use. The same mordants are there used as have been mentioned, with the addition of curds. In the Sambalpur district the seeds may be wrapped in a piece of cloth, which is pressed and squeezed by the hand under water until all the colouring matter has gone into the water when cloth and seeds are withdrawn together. Cloth, not silk, is the material dyed in these parts. Alum may be used in conjunction with it to get a pink colour. The Sambalpur method is reported as used also in Manipur.

Manipur.

Burma. In Burma the process of dyeing, now all but extinct, is as described. Both silk and cotton were dyed, but now practically all of the little dyeing still done in the country by Burmans and Talaings is done with imported dyes.

United Provinces. In the United Provinces and in the Raipur district of the Central Provinces, butter and curds are dyed with annatto.

In Bangalore seeds from pink-flowered plants were, says Mr. J. Cameron, sold at six seers to the rupee.

Annatto. (*J. H. Burkill.*)

BI
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DYEI
METH

PRICE
ANNA
SEED

The cost of seeds in the Sambalpur district is about Re-6-6 per seer. The cost of prepared seeds is about Re 1 per seer in Murshidabad and Raniganj. They are quoted at twelve annas to one rupee per seer in Ghatal, Midnapur district, and at Re 1-8 per seer in Cawnpur.

I wish particularly to point out that at these rates annatto seed is sold in London cheaper than in the districts of India.

The future of Annatto as a dyestuff. Cannot our Indian dyers be provided with cheaper annatto? It looks possible, and experimental growing is to be recommended. If instead of the desultory planting of a bush or two in garden hedgerows a small plot were only systematically cropped we should soon know how far the growing of annatto could be made profitable in India. Annatto, we are told, is giving place to aniline dyes because the dyers get the same effect at less cost with the latter, but then we notice that the supply of annatto seems to come to them at a too high price.

As an article of export. The possibility of exporting annatto stands on a different footing, for the home demand is a very limited one. Any great influx of stuff would cause a glut in the market.

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AGENTS.

IN BRITAIN.

Mr. E. Arnold, 41 & 43, Maddox Street, Bond Street, London.
Messrs. Constable & Co., 16 James Street, Hay Market, London.
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G. A. Natesan & Co., Madras.
Messrs.
Superintendent, American Baptist Mission Press Rangoon.
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Radhabai Atmaram Sagoon, Bombay.
D. B. Taraporevala Sons & Co., Bombay.
N. B. Mathur, Superintendent, Nazairkanun-Hind Press, Allahabad.

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(Foods and Fodder.)

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COIX SPP.

(JOB'S TEARS.)

[*Dictionary of Economic Products, Vol. II.*, C. 1683-1700.]

COIX SPP. OR JOB'S TEARS:

A review of all available information.

BY

SIR GEORGE WATT, M.B., LL.D., C.I.E., etc.

INTRODUCTORY REMARKS.

In December 1887, with the approval of the Government of India, I issued a circular letter regarding **Coix**, in which certain questions were pointedly put to my correspondents. This was followed by two most valuable papers in the *Kew Bulletin* setting forth the extent of European knowledge in the grain. In 1895 the information then to hand seemed to justify an even more thorough Indian inquiry than had been made and accordingly a *Circular Note* (*No. 13 of 1895-96*) was issued to all provincial Directors of Agriculture and sufficient copies sent to each to allow of distribution to all officials resident in localities where the plant was either known to exist or thought likely to exist. In due course this resulted in many reports coming to hand, accompanied by both botanical specimens and large samples of the corresponding grains. These have already been partially discussed in the Programmes of collections for the Indian Museum, Calcutta, and the Imperial Institute, London, for 1897-98 and for 1901. We are now, however, in a position to offer some definite information regarding the Cultivated and Wild forms of **Coix** met with in India. The remarks that follow may therefore be accepted as a review of the new information, along with a full statement of all past knowledge compiled from the better known authors of the world. What remains to be

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ascertained in the future may be said to be the actual area under the crop, the chemical properties of the various kinds of the grain now brought to light and the directions of possible future development.

From European Sources.

History.—So much attention was given by the early botanical writers to the subject of **Coix** that the inference might be drawn that it had formerly been a plant more extensively cultivated than at the present day. It is generally believed to be the *Lithospermon* of **Pliny** (*Book 27, Chap. 11*). During a period of some 300 years from the beginning of the 16th century onwards it was customary for European scientific authors to produce great works on the Natural History of the world, or of some particular country. In most of these *Lithospermon* or **Coix** is spoken of as a wild plant, or one cultivated as a curiosity only. The circumstance mentioned by some of the more directly botanical authors, such as **Rumphius** and **Loureiro**, that it was regularly cultivated in Eastern countries as an article of food seems to have escaped consideration. As representative of the opinions advanced by the historians, a passage may be here given from **Holland's** English translation of **Pliny**—a translation made in 1601 and thus about the very period in which **Coix** attracted so much attention. "But of all hearbs that be, there is none more wonderful than Greimile: some call it in Greek Lithospermon, others Ægonychon, some Diospyron and others Heracleos." "It bringeth forth close joining to the leaves, certain little beards one by one, and in the top of them little stones white and round in manner of pearls, as big as a cich pease, but as hard as very stones. Toward that side where they hang to their steles or tails, they have certain holes or concavities containing seed within." "And verily of all the plants that ever I saw, I never wondered at any more: so slightly it groweth, as if some artificial goldsmith had set, in an alternative course and order, these pretie beads like Orient pearls among the leaves." In accordance with the theory of signets it was very generally held (as affirmed in **Pliny**), that "a man no sooner seeth this hearbe, but he may presently know the virtues thereof and for what it serveth in Physike: a thing that he shall not observe again in any other whatsoever: for at the very first sight of those little stones, his eye will tell him what it is good for, without information from any person at all."

A. D. 70, circa.

Rumphius 1627–1702 Loureiro 1715–1796.

A. D. 1597.

Gerarde (*Herball, Ed. Norton, 1597, pp. 81-82*) gives a similar passage and one which also leaves little room for doubt regarding the identity of the plant. "It hath many knottie stalks producing from a tuft of threddy roots two foot high with great broad leaves like unto those of a Reede, amongst which leaves come forth many small branches like a strawe of corn: on the end whereof doth grow a graie shining seed or graine hard to break and like in shape to the

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seeds of Gromell but greater and of the same colour whereof I hold it a kind: every of which grains is bored through the middle like a bead and out of the hole cometh a small idle or barren chaffie eare like unto that of Darnell." One of the most beautiful of the early drawings of this plant is that given by **Besler** (*Hort. Eystett.* II., 13 *fol. 6, f. 1, published in 1613*). 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. **Miller** (*Gard. Dict. 1st Ed. 1731*) would appear to be the first author to indicate a knowledge in the seeds being edible. He remarks that it is "a form of corn often cultivated in Portugal and Italy and other warm countries, where they string the seeds as beads and in scarce years of other grains I have been informed the poorer sorts of people make bread of it, but I do not find it anywhere cultivated for that purpose.".

A. D. 1613

A. D. 1731.

The supposed medicinal virtues of the grain are alluded to by most of the early writers, but without exception all dwell on their suitability as beads (Anglo-Saxon, bedes). **Parkinson** (*Theat. Botanicum, 1640*) ever quaint and interesting, may be quoted as representative of the antiquity and universality of this knowledge.—"It is of little use in Physicke that we can understand in the natural places, or where it may be in more plenty than with us: yet some, as Pena and Lobel say, doe commend it, either in powder or the decoction thereof, against the stone or gravell in the kidnies and bladder: but beyond sea, the greatest use they make of it, is of the seede, to perforate and string them, as other things for beades, to stint God with their prayers."

A. D. 1640.

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 Arians on the hill slopes of the Himalaya." "The Arab travellers in the East become 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 naturalized in Spain and Portugal, where it is still known as *Lagrima de Job*."

From Asiatic Sources.

A. D. 1260.

It is significant that the word *kasi* (or some very similar word) should appear and re-appear all over India as the vernacular name for one or other of the forms of this plant. Thus we have the *ka-si*

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of the Nágas on the North East frontier of India, *kasei* in the Central Provinces, *kasai* in Guzerát of the Bombay Presidency, *kesai* in Berár and the *cheik* or *kyeit*, *kulese*, and *kalinse* of Burma. The word *ka-si* or *kessi* most frequently denotes a cultivated edible form. This has its parallel in the very general name of Job's tears in the languages of Europe, and may be accepted as indicating a commonality of origin. The Arabs we know have a tradition that Job used the flowers of *Inula* to heal the sores on his body, hence according to them *Inula* and not Coix would be the true Job's tears. That expression as applied to Coix rests most probably, on the shape of the grains which, as Gerarde puts it "every graine resembleth the drop of teare that falleth from the eye." But it is somewhat curious that in no Indian language has the resemblance to a tear been suggested by the vernacular names. In Assam Coix is often called *koamani*, that is, crow's jewel.

HABITAT.

Habitat and Distribution :—There are two undoubted wild forms of this plant and several cultivated states. By far the most widely distributed is **Coix Lacryma-Jobi** proper. This is met with (of the provinces of India) in the Himálaya, Rajputána, the Central Provinces, Bombay, South India, Bengal, Assam, Burma, and the Shán 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 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 practically confined to India and Burma. Of the cultivated (or semi-cultivated) special forms, the cylindrical fruited **stenocarpa** has been recorded as met with in the Nága Hills, Burma, the Shán States, Tonkin and New Guinea. Lastly, the fully cultivated and edible form, **Ma-yuen**, is grown (of the Indian provinces), in the Central Provinces, Sikkim, the Khasia Hills, Burma and the Shán States, and outside India it appears to be cultivated in Tonkin, China and the Malaya, but apparently in no other parts of the world. In his review of Botanical Geography (*Ray Soc. 1846, p. 86*) Prof. Grisebach specially refers to the edible **Coix** as a feature in the agriculture of Chusan but makes no mention of its most important area of production—Eastern Bengal, Assam, Burma, and the Malay. In fact were a review of the geographical features of interest of the cultivated plants of British India to be specially written, **Coix** would have to be commented on as a feature of great interest in the tract of country that stretches East by South from

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Nagpur to Sikkim, Assam, Burma, the Malay and China, and to be characterised as an important food grain with some of the most ancient of the aboriginal inhabitants of India.

BOTANICAL FORMS.

Botanical forms :—Mention has been made of certain names given to the forms of **Coix**. It will help to elucidate the practical and industrial facts, that it is desired to make here known, if some attention be now given to the forms of the plant as recognised and described by botanists.

In the *Flora of British India*, **Coix gigantea** has been treated as a variety of **Coix 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 may perhaps be the safer course to accept them as constituting two species, with under each, several varieties. The best names, if not the most ancient ones, 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. **C. aquatica** in that case can be retained for a variety under **C. gigantea**, though the plant accepted under that name may very possibly be the more prevalent and more widely distributed form of the two. The 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 **Coix Lacryma-Jobi** have the capsular-spathe, generally more or less spherical, and only slightly drawn out at the apex into a pyriform shape, also 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.

Number of species.

Differences between them.

The **gigantea-aquatica** series of **Coix** are always wild plants; the former is found on the lower hills—dry soils—a robust erect plant, the latter 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 also very hard. The leaves are much shorter than in **Coix Lacryma-Jobi**, most frequently only faintly auriculate and the upper (inner) surface often marked by curious transparent glands, which in the young

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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.

There are other characters in the inflorescence, shape of glumes, etc., etc., that further separate the series of forms under **Coix gigantea-aquatica** from those of **Coix Lacryma-Jobi,** but the above may assist the reader to distinguish them. The features that separate **C. aquatica** from **C. gigantea** will be given in a further passage.

The forms of **Coix 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.**

Hardness of shell of seed.

When they exist as wild plants the shell in all forms of **Coix Lacryma-Jobi** remains hard and polished and, while it may darken in colour and become pink, brown or even black, it never is found soft in texture nor chalky-white in colour. But no sooner is it cultivated than it 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, namely, the sheath, on being transformed into 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 **Coix 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 disk. 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 directed attention to that plant.

Coix gigantea, *Koen. ex Roxb. Hort. Beng. 66; Roxb., Fl. Ind. (Ed. C. B. C.) 650;* CATRI-CONDA, *Rheede, Hort. Malab. (1686-1703) XII., 133, t. 70;* LACRYMA JOBI PALUDOSA, *Burm. Thes. Zeyl (1737), 138;* LITHOSPERMUM AMBOINICUM *the* SALEE UTAN, *Rumph. Amb. (1750) VI., 223, tab. 9. f. 1.;* is also possibly C. AGRESTIS, *Lour., Fl. Cochin. (1790) I., 551;* C. AGRESTIS, *Kunth, Enum. Pl. (1833) I., 21;* C. STIGMATOSA, *C. Koch et Bouché, Ind. Sem. Hort. Berol. (1855) 9; Voigt, Hort. Sub. Calc. (1845) 710;* C. GIGANTEA, *Koen. ex Duthie, Fodd. Grasses (1888) 18;* C. LINGULATA, *Hack. in Oest. Bot. Zeitschr. XLI. (1891), 5;* C. LACRYMA-JOBI, *var.* GIGANTEA, *Hooker, Fl. Br. Ind. VII., 100;* also *Hooker,* in *Trimen, Handb. Fl. Ceylon 192.* Although *Bauhin (Hist. Pl. (1651) II., 449. f. 1)* regarded his two plates as representing the same plant, the one exhibits most of the distinctive features of C. GIGANTEA (f. 1 original) and the other (f. 2 *copied from Lobel*) those of C. LACRYMA-JOBI.

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Vernacular names:—*Danga gurgur,* BENG. (Roxb.); *ganja, giral, kara, kaurilla,* Dehra Dun, U. P.; *kesai,* BERAR (according to Duthie); *mrigaru riksen,* Garo Hills, ASSAM; *ledau-kyeik, kyeikpu,* KATHA; *kyeikaing,* MYELAT; *marlweir,* SHAN; *bohpreing,* TAUNGTHU, BURM.; *moana karabu* SINH.; *bo-bo hoang,* COCHIN-CHINA; *Judsu-dama,* JAPAN.

Rheede's illustration of the plant he named *Cafre* or *Catri-conda* would seem to belong to this species but as opposed to that view there is the fact that Roxburgh placed it under **C. lacryma.**

Roxburgh mentions that this species grows chiefly in the valleys amongst the Circar mountains and in Bengal. The Circar mountains are not very remote from the locality where the *Catri-conda* was found by Rheede but it is significant that **C. gigantea** has only occasionally been since collected in South India. Roxburgh says it is a perennial plant "Culm erect, ramous to the top round, smooth, jointed, from 8 to 15 feet high and as thick as a man's thumb at the base."—"The pedicels," he further says, "are naked; male spikes drooping with flowers threefold, the middle one pedicelled; female corolla six-valved, seeds ovate." His MS. drawing No. 872, preserved in the Herbarium, Calcutta, and a copy in the Kew Library, shows long erect thin branches; leaves linear-lanceolate, acute, margins not hispid, base hardly if at all auriculate, male spikes often long pedunculate and drooping; spikelets slightly spreading, as if racemose rather than spinose; glumes much more elongate than in **aquatica** and hardly emarginate, often beaked: capsular-spathe or involucre ovate to linear-ovate but quite regularly formed and having an oblique terminal lip. Roxburgh neither described nor figured the glands, occasionally present in this plant, though not so abundantly so as in **var. aquatica.** The above description and plate constitute however the type to which subsequent determinations have to be referred. Loureiro (*Fl. Cochin-China*) speaks of his **C. agrestis** as the smooth leaved non-edible form, that is found on the homesteads in dry sandy places and which when experimentally cultivated produces broad quite glabrous leaves.

Distribution.—The distribution of the plant may be inferred from the following record of collections:—

In the Kew Herbarium there are many sheets of which the following may be mentioned:—***INDIA: South India,*** Wight, 1729, 202

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(A) & (C) also 8625(A) Wallich *ex* Herb. Wight; ***Deccan***—Wallich, No. 8624(C)—*ex* Herb. Heyne, (E) ***Chenapah***, *ex* Herb. Wight; ***Bengal***—Wallich No. 8624 (F) & 8624 (G), *ex* Hort. Bot. Cal.; Prain, ***Parisnath, Bengal***; Rottler Herb. (*ex* Roxb.); Griffith, ***Afghanistan***; Forsyth Herb. (*ex* Roxb.); Abel Herb. ***E. Indies*** (*ex* Roxb.); ***United Provinces***—Duthie, ***Shahjahanpur*** No. 5036 (vern. *gunja* or *kaurilla*); ***Burma—Fort Stedman***, Collett, No. 51, (the type of **C. lingulata** *Hackel*). ***CEYLON:*** Herb. Rottler. ***JAPAN: Nagasaki***, Oldham No. 861 (921) (*djus-dama*), found on borders of streams—leaves usually broad; No. 369 in the woods—leaves normal; ***Yokohama***—Bennett, *ex* Herb. Hort. Bot. Petropolitani. See paragraph on distribution of var. **Ma-yuen**—reference to the West Indian cultivated plant, p. 218.

In the British Museum Herbarium in addition to duplicates of some of the plants already quoted, there are interesting additional examples of this species:—***Bengal***: Mr. C. B. Clarke's No. 20996 from Chaibasa in Chatia Nagpur and No. 24501 from Bárásat: a sheet that appears to have been contributed by Dr. Buchanan Hamilton (No. 1006 ? collected in Eastern Bengal in 1815)—a beautiful sample of this plant with the glandular-formations on the leaf well marked suggestive of its being possibly variety **aquatica**: Major Prain's No. 1397 from Monghyr. ***Central Provinces***: Mr. Duthie's No. 8493 a most interesting example the whole plant not exceeding six inches in height and all the structures though thus diminutive, characteristic of the species in every detail. ***Central India***: Gwalior, Mr. C. Maries' No. 159. ***South India***: A very typical sheet from Col. Beddome. ***Ceylon***: a specimen from the Central Provinces No. 942 that may possibly be variety **aquatica** and Mr. Moon's specimen. There are no examples of this species from any other part of the world.

In the Herbarium of the Royal Botanic Gardens, Edinburgh, have been deposited a duplicate set of most of the collections of **Coix** discussed in this paper under the heading "Review of Collections recently made in India." But in addition there are many fine sheets that amplify the citations given from the Kew Gardens and British Museum Herbaria. Of **C. gigantea** the most noteworthy samples are Buchanan-Hamilton's No. 1989 from Eastern Bengal—a superb specimen showing the narrow linear leaves profusely punctuated with glandular structures and the glumes large, broadly winged and deeply emarginate. Hamilton named this plant as **C. lacryma**, b.: it was collected in October 1811. Then there is Sir J. E. Smith's sheet said to be from Nepál which has gland-dotted broad

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leaves and acute entire glumes. Lastly a sample collected at Dehra Dun No. 8599 (of R. E. P. Herbarium).

The Flora of British India gives the habitat as "The hot valleys from the North West Provinces to Assam and southwards to the Malay Peninsula and Travancore, distributed to Afghanistan."

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DESCRIPTION.

Description.—The following detailed description may be useful *stem* perennial, erect; *leaves* narrow, linear, shortly acuminate-lanceolate, very slightly cordate-auriculate, *union* with sheath a broad triangular suture, projecting from either margin to the mid-rib, *sheath* long and strongly ribbed but quite glabrous and eglandular; *upper surface* of leaf hairy especially near the tip, glabrous on becoming old; hairs long, stiff, pointed, ascending and each arising from a minute gland which shows through as a swelling on the *under*-surface, and is seen to be a glistening blister on the upper; *margins* of the leaves hyaline with short stiff teeth but old leaves otherwise quite smooth; veins five to seven, on either side of the mid-rib, with the same number of veinlets between each pair of veins. *Inflorescence* profusely axillary, near the extremities of the shoots, usually within each leaf two or more spikes, one with a fairly long peduncle (or stalk) and bearing one or more spikes within a short spathe-like leaf, the other spike shortly pedicelled but devoid of a special spathe of its own; *male* spikes short, erect, few-flowered, racemose, the spikelets in threes, each two-flowered and the lower pair of spikelets sessile, one placed above the other, and the third with a fairly long slender stalk, thrown off to one side. *Rachis* and *pedicels* of the spikelets thin, elongated, angled, scaly, otherwise quite glabrous. *Glumes* ascending, ovate or ovate-oblong, winged on upper half, the lower and outer glumes emarginate, from the wings being prolonged beyond the natural apex; margins of the glumes hard, rigid, and serrulate as on the leaf-margins, only finer. *Capsular spathe* pyriform, mouth only slightly prolonged, oblique, entire, thickened (the character which presumably suggested the name **lingulata** given by Hackel to a form of this plant). *Nut* polished, bluish-white to orange or grey and often mottled, thick, hard, flattened on one side, and with two furrows longitudinally on the flat face but not constricted transversely, a condition met with apparently only in *var.* **aquatica**.

REVIEW OF COLLECTIONS RECENTLY MADE IN INDIA.

Review of Indian Collection.

United Provinces: *No. 8599*, from Saharanpur Botanical Gardens, forwarded by the Director of Land Records and Agriculture, under cover of his letter No. 28 of 8th January, 1897, which encloses Mr. Gollan's letter. The grass, writes Mr. Gollan, is not found wild in the immediate vicinity of Saharanpur but is plentiful in a wild state

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in the district of Dehra Dun, and the neighbourhood of Hardwar, where it is found growing during the rains in the rice-fields and damp ground. It is not collected nor does any economic use appear to be made of its seeds. It is known as *giral* and *karq*.

***Assam*:** *No. 8817 (seeds and botanical specimen) and No. 8815.* These came from Gáro Hills, Assam. The seeds are greyish-white in colour and are known as *mrigaru riksen*. It is said to be a wild form and never to be cultivated but grows on the hills. The fruits are used by the Gáros as ornaments only. The name *mrigaru* appears to be generic for all forms of **Coix** in these Hills, the cultivated form being known simply as *mriraku*. (*Conf. No. 8818 and 8821 under* **Coix Lacryma-Jobi**, *var.* **Ma-yuen**).

***Bengal*:** Roxburgh's **Coix gigantea**, he tells us, bore in his day the Bengali name of *danga grrgur*—a name that so far as the collections recently to hand show, would be more correctly applied to **Coix aquatica**. It is further somewhat remarkable that no example of this form has been procured (during the recent investigations) from the Province of Bengal.

***Burma*:** *No. 11805* is a sample of what I take to be this species. It came from the Katha District, where it is known as *ledau kyeik* or *kyeikpu*. The seeds are of a dull, mottled white colour. But the plant sent along with the seeds very possibly does not correspond, and is **C. Lacryma-Jobi**. *No. 12236* has been received from the Eastern Division Southern Shán States, and it has the characteristic shell and mottled fruits of this species but as no botanical specimens were furnished, it cannot be named for certain. It is said to be wild in Mong Nai and fairly common in marshy land. It is not used for any purpose, but in Burmese it is known as *kyeik-aing*, in Shán *marlwir*, and in Taungthu as *boh-preing*.

COIX GIGANTEA VAR. AQUATICA.

Var. aquatica, *Watt*; COIX AQUATICA, *Roxb. in Fl. Ind. III, 571*; *Voigt., Hort. Sub. Calc. (1845) 710.*

Vernacular names.—*Ganrer jail-gurgur*, BENG.; *dhan-gurgur, gurlu, gullu*, MANDLA; *Kasai*, NAGPUR; *gurlu, gullu, garru, kaldu, kasai, kasud, kachai, kasahi, gargud*, CENTRAL PROVINCES; *kyeik-the*, PEGU; *gyeit-songyu*, AKYAB; *geiksi*, TENASSERIM; *kayeik, kaleik*, SHAN STATES, BURMA.

It may be useful to record here Roxburgh's diagnostic description of this plant. It is a native of the lower part of Bengal, and he says is a "Floating and creeping plant from 50 to 100 feet leaves linear, most acute, with hispid margins; male spikes drooping, many flowered; flowers three-fold, the middle one pedicelled;

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female corolla from six to seven valved; seeds turbinate." In the Calcutta Herbarium, and in the Kew Library are preserved the original and a copy of Roxburgh's unpublished plate No. 1908. This might be described as showing a plant with swollen stems and floating roots; leaves linear-lanceolate, very slightly cordate, margin distinctly serrulate or hispid; male spikes shortly stalked, very prominently drooping, spikelets three, middle one pedicelled; glumes broad, ovate oblong, often acuminate or apiculate with pale coloured wings or margins. Capsular-spathe irregularly pear-shaped grooved (turbinate) chalky white to dark green or brown. Roxburgh makes no mention, however, of the glandular hairs that are so very characteristic of this plant. The above description and plate must be accepted as denoting the variety **aquatica**.

Distribution.

Distribution.—The distribution of the plant may be inferred from the following record of collections in the Kew Herbarium that I accept as belonging to this form—***INDIA***, Herb. Hook. f. and T. T., as follows No. 1, T. T., (No. 1447), ***Rowlee Ghat*** 1,000 ft. (October 1845) (a sample showing the long floating roots as in Roxburgh's plate); No. 3, ***Concan***, Herb. Law; No. 3, ***Mysore***, G. Thomson; and Nos. 4 and 5, ***Concan***, Stocks; Jacquemont, Bomb. Karli, Nos. 632 and 569; Wight, No. 202 B; McClelland, ***Rangoon***; ***East Bengal***, Griffith No. 6451 (a doubtful plant with very compact spikes); Kurz, ***Teenpahar, Bengal*** (in fields); Duthie, ***Central Provinces*** No. 8453; Watt, ***Balasore*** (24-2-83).

The following examples found in the Herbarium of the British Museum may also be mentioned:—Southern Marátha country (***North Kanara***) collected by A. P. Young, Esq., I. N., a beautiful example with the characteristic glandular formations, tipped by deflexed hairs, and with the angled and transversely constricted fruit of this variety all strongly marked. In the Edinburgh Herbarium there are many examples of this obscure variety. These all preserve the characteristics already indicated and support the opinion advanced that so far as India is concerned this particular form, though found on the mountains of Bengal, is much more prevalent in Western and Southern India and Burma than in Northern and Eastern India:—W. H. Campbell's No. 60, from Peninsular India (the label of which bears the name *Vishnu Chukram*) and Dr. Ritchie's No. 870 collected at Belgaum, a duplicate of which appears in General W. Munro's Herbarium.

It would thus seem that while C. **gigantea** may be spoken of as met with chiefly on the mountains of the Eastern and Central portions of India, the variety to which the name **aquatica** has been given, occurs on the banks of rivers and margins of marshes, ponds, etc., more specially of Western and South India to Burma and Japan.

COIX Spp.

Coix spp. or Job's Tears.

COIX GIGANTEA VAR. AQUATICA.

Description.

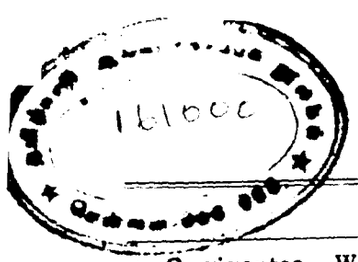
Description.—The following description is made from the series of Indian specimens I have identified with the above mentioned plant:—*Stem* perennial, floating; *leaves* as a rule short (relatively much broader than in C. **gigantea**), ovate linear-lanceolate, the upper ones greatly drawn out into long tapering very acute points, broadest near the sheath, very slightly cordate-auriculate, the blade appearing like a direct prolongation of the open loose sheath, and its union with the sheath as a rule represented by a narrow line; sheath thin, not strongly ribbed but very frequently possessing, near the union with the blade (and on the outside) a few large thickened glands with a crater-like depression on the top of each, which corresponds with the point from which a short, stout, deflexed hair has fallen off; *upper surface* of blade densely covered with large conspicuous glands which, in the young leaf, more especially near the tip, bear stout bristle-like, deflexed and rigid hairs, and give the upper surface of the leaf a rough feeling; *under surface* quite smooth; margins of the leaf only faintly serrulate, and chiefly near the base. *Spikelets* axillary, borne on very long, naked, strong, triangular peduncles which, above the fruit, often bear, within the deflexed portion, a tuft of hairs set on hard reddish glands, or the glands alone are present. *Male* spikes elongated, on very short peduncles, hence mostly nodding, many-flowered; they are strictly speaking spikes not racemes, though the spikelets are in threes, the two lateral opposite each other on the rachis and the third in the middle, borne on a fairly long ascending (not spreading) pedicel, each spikelet two-flowered; rachis and pedicels rigid, thick, strongly angled, with, on the margins, a few stiff hairs, bristles or teeth. *Glumes* broad, ovate oblong, acute or beaked, not emarginate, outer one of each spikelet with a strong fold along the inner surface, corresponding to the union of the wings, which acts as a clasping contrivance to hold the inner glumes, very much as in a bivalved shell; margins serrulate, but not very strongly so; spikelets imbricating and coarctating in six rows along the compact pendulous spike. *Capsular-spathe* irregularly pyriform, apex drawn out into a tube that ends in a mouth, obliquely prolonged into an acute lip. When half ripe, surface irregularly warted or corrugated, and constricted transversely near the middle, the upper half being furrowed into some 8 or 10 ridges, ultimately when quite ripe, smooth, hard, polished, angled, and of a dull white or greyish or greenish brown to dark brown colour. It is very hard and is only rarely eaten.

Review of Indian Collections.

REVIEW OF COLLECTIONS RECENTLY MADE IN INDIA.

Deccan, Bombay:—One of the most splendid examples of Coix ever seen by me very possibly belonged to this form

C. 1683-1700.



Coix spp. or Job's Tears. (*Sir G. Watt.*)

COIX Spp.

COIX GIGANTEA VAR. AQUATICA. Review of Indian Collections.

to C. **gigantea**. Whilst on a visit to the Commissioner of Settlements and Agriculture, Bombay, I observed over one of the doors of his house a screen, consisting of chains of Coix seeds. These were the largest I had ever seen and were, I believe, from ¾ to 1 inch in length. My host (Mr. Lawrence) said he thought the seeds had been obtained locally but he was unable to afford any very definite information regarding them. He has promised to institute a thorough inquiry.

Bengal:—*No. 8760* is the *ganrer* of Palamow, Chutia Nagpur, where it is not cultivated but grows wild in the marshy places throughout the district, or near *dhán* (paddy) fields. Hence perhaps its name *dhán ganrer or dhán gurgur*.

Central Provinces:—*Nos. 8762 to 8770.*—In the Mandla District it is known by the name of *gurlu*, except by the Gonds who call it *garru*. It is found wild near cultivated lands, especially swamps adjoining fields. The samples illustrate the most prevalent forms of the spathe—dull, lurid white to brown, brown or black, being less plentiful than the dull chalky-white. The plant flowers in September; and the fruit ripens in October and is collected in November and December. It is eaten by the poorer classes either boiled whole like rice or is broken in a mill like *dál* and used as a substitute for pulse. There are three forms, namely, white fruits (*Nos. 8762* and *8769*); green (*Nos. 8764* and *8767*); and dark brown or black (*Nos. 8763, 8768, 8770*). It is never cultivated. *No. 9698*, received from the Sambalpur District. The Commissioner of Settlements and Agriculture furnished a report for the whole province, on the subject of Coix and illustrated the same by specimens. These bear the following vernacular name:—*garlu, gullu, garru, kaldu, kasai, kasud, kachai, kasahi, gargud*, but apparently the different species are not separately recognised by the people. In the report it is stated that in some form or other Coix is found nearly all over the province except in the district of Chhindwára. The wild form, differentiated from the others as *dhán gurgur* (*No. 9698*) is common in rice-fields, springing up naturally as a weed. It flowers in October, ripens fruit in November and December, and dries up by February. It grows usually to a height of 2 to 6 feet and may be regarded as the aquatic form and is met with on *bahal* or low-lying fields and also on the banks of *talas* and edges of tanks. It has a fruit with a hard shell constricted at the top.

While travelling in Nagpur District in 1894 I collected a sample of C. **aquatica** which was called *kasai*; it was found floating on the margin of a tank (*Field No. 13849*). Mr. Duthie also collected a plant in the Sevat Valley at 3,000 feet in altitude (in fruit on the

C. 1683-1700.

COIX Spp.

Coix spp. or Job's Tears.

COIX GIGANTEA var. AQUATICA. Review of Indian.

17th September 1895) which is the same though the leaves of his plant seem unusually broad, suggestive of **C. gigantea** (*No. 17614*).

Burma :—*No. 10497* is the *kyeik-the* (phonetically spelt *cheik-the*) of the Pegu District, where it is found wild and is used for ornaments and rosaries. This with its large mottled pyriform fruits may well be spoken of as a typical specimen with elongated fruit received from Prome. *No. 11080*, dark brown in colour, has been furnished by the Deputy Commissioner, Amherst, in the Tenasserim Division and described as the wild plant of that locality. *Nos. 11559* and *11560* are samples of elongated fruits, white, deeply furrowed along the face; these came from Tharawaddy, *No. 11583*, known as wild *geiksi*, was received from Tenasserim; it has long, white (milky), angled fruits and prominent glands on the leaves. *No. 12162*, from Akyab, has a large creamy, white fruit. It is said to be wild and has been received under the local name of *gyeit songyu*.

Shan States :—*No. 15061*.—This is a somewhat exceptional form that has come from the Karenni, Southern Shán States under the name of *kayeik* in Lower Burma and *hpauug* or *kaleik* in the Shán States. It has remarkably long erect spikes and the nut is more spherical than usual, the lip ovate acute, spinose, and the fruits of a rich nut-brown or yellowish colour. In some respects this is intermediate between the form that I have above accepted as being **C. aquatica** and that which I have assumed to be **Roxburgh's Coix gigantea**.

COIX LACRYMA-JOBI.

Coix Lacryma-Jobi, *Linn. Sp. Pl.* 972.—LITHOSPERMON, *Pliny Nat. Hist. of World (transl. by Holland 1601) II.*, 284; LITHOSPERMO, *Mziori, Bock (Hieronym.), latinised to Tragus (1552) 916, lib. 2C. 140*; LACHRYMA-JOBI, *Dodoens, Hist. Frum. (1569) 40, t. 71*; *Lobel, Icon. Stirp. Pi. (1591) 44*; *Gerarde, Herball (Ed. Norton 1597), 81-82 and plate*; *Besler, Hort. Eystett. (1613) II., 13, fol. 6, f. 1*; *Parkinson, Theat. Bot. (1640) 430*; LITHOSPERMUM ARUNDINACEUM, *Bauhin, Hist. Pl. (1651) II., 449, and plate (ex Lobel)*; MILIUM SOLIS or LITHOSPERMUM INDICUM, *J. Bontius, Hist. Pl. (ex Piso) (1658), 152*; SESAMO ANNUO, *G. Zanoni, Istor. Bot. (1675), 171-80, t. 68*; LACHRYMA-JOBI, *Morison, Pl. Hist. Univ. (1699) III., 249, Sec. VIII, t. 13*; LACRYMA-JOBI, *Magnol, Charact. Pl. (1720) 62*; LACRYMA JOBI, *Bœrhaav, Index Pl. (1720) II., 166*; *Miller, Gard. Dict. 1st Ed. (1731)*; *Burm. Thes. Zeyl. (1737) 13, 8*; C. LACRYMA, *Linn., Hort. Cliff. (1737) 437*; *Sp. Pl. 1378*; G. OVATA, *Linnæ, ex Royen Fl. Leyd. (1740) 72*; *Weinmann, Phytanthozaiconogr. (1742) III., 206*; LACHRYMA-JOB, *G. Zanoni, Rari. Stirp. Histor. (1742) 136-8, t. 101*; *Linn. Fl. Zeyl. (1747) 156*; LACHRYMA JOBI India (*Salee*) *Rumph. Amb. (1750) V., 193, t. 75, f. 2*; C. LACRYMA, *Thunb. Fl. Jap. (1784) 37*; LITHAGROSTIS LACRYMA-JOBI, *Gaertn. Fruct. (1788) I., 7, t. 1, f. 10*; C. LACHRYMA, *Lour. Fl. Cochin. (1790) I., 551*; COIX (LARMILLE) *Lam., Encycl. (1783-1808) III., 421, I., 750*; C. ARUNDINACEA, *Lam., Encycl iii 422*; C. PENDULA, *Salisb. Prod. (1796) 28*; C. OVATA, *Stokes, Bot. Mat. Med. (1812) IV., 343*; C. LARMILLE, *Beauv. Agrost. (1812) 137, t. 24, f. 5*; *Aiton, Hort. Kew. (1813) V., 236*; COIX LACRYMA, *Willd. Sp. Pl. (1797-1824) 4, 202*; *Bot. Mag. (1824) Vol. 51. No. 2479*; *Roxb. Fl. Ind. (1832) III., 568*; *Kunth, Enum Pl. (1833) I., 20, Supp., 16, t. 3 & 4*; *Webb et Berth., Phyt. Canar. (1835) t. 242, 243*; C. EXALTATA, *Jacq. Eclog. Gram. (1813-44) 60, t. 40*; *Miquel, Fl. Bat. Ind. (1855) III., 476, t. 41B.*; C. LACRYMA, *Steud. Syn. Gram. (1855) 9*; *Church, Food-grains of India, fig. 10*; *Duthie, Fodd. Gras. (1888) 18-19*; *K. Schum. & Lauter b., Fl. Deuts. Schutzg. (1901) 164*; *Hooker f., Fl. Br. Ind. Vol. VII. 100*; *in Trimen Handb. Fl. Ceylon, 192.*

Vernacular names.—*Gurgur, jargadi*, BENG; *jargadi*, SANT; *sankhru, sankhlu, gargari-dhan*, HIND.; *kaiya, sankru, laru*, U. P.; *sanklu*, SIMLA, PB.; *dabhir*, MT. ABU, RAJ.; *gandula, garun, kasei, gulbi-gadi, gurlu*, C. P. (according to Duthie); *Ránjondhala, ranmakai*; MAR. (according to Dymock); *kasai*, GUZ. & PANCH MAHALS, DECCAN; *koamonee, kawrmonee*, ASSAM; *sikra kraou, koa sangti*, NAGA HILLS; *j'lonki, dhola-jhonki, kawa-jhonki*, CACHAR; *mim*, LUSHAI; *chang-nim-khombi*, (the edible form being simply *nim* or *num*) MANIPUR; *gyeik aing, gyeik-yaung, gyeiksi-aing*, BURM.;* *keekirrindæ karæbu*, SINH.; *salee*, AMBOINA; *jale* or *djali*, JAVA; *tómugi*, JAPAN; *gavidhuka, gavedhu, gavedhuka* SANS. (according to Dymock).

Roxburgh gives the following description of this plant:—"Leaves at base cordate; pedicels naked, not jointed; male spikes nodding; flowers paired; calyces smooth, ovate." Loureiro lays special stress on the recognition of a cultivated state of this species, as being distinct from the wild plant, and to the latter he gives the name of **C. agrestis** (a plant which I believe may have been **C. gigantea**). Rumphius also figures and describes a cultivated form (the *salee* of the Malayas) and affirms that it is a distinct plant from the wild condition *salee utan*. His cultivated plant is probably the variety below named **Ma-yuen**, and his wild plant I believe to have been **C. gigantea** though it is somewhat remarkable that Roxburgh makes no reference to it.

Distribution.

Distribution.—The following record of samples examined by me gives direct information regarding the distribution of the species:—

INDIA :—***United Provinces***—Udaipur, Duthie, No. 50 (vern. *kaiya*); Gurhwal No. 5037 (alt. 3,500); Kumaon, Strachey and Winterbottom (3,500 feet); ***Bengal***—Noakhally, Herb, Ind. Or. Hooker f. and T. Thomson No. 2; Forsyth (*ex.* Roxb.); Megna, Herb. Ind. Or. Hooker f. and T. Thomson No. 2; Griffiths, Eastern Bengal, 6447; Sikkim, Herb. Ind. Or. Hooker, f. and T. Thomson No. 2 (5,000 ft.); ***West*** and ***South India***: Deccan—Herb. Wight (No. 1730) named **C. exaltata**, *Link*. Herb. Rottleriana, from Mysore named **C. latifolia**, *Nob.*; Ootacamand, Herb. Munro. ***Assam*** : Sylhet and Khasia—Herb. Ind. Or. Hooker f. and T. Thomson No. 3

* By a more common transliteration these Burmese names would be rendered *Kyeik-aing, Kyeik-yaung* and *Kyeik-si-aing*.—ED.

C. 1683-1700.

Coix spp. or Job's Tears. (*Sir G. Watt.*)

COIX Spp.

COIX LACRYMA-JOBI.

C. 1683-1700.

COIX Spp.

Coix spp. or Job's Tears.

COIX LACRYMA-JOBI. Distribution.

(alt. 6,000 ft.); Wallich, Sylhet, No. 8623 (F.). ***Burma***: McClelland, Rangoon; Wallich, Penang, 8623 (K.) and (L.); ***CHINA***: A. Henry, Ichang, No. 2635; Hong Kong—Bot. Gardens No. 195. ***JAPAN***: General Munro, in woods—a long leaved form with pointed grain somewhat like those of **C. gigantea**, but no glands or other distinctive characters of that species. ***MALAYA***: Perak—King's collector No. 7212, a remarkable plant with long erect compact spikes, that deserves being viewed as a distinct and undescribed species. It is alluded to here provisionally. Tonkin—Balansa, No. 4897, typical example;—Ins. Philip; Timor, Herb. Mus., Paris; ***TROPICAL AMERICA***: S. Pacific Explor. Exped.; Yucatan—from Columbian Museum, No. 1031; Brazil (No. 67) and Peru (No. 1644), samples with leaves hardly cordate and leaf sheaths often hardened but somewhat as in the variety **Ma-yuen**; Burchell's No. 3628, has very long leaves hardly cordate; Pearce's samples from Corocoro have leaves, long narrow; Bolivia, Britton and Rusby, No. 527. ***WEST INDIES***: Antilles and Porto Rico—E. Hackel, No. 556. St. Vincent—damp situations near the sea—"Is called *Job's tears* in Brazil" where the seeds are used for rosaries called "lagrimas de Santa Maria"; Martinique. ***POLYNESIA***: Fiji Islands—Seemann, No. 692, grain slightly elongated; Tongatabu Isld. Challenger Exped. Samoa Rev. T. Powell (*ole ranasana*, vern.) typical; Rev. S. J. Whitmee's sample shows tendency towards **stenocarpa**; Balansa's No. 884 named var. **exaltata** is perhaps a cultivated state in transition passing into **Ma-yuen**, grain bluish-white, pointed, very abundant; Treasury Island No. 328 (vern. *ken-ken*); ***MASCARENE ISLANDS***: Madagascar—Rev. R. Baron No. 2514; Hildebrandt, Nos. 1732 and 2934; C. Holst, Flora von Usambara, No. 2226. North African area; Canary Islands:—(F. Bourgeau No. 147). ***TROPICAL AFRICA***: Sierra Leone, G. H. Garrett: Mohilla Island, Livingstone's Zambesi Exped., Sir J. Kirk; Johanna Island, C. J. Miller, Livingstone's Zambesi Exped.

Possibly a new species.

In the British Museum Herbarium there is a large assortment of the typical state of Job's tears of which the following may be specially mentioned in amplification of the distribution indicated by the enumeration of the series preserved in the Kew Herbarium:—***INDIA***: Darjeeling, Mr. C. B. Clarke's No. 12383; Wallich's No. 8623(A) said to have been obtained from Roxburgh; a specimen named C. **lacryma, var. exaltata**. *Link*, Hort. Berol. No. 1253; Mercára, Coorg, collected by R. F. Hohenacker, No. 606. ***MALAYA***: Banks and Solander's specimen; Singapore, also Sungei Ujong, collected by H. N. Ridley; Johore by J. B. Fielding; JAVA: Zollinger's No. 353; Perak, by Smith; Celebes: Macassar, collected by

COIX Spp.

Coix spp. or Job's Tears. (*Sir G. Watt.*)

COIX LACRYMA-JOBI. Distribution.

Barclay. ***CHINA***: Specimen by H. F. Hance No. 402; ***JAPAN***: Zollinger's sample presented by Shuttleworth. ***S. AMERICA***: Dr. Alven's sample from Surinam. ***WEST INDIES***: Trinidad, collected by A. Fendler, No. 930. ***POLYNESIA***: Bank's and Solander's specimen; Seychelles collected by E. P. Wright; Fiji, by Harvey. ***AFRICA***: Angola, by Welwitsch, Nos. 5004 and 7241; Johanna, by Hildebrandt No. 1732, Giryama & Tsimbu Mountains by W. E. Taylor; Madeira, *ex* herb. R. L. Lowe. ***MASCARENE ISLANDS***: Rodriguez by Prof. Balfour.

In addition to some of the samples already mentioned the Herbarium of the Royal Botanic Gardens, Edinburgh, possesses the following examples of this form:—***INDIA*** from Bengal, Chutia Nagpur, Rev. Dr. Campbell; from Parisnath hill, collected by A. Watt in 1876; Assam samples by Jenkins, Masters and Griffiths (*ex* Herb. Calc. also Ball); the Himálaya, Simla by Dr. Johnson, Bashahr, Lace, No. 1122, N.-W. Himálaya, Duthie; Rajputána, Mr. Duthie, No. 6742. ***CEYLON***: Mr. Brodie. ***MALAYA***: Singapore, *ex* herb. Cleghorn. ***MASCARENE AND OTHER ISLANDS***: Mauritius, *ex* herb. J. Ball; Ascension Islands, *ex* herb. H. J. Gordon; Madagascar, G. F. Scott-Elliot, No. 2237. ***WEST INDIES***: Trinidad, A. Fendler No. 930. ***SOUTH AMERICA***: Ecuador, W. Jameson No. 709.

I have already briefly indicated the main characteristics of this form, in the introductory note, and need not repeat what has there been stated. All the forms of this species are at once recognised by the texture of the leaf, and its peculiar scabrosities. The capsular-spathe varies very greatly and there are in consequence perhaps four well-marked varieties the characters of which are as follows:—

(*A*).—*The normal form* which exists in a wild state and has a spherical to ovate-oblong capsular-spathe, smooth polished, very hard and almost invariably bluish-white in colour.

(*B*).—*The cylindrical form* known as **var. stenocarpa** in which the capsular-spathe is greatly elongated, bluishwhite and cut off abruptly at both extremities; when cultivated it becomes thin and straw-coloured.

(*C*).—*A flattened spheroidal form*, which, as a rule, is broader than long. I propose for this condition the varietal name **monilifer**, because of its extensive use for and peculiar adaptability to the purposes of ornamental beading. All the examples of this variety are abruptly cut off at both extremities, and if not actually depressed, they have very often a large gaping mouth. They manifest a wide range in colour from chalky and milk-white to pink, to brown or even black. They are sometimes cultivated but are very exceptionally eaten,

COIX Spp.

Coix spp. or Job's Tears.

COIX LACRYMA-JOBI.

Distribution.

Both the largest and the smallest forms of **Coix Lacryma-Jobi** are met with in this series.

(*D*).—Lastly, there is *an extensive series of cultivated forms* that fall naturally under the variety **Ma-yuen**. These all agree in certain peculiarities while differing widely in other respects. They are universally cultivated edible plants; the shell is thin and easily broken between the fingers, is longitudinally striated, and in most forms there is a basilar portion constricted into a distinct annulus or disk. But in point of colour they manifest but one peculiarity in common, *viz.*, that they are never milky white. The lightest coloured forms are chalky-white (and these appear never to possess the annulus); straw-colours are very common; particoloured grains (dark brown at the base and straw-coloured at the apex) are frequent; blue, striated with brown furrows, are abundant and lastly brown and black are not unusual. The presence or absence of the annulus would seem to denote almost a subvarietal character since all the grains devoid of that structure are spherical in shape while those possessed of the annulus are much elongated and often irregularly pyriform.

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A very large series has been brought together from all parts of India and Burma. These may be most effectively discussed under the varietal groups already established.

1st var. typica, *Watt*, COIX LACHRYMA-JOBI. *(proper) Watt in Programme of Collections for the Indian Museum, Calcutta, and the Imperial Institute, London 1897-98.* The following notes indicate the collections to hand of this form assorted according to Provinces of supply:—

Bengal.—*No. 7681* came from the Bankura District, where it was found wild. The Santáls inhabitating that country recognise the plant under the name of *jargadi*, while by the other inhabitánts it is more commonly known as *gurgur*. It is used occasionally in the way of garlands and pendants, in dress and fancy basket ornamentation.

Himalaya.—While on tour in the Sikkim and Darjeeling Districts I collected the plant in fruit (November 1900) at Chengtung (*Field No. 14216*). So again far to the west the identical same plant was found by me, growing wild on the banks of a stream, at Nirmand in the Kulu District, Panjáb, at an altitude of 4,000 feet (*Field No. 13418*).

COIX Spp.

COIX LACRYMA-JOBI.

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Assam.—*No. 8128* has been received from Nowgong. It is there called *koamonee* and grows spontaneously near rice-fields. This particular sample curiously enough shows an equal admixture of both the bluish and the milky white grains, a difference attributed locally to transitional stages. The plants come out in May and June, bear fruit in July and August and are fit for reaping in October and November. But so far as has been ascertained the grains are not put to any economic use. *Seeds No. 8278 (botanical specimens No. 8709)* from Sibsagar, are stated to have no economic use in the district; the plant grows as a weed of cultivation in fertile lands and is known as *koamonee*. Specimens of headchains, as used by children, were submitted but the remark was made that they are not in much demand among the people in the plains though the Nágas seem very fond of them. *Seeds No. 8309 (and necklace No. 8310)* from Lakhimpur were received under the vernacular names—*koamonee* or *kawrmonee* in Assamese, *koa sangti* by Nágas, *argor* (probably a corruption of the Bengali name *gurgur*) by the colonised coolies on the Bengal side of the district. The plant is never cultivated but is found wild and in abundance on the hills near the banks of streams or margins of bhils (ponds). The plants generally begin to come out in May and June and reach a height of two to five feet. So luxuriant is their spontaneous growth that clumps may usually be seen averaging from five to thirty stems, and, if pruned, more than forty stems may shoot from the common stalk. These bear fruit in September and October, the yield being correspondingly heavy, since each bush may give more than a seer (two pounds) of grain. The fruits in the first stage are greenish but turn to brown or even black and become very hard. The Deputy Commissioner of Lakhimpur states that the young leaves of the plant are much used as fodder for cattle and elephants, the latter being reported as especially fond of them. In Lakhimpur, headchains of **Coix** are little in favour, except with children and a local superstition militates against their general adoption, for the popular belief holds that "he who wears a **Coix** necklace will lose his blood."

The Deputy Commissioner invites attention to what he describes as "the fallacy of the remark (quoted in *Kew Bulletin*, 1888, 145 and reproduced in *Dict. Econ. Prod.*, Vol. II, 493) and which was made originally by Mr. Bruce of Baliparas namely, the explanation of the vernacular name of *kawrmonee* as Crow's Bead, from the fondness of these birds for the berry." This, it is further contended, is no doubt "an error since there is no berry nor any nutriment in the grains of a kind to attract crows. A more accurate rendering of the term would be to call it "Crow's jewel (just as we say a toad's-stool)." *Seeds No. 8316 (and botanical specimens No. 9701)* have been

received from Jorhat under the vernacular name of *koamonee* (more correctly *koamani*) and the plant is there stated to be wild. The nuts are used for necklaces and other ornamental purposes but the use is, as in Lakhimpur, confined chiefly to the children. *No. 872* is from Cachar. This species is there called *jhonki*, *dhola-jhonki*, also *kuwa-jhonki*. It is known in Manipur as *chang-nim-khombi* as distinguished from the edible form which is known as *nim* and *num* simply. The plant grows near homesteads as well as in the jungles and springs up during the rains, but is never cultivated. The particulars regarding its economic uses are the same as in other parts of Assam.

The Deputy Commissioner of Kamrup forwarded a botanical specimen of the typical form of **Coix Lacryma-Jobi** unaccompanied with any separate consignment of seeds, and he remarked that the plant furnished was the only indigenous variety or **Coix** available in the district. It is reported to be very scarce, to grow in damp situations and to be used by the native physicians for certain medicinal purposes in cases of children and cattle. But no definite information was furnished regarding its special medicinal application nor has the statement of its use been confirmed by other local officers. In the Darrang District **Coix Lacryma-Jobi** is known by the characteristic vernacular name of *koiar-moni*; it grows spontaneously in shady places and wet soils. But apparently it is little known to the people. Of the Goalpára District it has been reported that it is not known at all, which seems a highly unlikely circumstance. *Seeds No. 10489* (*botanical specimens No. 10216*) from the Nága Hills. This manifests the typical condition of **Coix Lacryma-Jobi** and it is affirmed that this particular form is recognised under the local name of *sikra kraou*. The plant is not cultivated but grows spontaneously in moist fields and damp jungles. The Nágas use the grains for children's necklaces and other personal adornments. For the ornamentation of articles of personal dress, however, the elongated or cylindrical form (**C. Lacryma-Jobi, *var.* stenocarpa**) is that most in demand. In Manipur, as stated above, the oval-seeded form of **Coix** (the typical form) is known as *chang-nim-khombi* but is held to be of little account.

Central Provinces.—*No. 9697* from Sambalpur is a sample characterised by deep furrows running across the surface of the fruit and giving it a somewhat angular appearance. This condition is no doubt suggestive of a tendency towards the **gigantea-aquatica** series but in every other respect the sample may be accepted as representing the typical condition of **Coix Lacryma-Jobi**. It is very hard and finely polished and is used for the purpose of ornamentation by children, and sometimes by the adults

of aboriginal tribes who employ the fruits in place of glass beads. In Hoshangabad, Gond and Kúrkú boys wear the grains in the form of necklaces, while girls of tender age string a few together and make nose-rings of them. The same practice prevails to some extent in Bhandára. The plant grows on highlands and when in a green state is utilised as fodder for buffaloes and other cattle. Elephants are said to be very fond of it, particularly in times of drought. The stems, when dry are used for thatching *pán* (betel) leaf-houses, and even as ordinary thatch, especially for repairing purposes. When green and pliant, the thin stalks are used to tie up bundles of rice at reaping time. It has, however, no special vernacular name to distinguish it from the other and more common form of wild **Coix** in this province, *viz.*, **C. gigantea, *var.* aquatica.**

Burma.—*No. 10881* is from Akyab. No particulars have been furnished regarding it. *No. 10892* from Kyaukpyu in Arakan, has been received under the vernacular name of *gyeik aing*. It grows wild and is used by the Chins as beads for necklaces, and in the ornamentation of belts, etc. *No. 10897* from Pegu subdivision in Lower Burma. In his report regarding that sample, the Deputy Commissioner states that the plant is not indigenous in the Pyuntaza subdivision, where the seeds are nevertheless largely used to adorn the dresses of the Karen women at Nauza. But these remarks apparently refer to the cylindrical variety or **C. Lacryma-Jobi, *var.* stenocarpa**, and not to the plant furnished. *No. 10946* from Tavoy is reported to be found wild on the sea shores and to be used for necklaces and rosaries. *No. 11122* from Thar-awaddy. It was forwarded by the Deputy Commissioner as an edible pear-shaped form. No distinctive vernacular name was given and it is probably by an oversight only that it has been described as edible. *No. 11801* a packet of seeds accompanied by a botanical specimen; these manifest the characteristic features of **Coix Lacryma-Jobi, *var.* typica**. *No. 15058* from Mergui is the typical form of **Coix Lacryma-Jobi**.

Shan States.—*No. 12240* from the Eastern Division of the Southern Shán States. It is said to be found wild in Hong. It is there put to little use. But in the Kengtung Division the seeds are utilised to a certain extent for the head-dresses of the women belonging to the Kaw tribe. These head-dresses are in the shape of a rough crown in three tiaras, elaborately ornamented with the seeds of this **Coix**. These head-dresses not only vary in shape in the different clans but unmarried girls are distinguished from matrons by certain peculiarities in structure of the head-dress. Besides these crown-like head-dresses there is another head ornament of a

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Coix spp. or Job's Tears.

COIX LACRYMA-JOBI.

long, conical shape. It is by no means easy to obtain samples of these ornaments owing to the fact that every female, whether gentle or simple, has but one, and is consequently very unwilling to part with it. These head-dresses are, in addition to **Coix** seeds, ornamented with silver, beetles' wings, and squirrels' tails.

2nd *var.* **stenocarpa**, *Stapf in Kew Bulletin, 1888, 144-5; Hooker's Icones Plantarum, VIII., Pt. 3, pl. 1764; in Hook. f., Fl. Br. Ind. VII., 100*; C. STENOCARPA, *Balansa in Journ. de Bot. (Paris) IV., (1890) 77; Griffith Not. III., 10*; C. TUBULOSA, *Hack. ex Warb. in Bot. Jahrb. XIII. (1891), 260.*

Vernacular names:—*Sikra kratha, sikra krada*, NAGA HILLS; *shamshaw*, NORTH ARAKAN; *chumma-gyeit*, AKYAB; *sitya, kachin-kyeik*, KATHA. *hareik-she, kyeik-padi*, MYELAT; *maklwe-yau*, SHAN; *bongywe*, TAUNGTHU, BURM.

Distribution.

Distribution.—The following may be given as a brief statement of the examples of this plant in the Herbarium of the Royal Botanic Gardens, Kew. The enumeration usefully exemplifies its distribution:—***INDIA. Burma.*** Mergui Griffith, No. 6450 (very short, swollen form); Wight's sample from Griffith Herb.; Kurz, No. 1135 from Pegu Yomah; Watt (24th December 1887) said to be used by Karens to ornament their garments, and by the Angami Nágas to decorate their ear-rings. ***MALAYA.*** The specimens collected by Balansa in Tonkin carry the plant beyond India; it has also been collected in British New Guinea, *viz.*, between the South coast and the Owen-Stanley Range (by Burke), a specimen with a cylindrical-spathe but rather swollen, smooth and bluish-white.

In the British Museum Herbarium there is only one sheet of this form and that contributed by the Reporter on Economic Products to the Government of India. It was obtained from Burma in connection with the inquiry conducted in 1887—already mentioned. But there is a sheet of a plant from ***POLYNESIA,*** Fiji collected by Moseley that might be described as a transitional form between *vars.* **monilifer** and **stenocarpa.**

In the Edinburgh Herbarium will be found by far the finest series of specimens of this variety to be seen anywhere in Europe. It contains an exact duplicate of the Calcutta set of collections made in connection with the production of this report as also my private collections from Burma and the Nága Hills. One sample from Burma shows this plant to be a tall reed with stems as thick as the forefinger.

This variety is not described in Roxburgh's *Flora Indica*. The following may be given as a detailed description drawn from the extensive series in the Herbarium of the Reporter on Economic Products:

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Coix spp. or Job's Tears (*Sir G. Watt.*)

COIX Spp.

COIX LACRYMA-JOBI *var.* STENOCARPA.

Description.

Description.—*Leaves* broad, linear-lanceolate, gradually tapering into a long strong, sharply pointed tip, hardly if at all cordate at the base, *union* with the sheath a broad, triangular, discoloured suture, projecting from either margin to the mid-rib, *sheath* strongly ribbed, *upper surface* of the leaf quite glabrous and eglandular but traversed by numerous minute nervules which are hardly distinct from the nerves and these manifest (especially when young) very minute ascending teeth or thickened processes, especially along the length of the two or three nervules on either side of the mid-rib; these nervule teeth give a scabrid or hispid character to the upper surface of the leaf, quite absent from the under-surface; *margins* with a very characteristic serration, the teeth much longer and flexuose than in the preceding form, and having in addition two or three nervules (both on the upper and under-surface and close to the margin) that show fairly strong serratures (especially on the upper pointed extremity), so that the margin becomes thickened, involute and formidably barbed. *Inflorescence* prolific from the upper half of each stem; *spikes* axillary, two or three from each sheath producing peduncles that bear leaves with sheaths that give birth to one or two similar spike-bearing sheaths; *male* spikes short, lax, few-flowered, racemose; the spikelets in threes, the central with a long slender pedicel, the others subsessile; rachis and pedicels angled, very minutely serrulate along the angles, otherwise quite glabrous; *glumes* ascending, narrow, ovate or lanceolate; wings narrow, the outer ones often with the tip flattened out spathulately. *Capsular-spathe* cylindrical, often swollen in the middle, and constricted near both extremities, hard, polished, white, mouth cut almost square across and constricted.

Balansa is very emphatic that this plant should be treated as a distinct species, not a variety. If one or two specimens only are seen Balansa's opinion would be readily corroborated. But when a series of hundreds are brought together it becomes evident that the elongation of the fruit-spathe takes place very often in plants that at the same time bear fruits of the typical **Lacryma-Jobi** form. Further the panorama of forms connect inseparably **stenocarpa, monilifer** and **Ma-yuen** with the type of this species. The structure of the leaf and flower is identical in all.

It cannot be a separate species but is a variety.

Under this variety among the specimens on my table there are three distinct sets of forms:—

FORM A.

(A)—Very hard, bluish-white, irregularly shaped, swollen in the middle, often curved and mottled in colour.

Burma.—*No. 10885* from Akyab—is a short thick grain ½ an inch by ⅜ of an inch in length. It is constricted towards the lower

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extremity only and is of an irregular character both in shape and colour—some being long, others short and thick, still others curved, in color white, bluish-white or grey-brown. It is stated by the Deputy Commissioner to be a very late form, the plants surviving up to the middle of March, while the others wither up by February; it is locally recognised under the name of *chumma gyeit*. *No. 10890* varies in colour from steel-grey to brown; it has been received from North Arakan, under the name of *shamshaw*. It is longer and thinner than the previous sample and is cultivated by the Chins to a small extent and used for purposes of ornament. The seeds are simply strung together on threads either consecutively or alternately with glass beads, single rows of these being worn as necklaces. *No. 11584* from Katha, where it is known as *sitya* and is found wild on the Kachin hills. It is used for ornamentation, and is usually nearly ¾ of an inch long. *No. 11804* is a similar sample from Katha received under the name of *kachin-kyeik*.

Shan States.—In these States the cylindrical grain seems to be fairly extensively cultivated, and to be almost a regular article of trade. *No. 12233*, from the Myelat Division, Southern Shán States, shows a thick grain much swollen in the middle. It is known as *kareik-she* (or long *kareik*) or *kyeik-pyi* and is regularly cultivated. The plants are grown as a border round paddy fields and are sown in May and June and reaped in November and December. They are not edible but are used for ornamental purposes and are more expensive than the edible forms; price 4 to 8 annas per 1½ viss (1 viss=3·65lb. Av.) while the edible grains fetch 1 to 2 annas for a like quantity. *No. 12337*, received from the Eastern Division, Southern Shán States, where it is found wild in gardens, having been apparently cultivated at some former time. It is known as *kyeik-she* or *kareik-she* in Burmese, *makwe-yau* in Shán, and *bongywe* in Taungthu. It is also an abundant wild plant in Kengtung. It is said to be cultivated in some districts to a limited extent. The practice is to sow the seeds of both the round (**monilifer**) and cylindrical **Coix** in village gardens or on the edge of fields. The sowings are made at the beginning of the rains and the seeds ripen in November. The plant also springs up self-sown long after cultivation has been abandoned. *No. 15059*, from the Karenni Division of the Southern Shán States, received under the name of *kyeik* where it is cultivated and used exclusively for ornamental purposes. It is mainly employed for decoration of the shoulder bags which are so universally used by the Shán tribes. The bags in Kengtung and Karenni are different from those in the west of the Salween river, while the bags made in the lake districts of Ywang Hwe are the best of all. The seeds are never dyed. They are short, thin and cylindical.

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(*B*)—This might be spoken as the soft-shelled series of **stenocarpa**, in which the capsular-spathe is straw-coloured, very long and thin, and easily broken between the fingers. These correspond, in the **stenocarpa** series, to the **Ma-yuen** grains except that they are never edible.

Burma.—*No. 37* from Prome is constricted towards both extremities very much as in the Nága form described below under *No. 10215*, but is much paler coloured and softer. It is ¾ of an inch long, by ⅛th inch thick. *No. 11800*, also from Prome, is perhaps the longest specimen received, being fully an inch long and much like short pieces of straw. *No. 72* from Tharawaddy is nearly an inch long, but in other respects very like the sample from Prome. *No. 11561*, also from Tharawaddy, is one of the longest, thinnest and most cylindrical forms as yet received.

Shan States.—*No. 13233-1* from the Myelat, Southern Shán States, is milky white, hard, short but very uniform in shape and size.

(*C*)—*Transitional forms of* **stenocarpa**.

TRANSITIONAL FORM C(i).

Burma.—*No. 10896* is a remarkable form from Pegu that has the fruits so short that they can hardly be regarded as cylindrical. They are only twice as long as broad and not more than ¼ inch in length. Still I have little difficulty in persuading myself that this particular sample represents a transition between **Coix Lacryma-Jobi**—variety **stenocarpa**, and the variety **monilifer** below.

TRANSITIONAL FORM C(ii).

Naga Hills.—*No. 10488*. This interesting sample was furnished by the Deputy Commissioner, Nága Hills (under cover of his letter No. 1320G., dated 24th November 1897). It is one of the series of five cultivated and three wild forms of **Coix** sent from that locality. The wild forms are recognised in the Nága Hills under the generic name of *sikra* in contradistinction to the cultivated forms which are known as *kessi*. The sample *No. 10488* is a short thick condition ranging from ¼ to ⅜ths of an inch and merges into the ordinary form of **Lacryma-Jobi**. It is called *sikra kracha*. This is used for ornamental purposes, especially in making earrings. It is not cultivated but springs up naturally sometimes on the margins of fields but more frequently in the jungles. *No. 10490* (*Botanical specimens No. 10215*) is a second form more distinctly cylindrical and said to be known in the Nága Hills as *sikra krásia*. The capsular-spathe is constricted at both extremities in a somewhat striking manner; it is from ½ to ¾ inch long. This kind is chiefly used for making necklaces along with the ordinary form of **Lacryma-Jobi** which is called *sikra kracu*. *Conf.* **Coix Lacryma-Jobi**, *var.* **typica** (*No. 10216*), *p. 208*.

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Coix spp. or Job's Tears.

COIX LACRYMA-JOBI. *var.* MONILIFER.

3rd *var.* **monilifer**, *Watt*; described without a scientific name in *Watt, Dict. Econ. Prod. 1887, ii. pp. 493—494*; C. LACHRYMA-JOBI, *var.* GLOBOSA, *Tod. Ms. in Herb. Kew.*, also C. PUELLARUM, *Balansa. in Journ. Bot.* (Paris, 1896) IV., 77.

Vernacular names:—*Le kveik, kyeik-thi, ke-paung*, KATHA; *langli, lewnu, burumpo*, NORTH ARAKAN; *gyeit-thandu*, AKYAB, *kariek-lóng*, SHÁN STATES, BURMA.

Distribution.

Distribution.—It seems probable that the review of information furnished in the Dictionary (l.c.) was the first direct account of the flattened spheroidal form of **Coix** that it is intended to separate under the name **monilifer**. The following exhibits very briefly the more striking examples preserved in the Kew Herbarium, and at the same time denotes the distribution of the plant:—***INDIA: Burma***—Maymyo, Prain's 271; Tavoy, Wallich's No. 8623 (G) and (H) and possibly also (I). These are the only Indian examples in Kew of this exceedingly abundant plant. ***MALAYA***: Malacca: Griffith No. 6448; Luzon Philippine Is., Cuming, 448 (not typical); Rio Tanco collected by **A. Loher**. Tonkin—B. Balansa (No. 1693) small round (flattened on top and bottom), white grain, determined according to label to be **C. puellarum**, *Balansa*). ***CHINA:*** **Dr. A. Henry**, No. 7567, flattened reddish-white, smooth grain; Herb. Hort. Petropolitani—large leaved **Coix** with globose flattened grain much like many Indian examples of **monilifer**; Manchuria—a large globose grain, steel grey to blue, hard, smooth, —called "Righteous Man's grain," used as rice and sometimes strung like beads. Is said to be cultivated; ***JAPAN.*** General **W. Munro**, ditches and rice marshes, grain dull white, perhaps a form of **Coix Lacryma-Jobi** proper and not **monilifer**. ***AMERICA:*** Mexico—collected **Dr. E. Palmer** (No. 1337) in grain, this is I think the present plant, but the leaves are long and narrow, not at all auriculate, but at the same time they are quite devoid of hairs or glands, so that it is not **Coix gigantea**—by the label it is said to be "**Coix arundinacea**, *Lam.*," a synonym for **Coix Lacryma-Jobi**. ***EUROPE***: Todaro (*Flora Sicula Exiccata*)—a remarkable plant with large globose fruits and thickened leaf sheaths. It is named **Coix Lacryma**, *Linn., var.* **globosa**—a name never published.

As amplifying the distribution still further, the following additional examples may be mentioned, preserved in the herbarium of the British Museum. ***INDIA: Assam***: Griffith's No. 1375, a chalky-coloured grain slightly striated, that may be one of the hard-shelled forms of **Ma-yuen**. ***Nepal***: Wallich's No. 8623 (G). ***MADEIRA***: Banks and Solander's specimen collected in 1768. ***MALAYA:*** Singapore: a sample collected by **Walker** which may be accepted as intermediate between the typical **Lacryma-Jobi** and *var* **monilifer**. Borneo: an interesting plant collected by **J. Whitehead**, which has small milky-blue fruits almost intermediate between *vars.* **monilifer** and **stenocarpa**. ***AMERICA:*** Brazil: a sample presented by **R. J. Shuttleworth** that has the fruits very much as in **monilifer**.

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Coix spp. or Job's Tears. (*Sir G. Watt.*)

COIX Spp.

COIX LACRYMA-JOBI. *var.* MONILIFER.

The Edinburgh Herbarium contains a very much more representative assortment of this form than can be seen in either of the above mentioned collections, because of its containing a fairly complete set of the plants specially brought together in connection with the investigations recently conducted by the Reporter on Economic Products to the Government of India. In addition to these there is a plant collected by **Madden** at Dehra Dun (No. 817) that is worth being mentioned as also one from China collected by **Carles**.

Description.

Description.—The flattened spheroidal form may be said to constitute the connecting link between the typical **Coix Lacryma-Jobi** and the variety **stenocarpa**. In fact the plants that I have placed in this position may almost be said to pass imperceptibly into the short fruited forms of **stenocarpa**. The *leaves* are identical with those of the type (**Coix Lacryma-Jobi**), only as a rule they are shorter and broader. The *male* spikes are very slender and versatile; the *glumes* small, narrow, pointed, scarcely winged. *Capsular-spathe* spherical, broader than long, flat on both extremities, the mouth large, gaping, and instead of a basilar annulus there is a circular depression which becomes a perforation. In colour they are bluish-white, steel grey, straw-coloured, pinkish brown or black. They are always exceedingly hard, smooth, polished, never striated and though sometimes elongated until they are longer than broad, they are never pyriform, not possessed of a beak or elongated upper extremity.

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Burma.—*No. 11589.* This is a beautiful, pinkish brown grain, received from Katha where it is known as *kyeik-thi*. It is about ⅛th of an inch in diameter and almost perfectly spherical in shape. It is found wild in the Kachin Hills. The seeds are used for beads and ornamental purposes for which their flat extremities and large well defined central perforation render them eminently suited. *No. 11588* also from Katha is an exactly similar grain to *No. 11589*, except that the capsular-spathe is pure white instead of pinkish brown. *No. 11586*, also from Katha, is a very large straw-coloured, flattened spheroidal grain. *No. 16888* is the *langli* of North Arakan, where it is employed for necklaces, and is for that purpose specially cultivated. It is identical with the Katha *kyeik-thi*. *No. 16049*, the *gyeit-thandu* from Akyab, is identical with the white

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Coix spp. or Job's Tears.

COIX LACRYMA-JOBI. *var.* MONILIFER.

Katha grain. It is reported to be wild and to be largely used in that locality as necklaces by females. *No. 11561-A.* is a large straw-coloured grain that agrees with the preceding in most characters except in the light coloured shell and comparatively larger size. It comes from Tharawaddy.

Shán States.—*No. 12234*—This is a somewhat remarkable form received from Myelat in the Southern Shán States. It is there known as *kareik-lông* or round *kareik*. It is not edible and is a flattened spheroidal form, cultivated in Thamakan districts as a border plant around paddy-fields. It is used for ornamental purposes only: the mouth of the grain is often very large and gaping giving it an urceolate appearance. *No. 12235*—From the Eastern Division, Southern Shán States, there has been received an immense grain. It is a dark brown, polished flattened, spheroidal nut, with faint striations and is fully ½ an inch in diameter. It is said to be cultivated for food in the Kengtung Division of Mong Nai. This is the largest example of **Coix Lacryma-Jobi** in the entire Indian Museum Collection, while *No. 10889* (below) is the smallest.

TRANSITIONAL FORMS.

Transitional Forms.—The following are the transitional forms of **monilifer** passing either into **stenocarpa** or into the typical form **Lacryma-Jobi**.

(*A*) *Passing into the var.* **stenocarpa**:—

Burma:—*No. 11587.*—This came from Katha where it is known as *kyeik-thi*. It is never cultivated but used as an ornament by the Kachins. Capsular-spathe is very hard, of a steel grey or bluish white colour, blunt at both extremities, and about ¼ inch long with ⅛th of an inch in thickness. *No. 11803*, also from Katha, is a somewhat shorter grain, with a thick body and the mouth of the tube open and large. It is called *le-kyeik*. *No. 11585, kepaung* also, from Katha has a more elongated tube and merges into **stenocarpa.** It is stated to be wild and occasionally used for ornament by the Kachins. *No. 12163* is known as *gyeit koluma* in the Akyab District. It is a beautiful sample, with smooth regular grains tapering towards both extremities. It grows wild and is worn as necklaces by certain women. It is doubtless a form very near **stenocarpa.** *No. 10889* is a very small grain, about ⅛ inch in length, much like the preceding in shape, bluish white in colour. It is a polished hard grain with a distinct annular portion at the base. It is known in Arakan as *bewnu* and is cultivated to a small extent and used for necklaces. It is admirably suited for bead-making and would no doubt find a large sale if available in quantity.

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Coix spp. or Job's Tears. (*Sir G. Watt.*)

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TRANSITIONAL FORMS.

(*B*)—*Passing into* **C. Lacryma-Jobi** *var.* **typica**:—

Burma:—*No. 10887.*—From North Arakan is sent as the only wild variety known in that district where it is called *borumpo*. It is used for purposes of ornamentation. This is so close to the typical **Lacryma-Jobi** that its position here is of doubtful merit. From Katha has also been received a black grain, *No. 11589A.*, very hard and highly polished, of a spheroid formation but slightly tapering towards the apex.

Shán States:—*No. 16050.*—From the Eastern Division, Shán States, is a pinkish straw-coloured grain. It merges into the **Coix Lacryma-Jobi** in shape, and I should place it under that form but for the fact of its colour. Grey, pink, brown, and black are colours more associated with **monilifer** than with the type.

COIX LACRYMA-JOBI. *var.* MA-YUEN.

4th *var.* **ma-yuen**, *Stapf in Hook. f., Fl. Br. Ind. VII., 100; F. Romanet du Caillaud, Bull. Soc. Ac. limat. (Ser. II.) VIII. (1881) 442-4;* C. AGRESTIS, *Steud., Syn. Gram. (1855), 9;* C. CHINENSIS, *Tod., Ind. Sem. Hort. Bot. Pan. (1861), 5; Balansa, Journ. de Bot. (Paris 1890), 77.*

Vernacular names.—*Bir-gaunli*, DARJEELING, BENG.; *dhan-gurgad*, SAMBALPUR, C. P.; *mriraku*, GARO HILLS; *kessi sikra, kessi kerenyessi, kessi teyahu, kessi kedyatha, kessi samaphe*, NÁGA HILLS; *Sohriew, sohriew mynnar, sohriew reiwjar* KHASIA and JAINTIA HILLS, ASSAM; *gweik-win*, TAVOY; *taunkya-kyeik, kachin-kyeik-pyu, kalinsi*, KATHA; *burum*, PROME; *sazyeik*, ARAKAN; *geiksi, gyeiksi, gyeik-win*, or *gyeik-yin*, TENASSERIM; *kareik-kyé, kareikh-pyu, than-kareik*, MYELAT DIVISION; *kyeik-ya, kayeik-lon, sakyeik*, KARENNI DIVISION, SOUTHERN SHAN STATES; *kalikithi*, INTHU; *luthi, makauk-lne*, SHÁN; *beu* or *to*, TAUNGTHU, BURMA; *ce-yin* or *ce-yin-y-dasi*, CHINESE; *bo-bo*, ANNAMITE of TONKIN.

Distribution.

Distribution.—In the Kew Herbarium there is a fairly extensive series of samples of this plant. The following may be accepted as denoting the chief peculiarities of these and the range of distribution of the plant:—***INDIA:*** ***Bengal*** Eastern, Griffith No. 6446 (grain white globose: this may be viewed as hardly different from **monilifer**); Sikkim, Herb. Ind. or. Hooker f. and T. Thomson, No. 1 (Coll. J. D. H.) cultivated and found at an alt. 2-4,000 feet (it has the fruits straw-coloured and the lower leaf sheaths often showing a tendency to harden as in the fruit-spathe; C. B. Clarke's No. 12383 (D.) collected in Darjeeling district; ***Assam***; Khasia Hills—Herb. Hooker f. and T. Thomson, No. 1, collected in June 1850, said to be cultivated on the Khasia Hills alt. 4-5,000 feet (it has the grains chalky-white, globose and ribbed, also the stems and sheaths often bluish coloured). ***Burma,*** Mergui, Griffith, No. 6449: (this sample has leaves very long and the grain straw-coloured); Watt, (a grain almost spherical, white and furrowed, possibly a cultivated state of **monilifer**);

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COIX LACRYMA-JOBI var. MA-YUEN.

Distribution.

also from Southern Shán (*ex* Herb. Cal. 1895), (a cultivated plant with large grey-brown furrowed seeds). ***CHINA:*** Hong Kong—sample of grain yellow furrowed, sent as the *y-dzi* of Chinese and *bo-bo* of the Annamites: (this may be accepted as the type of Caillaud's Cochin China plant). ***MALAYA:*** Tonkin—B. Balansa, No. 4874 (named **C. chinensis,** Tod.) cultivated, a straw-coloured grain, deeply furrowed. Philippine Islands—Luzon Central, **A. Loher** (1866) (a straw-coloured grain, but almost smooth and fairly hard). N. Luzon No. 2007, said to be used as food by the Igorrotes of North West Luzon (grain very large, flattened, spheroidal, pinkish-white, leaf sheaths thickened, is probably only one of the large seeded cultivated forms of **monilifer** rather than **ma-yuen.** (I place it here with some hesitation). Saigon—Herb. L. Pierre No. 1938, (leaf sheaths thickened, grain elongated, brown, furrowed). Borneo: **Mr. Motley,** No. 1117, (characteristic straw-coloured and furrowed grain, but smooth and somewhat pointed). ***AMERICA:*** Demerara—this is a most curious specimen (collected by **Mr. Parker**), which has the leaf sheaths thickened into long tubes (a condition often seen in **ma-yuen**) is possessed of straw-coloured grains but the leaves show wart-like formations that bring to mind some of the examples of **C. gigantea,** in fact it may be a cultivated state of the plant.

In the British Museum Herbarium there are not many examples of this form that need be mentioned. The following are however of considerable interest. ***INDIA:*** Khasia hills—*ex* herb. **Schlagintweit** (at alt. 2,800 to 4,500 feet). ***MALAYA:*** Pierre's No. 1938 (a sheet slightly different from the corresponding one in Kew) a dark bluish fruited example with soft shell. ***CHINA:*** Dr. A. Henry's No. 2655 (A.) a pale straw-coloured grain, pointed and polished. ***EUROPE:*** the plant raised by **Todaro** (Hoft. Bot. Pan. No. 918), apparently from seed procured from China, and to which he gave the name of **C. chinensis** (a name never apparently published), would seem to be this variety, although the sheet in Kew, which bears the varietal name of **globosa,** may be **monilifer.**

In the Edinburgh Herbarium will be found splendid series of specimens belonging to this variety. These represent the special collections recently made by the Reporter on Economic Products to the Government of India as well as some earlier sets. Some few years ago I collected **Coix** *var.* **Ma-yuen** in the Nága Hills (No. 6629) when I learned that the straw-coloured form was called *mung* and the steel-grey or black form was *kudhila thia* and the orange yellow grain *ke-see.* A sample (No. 9696A) procured by me from the Central Provinces carries this cultivated grain further into the

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COIX LACRYMA-JOBI var. MA-YUEN.

Description.

interior of India than could be learned from the study of the Kew and British Museum Herbaria.

Description.—Popularly the series of plants referred to in this position might be described as the cultivated edible Job's tears. There are many well-marked forms or sub-varieties, the fruits of all of which are characterised by having a thin, loose, easily broken shell. They are often longitudinally striated and in many examples are constricted at the base into what has been spoken of as an annulus. There is a wide range in size and shape of the fruit-spathe, from almost spherical to pyriform. Some are so strong as to be hardly breakable between the fingers, others are almost quite soft. The striation is perhaps the most significant feature of the series though in sperical states the striation becomes indistinct. All are regularly cultivated, the hardness of the shell very possibly denoting recent or partial cultivation.

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The forms assigned to this position may be said to be referable to two distinct sections according to shape, colour and texture of spathe-shell:—

First section of Ma-yuen.

Section (*A*).—Spherical, fruit-spathe never bluish-white, an annular ring at the base usually present and longitudinal striation partially developed.

Sub-section.—Fruits, straw-coloured.

Bengal: **Mr. A. C. Hartless** sent *No. 14968* from Darjeeling. It is known as *bir gaunli.* Is evidently a very profusely growing plant with leaves one to two feet in length and a very soft loose shell not at all polished.

Assam: *No. 8818 (botanical specimen) and 8821 (seeds).*—This is the *mriraku* of the Gáro Hills. It is very hard and polished, is of a rich straw colour, and faintly furrowed, but has no trace of an annular basal portion. It is sown in March-April, and ripens in November and December. It is roasted by being placed over the fire and then husked. It is both eaten as a grain and used to produce the Gáro fermented drink. *No. 10601 (and bot. sample No. 10210).*—This is the *kessisikra* of the Nága Hills. One of the commonest cultivated forms and very like the Darjeeling sample having, however, longitudinal furrows more distinct. It is believed that the Trans-Dikhu Nágas as also Sema Nágas live very nearly entirely on this and one or two other closely allied forms of **Coix.** There is no rainy season crop. It is sown in May and reaped in November and December. The crop is raised on *júm** lands never on sub-merged paddy lands—in fact it may be said to be raised on land

* *Júm* is nomadic hill cultivation implying the burning of a patch of forest, and its abandonment after cropping for 2 or 3 years. Conf. *taungya,* p. 222.

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COIX LACRYMA-JOBI. var. MA-YUEN.

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too high and too dry for rice. It is, moreover, believed to exhaust the soil much less than rice. The rotation is usually Job's tears first year after cleaning, followed by rice next year and a fallow of five years thereafter. A plot of land, say, 18 × 20 feet, would yield from 10 to 30 seers according to the value of the soil. This particular form of **Coix** is rarely made into *atta* (or flour) but is eaten whole like rice and is always sown mixed with *kessiteyahu* (No. 10212). The *dzu* beer made from these separately or mixed is the cheapest quality but it turns sour after 10 or 12 days.

Nagas have a rotation into which Coix enters.

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Burma.—*No. 11732.*—From Amherst has been received a small spherical form of a straw-colour. It is said to be used as a side-dish, not as a staple of food and resembles glutinous rice. It grows wherever paddy (rice) will grow.

Sub-section—Fruit chalky-white.

Burma.—*No. 10944*—Mergui and Tavoy. **Coix** is said to be sown mixed with paddy and reaped at the same time. It is a fairly important crop with the Karens and a certain amount is exported to Penang. There are reported to be two kinds, a white and a black. The unhusked seed sells at R1 per basket and the husked and pounded grain at R4-8 per basket. It is known as *gweik-win*. The white sample alluded to is often very hard, faintly striated longitudinally and is sometimes prolonged into a fairly well-formed beak as in **C. aquatica**. *No. 11581*—from Tenasserim is a very similar, though considerably smaller, form and more spherical in shape. It is said to be called *geiksi*. *No. 13790* is an exactly similar white striated grain, from Katha known as *kachin-kyeikpu*.

Assam.—*No. 8200*—From the Khasia Hills has come a spherical white striated grain, called *sohriew kynnar* or *sohriew*. It is very nearly identical with the Kátha grain. It is said to be sown in April and May and harvested in December. Occasionally it is alternated with potatoes. The grain is husked, then ground in a mill, and eaten as food by the Khasias. It sells at R2 per maund. A second consignment (*No. 11674*) was received along with botanical samples. The grains of this consignment (said to be identical with the former supply) are much less striated possibly because not so ripe. *No. 8201*—also from the Khasia Hills, received under the name of *sohriew reiwja*, cannot be separated from *No. 8200* already discussed.

Second section of Ma-yuen.

Section (*B*).—Pyriform grains with a short basal annulus and strongly striated.

Sub-section—Straw-coloured or parti-coloured.

Bengal.—Mr. C. B. Clarke collected this plant in August 1870 in the Darjeeling District at an altitude of 4,000 feet, but he furnishes no information as to whether it was found under cultivation or on

abandoned *júm* land. The fruit is small, pyriform, straw-coloured and rather polished.

Assam.—*No. 10212.*—This is the *teyahu-Coix* (or *kessi*) of the Nága Hills. It is doubtfully distinct from *No. 10210*, except that it is more pyriform and with the base of the fruit of a darker colour. The two are often grown mixed. A third form (*No. 10211*) is called *kessi kedyatha*. This I am unable to separate from *No. 10212*. They are not ground into *atta* but are eaten like.

Central Provinces.—*No. 9696*, the *dhán gurgad*, is a pyriform straw-coloured form grown at Sambalpur to an extent of perhaps 100 acres and recognised as the best local variety. It is used as an article of food by the aboriginal tribes. The fruit is shelled and the grain reduced to a kind of meal or flour. Water is then added and the cakes cooked on the fire in the usual way. Occasionally it is mixed with the flour of some cereals such as wheat, or millets. At times a sort of gruel is prepared from the grain. The unhusked seed is sold at 2 to 3 annas a seer.

Burma.—*No. 10886*, from Prome, is a very similar grain only a little more distinctly striated than the Sambalpur form. It is said to be known as *burum* and is stated to be the only kind used as food in North Arakan. It is the common edible form of Burma. *No. 11590*, from Katha, is a small pyriform grain, straw-coloured above, dark-brown below. It is called *kalinsi* and is used for food similar to rice. It is grown along with *taungya*-paddy (*i.e.*, on *júm* land). *No. 10891*, from Arakan, is a similar, though more elongated, grain and with a very distinct annulus, it is of a dull bluish grey colour. It is there known as *Sagyeik*.

Shan States.—*No. 12232*, from the Myelat Division of the Southern Shán States, a small white grain has been received. It is pyriform, has a fairly distinct annulus and is prominently striated. It is called *kareik hpyu* (or white *kareik*). *Kareik*, also pronounced *kaleit*, is the generic name for **Coix**. It is a winter crop, cultivated and used by nearly half the population of the Myelat Division.

Sub-Section.—Bluish-black colour, strongly striated and with a pronounced annular process.

Assam.—*No. 10213*, the *kessi kerenyessi* and *No. 10214*, the *kessi samaphe*: these two forms have come from the Nága Hills. They are both of them large, dark-bluish grains, pyriform, deeply striated, and with a very distinct annulus. The former is a larger and paler coloured grain than the latter. They are both said to be specially suited for the preparation of *atta* (flour) and the manufacture of *dzu* beer. The *kessi kerenyessi* is specially prized for

Conf. with pp. 220, 225.

its beer, which will keep about 3 months in the cold weather and is also said to be stronger than the beer from any other kind.

Burma.—*Nos. 10893* and *11802* are very much like the preceding. They come from Prome. *No. 11560*, a smaller grain from Tharawaddy: it is a small bluish form strongly striated. *No. 10945*, from Tavoy District, Tenasserim, is a very dark-blue form and has received the vernacular name of *gyeik-yin*. The basal annulus in this case is scarcely distinct. *Nos. 10882* and *10884*, from Akyab. They are lighter coloured grains than most of the others in this subsection. *No. 10882A* is an extraordinary form received also from Akyab. It is a longish bent grain with a very strong annulus and of a dark bluish brown colour. *No. 11806*, from Katha. Is a large coarsely formed grain with a strong annulus and also of a dark bluish brown colour. It appears to be known as *taungya-kyeik*. *No. 11582*, an exceedingly black striated grain, has come from Tenasserim, where it is called *geik-si*. The grain is very hard and polished. *No. 11732-1*, from Amherst, was received along with the straw-coloured form already described. It is a dark brown-black grain, scarcely striated, very hard and polished, and looks as if only partially cultivated. It is the hardest shelled grain of all the long series of forms, which I have placed under the variety **Ma-yuen**. *No. 13788*, from Thaton District, was sent as an odorous and edible variety of that locality; it is identical with the sample from Amherst described above.

Shán States.—*No. 12239* has been received from the Eastern Division, Southern Shán States. It is known under the following vernacular names:—*sakyeik* in Burmese, *makauk-lwe* in Shán and *beu* or *bo* in Taungthu. It is cultivated as a food grain in Mongsu, Mong Pawn, and Mawkmi, and is stated to be common everywhere throughout the division. It is a small form dark brown or black in colour and with a pronounced annulus. *Nos. 12230* & *12231*, blue forms of the edible **Coix**, are the *kareik-kyi* or *than-kareik* obtained from the Myelat Division of the Southern Shan States. They are very similar to the Akyab grain described above. These are sown with *taungya** (dry) paddy in May and June, and are reaped in November and December. They are occasionally grown with Indian corn, and are eaten either boiled with rice or separately. They are used by all the tribes inhabiting Myelat. *No. 12231* is a slightly smaller grain with the ridges of the striation of a lighter blue colour than the furrows. *No. 12239*, also a blue striated grain, came from the Eastern

* Taungya—a patch of forest land cleared and put under cultivation; from *taung*, a hill, and *ya*, dry cultivated land as contrasted with ordinary paddy land or land liable to floods. Conf. *jum* land, p. 219.—ED.

Division, Southern Shán States. It is called *bohpreing*, and was placed in a consignment spoken of as wild. This is apparently a mistake. *No. 15060* from the Karenni Division, of the Southern Shán States, is a very striking plant. It is profusely flowering and fruiting, and has very short broad leaves and large blue striated nuts. It is known by several names of which the following are the most important:—*kyeik-ya*, *kyeik-lon*, *sakyeik*, *luthi*, in Burmese; *kaleik-thi* in Inthu; *makauk-lwe* in Shán; *kabuse* in the Red Karen Country, and *beu* in the White Karen Country. It is said to be sown in Jeun and reaped in October.

Food.—This curious 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 food. The plant grown as a regular field crop, is invariably one or other of the many forms of the variety **Ma-yuen** already fully detailed. 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 for food the shell is soft and amenable to ordinary methods of milling.

Roxburgh was apparently unware that **Coix** had to be included among the edible cereals of India, though doubtless he had read **Rumphius'** description (1750) of its cultivation in the Islands of the Malays, and **Loureiro's** account of it in Cochin-China. In the Agri-Horticultural Society of India's Transactions for 1841 (*VIII, p. 348*) mention is made of the grain being sent from Amherst. **Mr. Riley**, who presented the sample, said "the plant was of a very hardy nature and thrives upon almost any kind of soil yielding a good amount of produce and in taste resembling wheat." **Wallich** identified the plant as **Coix lacryma.** **Sir J. D. Hooker**, in his Himálayan Journals (1848), gives some interesting particulars regarding its cultivation in the Khasia Hills. "Each plant," he tells us, "branches two or three times from the base and from 7 to 9 plants grow in each square yard of soil; the produce is small, not above 30 to 40 fold." **Mason** in his "Burma and its People," (1860) published much useful information and this has been brought up to date in the new edition by **Theobald** (1883). We there read that "**Coix** affords a good example of the results of cultivation of a wild plant, the seed of which is of a stony hardness, but which is soft in the cultivated form and the kernel sweet. It is much cultivated by the Red Karens and may be often seen for sale parched in the bazaars."

FOOD. USE AS A GRAIN.

In the review above, of the collections recently furnished to the Reporter on Economic Products from very nearly every important locality of India, I have quoted, under the special forms, the practical observations of the local authorities. This course was deemed preferable to a compilation of data into a common paragraph on cultivation, of facts and opinions that would seem in many cases only applicable to the individual forms of the plant. It may therefore be accepted as undesirabie to republish that information in order to support the statement that there exists in India a fairly extensive and certainly a widely dispersed cultivation of the plant. There are great diversities in size, shape and colour of the grain, as also in the quality and the purpose to which put. These diversities, confirmed by the existence of many vernacular names, establish belief in an ancient knowledge as possessed by the aboriginal tribes of India. It has already been affirmed that very possibly the pastoral Aryan invaders grew this grain on the slopes of the Himálaya, very possibly anterior to their becoming localised and assuming cultivation as a craft.

Dispersal through India

If that view be correct, its systematic production has entirely disappeared from the Himálaya except in Sikkim : on the plains and lower hills of India it is now met with in the Central Provinces and the adjoining mountainous tracts of Bengal only. But from Darjeeling and through Bhután to the Mountains of Upper and Eastern Assam, the Khasia and Gáro Hills and the Nága Hills, etc., to Burma and the Shán States, **Coix** might be described as not only a fairly plentiful crop but an exceedingly important article of diet. The perusal of the foregoing observations on the forms of the plant may be accepted as having brought out the somewhat surprising circumstance that certain forms of the grain are roasted, then husked and eaten whole, being either parched (as with Indian corn) or boiled as with rice. Other forms are so very different that the grain may be milled and ground to flour (*atta*), and thereafter baked into bread. It seems probable that the properties that necessitate so very different methods of treatment and preparation, involve a diversity chemically and structurally quite as great as that which exists between the hard and the soft wheats or the glutinous and the starchy rices.

Story of its introduction to China.

Romanet du Caillaud (*Bull. Soc. Acclimat Ser. II., 1881, Vol. VIII, pp. 442-4*) tells us that in the 1st Century A.D. the Chinese General Ma-yuen conquered Tonkin and became so fond of the Annamite grain *bo-bo* (the *y-dzi* of the Chinese) that he carried away several cart-loads of seed and thus introduced its cultivation into China. Bretschneider (*Botan. Sinicum, Pt. III, 1895, p. 384*) says of **Coix** that it is cultivated near Peking under the name *ts'ao sz'r*. He then adds that there are two varieties one with white, the

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other with grey coverings to the fruits. "I have also observed," he adds, "in the druggists' shops a variety (or species) with small oblong pointed fruits." This oblong pointed fruit might be **C. gigantea**, and, if so, it would be most interesting to find that species in China. Many writers have given their opinions on the **Coix** grain of China. It is often spoken of as the *Ee-jin* or *Ee-yin* and is reputed to be one of the most remarkable of foods. Dr. Smith wrote that it is larger and coarser than pearl barley but equally good for making gruel.

In Japan.

In a small book on the Useful Plants of Japan (issued by the Agricultural Society of the country) it is called the *tomagi* or *hatomagi*. "It is an annual cereal grass cultivated in common dry land. The stalks grow to a height of 4-5 feet. The grain pounded in a mortar and cleaned is consumed as meal and *mochi*. An infusion of the parched and ground grain is used instead of tea and is called *kosen*. A Chinese variety of larger grains, greyish brown in colour, with thinner shells is more easily crushed and cleaned." A gruel of the flour is specially commended by Romanet for use in hospitals. The Chinese use the grain in soup, as pearl barley is employed in Europe.

BEVERAGES PREPARED FROM COIX.

Manufacture of beer.—The references to the Japanese habit of drinking a decoction of the grain and to the preparation of gruel and tea from it, necessarily suggests the more extended use in the manufacture of a kind of malted beer which, in the Nága hills is called *dzu*. But a surprising feature may be said to be the circumstance that the *dzu* made from one grain is of a much superior flavour to that from another, and further that the *dzu* of one grain may be kept for months, while that from another goes bad in a few weeks. I have personally experienced much pleasure while travelling in the Nága Hills in drinking fresh *dzu*. It is something in flavour between that of butter-milk and cider, and on a hot day at the termination of a long march is most acceptable. Some of the forms of **Coix** (like many rices) have a rich perfume and such grains when used in the preparation of beer are said to give it a fruity flavour and delicate aroma.

Conf. pp. 220, 221.

MEDICINE.

Medicinal properties.—A Missionary, writing of Tonkin to M. Romanet du Caillaud, said that Job's tears made a refreshing drink, was a good blood purifier and excellent diuretic. The gruel prepared from the ground seed he observed as also *Eau de Larme-de-Job* was extensively employed in the summer to cool the body. By the Tonkin people it is spoken of as the "grass of life and health" is believed to neutralise the miasma of the air and to purify water when boiled like tea with a small quantity of **Coix** flour and set by

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to cool before being used. In India **Coix** can hardly be said to enjoy any reputation for medicinal virtues. The **Rev. Dr. Campbell** tells us that among the Santals the root is given in strangury and in the menstrual complaint known as *silka*. Dymock, (*Veg. Mat. Med.*) says the seeds are sold in the drug shops of Bombay under the name of *kassai bij*. The *Pharmacographia Indica* says that the wild form only is used medicinally and that it is considered strengthening and diuretic.

CHEMISTRY.

Chemical properties.—The grain of **Coix** both wild and cultivated has been subjected to chemical tests and the somewhat conflicting results that have been published doubtless are due to the botanical position of the particular plant under examination, not having been previously ascertained. In **Professor A. H. Church's** *Food Grains of India* (*published 1886, p. 60*) occurs the following remarks: "In the sample of this grain which gave the above analytical figures it was found that the edible seed after the removal of the hard and shining grey husk did not weigh more than 1 for every 4 parts by weight of the whole grain operated upon." In the *Kew Bulletin* (*for 1888, p. 59*) is published **Professor Church's** second examination and this a specimen admittedly of the cultivated grain. "From four parts by weight of the sample," he says, "three parts of husked grain were obtained—three times the quantity yielded by **C. lachryma**" (presumably the comparison drawn is to the sample reported on in *The Food Grains* which was probably a wild grain). Subsequently **Professor Church** gave his third analysis in the *Supplement to the Food Grains* (*1901, p. 3*) the grain examined having been the cultivated **Coix** of the Khasia hills. The following sets forth the practical results of the first and third of these examinations:—

	Nutrient Ratio.	Nutrient Value.
Wild Coix	1 : 3·8	·89
Cultivated Khasia Hills	1 : 4·4	90

Commenting on his final results **Professor Church** says that the quantity of albuminoids approaches to that of some kinds of pulse and that the proportion of oil or fat is larger than that present in the great majority of cereals. The following detailed analysis gives the composition of the grain in 100 parts, as published by **Professor Church** and subsequently by the Haarlem Museum authorities, by **Mr. Hooper** of the Indian Museum Report and by **Drs. Paton and Dunlop** in *The Agricultural Ledger* No. 6 of 1904, page 50.

	Professor Church.		Haarlem Museum, 1901 (cultivated grain).	Indian Museum, 1901-02 (cultivated grain).	Paton and Dunlop, 1904 (wild plant).
	1886 (wild plant).	1901 (cultivated grain).			
Water	13·8	14·8	13·91	8·00	10·74
Albuminoids	18·7	16·6 *	21·72†	22·46	18·81
Starch	58·3	60·1	55·29	61·82	59·55
Oil	5·2	5·8	1·30	4·92	6·2
Fibre	1·5	0·9	1·48	·70	1·28
Ash	2·1	1·8	1·79	2·10	3·4

* 2·66 nitrogen. † 3·47 nitrogen.

In *The Agricultural Ledger* No. 7 of 1903, p. 150, **Dr. Leather** gives the results of the examination of **Coix** which differ in the small amount of albuminoids that he found (9·44) due undoubtedly to the shell being included. **Dr. Leather** expresses the total nitrogen found at 1·58 and the albuminoid nitrogen as 1·51.

Paton and Dunlop were specially investigating certain famine foods. The form of **Coix** they examined was therefore a wild grain and may have been **Coix Lacryma-Jobi**, but possibly it was **Coix gigantea.** They remark:—"Our analyses as well as those of **Dr. Church** show that this is a food specially rich in proteids and fats. When separated from its very hard husk it should form a food of great value, especially as its energy-value is the highest of all the foods studied."

INDUSTRIAL AND DOMESTIC USES.

Industrial and Domestic uses.—From a remote antiquity both in Europe and in India, the grains or seeds, especially of the wild plant, have been used as the beads of rosaries. By the aboriginal tribes of India and Burma they are largely employed in personal adornment. Necklaces, ear-rings, head-dresses, etc., are often largely composed of them, and dresses, bags, baskets, etc., extensively ornamented with them. For these purposes a semi-cultivation has been pursued, possibly for centuries, that has resulted in the development of special grains, in cylindrical or spheroidal forms and in a rich variety of colours. In Nepál, Oudh and among the hill tribes of the central tableland of India generally, they are employed either by themselves or in conjunction with cowrie-shells, in the decoration of baskets, agricultural implements and cattle. By the Karens of Burma the cylindrical grains cover certain portions of dress and are

elaborated in designs that simulate (or perhaps may have suggested) some of the patterns seen in embroidery. With the Angami Nágas, ear-rings are constructed that consist of a rosette of the elongated seed surrounding the metallic green wing-cases of a beetle.

The possibility of a profitable expansion of the industrial uses of these seeds, to a large extent suggested the inquiry, the history of which and many of the practical results of which, have already been fully set forth. A fairly large trade exists in the use of these seeds, as for example the construction of the Japanese bead door-curtains. Mention has been made (under **C. aquatica**) of an exceptionally large seed discovered by me in Poona and there made into one of these curtains. It seems probable that **C. gigantea** and **C. aquatica** together with some of the larger forms of **monilifer** are most likely to be utilized in that manner. But in discussing possible future industrial developments it is essential that the separation indicated into the forms of **Coix Lacryma-Jobi** that are cultivated and those that are wild, should be clearly kept in mind. Cultivation destroys very rapidly the hard pearly shell, upon which to a very large extent the industrial demand depends. It also changes the colour of the grain and produces dull chalky whites and straw colours, utterly devoid of the rich glossiness of the wild grains. By the selection and partial cultivation of spontaneous varietal forms or sports (such as those named **stenocarpa** and **monilifer**) these dangers are ever present. This fact is fully appreciated by the Burmese experts and the cultivation, partial though it be, is abandoned for a time or fresh stock secured from the jungles, when degeneration is observed. In the series on my table there are exceptionally long forms of **stenocarpa**, with soft striated straw-coloured shells, quite useless as natural beads, just as the transition is also demonstrated from **monilifer** to **stenocarpa** on the one side and to **Ma-yuen** on the other. It is thus difficult, if not impossible, to guarantee a continuous supply of any one shape, size or colour of grain, and this may at once be admitted as (from the European point of view) a serious obstacle to a greatly increased demand. The smaller and more gracefully formed examples of **monilifer** and of **stenocarpa** it would seem stand in fair chance of coming into use in Europe as beads especially in the construction of bugle-trimmings and as buds and other special portions of artificial flowers. They would be cheaper, more durable than the glass at present used, and since they may be dyed any desired shade of colour, they might be extensively used in dress trimmings. The difficulty of producing and maintaining certain sizes and shapes of grain would doubtless soon be overcome, were a profitable demand to arise for a larger production than at present exists.

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Further analyses by Mr. D. Hooper.

[The following six analyses, with the exception of the first, have not been seen by Sir George Watt. They were received as the above papers were passing through the press.—Ed.]

No. 1. **Coix gigantea**, *Roxb.* from Dehra Dun, 8599 (see p. 197) 100 parts of seed gave 25 kernel and 74 shell.

No. 2. **Coix gigantea**, *Roxb.* var. **aquatica**, *Wats.* Mandla, C. P., 8768 (see p. 201) 100 parts of seed gave 32 kernel and 68 shell.

No. 3. **Coix Lacryma-Jobi var. Ma-yuen**. *Stapf.* Chalky (see p. 220) white form, Khasia Hills, 8201. 100 parts of seed gave 37·5 kernel and 62·5 shell.

	1	2	3
Kernel—			
Water	8·00	8·00	9·60
Oil	4·92	5·56	5·70
Albuminoids	22·46	18·75	17·46
Carbohydrates	61·82	64·10	64·58
Fibre	·70	·83	1·00
Ash	2·10	2·70	1·66
	100·00	100·00	100·00
Shell—			
Water	5·80	11·20	7·80
Oil	1·00	1·15	3·30
Albuminoids	12·50	6·25	7·21
Carbohydrates	26·10	8·60	27·93
Fibre	34·00	38·35	40·00
Ash	20·60	34·65	13·76
	100·00	100·00	100·00

C. 1683-1700.

G. I. C. P. O.—No. 1856 R. E. P.—22-10-1904.—2,500—P. M. M.

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