THE

FIBROUS PLANTS OF INDIA

FITTED FOR

CORDAGE, CLOTHING, AND PAPER.

WITH AN ACCOUNT OF THE

CULTIVATION AND PREPARATION

OF

FLAX, HEMP, AND THEIR SUBSTITUTES.

BY

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PREFACE.

Having a few years since paid attention to the subject of Fibres, and anticipating that the troubled state of Europe would cause a demand for those of India, I resumed the subject in the autumn of the year 1853.

In the following spring the distinguished senator, of whom the Indian Medical Service has reason to be proud, and whose loss the public has now to lament, Joseph Hume, Esq., M.P., having suggested Indian Fibres as a subject for inquiry to the Council of the Society of Arts, they did me the honour to ask whether I could prepare a paper on the subject. My time was then fully occupied with a general work on the 'Commercial Products of India,' several sheets of which were then, as they still are, in type, and the period for my Course of Lectures at King's College was approaching. I therefore found it impossible to devote sufficient time to the elaboration of a suitable paper, but offered to give a Lecture, which might be reported if thought desirable. This I did on the 11th of April, and, with the permission of the Honorable the Court of Directors, illustrated it with specimens of Fibre, Canvas, and Cordage, the property of the East India Company. The Report of it was published in the 'Journal of the Society of Arts,' on the 14th of April, 1854.

The Lecture having been reprinted, both in this country and in the Colonies, elicited much additional information, some of which came in time to be recorded in its proper place in the present work. The Lecture was also republished in the Pamphlet form, because, as was stated, it was out of print—though this is usually a reason for authors republishing their own productions. One editor complained that he had seen it reprinted more than a hundred times, and that it would never produce as much paper as it had been printed on. As I myself never sent it, either directly or indirectly, to any one for the purpose, I was happy to find that the aspect of the times made the subject appear sufficiently interesting to induce so many to republish so imperfect an account.

Having been requested to place the information respecting Indian Fibres in some permanent form, I commenced the present work at the conclusion, last summer, of my Lectures at King's College. It has extended much beyond the limits which I had prescribed for it, partly owing to the number of subjects to be treated of, but especially owing to the variety of points requiring to be attended to respecting each; in order that the culture of the plant and the preparation of the fibre—*e. g.*, of Flax—should be attended to according to the scientific principles and the improved practice of the present day. The object being that these should assist colonists and planters in escaping failure with the culture of Flax, at the same time that they might apply the information to the culture and preparation of other fibres.

Respecting Flax, I have been enabled to bring together much valuable information, in consequence of so much having been done and written: so it is because much has been done, though little is known regarding Indian Fibres, that my limits have been so much exceeded. This was necessary, in order that others might be able to make use of the information which is on record, and future experimentalists advance from points reached by their predecessors, instead of repeating as new what has long been known.

This copiousness of information is due partly to the Court of Directors of the East India Company having directed the culture of Fibres in India at the beginning of this century, as recorded in Wisset 'On Hemp, &c.,' and in Dr. Roxburgh's detached papers (*v.* p. 6); and partly to the subject having attracted the attention of many writers in the valuable 'Trans. and Journ. of the Agri-Horticultural Society of India.' The Great Exhibition of 1851 produced a fine collection of Indian Fibres. Many of Dr. Roxburgh's specimens are still in the India House, my own collection has afforded others, and the market has supplied such as are known in commerce.

The greatly increased Importation of Fibres from India proves the importance of the subject, and indicates, from the rapidity of the rise, how much more is still practicable. In successive editions of M'Culloch's 'Commercial Dictionary,' we find the following Imports into Great Britain; but, under the head of Hemp from India, are included the various Fibres described in this work, with probably no real Hemp, though this *may* be imported from thence.

Quantities of Hemp imported into the United Kingdom:

	1831.	1847.	1851.
From Russia	506,803	544,844	672,342
„ British Territories in East Indies .	9,472	185,788	590,923

If any effectual impediments had been interposed to the receipt of Hemp and Flax from the ordinary sources, a greatly increased supply of Fibres would have been received from India, and might be so at any time, if adequate notice were given of the expected demand before the seasons of cultivation—that is, before June and October. As the above increase in the Imports has been chiefly in the lower qualities of Fibre, it is reasonable to expect that some demand may arise for those which are superior in point of strength and equal fineness, to any which are imported, and that they will be able to bear the expenses of freight, &c., at least as well as the others.

While this sheet is passing through the press, a debate on "the Trade with Russia," has taken place in the House of Commons, on the 21st of February; when it was stated, that there had been recently a considerable importation of Hemp from India, but that ruinous losses had been sustained on the Linseed from India. This must have been of the ordinary produce of the country, and not the consequence of extended cultivation, produced by increased demand. A rise of price probably took place in the local markets, in expectation of higher prices prevailing in this country. Bombay Hemp, as observed at p. 288, usually sells there at from Rs. 5 to Rs. 8 in June; but in June, 1854, the price was Rs. 11 per cwt. But as this rise in price did not take place, the Linseed had to be sold at the ordinary rates; at which, however, Indian Linseed can compete with others, as is proved by the large and increasing imports from India. It was also asked, in the same debate, "Why does not he (the merchant) go to India now for it (that is, Flax), and the speaker replied, "on account of the difference of price." Little Flax is produced in India, for reasons which have been fully detailed in this work. But there is no reason to believe that it will be dearer than in other countries, when grown in suitable localities. In a letter from the Messrs. Noble, it was well stated, that a temporary stoppage of the trade "would give an impetus to the growers of fibres in the Colonies;" and that "the producers would be able to send it (after they were once fairly started), at prices that would compete with Russian Hemp, when at its lowest prices; and it would also be of great advantage in doing away with the prejudice now existing on the part of consumers about trying a new article."

In sending Fibres to the English market, it would greatly facilitate their employment, if the natives of India would prepare them in a cleaner state, and have them made up in the manner to which manufacturers here are accustomed. Most of the Fibres treated of have been examined by practical men of skill, who consider them to be well adapted for many purposes, and have assigned to them such prices as they seem to be worth. These appear to be sufficient to pay for their culture and export.

I have to acknowledge my obligations to Mr. Ord, of Threadneedle Street, who examined all the Fibres sent to the Exhibition of 1851; and also to the Messrs. Noble, who have recently examined the whole collection of Fibres.

It is often said that the only mode of ascertaining the value of a Fibre, or of any other product, is to see what it will bring in the open market. This is, no doubt, true of such things as are *known*. But if a new product is sent into the market, few of the regular purchasers will buy it, as they want that to which their machinery and manufactures are suited. I am told, that it is only by sending an article for some years into market, that it attracts notice. When worked up and found useful, inquiries are subsequently made for it, and by degrees its properties are determined, and its real value ascertained; as we may see on examining the present and former comparative prices of Jute. The process will be much expedited by employing brokers who pay special attention to particular classes of articles, and by giving them all the information possible. It would also be promoted by the more general establishment of Trade Museums, as these would assist in dispelling much of the ignorance which prevails respecting many valuable Natural Products.

Merchants and manufacturers in this country, on the other hand, complain, that having written to India for particular Fibres, they are unable to obtain them in any quantity. But they can hardly expect that parties abroad should keep supplies of little-known articles for such accidental demands. It is very certain that if but moderate encouragement is given to such articles on their first appearance in the market, the supply will by degrees become very greatly increased; while of the Fibres which are already cultivated, the supply might at once become considerable, by sending orders for them before the season of cultivation. Indeed, it was observed in a recent Bombay paper, that the merchants there had been astonished at the quantity of Fibres which had been brought into the Bombay market.

The subject of Fibres has of late attracted considerable attention in India, as the Governor-General has issued instructions for the sending to England some of the stronger Fibres, both from the Northern and the Southern parts of that Empire. The Madras Government has also given directions for the investigation of the fibrous materials procurable in that Presidency. Dr. Clagham, in a letter dated 13th January 1855, states that Mr. Underwood has succeeded in separating them at a cheap rate. At Bombay a Company has been established for the collection of materials for paper-making, while individuals are paying attention to the preparation of Fibres. In Sindh and in the Punjab, the culture of Flax has been taken up and patronised by the Indian Government and the Court of Directors.

At the conclusion of this volume I have appended some Observations on Materials for Paper-making, as well as the Report which I wrote at the requisition of the Lords of the Committee of the Privy Council for Trade.

LONDON; *24th February*, 1855.

TABLE OF CONTENTS.

India abounds in Fibres; Hemp and Flax plants grown there. Culture of Fibrous Plants in India at the beginning of this century, p. 6; Results, 8; Present Exports, 9; Difficulty of introducing New Articles into Commerce, 12.

The nature of Fibre, p. 17; Preparation of, and of Cordage, 19; Twisting of Cordage, 20; Loss of Strength by Twisting, 22; Effects of Tar on Cordage, 24; Injurious effects of, 25.

Arrangement of Fibrous Plants, p. 27.

FIBRE OF ENDOGENOUS PLANTS (*generally white*).

Preparation of the Fibre of Endogens, 29.

GRASSES, SEDGES, ETC.

Grasses used as Cordage, p. 30; Spartum and Esparto, 31; Moonja, Sara, Koosha.

Sedges, p. 33. Calcutta Mats. Bhabhur Cordage. Bulrushes, 35.

Screw Pines or Vacoa, p. 35. Nipa, called Nepah Palm.

LILIACEOUS PLANTS.

Pine-apple Tribe, p. 37. Penguin, Curratow, &c. Pine-apple in India, Singapore, and Islands, for weaving, p. 39; Pina cloth. Fibre for Cordage; strength of, 41.

Pita or Agave, commonly called Aloe, p. 41; Cordage of, in America, in India; Experiments on, at Toulon, in Bengal, at Madras. True Aloes, 51.

Moorva or Moorga Fibre, p. 51; ancient use of; cultivated by Dr. Roxburgh; compared with Hempen Rope; woven into Cloth; Strength of, as Rope, 56.

Yucca Fibre, p. 57; New Zealand Flax, 57; Rushes, 60; Seetul Patee Mats, 60.

PLANTAIN TRIBE.

The Plantain and Banana Tribe, p. 61; Geographical Distribution of.

Manilla Hemp (*Musa textilis*), p. 64; Cordage and Cloth of.

Plantain Fibre (*Musa paradisiaca*), p. 69; Preserved Plantains; Plantain Meal; Chemical Analyses; Cultivation of Plant; Preservation of Fruit, Meal; Preparation of Meal and of Fibre; Cost of producing; Plantain Paper and Cordage.

PALMS.

Palms, p. 91; their Distribution and Uses. Canes and Rattans; Palmetto; Date tree; Chattah pat; Palmira; Talipat.

Ejoo or Gomuto, and Kittul or Black Vegetable Bristles, p. 99; durability.

Cocoa-nut Palm, p. 102; in Laccadives, Malabar; Uses of; Toddy; Oil; Fibre or Coir; Cordage and Cables of, at Bengal and Bombay.

Exports of Cocoa-nut Products, p. 119. Other useful Palms, 123.

General Observations on Fibre of Endogens, p. 125.

FIBRE OF EXOGENOUS PLANTS (*Brown Fibres*).

Exogens, p. 129; Structure of; Fibre of. Objections to Indian Fibres; valuable properties of; defective preparation of.

FLAX.

Flax and Linseed, p. 135; Importance of; Imports and Consumption.

The Flax Plant and its Products, p. 142; Composition of Linseed; of Linseed Oil.

Chemical Constituents of Flax Plant and of Flax Soils, p. 146.

Culture of Flax, p. 152; Climate suited to; Directions for Culture, by Royal Irish Society, 155; Observations on Culture of Flax, 159; Profits of, in Great Britain, 162.

Report on the Culture of Flax in India, p. 163; Experiments in 1840-41; Effects of Indian Climate and Culture on Flax Plant; Proposed Sites for New Experiments, 171.

Analysis of former Experiments, p. 172, 181; at Shahabad, by Flax Society, &c. Practical Instructions for Culture of Flax in Bengal, by Mr. Deneef, Belgian Farmer, 175.

English Reports on Indian-grown Flax, p. 181. Observations on Results of Experiments, 184. Culture in other parts of India, 186; Saugur and Nerbudda, Madras, Bombay, Bundlecund, Northern Doab, in Punjab. Report on First Produce in Punjab, 195. Directions for Culture in Punjab, 196. Culture in Sindh, 197.

Separation and Preparation of Flax Fibre, p. 199; by Royal Flax Society; Schenck's Process; Dr. Hodges on Changes; Watt's Process; Report on.

Composition of Steep-water, &c., p. 208; Buchanan's Process, Pownall's.

Chemical Processes for Separating Flax, p. 213.

Mechanical Processes by Hand, with Woodcuts, p. 216.

Mechanical Processes for Separating Flax by Machinery, p. 220; Hill and Bundy's; Dickson's Machine; Davy's; Heckling.

Exports of Linseed from India, p. 227. Imports of Flax, Tow, and Linseed into Great Britain, 229. Conclusion, 231.

RUSSIA MATS.

Lime tree and Russia Mats, p. 233. Indian Substitutes for Russian Bast, 235.

JUTE.

Jute or Jew's Mallow, p. 240; Culture, Preparation of Fibre. Manufacture of Gunny and Gunny Bags. Exports, 251.

THE SO-CALLED INDIAN HEMPS.

Indian Hemps, or those so-called, p. 251. Ambaree or Hemp-like Hibiscus, 254; Deckanee Hemp

Other Fibre-yielding Species of Hibiscus; Sida, &c, p. 259.

Cotton Cordage and Canvas, p. 264.

Silk Cotton Tree, p. 265; *Abroma angusta* for Fibre.

Tabulated Results of Dr. Roxburgh's Experiments on Indian Fibres, pp. 268-9.

Sunn Fibre, p. 270; Culture, Preparation, Strength; Culture in Madras Territories, 279; in West of India, 282; Conkanee Hemp; Brown Hemp of Bombay, and of Malabar Coast; Wuckoo-nar of Travancore.

Comparative Strength of Sunn Cordage, p. 289

Jubbulpore Hemp, a good substitute for Russian Hemp, p. 290.

Dhanchee Fibre, *Sesbania aculeata*, formerly *Æschynomone cannabina*, p. 293.

Maljhun, p. 295; Dhak, 297; and other Leguminous Fibre-yielding Plants.

Exports of Sunn and other Hemp-like Products, p. 299.

COROLLIFLORALS.

Dogbanes, p. 302; Oleander, Vinca, Asclepiads, 303; Jetee Fibre, &c.

Mudar or Yercum Plant, p. 306; Gutta-Percha-like Sap, Down, and Fibre.

APETALOUS PLANTS.

Nepal Paper Plant (*Daphne cannabina*), p. 311.

TRUE HEMP (CANNABIS SATIVA).

True Hemp (*Cannabis sativa*), p. 314; properties and secretions of. Report on Culture of, in Himalayas, 316. Soil and Climate suited to ordinary Culture. Reports on Culture in Gurhwal, 321. Culture in Nepal, 323.

Hemp Culture in Plains of India, p. 324. Report on Hemp grown in India, by Mr. Deneef, 325

Quality and Cost of Hemp in Himalayas, p. 327; Report on, by Mr. Deneef, 328; Cost of Himalayan Hemp, 330; Strength of, 331; and of other Indian Fibres, 332.

Culture and Preparation of Hemp in Europe, p. 333; Peculiar modes, 336; Crop and Profit, 338.

Imports of Hemp and of Hemp-like Fibres from Russia and India, p. 339; Prices, 340.

BREAD-FRUIT AND MULBERRY TRIBE.

Bread-Fruit tribe, p. 340. Paper Mulberry, 341. Paper and Cloth; Mulberry; Fig tree; Jack tree, 343

NETTLES.

Nettles; their Uses as Fibrous Plants, p. 344.
China-grass, or Chû Mâ, p. 345. Medals for Caloee, or Ramee of Malays, 346. Rheea of Assam, Report on, 349. Identity of Chû Mâ, Caloee, Rami, and Rheea, 351; Culture of, in Java; fitness for fine purposes, 353; Strength of, and of Wild Rheea, for Cordage, 355. Transmission of Rheea Fibre from Assam, &c., to this country, 357.
Cultivation of the Tchou Ma, according to the Chinese, p. 359. Preparation of Fibre, 361.
Indo-Chinese method of preparing Rheea Fibre, by Major Hannay, p. 363.
Other species of Nettles; Bon Rheea, p. 363; Mesakhee Fibre, 365; Chor Surat, 366; Horoo Surat, or Neilgherry Nettle, 366; Pooah Fibre, 368. Other Himalayan Nettles, 370
Great Strength of Rheea and other Fibres for Cordage, p. 372
Concluding Observations, p. 376

APPENDIX.

Import of Flax and Hemp from Russia, and all other countries, from 1801 to 1853, p. 381
Observations on Materials for Paper-making, p. 382
Report on, for Committee of Lords of Privy Council for Trade, p. 387

THE

FIBROUS PLANTS OF INDIA

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THE combination of strength with flexibility makes many natural products so useful to man, that they attract his attention even in the earliest states of society. The necessity of sometimes tying up cattle, tethering a horse, or towing a raft, would readily lead to the twisting together of strips of skins or the tough bark of trees, so that length might be obtained, while strength was not sacrificed. Many of the same substances were early applied to the arts of platting and of mat-making; while the felting of wool was discovered at very remote periods in the northern parts of Asia. All these arts probably preceded the discovery of that of weaving, when textile fabrics, whether of wool or of vegetable fibre, came to be substituted, as clothing for man, for the skins and furs of animals or the primitive matting of rushes.

It has been very satisfactorily shown by Mr. Yates, in his 'Textrinum Antiquorum,' that in ancient times the inhabitants of Europe and of Western Asia were enveloped in skins and furs, or garments of wool and of goat's hair, while the Chinese were probably clothed in silk. Hemp was early employed for the same purpose by the Scythians. The Egyptian priesthood, we know, were allowed to wear only linen; while the Indians are described as wearing cloth made of fleeces from trees, which surpassed those of sheep in beauty and excellence. That cotton is meant, is evident not only from the description, but from the Indian name carbasus (from the Sanscrit kurpasum) being used to describe their dress—as "corpora usque pedes carbaso velant." But the natives of India were at still earlier periods acquainted with the arts of spinning and of weaving, as may be proved by a reference to their Vedas; while in the Institutes of Menu, written 800 years before the Christian era, we are told, that the sacrificial thread of a Brahmin must be made of cotton; that of a Cshatriya, of *sana*[1] thread only; that of a Vaisya, of woollen thread.

India is a country of such vast extent, and so diversified in soil as well as in climate, that we may readily believe it to be capable of producing almost every kind of natural produce, and among these every known variety of fibre. If we consider, moreover, how early India was civilised, how long the greater number of the useful arts have there been practised, we might safely infer that the country must long have possessed a variety of products fitted for the several purposes to which flax and hemp are elsewhere applied—that is, for platted or for twisted manufactures; as well as for the coarser and the finer textile fabrics, such as the construction of mats, the twisting of bow-strings, or lines for fishing, or for the making of nets; ropes for tow-lines, tethers for camels or other beasts of burden, or for harnessing cattle; yarn for the manufacture of canvas for sacking, or for sails for their shipping, or for the production of their "webs of woven air."

Cotton, was early, as it still is, employed in India for many of the purposes to which leather, hemp, and flax, are alone thought applicable in other countries; as for the coverings of carriages, the construction of tents, of canvas, and of cordage. And this, notwithstanding that India possesses, and its inhabitants are acquainted with, a vast number of fibre-yielding plants. These are little known to, or but slightly appreciated in other countries, though they are undoubtedly

[1] That is, of *sunn*, probably Crotalaria fibre, q. v.

possessed of very valuable properties. Further, by proceeding in such inquiries, we shall find that the natives of India, besides writing on the leaves of palm-trees and the bark of the birch, as well as engraving their records on rocks or on plates of metal, have long been acquainted with the manufacture of paper. We may, therefore, enquire whether cotton is the only material which they convert into this useful product, or whether there are not other substances which they themselves employ, and which we may also apply to the growing (I had almost said insatiable) wants of this manufacture, as necessary for our comfort and commerce, as for the continued and advancing civilisation of the world.

If we extend our inquiries only to the plants which are cultivated by the natives of India, many will no doubt be surprised to find among them not only the true Hemp but also the true Flax plant; and the more so when they learn, that both are extensively cultivated, not in one, but in almost every part of the wide-spread territories of the Indian empire. Still more curious is it, that in few places are these plants valued for their fibres, which in Europe are almost the sole objects of attention. But in India, the Hemp plant is esteemed for the intoxicating properties secreted by its leaves, and the Flax plant for the oil stored up within its seeds. The stems of both plants, which in Europe are valued for their fibres, are in India either thrown away or burnt. It will at once be concluded, as has more than once been the case, that countless loads of valuable fibre are thus yearly lost, either from the ignorance or the carelessness of the cultivators. Without denying that this may, in some degree at least, be the case, we may say in this, as in many other things, a little knowledge leads but to incorrect conclusions.

The Hemp plant being valued for its intoxicating secretions, it has been found by the people of India, that these are best produced when the plants are freely exposed to light and air, and therefore they place them at distances of nine feet apart from each other. This exposure to light, heat, and air, in a rich soil and brilliant climate, is so well suited to the plants, that they grow to a great size and throw out branches on all sides; but the fibres, instead of being flexible and strong, are found to be woody and brittle. And this is only what might be expected, for the fibrous product of plants is only the woody fibre in a younger state, and may be considered as wood in a separated form, while wood may be described as consisting chiefly of amalgamated fibres. Exposure to light and air is well known to be essential to the formation of good wood, by favouring the proper secretions of the tree and the thickening of the woody fibres. But this necessarily diminishes their flexibility, and therefore is not suited to plants which are grown on account of these fibres. Hence, to obviate this undue exposure of the plants to light and air, and to favour their shooting upwards, and to prevent the formation of lateral branches, the seeds of both the hemp and the flax plant are sown thick in Europe; and the plants grown closer as the fibre is required to be finer. But the Flax plant in India being cultivated for its seed, is, on the contrary, either sown in lines on the outside of and as an edging to, or broadcast and intermixed with, other crops. The seeds are collected when they are fully ripe, or when the other crops have been harvested. The effect is, that the plants are checked in their upward growth, and attain a height of only a foot or of eighteen inches, have numerous lateral branches, and are loaded with seed-vessels; each seed containing a larger proportion of oil than is found in those grown in Europe; but the fibre is short, brittle, and unfitted for the general purposes of flax.

It does not appear that the Indian climate is the best suited to the production of good flax and hemp; for it is one of comparatively short seasons, of great alternations of dryness and of moisture, as well as of considerable extremes of temperature. But the Creator of all has enriched the country with a variety of plants which do flourish well even within these extremes. The Indian mode of cultivation is better suited for the secretion of the resin in one case and of oil in the other, than for the production of strong and flexible fibre in either plant. For the production of this, both plants require a comparatively slow growth in a moderately moist and temperate climate. This it would be unreasonable to expect to find, either in the comparatively arid tracts of north-west India, or in the moist and warm plains of Bengal. In fact, if it were not that the autumnal and winter temperature of these districts approaches the summer temperature of European countries, flax plants could not be grown at all, so as to yield either oil, seed, or fibre. But, as it is, we may appropriately consider, under the respective heads of Flax and of Hemp, whether it may not be possible, by modifications of culture, or by selection of suitable sites, to grow both these plants, within the limits of India, so as to yield useful fibre.

On the other hand, it is now well known that India possesses, and indeed exports, various fibres which are produced by several fast-growing plants. Of these fibres, some, though long and fine in texture, are deficient in strength; others appear coarse in texture, or are harsh in feel, and yet not remarkable for tenacity. It has therefore been inferred by some very intelligent men, that the heat and moisture of the climates where these grow are favorable to rapid growth, which of itself is sufficient to account for the want of strength; and that therefore we cannot expect to find them suited to the production of good fibres. But here the conclusion come to is equally hasty, for no distinction is made between what is due to the nature of the plant itself, and what to its mode of cultivation, or to the preparation of its fibre, and what to the effects of soil and of climate. We do not in this country expect the willow to have the strength of the oak, nor that a rope of rushes will have the tenacity of even a cord of hemp. Yet all may be seen growing in the vicinity of each other. There is as little reason for expecting that the soft and silky Jute of India is to have the strength of either flax or of hemp; and because it does not have it, for inferring, that there cannot be produced in its vicinity other fibres possessed of greater strength. But, if we were to judge from the density and strength of some of the woods produced in the hottest and moistest, as well as in some of the driest climates, we might expect to find plants in the same localities which are equally conspicuous for tenacity of fibre. Instead, however, of inference, I hope to be able to prove to the satisfaction of even the most sceptical, that India grows plants in some of its dry and barren plains, yielding fibres which are as strong and tough as any produced in other parts of the world; but which are equalled in such qualities by others growing in some of its moistest and hottest valleys. Some of these, while possessed of the greatest strength, are also divisible to any extent of fineness. Most of them exist in sufficient quantities, or are so easily cultivated, as to be of great commercial and manufacturing value. Because it has been ascertained that they can be brought to the markets of Europe even from these distant fields, so as to contend in price, even in ordinary times, with the favoured products of the nearest countries.

Though India possesses so large a number of fibre-yielding plants, but few of them are objects of European commerce, or are known to the manufacturers of cordage or of textile fabrics in Europe. This is not because no efforts have been made to make them known; for Dr. Roxburgh, in consequence of orders from the Court of Directors of the East India Company, so long since as the beginning of this century, grew many of the plants in the neighbourhood of Calcutta, separated their fibres, twisted them into twine, and tried their strength, as well when plain as when tanned or tarred. He also sent specimens to the India House, where some of them are still in existence, and also to the Society of Arts, in whose 'Transactions' for the year 1804 many of them are described. The Court of Directors, indeed, must have made inquiries for substitutes for hemp in the latter part of the last century, for, in some of the publications quoted below,[1] references are made to the Board of Trade Consultations in Bengal of the date of 1792, which relate to the Reports of the Collectors of Districts. These give much valuable information respecting the culture of

[1] 'A Treatise on Hemp, including a comprehensive account of the best Modes of Cultivation and Preparation as practised in Europe, Asia, and America; with Observations on the Sunn Plant of India, which may be introduced as a Substitute for many of the purposes to which Hemp is now exclusively employed.' By Robert Wisset, Esq., F.R. and A.S., London, Clerk to the Committee of Warehouses of the East India Company. The first edition in 1804, the second in 1808.

'Observations on the Sunn Hemp of Bengal; with statements of Experiments made from 1802 to 1806 to ascertain its comparative Strength with Russian Hemp, and the advantages of encouraging its Culture and Importation.' London: 1806.

'Observations of the late Dr. William Roxburgh, Botanical Superintendent of the Honourable East India Company's Garden at Calcutta, on the various Specimens of Fibrous Vegetables, the produce of India, which may prove valuable Substitutes for Hemp and Flax, on some future day, in Europe.' Edited by a Friend, and published at the expense of the East India Company, for the information of the Residents, and the benefit that may arise therefrom throughout the Settlements in India. London: 1815.

Sunn Hemp in India. In a pamphlet, published anonymously in 1806, 'On the Sunn Hemp of Bengal,' p. 11, as well as in Macpherson's 'History of European Commerce with India,' p. 242, we are told that great losses were sustained in the years 1796, 1797, and 1798, by the East India Company, and "that their expenditure upon that object exceeded the amount of the sales by more than £45,000, and that all such imports were discontinued until the year 1800, when differences again occurred with the Northern Powers of Europe." But we learn from a letter of Dr. Roxburgh, dated 24th Dec., 1799, that the Court of Directors had sent out Mr. Sinclair to establish the cultivation of hemp; but he having died shortly afterwards, the experiment was continued by Mr. T. Douglas, and, according to Dr. Roxburgh, in a most expensive manner.

The Lords of the Privy Council for Trade and Foreign Plantations, in a letter dated the 4th of February, 1803, recommended to the Court of Directors of the East India Company, to encourage as much as possible the growth of strong hemp in such parts of their dependencies as might be best suited to the production of that article. On the 23d of the same month, the Court replied, that they would take the needful measures for accomplishing the object of their lordships' wishes (*v.* 'Product. Resources of India,' by the author).

Farms were accordingly directed to be established for the cultivation of hemp and of substitutes for it. Dr. Roxburgh, Superintendent of the Botanic Garden at Calcutta, was appointed to the charge of one of them. As above stated, he cultivated a great variety of the fibrous plants of India, made experiments with the fibres, and sent specimens of them to this country. Though Dr. Roxburgh published no separate work on the subject, he wrote letters and reports, and included detailed descriptions of the plants in his botanical works. His separate papers were collected together at his death into a small volume, entitled, 'Observations, &c., on the various specimens of Fibrous Vegetables, the produce of India, which may prove valuable substitutes for Hemp and Flax on some future day in India.' Dr. Roxburgh's exertions were acknowledged by the Society of Arts by the award of their gold medal.

Among the fibrous plants which Dr. Roxburgh submitted to examination, was the Caloee of Sumatra, which he subsequently named *Urtica tenacissima.* He was informed by a friend at Canton, that the grass cloth of China was made from its fibres. The experiments were continued until 1811; for Dr. Buchanan, who was appointed to succeed Dr. Roxburgh, sent in that year three bales of the Caloee fibre of Sumatra to the India House. These the Court of Directors forwarded to Messrs. Sharpe, then of Mark Lane, who reported, that a thread spun of the fibres bore 252 lb., whereas the weight required to be borne by Russian hemp of the same size in her Majesty's Dockyard was only 82 lb. The Society of Arts, in the year 1814, awarded a silver medal to Capt. J. Cotton, then a Director of the East India Company—who had also paid great attention to the Sunn—for the introduction of this fibre, of which the reports were so favorable for strength and for other qualities. It has since been discovered to be abundant in Assam, and other parts of India.

Among the fibres subjected to experiment by Dr. Roxburgh, were the *Sunn* of Bengal (*Crotolaria juncea*), the Brown Hemp of Bombay (*Hibiscus cannabinus*), and the *Jute* produced by different species of Corchorus, which, though weak, has many valuable properties. Considerable quantities of the different kinds of *Sunn* and of *Jute* were imported by the East India Company. These were at times discontinued, and again resumed; but now we may consider them as trophies of the last war, inasmuch as they have become permanent and considerable articles of export. We may therefore fairly hope, as attention has, in the present war, been directed towards the Hemp of the Himalayas and the Rheea of Assam, that these also may become permanent sources of benefit to India, because they possess, in a superior degree, every quality required of fibres. Before proceeding, we may mention the quantities in which Jute and Sunn are now exported from India.

Though the accounts are imperfect of the export of these, at that time small matters, yet we perceive by the accounts of the Exports of India, given in to the Committee of the House of Commons for the Affairs of India, in 1831, that in the official year 1796-97, only 591 maunds of hemp, flax, and twine were exported from Calcutta to the United Kingdom, but 2883 maunds to the United States of America.

Of jute, at the same period, 521 maunds to the United Kingdom, 159 to America, and 1100 maunds to Hamburgh.

Gunny cloth, or sacking, which in Bengal is made of jute, is exported either in pieces or made up into bags; of these, besides considerable numbers to Penang, China, and New South Wales, 34,000 were exported to America in the year 1796. Since which, the quantity has gradually increased, having been, in 1849-50, 6,545,964, and of jute 33,302 maunds; so that India has contributed something to the success of the American cotton trade, as Bengal gunny bags are everywhere preferred in the Southern States for the packing of cotton. The following are the exports from the three Presidencies for the official year 1850-51; the maund being equal to 82 lb.:

	Hemp (Sunn).	Hemp (Sunn) twine.	Jute.	Gunny bags.	Gunny pieces.	Coir.	Canvass
	Maunds.	Maunds.	Maunds.	Number.	Maunds.	Maunds.	Bolts.
Calcutta .	7635	10,301	793,299	8,759,185	276,528	2654	
	Cwt.	Cwt.				Cwt.	
Madras .	2095	1372	—	58,950	—	109,288	470
Bombay .	11,793	274	—	188,540	—	4178	—

Besides these, as belonging to fibre plants, we may mention that, in addition to linseed oil, considerable quantities of linseed are exported from all three Presidencies, as will probably also soon be the case from Sindh.

		Maunds.	Cwt.	Cwt.
Linseed exported in 1850-51	From Calcutta,	765,497	Madras, 801	Bombay, 45,135.

The true Hemp is nowhere mentioned in these returns, though the plant is cultivated everywhere on account of its intoxicating properties. But Bombay being unable, from its insular situation, to produce enough for its own consumption, imported from the Concan 514 cwt. of *ganza*, or the dried leaves and flowers of the *true hemp*. In the above returns, by the word Hemp is no doubt intended the *Sunn* fibre of India, under which name, however, are probably included the fibres both of Crotolaria and of Hibiscus; while the gunny bags of Madras are probably made of Crotolaria fibre, as may be those of Bombay. But the latter also imports a large number of gunny bags from Calcutta, probably for packing some of the cotton produced in its own provinces.

As calculated to show the great importance of the commerce in fibrous materials, and also the extent of the interests involved in their growth and manufacture, as well as interesting for comparison with the exports from India, we insert here an account of the quantities of Hemp and of Flax imported into the United Kingdom for two years, that is, 1801 and 1853. A comparison of these will show the great increase in the imports of these two articles during the last half-century:

Years.	FLAX and TOW, or CODILLA of HEMP and FLAX.		
	From Russia.	From other Parts.	From all Parts.
	Cwt.	Cwt.	Cwt.
1801	188,106	85,613	273,719
1853	1,294,827	607,650	1,902,477
	HEMP UNDRESSED.		
1801	682,175	67,171	749,346
1853	806,396	412,374	1,218,770

Other fibres which were tried and made known at the above period, still remain unnoticed in Europe, and seem even to have been forgotten by the Indian community. This must be ascribed, on one side to the long peace having rendered manufacturers here indifferent to distant sources of supply; while in India the changing nature of European society, causes things familiar to all at one period, to become totally unknown only a few years afterwards. This effect is further promoted by the entire neglect of the Natural Sciences, which treat of these and other products as parts of general education. It would seem to be thought, that the earth we tread on, the air we breathe, and the animal and vegetable worlds by which we are fed and clothed, are not worthy objects of attention nor sources of valuable information. Not only are they so, but they are as well calculated as any other studies to train the mind to habits of correct observation, of careful induction, and of methodical arrangement. It is sometimes said, that these are subjects for professional rather than for general education.

Without admitting the truth of this opinion, we might yet have the evil rectified, if we found, that though soldiers and civilians neglected, some of these studies were pursued by planters and colonists, merchants and manufacturers. This is so far from being the case, that I was induced in another work to observe, that "the generality of modern experimentalists seem to be unacquainted with the labours of their predecessors, many of them commencing improvement by repeating experiments which had already been made, and announcing results as new which had long previously been ascertained."

We certainly now hear everywhere of the establishment of Schools where the principles of chemistry, of vegetable and animal structure, and physiology, are to be taught on account of their application to the improvement of gardening and of farming: while Trade Museums are being established to inform the manufacturer and merchant of the innumerable, to them useful substances, which nature everywhere produces, and which man so frequently neglects. From the general inattention, moreover, to such subjects, the short Reports and Essays which have been written on different useful products, are soon forgotten, and disappear from circulation. And, though great books have been pronounced to be great evils, small ones are like writings on the sand, which the waves of time obliterate, or remove so out of sight, as to be discovered only by the more diligent students of nature.

By some it has been said, that if these Indian fibres possess any useful properties, or can be afforded at reasonable rates, and there is any demand for them, that they will be sure to find their way to market. But others inquire, If there are such things, why don't they come to us? To this we may reply, that of the useful properties of many of these products there can be no doubt, as will be shown in the course of these pages. They are abundant, or may easily be cultivated, and can be supplied at rates to contend successfully with similar productions from other countries. Mr. Henley has lately shown, that fibrous materials may be supplied in Bengal at about four shillings a maund,[1] which is also the price of the *true hemp* in the Himalayas. Of the demand we may judge from the endless

[1] See Plantain, Jute, Sunn, and Hemp, for the prices at which fibres may be obtained in India.

inquiries, when there happens to be, from whatever cause, a dearth of the usual supplies. We may therefore infer, that as they are possessed of useful properties, and are purchaseable at reasonable prices, they ought to participate in the commerce of Europe in ordinary times. But there are great difficulties in their doing so at any time, for new articles are not enquired for, or even looked at, except in the above exceptional cases. And even in these, great indifference is displayed, unless you can say that large quantities are at once procurable. The colonists being seemingly expected to keep warehouses stored with raw products for the paroxysmal demands of European commerce; as if it were not enough to have within their reach the inexhaustible storehouse of nature, ready at all times to answer all legitimate demands. The Ryots of India are mostly too remote from the centres of commerce, or too apathetic to do anything different from what they have been accustomed to, while Europeans do not receive much encouragement in travelling out of the beaten track. For if we enquire into the history of many of the most important articles of commerce, we shall find that they were at first either neglected or abused. Large sums were expended, and much money was lost, before they came to be established as regular articles of commerce.

The difficulty in making new things known and appreciated as articles of commerce, arises chiefly from the habitual neglect of such things when sent for inquiry from abroad, in order to have their value ascertained at home. For if sent as specimens, I have seen many reports, in which they are pronounced to be of "no value," because they are "unknown in the market." The importer is sometimes advised to send the article in larger quantities to market for a few years, as it will then have a chance of being looked at and its true value ascertained. The planter is not often inclined to follow this advice. For if one more adventurous than his neighbours does send a quantity sufficient even for manufacturing purposes, it is not usually brought to the notice of the more inquiring manufacturer. The article being necessarily consigned by the planter to his agents, is by them transferred to a broker, by whom it is sold with other colonial produce, with little or no information respecting its properties, or the quantities in which, and the prices at which it could be supplied, if it should be approved of. Indeed, I am informed, that the novelty of the appearance, or the strangeness of the name, is more often the subject of jest, than the article is one of serious enquiry. At all events, the result usually is, that the article is sold at a price which does not pay its expences, and the planter is deterred from sending any fresh quantities. Further progress is, in that quarter at least, thus stopped, even at its commencement.

Even without such impediments, the difficulties are considerable in bringing any new article into use in sufficiently large quantities to be an object of commerce. The natives of India, who are the universal cultivators or collectors of raw produce, being unwilling to enter upon practices or speculations unknown to their forefathers. Any European who, instead of following the established routes of commerce, endeavours to trace out a new one for himself, is, I am told, considered an unsafe man—certainly with some truth, as long as his labours in a new field are so little appreciated or requited by the consumers in Europe. He is, moreover, while the value of a new article is unknown, subjected to the inconvenience of not having advances made in India upon what he may have shipped, as is the case with the ordinary articles of commerce. The merchants in India, or agents as they are usually called, are unwilling or unable to engage in the export of new articles; for the Bombay Chamber of Commerce have described how difficult it is for the merchants resident in the capital to come in contact with the cultivators in the country, also that they are but a "small body," "in most cases the agents of others, whose orders they must comply with;" but Mr. Bracken explained that they are engaged in agency and banking in all its branches, as agents, and in making advances of money for commercial purposes.

One great objection which is frequently made against entering into any speculation for the cultivation of any particular product in India, is the necessity of making some advances of money before the natives can be induced to undertake any particular culture or preparation. This is, no doubt, true, but it is the fashion of the country, which it would be extremely difficult to alter, and certainly not for a great many years. The advance can be effected, however, without much trouble and with little risk, if respectable *dulals*, or native agents, are employed.

But under the operation of this practice have arisen, the great commercial products of India, such as indigo, silk, opium, &c. The practice, so far from being exclusively Indian, may be considered rather as Asiatic, and, indeed, much more general even than that. For, if we inquire into the history of some extensive articles of import, we shall find English agents established near the places of production, and English capital continually sent out to vivify the exertions of colonists or of the natives of the country. Indeed, it can hardly be otherwise, if we compare the wants of many countries with the enormous quantities of produce required to satisfy the demands of even a single large manufacturer: this being often equal to that of some kingdoms. The Russian trade in hemp and flax itself seems dependent for its great extension upon English capital, for I am informed that money is annually sent to different ports of Russia, agents are thence dispatched into the country districts; these buy up the quantities which each cultivator has been able to grow but cannot prepare before winter; so that the article is not delivered for six months afterwards. The Earl of Clarendon, in his speech on the Russian war, in the House of Lords, on the 10th of August, said: "We must consider, too, that the trade with Russia is usually conducted with English capital; that English capital has been indispensable for their production and for bringing them to market, and that that has entirely ceased; and that all the industry of the country has, to a great extent, been paralysed, while the want of markets has deprived the Russian proprietor of all that he had to depend on to meet the expenses to which he is subject." Indeed, I am happy to say that some of the capital, which used to be sent to Russia for the purchase of hemp and flax, has this year been sent to India for the purchase of its peculiar fibres, and among them, probably, of Indian-grown hemp.

Though the fate of the generality of experimentalists is to have their efforts unnoticed, and thus to be deterred from further attempts, there are, I am also glad to state, some, and among them not the least intelligent and successful of manufacturers, who do themselves inquire after new products likely to be useful in their special businesses, and who, having obtained, first make a scientific investigation of the properties of the new substance, and then having subjected it to the practical working of their factories, have in a few instances, which I myself have brought to their notice, given remunerative orders directly to the planter for his produce.

A manufacturer may justly object to employ a new thing, with the properties of which he is but partially acquainted; and which, having investigated, he has no information of the quantities or price at which it can be supplied, supposing that he found it suitable for his purposes. Because, unless obtainable in quantity, regularly and at reasonable prices, he is unable, he says, to do any *good* with it. Therefore, in sending a new product to market, it is essential that it should be accompanied with the necessary statistical information. It is not of this, however, but of the total neglect of their endeavours, which planters complain. These, if stimulated by enquiry, would be induced to collect or to cultivate, to prepare, and to send to the markets of Europe, a new or little-known article, and to take measures for keeping up a regular supply for such manufacturers as might be the first induced to employ it. Information, therefore, both of a practical and of a scientific nature, is essential for bringing new or comparatively little-known articles into use.

But the attempt to diffuse information, and to take advantage of the public attention being directed to this subject, seems to be objected to by some political economists. For it is said—"Some persons, amongst the rest Mr. Sharp, seem anxious to profit by present circumstances, to bring forward the fibrous productions of India, to the exclusion of those of other countries. Their object is not trade, but to give employment to our fellow-subjects in our colonies and dependencies, &c." This at the same time that others are enquiring—Why are not the resources of India more largely developed? If the object were only to give occupation to our fellow-subjects of the East, it would still be a laudable one, as many have been deprived of their hereditary occupations as weavers, by the gigantic progress made by the cotton trade of this country. But who the parties are who have attempted to give this occupation, without attending to the legitimate demands of trade, does not appear. Certainly not those who have been adopting very effective measures for securing, as an article of trade, ample supplies of fibrous material now produced in enormous quantities in different parts of the world, and allowed everywhere to go to waste, though capable of the most important applications, both here and elsewhere. It is also said, that the object in the main seems to be, " enriching some few hundreds or thousands of our countrymen, who have estates, or a pecuniary interest in the East and West Indies." The objections to enriching one party at the expense of another, was never thought of when thousands of the weavers of Dacca were ruined, at the same time that the manufacturers of cotton goods here were enriched. But this effect was inevitable, as the high state of mechanical invention in England produced machinery of which the products could undersell those of the Indian loom, even in the distant fields where the cotton was grown.

In the present, as in all other instances, the Indian ryot is quiescent and indifferent. It is the manufacturers and Chambers of Commerce of this country who enquire, that as war diminishes the ordinary supplies, why cannot their wants be supplied from India, as that country grows what they want? Opportunity has therefore been taken, and we trust wisely taken, to direct attention to the neglected riches of our Indian empire, and thus to remove some of the difficulties which impede the introduction of new things into market. Feeling confident, that as the country possesses many fibres which are of good quality, and the climate, where both land and labour are cheap, is favorable to their growth, that some of the success which eventually attended the efforts made during the last war, will attend the present attempts. Indeed, we trust to a still greater extent, as some of the fibres now available are possessed of the strength of the best of those then tried, but which, from their rarity, were not procurable in sufficient quantities for the purposes of commerce. All that is attempted is to inform the consumer here of what India is capable of supplying, and of enabling the producer there to send it in such a state to market as to attract the attention of the intelligent manufacturer. That is, to put information before him in its most complete form, and accompanied by specimens which can be handled, either in their raw state, or as converted into cordage; with accounts of the growth and culture of the plants, their productiveness, and prices. Thus it may be hoped, that the distant cultivator of India, himself in so different a state of society, may be placed on a footing to meet the demands of the more advanced manufacturers of Europe at the average prices of ordinary times. In so doing, though not imitating, we are only pursuing the path which has at last been taken in this country of forming Trade Museums for the exhibition of specimens, and the diffusion of information respecting the raw products of all parts of the world. We might go further, and yet have good precedents to adduce—as, for instance, the yearly grant of £1000 a year to the Royal Flax Improvement Society, for the culture of flax in Ireland, a measure which, though unnecessary in England, has certainly been most useful in that country.

THE NATURE OF VEGETABLE FIBRE.

Before proceeding to take into consideration the different kinds of fibre, or the plants which yield them, it is desirable to have some definite ideas respecting the nature of fibre, and in what kinds or parts of plants we may expect to find it.

Plants are found to be composed of CELLS only, or both CELLS and VESSELS.

Cells are completely closed vesicles, usually containing fluid, of which the sides are formed of excessively thin and pellucid membrane. This is their characteristic when young, but as they get older their sides become thickened by the deposit in their interior of more solid material. Though these cells are destitute of visible pores, they are necessarily permeated by fluids, which deposit the matters found within their interior; and among others of the secondary cell-membranes, which in certain states possess a fibrous structure. These are by some, indeed, supposed to be composed of primitive fibres, often arranged spirally, which are of extreme fineness and transparency, but which in time become thickened like the cells.

Vessels.—Cells may be short and varying in form, or oblong; sometimes much elongated, as is the case with Cotton. But at other times, several cells becoming joined end to end and the intervening partitions absorbed, form vessels, which, like the cells, become thickened on their sides, and have formed within them fibrous matter of different kinds. Neither cells nor vessels are fitted for yielding useful fibrous material, either for cordage or for textile fabrics; but, as many contain fibre as a part of their structure, they may be reduced into pulp for paper-making.

Woody Tissue or Fibre.—Within the cellular tissue are found the above-described vessels, and along with them what is called woody *fibre* or tissue. This, together with some vascular bundles, constitutes collectively the chief part of the wood of plants, and gives support to the whole vegetable fabric. These woody fibres consist of elongated cells or tubes with tapering extremities, which overlap each other, and by their union longitudinally form the fibres which are extracted for economic purposes. But when so obtained, they are seldom separated into their ultimate fibres, but, rather united together into bundles of fibres. These are found in the wood, in the inner bark, and in the leaves of plants.

These woody fibres are extremely slender and transparent, but tough. Like the membrane of the cells, that of the fibre is also without pores, but permeable to fluids, and becomes thickened by the internal deposition of layer within layer, of matter which surrounds the cavity of the cell. In length these constituent cells of the fibre do not exceed from one third to one line. The bast cells of flax and hemp are long, but it is difficult to measure them exactly, as it is impossible to ascertain where one cell terminates and another begins. When moistened, "considerable swelling takes place, principally in the direction of the breadth, and only in a small degree in the longitudinal direction."

The original membrane which forms the basis of the fibre-cell is composed of carbon, hydrogen, and oxygen. But, as Mohl has observed, "the combination of cell-membrane with inorganic substances, is a very general condition. In almost all plants, a skeleton (the ash), corresponding to the form of the membrane, and composed of the alkalies, earths, and metallic oxides which had been deposited in it, remains behind after the cell has been burnt. The younger an elementary organ is, the more abundant, in general, the alkalies appear to be; the older it is, the more exclusively the earths and metallic oxides seem to be combined with its substance." Hence the best fibres are found in the young bark of plants, or in fleshy leaves; and therefore, plants when grown for their fibre, are generally sown and grown close together. This is done in order to favour their shooting upwards, and to prevent their too great exposure to heat, light, and air, which favour the formation of the different secretions of the plant and the consequent hardening of the woody fibre.

PREPARATION OF FIBRE AND OF CORDAGE.

This woody or fibrous tissue, formed as it is by the junction, end to end, of elongated cells, is, when in its natural state in the living plant, adherent to the membranous sides of the cellular tissue, and surrounded with mucilaginous, resinous, or other vegetable secretions. It must, necessarily, be separated from all these before it can be applied to any economical purpose.

This separation of the fibre from the rest of the vegetable matter is effected, either by stripping the bark from trees, or taking fibre-yielding leaves, and pounding them between stones and subsequently washing; or simply picking the fibres by hand, and thus separating them from the rest of the vegetable mass. But it is more usual, and also more expeditious, to separate the fibres by previous maceration in water. Fermentation then takes place, much of the vegetable tissue becomes destroyed, the fibres loosened, and then easily separated by washing or beating. Various attempts have also been made to separate the fibres by mechanical means. These, as well as the other methods suited to different plants, will be described under their respective heads, but more especially in the section which treats of Flax, as that plant and its fibre has had much attention devoted to it.

But fibres, when thus separated for economical purposes, are rather bundles of fibres than in the separated state of the ultimate fibre. Sometimes the commercial fibre, or some portion of it, is in the state, as stripped from the stems, of narrow flat ribbons, and therefore with sharp edges. Hence the necessity of passing them between rollers, or of submitting them to a rough process of combing, called *heckling*. Thus, not only impurities are got rid of, but the fibres are divided, laid parallel, and the short ones separated, constituting *codilla* or *tow*.

The longest of these fibres being usually not more than from three to four feet in length, are obviously too short for conversion into ropes of any length, or for weaving into cloth, without first undergoing some preparation. The natives of the great Eastern Archipelago join the ends of different fibres together by means of some adhesive substance, and thus form the "invisible knots" of an old author and obtain a thread, which, without spinning or twisting, is long enough for weaving.

If this were practicable with all fibres, they might be joined together end to end, then laid side by side and formed into bundles, which might be wrapped round or tied at intervals, and form a rope in which the strength of each fibre would be retained. Some ropes thus made for the purpose of experiment by Duhamel, were found to be of great strength but of little durability. The outer case wore off, and the rope opened at the bendings, so as to let in water. This being retained, assisted the decomposition of the rope.

It has been long discovered that we may obtain length by twisting fibres together, when they press upon each other, so that any single fibre is unable to overcome the resistance, caused by the friction upon it of surrounding fibres. It will then break more readily than slip out from the mass. By this means, a certain degree of compactness is also obtained, so that the infiltration of water is prevented, and the rope preserved from decomposition. Though a certain degree of twist is essential, any excess is injurious; for a rope may be so twisted as to break in the operation. And therefore a rope, brought up to this point without breaking, would be unable to bear any further strain, or to support any weight at all, and consequently be useless. Great precautions are therefore necessary in twisting the fibres, so that they shall retain as much as possible of their original strength, and be preserved from sustaining any further injury.

In making a rope, the first operation is to twist a certain portion of the fibres into a thick thread, which is called a *yarn*. These yarns vary in size, from one twelfth to a little above one ninth of an inch in diameter. These yarns are then *warped*, or stretched so that they may bear any strain equally. The next process is to twist a number of yarns, say from fifteen to twenty-five, into a *strand*. The twist of the strand is in an opposite direction to that of the yarn of which it is composed, in order that any tendency in the yarns to untwist may be counteracted by an opposite tendency in the strand. Three of these strands are formed into a *rope,* and three ropes into a *cable.* The term rope is generally confined to those which are above an inch in circumference; those which are less being called *twine, line,* and *cord;* though some of the latter terms are used with less strictness, as *fishing lines* and *clothes lines* are of very different diameters. Other kinds are distinguished by the name of ratline or of lashing; sometimes they are distinguished by the weight of a certain quantity—thus, pound line signifies a line weighing 60 yards to the pound: 160 fathoms of white or untarred yarn weigh from two and a half to four pounds.

In a popular work by Mr. Tomlinson, the different operations of ropemaking are described as follow: 1. *Heckling,* or hackling, of which the object is to separate the short fibres or tow, and to straighten the long ones, in order to enable them to run freely in spinning. 2. *Spinning,* or twisting the fibres into threads or yarns. 3. *Tarring* the yarns. 4. *Twisting* the yarns into strands. 5. *Laying,* or twisting three strands together, so as to form what is called a *hawser-laid* rope. In this process, which is called the *first lay,* each strand consists of as many yarns as are found requisite to give the required thickness to the rope. 6. *Second lay,* or *shroud hawser-laid rope.* This consists of four strands laid in the same way and under the same conditions. This rope has a straight loose strand, consisting frequently of only a few yarns, running through its centre; the object of this core-piece being to render the rope solid. 7. *Third lay,* or *cable-laid rope.* This consists of three hawser-laid ropes, each formed of three large strands, twisted or laid together in one gigantic rope or cable.

A very important consideration is the due degree of twisting which ropes ought to receive in order to retain the utmost degree of strength. Another is the benefit or injury which is derived from a large or a small quantity of tar, because this, instead of being a preservative in all situations, as is generally supposed, is very often injurious, as is fully illustrated by the following experiments. The abridged account of these we have taken from Sir D. Brewster's 'Edinburgh Encyclopædia:'

It was long ago shown by Dr. Hooke, from several experiments on the strength of cordage in 1669, that the strength of the component parts of the rope was diminished by twisting. This fact, indeed, has been long practically known to sailors, who are familiar with the superior strength of rope yarns when made up into a *salvage*, which is nothing more than a skein without twisting. Salvages are invariably used for slinging great guns, rolling tackles, and for every kind of work where great strength and great pliancy are required.

In the 'Memoirs of the Academy of Sciences,' M. Reaumur has given an account of his experiments on the strength of ropes compared with that of their parts.

2. The yarn of a skein of white thread bore each, at an average, 9¾ lb.
Two yarns twisted slack into a cord broke with 16 lb.

Hence we have the absolute strength of two yarns . .	19½ lb.
Real strength	16
Loss of strength by twisting . . .	3½ lb.

3. The average strength of some thread was such, that each broke with 8 lb., whereas when *three* were twisted they bore only 17½ lb.

Hence we have absolute strength	24 lb.
Real strength	17½
Loss of strength by twisting . . .	6½ lb.

4. The average strength of some thread was such, that each broke with 7½ lb., whereas when *four* were twisted they broke with 21½ lb.

Hence we have absolute strength . . .	30 lb.
Real strength	21½
Loss of strength by twisting . .	8½ lb.

5. The average strength of other four threads was such that each broke with 9 lb., whereas when twisted, they broke with 22 lb.

Hence we have absolute strength	36 lb.
Real strength	22
Loss of strength by twisting . . .	14 lb.

6. A well made and small hempen cord broke in different places with 58, 63, 67, and 72 lb., so that its average strength was $\frac{58 + 63 + 67 + 72}{4} = 65$ lb.
The cord consisted of three strands, and another part of it was untwisted, and its three strands separated. One of them bore 29½, another 33½, and the third 35.

Hence the absolute strength of the three strands, when separate, is	98 lb.
Real strength when twisted	65
Loss by twisting . . .	33 lb.

7. Another part of the same cord, which broke with 72 lb., was separated into its strands, when they bore 26, 28, and 30 pounds.

Hence we have absolute strength	84 lb.
Real strength	72
Loss by twisting . . .	12 lb.

Dr. Robison has given an account of a very interesting experiment by Sir Charles Knowles, upon a piece of white or untarred rope, $3\frac{1}{3}$ inches in circumference. It was cut into many portions, and from each of those portions a fathom was taken off, and carefully opened out. It consisted of 72 yarns, each of which was examined separately, and found to bear 90 lb. at an average for the whole. Each piece of rope corresponding to these was examined separately, and the mean strength of the same pieces was 4552 lb.

Hence we have absolute strength of yarns . . .	6480 lb.
Real strength	4552
Loss of strength by twisting . . .	1928 lb.

As the diminution of strength in the yarns, demonstrated by the preceding example, obviously arises from their position when twisted, in consequence of which they do not all bear the load at the same time; and not from any permanent weakness produced by the twisting it became reasonable to believe, that the twist given to ropes should be as moderate as possible.

* * * * *

The degree of twist commonly employed was such that the rope was *two thirds* the length of the yarns which composed it. M. Duhamel,[1] who made many valuable experiments on this subject, in the royal dock-yards of France, caused some rope, to be worked with only *three fourths* of the length of the yarn. This last rope with the inferior degree of twist, bore 5187 lb., whereas the other bore only 4321 lb. He next caused these ropes to be made with different twists, and obtained the following results:

Degree of twist.	Weight borne by each. One experiment.	Another experiment.
$\frac{2}{3}$	4098	4250
$\frac{3}{4}$	4850	6753
$\frac{4}{5}$	6205	7397

So far these experiments were highly satisfactory; but it still remained to be seen, whether or not the ropes which had an inferior degree of twist, had not also an inferior degree of useful solidity, notwithstanding their superiority of strength in carrying weights.

In order to determine this point, M. Duhamel had a considerable quantity of rigging made with yarns, wrought up into only *three fourths* of their length, and got them put into actual use on ship-board, during a whole campaign. The report given by the officers of the ship was highly satisfactory. They proved that the ropes thus manufactured were *one fourth* lighter than the common kind; that they were nearly *one eighth* more slender, so as to give less hold to the wind; that, from their being more pliant than the common ones, they run easier through the blocks, and did not run into what are technically called kinks; that the new cordage required fewer hands to work it, in the proportion of *two* to *three;* and that it was at least *one fourth* stronger.

* * * * *

Wherever ropes are not exposed to short bendings, as in the case of standing rigging, where they can be defended from water by tarring, &c., the least twisted cordage may be advantageously employed, and should, according to M. Duhamel's experiments, be made from strands; for it is demonstrable that in fine stranded cordage, when the twist of the strands is

[1] 'Traité de la Fabrique des Manœuvres pour les Vaisseaux, ou l'Art de la Corderie perfectionée.'

exactly equal to the twist in the laying, the strands lie less obliquely to the axis than in other ropes, and therefore bear a greater load.

* * * * *

In examining the strength of cordage, $3\frac{1}{2}$ inches in circumference and under, M. Duhamel found that the strength increased a little faster than the number of equal threads, thus:

Ropes of 9 threads bore	1014 instead of	946 lb.
12	1564	1262
18	2148	1893

According to the experiments of Mr. Huddart, no strength is lost in the common way when there are only three yarns in the strand. When there are more than three yarns, the loss is one sixth, and with a hundred yarns it is about one half. His registered cordage, according to theory, loses nothing, but by actual experiment it loses one eighth.

The following rule is given by Dr. Robison for obtaining the strength of ropes:

Multiply the circumference of the rope in inches by itself, and the fifth part of the product will be the number of tons which the rope will carry.

For example, if the rope is 6 inches in circumference, we have 6 times 6 = 36, the fifth of which is $7\frac{1}{5}$ tons.

Tarring Ropes.—There is no branch of the rope manufacture more important than that which relates to the tarring of the cordage. The following experiments were therefore made by M. Duhamel on the relative strength of tarred and white or untarred cordage.

August 8th, 1741.

Untarred Rope.	Tarred Rope.	Difference.
Broke with 4500 pounds.	3400 pounds.	1100
4900	3300	1600
4800	3250	1550

April 25th, 1743.

Untarred Rope.	Tarred Rope.	Difference.
Broke with 4600 pounds.	3500 pounds.	1100
5000	3400	1600
5000	3100	1900

Sept. 3d, 1746.

Untarred Rope.	Tarred Rope.	Difference.
Broke with 3800 pounds.	3000 pounds.	800
4000	2700	1300
4200	2800	1400

The ropes with which the preceding experiments were made, were three French inches in circumference, and were made of the best Riga hemp.

M. Duhamel next examined the relative strength of a parcel of tarred and untarred cordage, which had been manufactured on the 12th of July, 1746. It had been laid up in the storehouse, and the following results were obtained at the dates mentioned.

	Difference of time in Months.	Untarred Rope.	Tarred Rope.	Difference.
		Pounds.	Pounds.	Pounds.
1746. April 14th .		2645	2312	333
1747. May 18th .	11	2762	2155	607
1747. Oct. 21st .	6	2710	2050	660
1748. June 19th .	9	2575	1752	823
1748. Oct. 2d . .	4	2425	1837	588
1749. Sept. 25th .	12	2917	1865	1052

From these results M. Duhamel concludes:

1. That *untarred cordage* in constant service is *one third* more durable than the same cordage when tarred.

2. That *untarred cordage* retains its strength for a much longer time when it is kept in store.

3. That *untarred cordage* resists the ordinary injuries of the weather *one fourth* longer than when it is tarred.

These results of direct experiments have been confirmed by the observations of seamen; but they have invariably found, that untarred cordage is weaker than tarred cordage, when it is exposed to be alternately wet and dry; that tarred cordage is chiefly useful for cables and ground tackle, which must be constantly soaked in water; and that cordage, *superficially tarred*, is always stronger than what is thoroughly tarred, and resists better the alternate conditions of dryness and wetness.

Several important experiments on the relative strengh of tarred and untarred ropes were made by Mr W. Chapman,[1] chiefly with the view of determining the effects of his method of preser ving ropes with purified or washed tar. Three pieces of rope were made on the 10th of August, 1808, of 12 threads in each strand. The first was an untarred rope, the second a rope made of washed tarred yarn, and the third a common tarred rope. A part of each of these ropes had their strength tried on the breaking machine; and another part was steeped in water for about three months, and then taken to a foundry stove, which is supposed to have been at about 130° of Fahrenheit. They remained in the stove about three months. After that they lay at Mr. Chapman's ropery till Nov. 3d, 1803, when the following experiments were made with them:

	When made. Aug. 10th, 1802.	Nov. 3d, 1803.	Portion of original Strength retained.
	Cwt.	Cwt.	Cwt.
White rope	33·4	1·9	5·7 pr.cent.
Common tarred rope . .	22·2	7·35	33·0 pr.cent.
Washed tarred rope . .	29·1	12·35	43·8 pr.cent.

The tarred ropes were both brittle; but the latter was more so, and they both cracked on bending.[1]

[Mr. Chapman has also observed that though cordage is injured by tarring in cold climates, it is much more rapidly so in hot climates.]

The following experiments were made in 1807, by Mr. Chapman, for the purpose of showing the injury arising from the retention of that portion of the essential oil which cannot be dispensed with, and also the injury which arises from the progressive disengagement of the acid of essential oil.

	Weight with which it broke when Moist.	Weight with which it broke after exposure to a Stove for four months.
	Cwt.	Cwt.
Untarred rope	45·75	38·97
Rope tarred with cold tar .	51·29	26·40
Ditto with boiled tar.	38·94	25·07

[1] Author of 'Treatise on the progressive endeavours to improve the Manufacture and Duration of Cordage;' London, 1808.

The first column shows the strength of the rope when made; and the second after having been exposed to the heat of a stove from 85° to 100° Fahr.

The following experiments, also made by Mr. Chapman, confirm those of Duhamel, respecting the diminution in the strength of cordage produced by tarring. The ropes were registered on the improved principle, and were made with the same yarn, and with 17 threads in each strand.

	Girt in inches.		Comparative Strength.
		Cwt.	Cwt.
1806. Oct. 2. White rope .	2·75	Broke with 75	100
„ Oct. 24. Tarred rope .	2·8	„ 55	73·3
1807. May 8. Same rope .	2·8	„ 41·4	55·2

The following experiments were made with ropes made of the same yarns, and of nine in each strand.

	Girt in inches.		Comparative Strength.
		Cwt.	Cwt.
White rope . . .	1·7	Broke with 27·5	100
Tar of whale oil .	1·85	„ 22·5	83·7
Tar and tallow . .	1·8	„ 17·5	63·6
Tar unpurified . .	1·7	„ 15·95	57·7

Whale oil and tallow have therefore an excellent effect, particularly the former.

* * * * *

The following experiments were made by Mr. Chapman on the elasticity of ropes of different kinds, when strained with $\frac{7}{8}$ths of their breaking stress:

	Original Length.	Length when Strained.
	Inches.	Inches.
Registered primary strands . .	24	$24\frac{3}{4}$ to 25
Registered shroud laid ropes . .	24	26 to $26\frac{1}{2}$
Common made shroud laid rope .	24	$27\frac{1}{2}$ to 28
Registered cable laid rope . .	24	27 to $27\frac{1}{2}$

The three kinds of rope last mentioned, stretched on an average 1 inch in 24 with a fifth of their breaking stress, which is from $\frac{1}{2}$ to $\frac{2}{5}$ lb. of the whole stretching of the registered shroud laid ropes, but only from $\frac{2}{7}$ths to $\frac{1}{4}$th of the stretching of the common made shroud ropes.

In May, 1805, Sir Joseph Banks, being anxious to try teak tar for ropes, two three-inch ropes were made of the same yarns, one with teak tar, and the other with common tar. They were then placed in the same storehouse, and were broken Sept. 28th, 1807.

Common tarred rope broke with 3848 pounds.
That made with teak tar broke with 5980

The common tarred rope being only about *two thirds* the strength of the other.

It is interesting to conclude with a notice of the efficacy of an Indian product. It will probably be found that the Indian practice of tanning ropes is also efficacious, and has the advantage of not injuring the texture of the fibre, as will be mentioned when noticing Dr. Roxburgh's experiments.

ARRANGEMENT OF FIBROUS PLANTS.

In treating of the different Indian fibres, it is desirable to adopt some methodical, instead of an accidental arrangement. For such, as for instance, the alphabetical, would necessarily be irregular, when the selection of the names must be made from a variety of languages, according to the places where a fibre or the plant yielding it is best known. Preference will of course always be given to any name known in commerce. But some of the articles to be treated of are unknown in the markets of Europe, and a few, though common in every part of India, are yet not known there by any common name. A selection must, therefore, be made of one of the names, as this is essential for distinguishing the articles one from another, and to assist in fixing the attention upon each individually. Thus we shall avoid calling every new fibre, *hemp*, when one only can properly be so named. In the same way, the South Sea Islanders called every new animal they saw, a pig, because that was the only one with which they were acquainted.

Without entering into minute details, we shall adopt an arrangement founded upon the botanical affinities of plants, not purely because it is scientific, and therefore more satisfactory; but because it will enable us to make a number of comparisons with fibres obtained from plants of the same family in other parts of the world. It will also enable us to draw some practical deductions from the information we may thus bring together. Though I have no doubt that some who consider themselves eminently practical, will sneer at the idea of a scientific arrangement being productive of such results.

Botanists have for some time arranged all plants into a few large divisions, from characters derived from their internal structure: thus, some being composed of cells only, are called *Cellular;* others are called *Vascular,* because, in addition to cells, they also contain vessels usually accompanied by woody tissue. The cellular tissue being developed in every direction, is sometimes called the *horizontal* system, while the vascular growing vertically, is distinguished as the *longitudinal* system. It is in this direction that the fibres of which we have to treat are placed in the plant. The development and arrangement of these two systems produce three distinct forms of growth and of internal structure.

Acrogens, or summit growers, so called from the growth of the stem taking place by the junction of the bases of the leaves at the top of the stem, as in Tree Ferns. Under this—used as a general term—cellular plants, such as Mosses, &c., are included; but none of them yield fibre, either for cordage or for textile purposes, though it is possible that some of the ferns contain fibre enough to form pulp for paper-makers.

Endogens, or inside growers, are so called because the bundles of vessels and fibres proceed from the bases of the leaves into the cellular centre of the stem, and are thence pushed outwards by the new growths, so that the outside of such stems, as of Palms, is harder than the inside. These plants have no regular bark which can be stripped off, and their leaves have the veins running parallel to each other. It is these leaves which abound in fibre, which may be separated by simple pressure and washing, as in the Pine-apple, Agave or American aloe, Plantain, and many others. In Palms, the structure of the leaves is too dense for the fibres to be separated so easily.

Exogens, or outside growers, are so called from additions to their stems being made on the outside of the growth of former years, as seen in the rings of wood on a transverse section of the trunk of any of the ordinary trees of Europe. There is also a distinct bark, of which the outer part is composed of cellular, but the inner contains the woody tissue. From this the fibres are separated for various economic purposes, usually by stripping off the bark and then steeping it in water, as with Flax and Hemp, Jute and Sunn. The leaves of Exogens have a reticulated or net-like, instead of a parallel venation.

The above characters, taken from the parts of vegetation, are found to be accompanied by others equally characteristic, in the parts of fructification. Thus the spores of Acrogens, in germinating, are unaccompanied by anything like a leaf; the Endogens have a single seed-leaf, as may be seen in Wheat and other Cereals, as the Rice; while Exogens, in sprouting display two of these seed-leaves, as in Peas and Beans.

From these peculiarities other names are given to the above divisions, but which it is needless for our purposes to notice.

PREPARATION OF THE FIBRE OF ENDOGENS.

Though both the stem and the leaves abound in fibre, it is from the latter chiefly that this is separated for practical purposes. The fibres of some plants are not separated from the rest of the vegetable matter, but the stems and leaves are simply dried and twisted, as in the case of some Grasses, Sedges, Rushes, and even the leaves of Palms. The leaves of others are simply beaten with a stone on a flat board or on another stone, and afterwards the rest of the vegetable matter washed away. Occasionally such fleshy leaves have been passed between rollers, as those of a sugar-mill, and with the consequent saving of both time and labour, also with a diminution of cost. Very frequently, however, these leaves are steeped in water until fermentation takes place, when the labour of separating the fibre is much diminished. But this often takes place with great loss of strength as well as of the beautiful white colour, for which most of these endogenous fibres are particularly distinguished.

Dr. Hunter, who has paid much attention to the separation of this class of fibres, has observed that the ordinary modes of separating the fibres of plants in India, that is, steeping them in water, are exceedingly faulty. Every day's steeping of a vegetable substance in water takes from its strength, and communicates a tinge to the fibres which can only be removed by the subsequent application of some chemical agent, such as lime, the alkalies or chlorine, which in some cases, no doubt, diminishes their strength. He observes that in most parts of India the fermentation which takes place in plants heaped together or steeped in water proceeds so rapidly, that it is extremely difficult to prevent the accession of putrefactive decomposition. This, he says, commences in succulent plants, when immersed in water, in twenty or twenty-two hours, during warm weather. The sooner, therefore, that the decomposing parts of a plant—that is, the mucilaginous, saccharine, and other constituents of the sap and pulp—are removed, the whiter are the fibres, and they retain more of their original strength. The fibres cleaned within a day or two after the plant or leaf had been cut, were found to be white, strong, and silky. On wetting the same repeatedly and exposing them to the dew, it has been found that their strength is impaired.

Those fibres that were steeped in water for a few days acquired somewhat of the colour of English tow. Those steeped for three weeks became quite rotten, brown, and brittle. Dr. Hunter has further ascertained by experiment that the partial drying of the leaves or bark of plants in the sun, as recommended and practised by the natives, does more harm than good, as it makes the process of cleaning more tedious, and is apt to tinge the fibres. Such as have been thoroughly dried in the sun before being cleaned, give brittle and often brown-coloured fibres, unless there be naturally very little moisture to be dried up. The only way he found of preparing fibres by rotting, is that followed by the natives in a few localities near large rivers, where the leaves of the Agave, from their outside hardness, are sometimes buried under wet sand below the level of the water in the river.

Grasses (*Gramina*).

The grasses so extensively diffused, and in different forms as pasturage for cattle and corn for man, so essential for the continued existence of the animal kingdom, are seldom thought of as materials for cordage. Yet they were probably the first substances which were converted into rope; for the simple twisting between the hands of the flexible leaves and pliant stems of many of the grasses will form a rope, as is daily practised with bands of hay or those of straw. In the chairs of the Crystal Palace, we may see the rush-like bottoms are formed of the twisted straw of rye. Others are employed for thatching, and some for platting, screen- and mat-making. All purposes which indicate the presence of fibre of sufficient tenacity to bear at least a certain degree of strain and of pressure. But in these plants, as well as in sedges and rushes, the fibre is not always separated from the rest of the vegetable matter, but the whole leaf or stem is dried, and used in its entire state. As the fibre, however, possesses the requisite degree of tenacity, it can be separated in the form of pulp and used for paper-making, as will be again mentioned in the subsequent pages.

The grasses abound in India; in the plains are numerous species of genera little known in Europe; with the cultivation of rice, maize, joar, and many millets in the rainy season; and in the cold weather, of wheat, barley, oats, and millet; while in the Himalayas the pasture-grasses are many of them the same as in Europe, and the cereals are cultivated in the spring and summer, with some rice in the rains. (*v.* Author's paper 'On the Corn and Pasture-Grasses of India, in Illustrations of Himalayan Botany,' pp. 415—427; reprinted in 'Trans. Agric. Soc. of India,' viii, p. 91.)

Though the grasses were probably among the first substances used for cordage, none of them seem ever to have been objects of export commerce; partly because they are so universally diffused, and partly because they are bulky and deficient in strength. One or two have, however, been sufficiently distinguished to have been noticed by the ancients. One of these is the Esparto of the Spaniards, supposed to be the Spartum of the Romans. It is probable, however, that a very different plant (*Spartium junceum*) was also sometimes included under this name, for it was not uncommon for what we consider very different plants to be included under one general name, if they were used for the same purposes. Indeed, it is not unusual, even in the present day, for very different substances to be included under one general term; as is the case, for instance, with the word *hemp*, of which we shall have to mention several instances. The *Esparto* of the south of Spain, especially of the provinces of Huesca, Murcia, and Almeria, is *Stipa* (or Macrochloa) *tenacissima*, called "mat-weed" by Ray, and supposed to be "the rush of a dry soil" of Pliny. It grows in tufts, with long leaves, and is still used by the Spaniards for making sandals, mats, baskets, and ropes; and also sacks, nets, and toils, which the shepherds use as hurdles for their sheep. Some seems to have been exported both to the South of France and into Italy, for making baskets, sacks, and ropes, as this was prohibited in 1783 and 1790. It is also employed for stuffing palliasses; and some paper made of it was sent to the Exhibition of 1851. *Lygeum Spartum* is supposed by others to be one kind of Spartum, as it is also called

Esparto by the Spaniards. *Arundo arenaria* is used in the Hebrides for many of the same purposes as Esparto is by the Spaniards.

In India several of the indigenous grasses are employed for the same purposes as the above. Thus the *Moonja* of the natives (*Saccharum Munja*) is collected after the rainy season and kept for use, as it is employed in tying up their cattle at night and for ropes for their Persian wheels. It is said also to be one of the grasses employed for making tow-ropes by the boatmen about Benares. The *Shur* or *Sara* of Bengal (*Saccharum Sara*), or the Pen reed grass, Mr. Henley informs me is another species employed by the boatmen about Allahabad and Mirzapore, and esteemed as a tow-line for its strength and durability even when exposed to the action of water. It is said to be beaten into a rude fibre and then twisted into a rope.

Besides the above, the sacred grass of the Hindoos, the *dab* or *koosha* of the Brahmins (*Poa cynosuroides*), is also made into rope in North-West India. Other species of Saccharum are used for thatching and for screens, and some for making writing-pens and for arrows. The fibres of the *Khuskhus* or Vetiveyr are more remarkable for their agreeable odour than for their tenacity, while the Bamboo, the most gigantic of grasses, might be enumerated with timbers rather than with fibres, though its split stems are often employed for making mats in India, and the young shoots for paper-making by the Chinese. Many others of the grasses might be converted into half-stuff for paper-makers, and have the great advantage of affording large quantities of a cheap material.

The *Nul* or *Nar* of Bengal is described as being employed for making the mats known by the name of Durma, which are formed of the stalks split open. Dr. Stocks informs me that in Sindh the grass called *Sur*, which perhaps is *Arundo karka*, has its culms, *sur jo kanee*, made into chairs, and its flower-stalks beaten to form the fibres called *moonyah*. These are made into string or twine (*moonyah jo naree*), and into ropes (*moonyah jo russa*).

While this sheet is passing through the press, I have been informed by Mr. Burns, of the Indus Flotilla, who has been several years in Sindh, that the boatmen of the Indus universally employ the Moonj (probably the above *Saccharum*

Munja) as a towing rope and for the rigging of their vessels, in all places above Sukkur. But below that place Coir rope is very generally employed, being better able, I believe, to stand the action of salt water. The Moonja, however, is possessed of great tenacity, as is evident from two-inch ropes, often fifty fathoms in length, made of its fibres, being sufficient for dragging their largest or 1200-maund boats up the Indus, and consequently against the full force of the stream, even round projecting points. The rope is also possessed of lightness, so advantageous for rigging, and is capable, also, of bearing, without injury, alternate exposure to wet and to subsequent drying. Both qualities being essential for a tow-rope. Mr. Burns has also informed me that plants growing beyond the range of the overflowings of the river, or of the influence of the tides—that is, in the interior of the country, where, indeed, it grows in vast abundance—are possessed of the greatest strength. The upper leaves, about a foot or so in length, are preferred and collected. Having been made up into bundles, they are kept for use. When required for twisting into rope, they are first moistened in water: two men then, sitting opposite to each other, take one of these moist bundles and beat it alternately with mallets, until the loose cellular are separated from the fibrous parts. These are then ready for twisting into the ropes which are so extensively employed on the Indus. It is evident that a continuation of the same process, or the employment of the *Dhenkee* of India, would afford a very ample supply of half-stuff for paper-makers, and at a cheap rate.

SEDGES (*Cyperacæ*).

Sedges nearly resemble grasses in appearance, but grow usually in moist situations, and are distinguished from them by their angular stems. They are remarkable for so few of them being useful for any purpose—not even for fodder. One of them, however, is famous as having yielded the Papyrus of the Egyptians, employed by them for making paper, ropes, and even boats; and of which the plant is so frequently represented in their sculpture and paintings. An Indian species of Cyperus (*C. tegetum*, Roxb.; called *Papyrus Pangorei* by Nees von Esenbeck), the *Madoorkati* of the Bengalees, which is extremely common about Calcutta and in Bengal, is very extensively employed for making the elegant, shining and useful mats for which the capital of India is famous, and which are frequently imported into Europe. Dr. Roxburgh states that the culms or stalks of the plant when green are split into three or four pieces, which in drying, contract so much as to bring the margins in contact, in which state they are woven into mats, and thus show a nearly similar surface on both sides. Specimens of the strips of this sedge were sent to the Exhibition of 1851, as well as mats made of them. These strips are tied up in bundles about four inches in diameter and four feet in length, and seem, besides their extensive use for mat-making to be well adapted for platting.

The cotton-grass (*Eriophorum*) of Europe is a conspicuous ornament of turf-bogs and marshy moors, from having its seeds clothed at the base with a silky or cotton-like substance. With this, pillows are sometimes stuffed, and wicks of candles as well as paper, made. There is a species of the genus very common in the Himalayas, both in low valleys and at considerable elevations. This, I named *Eriophorum cannabinum*, in consequence of my finding it everywhere employed in making ropes for all ordinary purposes by the mountaineers. Its name, *bhabhur* and *bhabhuree*, has a considerable resemblance to that of the papyrus, considering that the *b* and *p* are letters so frequently interchanged for each other. All who have scrambled up the steeps of the Himalayas are sensible of the great support they have received from the toughness of the tufts of the bhabhur. Specimens of the dried leaves, made up into bundles about three feet in length, were sent to the Exhibition of 1851, from Beerbhoom. Also twine made from it: this, though rough, is strong and well fitted for ordinary purposes.

Capt. Huddleston, in a paper on the Hemp and other fibres of Gurhwal, in the Himalayas ('Trans. Agric. Soc. of India,' viii, p. 272), mentions the Bhabhur as holding a conspicuous place, "from its extensive use and most abundant supply throughout the whole of the hills, affording a most economical substitute as an article of cordage, in lieu of others of a more costly and durable nature. All the jhoolas or rope bridges, which are erected over the large rivers, where sanghas or wooden-planked bridges cannot be made, on all the principal thoroughfares of this district, are constructed of this silky species of grass, the cables of which are of a considerable thickness. These rope bridges are a very safe means of communication over the large and rapid rivers intersecting different parts of the country, both for travellers and men with loads; and, where the footway and sides are properly laced with brushwood, afford an easy enough roadway for loaded sheep—but neither ponies nor cattle can travel over them. This grass grows abundantly in all the ravines up the sides of the mountains, and is to be had only for the cutting—but it is not of a very durable nature, though pretty strong when fresh made into ropes. It lasts about a twelvemonth only, or a little more, and the people in charge of the rope bridges are constantly employed in repairing and annually renewing the ropes and stays. The 'chinkas,' or temporary bridges of a single cable, upon which traverses a seat in the shape of an ox-yoke, are also sometimes made of this grass."

Bulrushes (*Typhaceæ*).

Bulrushes, so conspicuous in the marshes of Europe, extend also to similar situations in most parts of India. The leaves are in some parts of Europe employed in making mats and winter coverings for plants, as well as for stuffing chairs. I have already recorded that the leaves of *putera* and *reree* (or *Typha elephantina* and *T. angustifolia*) are employed in making mats in North-West India. Dr. Stocks informs me that in Sindh the former is called *pun*, and its leaves employed for making mats and baskets. The pollen, like that of Lycopodium, is inflammable, and used as a substitute for it in Europe. It is also collected in Sindh, and there called *booree.*

Vacoa or Screw Pines (*Pandanaceæ*).

The Screw Pines, having fruit something like that of pines, and flowers not more developed than those of the Bulrush, are remarkable for their gigantic Bromelia-like leaves, arranged in a spiral manner. Though abounding most in

Mauritius and Bourbon, species are also found in the southern parts of India, as well as in the Straits and Burma. "The leaves are composed of tough longitudinal fibres, white and glossy, which enable them to be employed for covering huts, making matting, as well as for cordage, in the South Sea Islands; and in Mauritius for making sacks for coffee, sugar, and grain." ('Himal. Bot.,' p. 408.) The species which is best known in India is the *Keora* or *Ketgee*, the Kaldera bush of the Madras Peninsula, called *Pandanus odoratissimus* by botanists, on account of the exquisite perfume of its flowers. Dr. Roxburgh ('Fl. Indica,' iii, p. 741) has, under this plant, mentioned the uses to which the species most common in the Mauritius is applied; which, as well as some of the other species, is known there by the name Vacoa or Baquois. It appears to be the *Pandanus sativus* of Du Petit Thouars, but which Mr. Henley mentions as *P. Vacoa*. He having observed the valuable uses to which the plant was applied in the Mauritius, recommended its introduction into India; in some of the dry southern parts of which, it would, no doubt, though slow of growth, be a valuable acquisition, from the facility with which good sacking may be manufactured from its leaves. Mr. Henley describes this most useful Vacoa of the Mauritius to grow to the height of thirty feet, when permitted to do so; but, in general, the cropping of the leaves, which commences in the third year, keeps the plant down to the height of from six to ten feet. The plant is remarkable for the aerial leafless roots which it sends down as supports for its stem, and which are of so fibrous a nature as to be employed for making paint brushes for common purposes. The leaves are cut every second year, beginning when the plant is three years old, and each plant yields enough for two large bags. The preparation must begin with the leaves immediately they are removed from the trees, and consists, first, in splitting the leaves into fillets, which are from three fourths to one inch broad at the base, but taper to a point, and are from three to four feet in length. One of them will support the weight of a bag of sugar, or about 140 lb., without breaking. Mr. Henley states that the leaves of the other species with which he is acquainted are comparatively weak. ('Jour. Agric. Soc. of India,' 1843, p. 92.)

The Nipah Palm (*Nipa fruticans*), which, from the appearance of its foliage, is generally supposed to be a Palm, though stemless, but which, in the nature of its flowers, approaches the Screw Pines, is a plant of which the leaves are applied to mat-making and thatching. It is a native of the Indian Archipelago, which extends northwards to the Mergui River, where it is found in perfection, but only a few specimens as far north as Moulmain. It flourishes in brackish water, along with the Mangrove, and its lower parts are inundated when the tide rises. It abounds in saccharine sap, which may be evaporated into an excellent sugar, or fermented into a kind of "Palm wine." Its leaves are those chiefly employed in the Tenasserim provinces for covering the roofs of houses, and large quantities are sent northwards from Mergui for this purpose. They are also made into mats, and no doubt abound in fibre, though this is not separated for economic purposes.

THE PINE-APPLE TRIBE (*Bromeliaceæ*).

The Pine-apple, or Ananas, is so well known as an object of the most careful culture in Europe, on account of its pleasantly sweet and aromatic fruit, that we should not expect to find it included among cordage plants. But its long and rigid leaves, which are thorny at the edges and point, abound in a quantity of fine white fibres, which are, in some countries, woven into the finest fabrics, netted, or twisted into lines for fishing and into ropes possessed of considerable strength. These are said not to be injured by constant immersion in water—a property which the natives increase by tanning them. Not only the cultivated Pine-apple, but others of the genus and family, are possessed of similar properties, as the Penguin, or broad-leaved wild ananas (*Bromelia Penguin*), which is common on the rocky hills in Jamaica and other West India islands. It is employed in making fences to their fields; and its leaves, after being steeped in water and beaten with a wooden mallet, yield a strong fibre, which is twisted into ropes, and manufactured by the Spaniards into cloth, of which they make hammocks, &c. So *B. Karatas*, or upright-leaved wild ananas, which includes the Caraguata of Piso, and is common in South America; and the Curratow or Grawatha (*B. sagenaria*), probably the same as the Craute de rede, common on the coasts near Pernambuco, and other parts of Brazil. So also *B.* (now *Bilbergia*) *variegata*, or Caroa, which grows in wild luxuriance for miles, and yields excellent twine for nets in Brazil; and the so-called New Orleans moss or "long beard" (*Tillandsia usneoides*), of which a bale was sent to the Exhibition of 1851, and proposed as a substitute for hair, for stuffing chairs, cushions, and mattresses.

The fibre commonly called Curratow, is twisted into thick rope; one of these is said to have been in use for many years at the city of Paraiba, for hoisting in merchandise. Large anchors are said to have been dragged up with this rope, when those of hemp parted. (*v.* Koster's 'Travels in Brazil,' ii, p. 341.)

The cultivated Ananas, or Pine-apple, like the other species of Bromelia, is a native of the warm parts of the continent, or of the islands of America. The Spaniards and Portuguese, when introducing the plants of the Old World into the countries they discovered, also transferred some of those of America into the parts of the Old World with which they were connected, such as the west coast of Africa, the south of India, and the Phillipine Islands. In all of which, the pine-apple has become so established and apparently wild, as to be by some considered even to be indigenous.

The Pine-apple (*Ananassa sativa*, formerly Bromelia Ananas), being a native of the moist forests of South America, from the level of the sea to elevations of about 1800 feet, requires, for its successful culture as a fruit, a warm and moist climate; but, like others of the family, the species are capable of existing in a warm, dry air.

The Pine-apple is said to have been introduced into India by the Portuguese, in the year 1594. It has, in some parts, become so naturalised, as to appear indigenous. Capt. Turner, in his journey to Teshooloomboo, mentions it as very abundant at the foot of the Himalayas. It flourishes in Assam, and forms thickets near Rangoon, producing, also, according to the accounts of different visitors, very juicy, well-flavoured fruit. Dr. Wallich, in the year 1836, presented to the Agricultural Society, a bag made on the Khasia Hills, of Pine-apple fibre, having purchased it for a trifle at Cherapoujee. He mentions the enormous quantity of Pines grown on that range, and that the plant appears as if it were quite a natural production. Dr. Helfer describes the Pine-apple as so abundant in the Tenasserim provinces, as to be sold in Amherst Town in the months of June and July at the rate of one rupee for a boat-load. It chiefly abounds in low grounds, though it is also to be found in the hills amongst the Kareans. The natives know it only by the American name, which they transform into *Nannah thi*—thi designating fruit. They do not seem to be acquainted with the beautiful fibre yielded by the leaves.

The Pine-apple is described as growing in great abundance in the Phillipine Islands, but as producing only a small, rather dry fruit. But we require some precise information to enable us to judge whether this is actually the plant escaped from cultivation. M. Perrotet considers it a distinct species, and has named it *Bromelia Pigna,* from the Spanish name *Pigna* or *Pina,* signifying a cone. There, this wild plant is valued on account of the fine hair-like fibres which are separated from out of the leaves. Of these fibres, the celebrated pine-apple cloth of the Phillipines, sometimes called "batiste d'ananas," and resembling the finest muslin-like fabric, is woven. This is embroidered by the nuns of the convents in Manilla, with great skill and taste. Some beautiful specimens of these, under the name of Pina muslin, were to be seen in the Exhibition of 1851. This is sometimes called grass-cloth, but erroneously. With a magnifier the fibres may be seen to be very numerous and fine, but not twisted at all, as in grass-cloth or the finest muslins and cambrics. Mr. Bennett, in his 'Wanderings,' observes that one of the coarser fibres may be subdivided into threads of such fineness as to be barely perceptible, and yet sufficiently strong for any purpose.

Mr. Bennett mentions visiting a plantation near Singapore, made by a Chinaman, for the preparation of the fibres of the ananas or wild pine-apple, which are exported to China, being used there "in the manufacture of linens." The Chinese said he got $1\frac{1}{2}$ rupees the catty, for the fibre. The leaves recently gathered—and the largest are preferred—are laid upon a board and the epidermis is removed with a broad knife. Upon its removal from the upper surface of the leaf, the long and beautiful fibres were seen lying upon the lower and denser epidermis, running in a longitudinal direction; the fasciculi of fibres were then readily detached by the hand on being raised with the broad knife.

The separation of the fibre of the ananas is practised in other places besides the Phillipine Islands. The Singapore Committee forwarded specimens (*Tali nanas*) from Malacca, as well as some of three different qualities prepared at Singapore, and a portion as ready for weaving, that is, with the ends gummed, or joined together by some adhesive substance; thus forming the "invisible knots" of an old author. Specimens were also sent from Java and the island of Celebes.

Dr. Roxburgh does not appear to have paid much attention to the separation of the ananas fibre; but in the year 1839, a lady (Miss Davy) sent specimens of a thread prepared from the wild pine-apple plant of Assam, of various degrees of fineness, observing that the thread must be prepared when the leaves are green, as nothing can be done with them in a dry state. Miss Davy subsequently sent specimens of cloth manufactured from this thread to the Agricultural Society of Calcutta, observing that she had had much difficulty in getting it woven, as the principal manufacturers in Dacca positively refused to undertake making it into cloth. A weaver in the jungles near Dacca, afterwards undertook to do so, and wove the cloth which was sent. Of this, Miss Davy had some embroidered in silver,—a style of work in which the natives of that part of the country excel. The specimens of the fibre were shown by Mr. E. Solly to spinners in this country, but who did not consider it could be substituted for flax in the manufacture of textile fabrics. A patent was, however, taken out by Mr. Zincke, for the manufacture of thread from this fibre, because, when bleached, it could be spun in the same way as flax. The process of bleaching, by destroying the adhesion between the bundles of fibres, renders it much finer; and hence enables it to be extended between the rolls in the process of spinning. He considers that, from its beautiful silky lustre, combined with considerable strength, it is well adapted to form a substitute for linen.

These pine-apple fibres (*anasa nara*), and the tow or oakum from them, were also sent from Madras and from Travancore, showing that the art of separating these fibres is extensively diffused. Dr. Hunter received some very fine, strong, and silky fibres from Porto Novo, prepared by Mr. Lima. But as the plants are not so abundant as in some other localities, we cannot therefore expect the fibres to be prepared so cheaply as elsewhere.

Besides the fibre, some twine and cord made with it was also sent from Madras and from the eastward.

Two skeins of the Pine-apple fibre were sent by the Court of Directors to the Society of Arts for a report on their properties, as long since as January, 1836, but the specimens were too small for a trial of their tenacity.

Mr. Bennett says, that at Singapore, from the expense attending labour, the pine-apple fibre could not be prepared under thirty-eight or forty dollars the pecul; but in Penang, or other places where labour is cheap, and women and children could be employed upon it, the expense would hardly exceed ten dollars per pecul.

In the experiments which I have had made with these various fibres, a certain quantity of those prepared at Madras bore 260 lb., while a similar quantity from Singapore bore 350 lb. before they broke; but New Zealand flax in the same proportions bore only 260 lb.

In a report from the Arsenal of Fort William, dated June 3d, 1853, the results are given of some experiments made by Conductor Wilkins on several kinds of rope manufactured by Messrs. W. H. Harton and Co., of Calcutta; and among these there is one of Pine-apple fibre, of three inches and a quarter in circumference. The Government proof is that a rope of this size should bear a weight of 42 cwt., but it bore no less than 15 cwt. more, that is, it broke with a weight of 57 cwt. ('Journ. of Agric. Soc. of India,' vol. viii, p. 182); proving incontestably that Pine-apple possesses strength for cordage, as well as fineness for textile fabrics.

PITA or AGAVE, commonly called ALOE (*Agaveæ*, a tribe of *Amaryllideæ*).

Hindee—Cantala and Bans-keora. *Tamul*—Petha-kalabuntha.

The species of Agave, commonly called aloe plants, are natives of America, which have become so naturalised in many parts as to appear to be indigenous in Africa, parts of India, and in the south of Spain. So much is the latter the case, that some authors take this American plant to be the aloe wood mentioned in Scripture. But there is not the slightest foundation for this opinion, nor indeed for the true aloe plants of which the agaves so frequently assume the name.[1] But, as they also yield some fibre, it is better to retain for them their appropriate name of Aloe.

The Agave plants, to which the name of American aloes is so frequently applied, resemble the true aloes in their sword-shaped leaves with parallel veins, which, however, grow to a gigantic size—that is, from eight to ten feet in length—in a cluster from the root, with their margins usually armed with short thorns, and their points with a hard and sharp thorn. This makes these plants so useful in the construction of hedges; a use to which they are applied in the south of Spain and of Italy, as also in Sicily. These plants come to perfection in about three years, though they do not flower for eight, and, in some situations, perhaps not for twenty years, when they throw up a tall candelabra-like flower stalk. This has, no doubt, given origin to the fable of their flowering only once in a hundred years. It is the leaves of these plants which abound in fibres of great length, and of considerable strength. Being also tough and durable, they are separated for the purpose of making string and rope, not only in their native countries, but also in those into which they have been introduced.

The author, in his 'Illustrations of Himalayan Botany' (p. 375), observed, respecting these plants: "The species of agave are not only ornamental as plants, and useful as hedges, but are important for their products. The roots, as well as leaves, contain ligneous fibre (*pita thread*), useful for various purposes: these are separated by bruising and steeping in water, and afterwards beating; practices which the natives of India have adopted, either from instruction or original observation. The Mexicans also made their paper of the fibres of agave leaves laid in layers. The expressed juice of the leaves evaporated, is stated by Long, in his 'History of Jamaica,' to be also useful as a substitute for soap. But the most important product of

[1] The Aloes wood of Scripture is the *Ahila* wood of the East, so famed for its fragrance, yielded by *Aquilaria Agallochum*, &c. (*v. Ahalim* by the author in Kitto's 'Cycl. of Biblical Literature,' i, p. 95.)

agave, and especially of *A. americana*, the species now most common in the South of Europe, is the sap, which exudes upon the cutting out of the inner leaves, just before the flower scape is ready to burst forth; of this a very full account is given by the illustrious Humboldt, in his 'Political History of New Spain' (book iv, c. 9).

The fibres of these Agave leaves are, in Mexico, converted into twine, cord, or rope; the last used in mines, and on the western coast, towards Guayaquill, for the rigging of ships. Humboldt describes a bridge over the River Chambo, in Quito, 131 feet in span, of which the main ropes, four inches in diameter, were made of the fibres of the agave; and upon these ropes the roadway was placed. In the West Indies, the negroes are described as making ropes, fishing-nets, and hammocks of agave fibres. The fibre is thus prepared: the longest and most perfect leaves being cut off, are laid upon a board and scraped with a square iron bar, which is held in both hands, until all the juice and pulp are pressed out, the fibres only remaining. Stedman says, the fibre is like white silk, and hence it obtains the name of silk-grass; though this name seems to be also applied to the fine fibres of *Agave vivipara*, and of *A. yuccæfolia*. But others of these white endogenous fibres are better entitled to the name, as they are softer and more flexible. Stedman says, ropes made of this material are stronger than any in use in England; but that they are liable to be sooner damaged by immersion in water. In Portugal the fibre is called *filo de pita*, and applied to various purposes. In Spain, also, the fibre is called Pita, and used for making string and rope, the plant being abundant in the southern provinces. In Sicily, the fibre is said, by Dr. Balfour, to be called Zambarone, where cordage and mats are made of it. Pita fibre is extensively used in South America for even considerably sized rope.

Pita fibre and rope have been stated to be prepared from the Agave so common in the south of Spain, though not to the extent at which the manufactory might easily be carried on. M. Ramon de la Sagra recommends the introduction of other kinds from Guatimala and Columbia, which are known there by the names of "Cabulla" and "Cocaiza." Species of Fourcroya also yield excellent fibre. *F. gigantea* is common at St. Helena, and has been introduced into Madras.

Pita fibre was sent to the Exhibition of 1851 from the island of Madeira, and also from Barbadoes and Demerara. Thread and paper made from *Agave americana* were also sent from Mexico, and fibre is also said to be obtained there from a species called "*Moogaï*"—*A. diacantha* by botanists.

The name Pita seems to be also applied to similar fibres obtained from species of Bromelia and of Yucca, as well as of Agave, according to Dr. Hamilton, of Plymouth; and it is probable that it is so, for these are all very similar to each other. Dr. Hamilton further states, that the weight of Pita fibre being one sixth less than that of hemp, the difference would be very considerable for the entire rigging of a ship and produce a sensible reduction in the top weight, and thus increase the stability of the hull. He considers it also more durable than hemp, and that it bears the alternate action of humidity and of dryness with little injury; hence it is preferred for cables, standing rigging of vessels, nets for fishing, &c. The difference in hygrometric action is also in favour of the pita. In a few months' trial in H.M.S. Portland, a log-line, 300 feet long, of Pita, contracted sixteen feet two tenths, whilst a similar one made of hemp contracted twenty-one feet six tenths; the contraction, moreover, of the Pita ceased on the third day, while that of the hempen cord continued the whole time. The two lines have been deposited in the stores of the dockyard at Plymouth.

At Amboyna, says Labillardiere, the natives produce threads from the bastard Aloe, called *Agave vivipara*: the master of the house went and cut a leaf off this plant, and, resting it on his thigh, in order to scrape it with his large knife, he took off its pulp, and obtained from it a fascicle of threads as long as the leaf, and as strong as those of our best hemp.

The Agave grows well on the north coast of Africa, and its fibre has been paid much attention to by the French since their occupation of Algeria. There, it is stated, when fodder is scarce, cattle will eat the younger leaves when cut into transverse slices. A cloak and paper made of this fibre were sent to the Exhibition of 1851; and ropes have been made of the fibres—of these the strength is very considerable.

The Agave or Pita fibre being so extensively employed in different parts of the world, there is no doubt that it would be a valuable culture for many parts of India. It was probably introduced into India by the Portuguese, and is now common in both the northern and southern parts of India. The species which I found most common in the north-west of India was *Agave vivipara*. This seems to be the same as the *Agave americana* of Roxburgh ('Herb. Amb.,' v, 94). I observed that on rich soils, the plant invariably produced bulbs, but no seeds; while on a poor stony soil and dry climate, like that of Delhi, seeds alone are produced. This species must be closely allied to the *A. Cantala* of Dr. Roxburgh, which is, no doubt, a naturalised plant. These species or varieties flourish in dry parts of the country, where few fibre-yielding plants succeed so well, such as in the Deccan and in Mysore. Far in the north-west, the outer hedge of the Saharunpore Botanic Garden was formed of the Agave, and the fibres were commonly used for all garden purposes. Dr. Buchanan, at the beginning of the century, found the villagers in Mysore employing it for making strong hedges, and separating the fibres for cordage; and Mr. Webb, who was employed with Dr. Anderson in cultivating the Nopal for the Cochineal insect, had a plantation of the Agave, near Madras. Of this the fibres were made into rope, and reported upon at the arsenal of Fort St. George, as long since as the year 1798.

Mr. William Webb having made a plantation of the Agave plant, in the year 1798 manufactured ropes from its fibres, which he considered superior in strength to that made in Europe. He also stated that he believed rope without tar is preferable for all military purposes. He submitted a coil of this rope to the Military Board of Fort St. George, with a suggestion that he should be allowed to supply it in lieu of rope made in Europe. Capt. P. Malcolm, of H.M.S. Suffolk, writing from Cochin, reported upon it, "as strong, if not more so, than Coir, and as having the advantage in pliability." A Committee of the Military Board were "of opinion, that its appearance promises well, and that from a trial that has been made of it, it is at least equal when new to the best Europe rope of the same size in point of strength. Sixteen of the battering guns having been mounted with it before it gave way, while Europe rope of a larger kind failed after it had been employed in mounting only four guns." But it was observed that the yarns were made too large, and that diminishing their size would augment their strength. With respect to its durability, the Committee had no experience, but reported, that part of a coil which Mr. Webb stated "had been fixed to the anchor of his boat at Ennore, and kept constantly under water for six months, appears to have undergone no other alteration than Europe rope would have done in the same situation."

In another report made by the Commissary of Stores, Fort St. George, dated 27th July, 1801, on a coil of Aloe rope manufactured at Seringapatam, it is stated that "the coil of Aloe rope was, on its being received at the Arsenal, the 10th of June, immersed in a tub of water for twenty-four hours, and then exposed to the open air in the yard; since which date, a few showers of rain have fallen, after each of which the coil was turned; and upon being examined and tried the 27th instant, it was found to be quite rotten." From this it was inferred that Aloe rope will not stand wet; and it was stated that this was also the result of similar rope supplied to H.M.'s squadron then in India. ('Madras Artillery Records' for 1839.)

Though nothing is so objectionable in a rope for naval purposes as inability to bear exposure to wet, the above experiments are inconclusive, because we are without any information respecting the species of Agave which was cultivated, and also respecting the soil and climate where it was grown, as well as the time which the fibre was macerated before it was separated. All which influence not only the strength of fibre, but its capability of bearing moisture. The result of the experience in India is, moreover, contrary to that of South America.

The employment of the fibres of this plant seems very general, as it has since become widely distributed through the Madras Presidency. Thus, it is so employed at Masulipatam and at Bellary. At Cuddapah, the natives make ropes of it thirty cubits in length. The plant is abundant about Madura, whence fibre and cordage were sent. The fibres are prepared by pressing the leaves between two horns and then washing the pulp away. The ropes are described as being manufactured in great abundance, and at a trifling expense; and that they are much used for lashing bales of calico. The fibres are also separated on the Malabar coast, and specimens were sent from the prisoners in the jail. But the most varied assortment of specimens was sent from Madras, prepared at the instigation of Dr. Hunter in his School of Arts, and by the prisoners in the jails at Madras. Of these, the Agave was in the state both of fibre and of oakum; also made into string, cord, and rope, and dyed orange, red, maroon, and green, showing how well this fibre takes these colours. Also, some good paper, made with this fibre, mixed with that of gunny bags. In Madras, this plant is called *petha kalabuntha*. The usual way of preparing these fibres is to steep them in water for three days, and then to clear away the herbaceous parts. But the best way of steeping is that practised by the natives in some places; that is, of sinking the leaves in wet sand. But the fibres may also be separated by first beating, and then scraping away the rest of the vegetable tissue. The beating is required on account of the hardness of these agave leaves. Pressing them through grooved cylinders, would, no doubt, be efficacious and also expeditious.

The Agave is also common in the Bengal Presidency, where it is called *cantala;* and also *bans keora*, or "Bamboo Pandanus." Though, probably most valuable in the upper provinces, yet, in December, 1839, Mr. Bond, master-attendant at Balasore, sent to the Agricultural Society of Calcutta, a piece of cloth manufactured by him from a species of the Aloe plant, of which he sent a leaf; and stated that the cloth had been woven without the thread having been spun. I have already mentioned that the fibre was constantly employed for garden purposes at Saharunpore.

Mr. Tonnochy, B.C.S., succeeded in spreading the culture in the Boolundshuhur district, by exposing, in his office, some of the dressed fibre, and also a couple of sattranjees or carpets made of them, together with heaps of seed. These all disappeared. Mr. Tonnochy encouraged the culture as a hedge-plant, because it was not only valuable on its own account, but also, because enclosing the fields so much enhances the value of land. The long, flowering stem was, moreover, found useful as a ridge-pole for cottages.

In the year 1852, Sir R. C. Hamilton, resident at Indore, forwarded some specimens of the fibre of the *Agave Cantala* which grows freely in Malwa, and to which attention had been directed during the temporary want of "Bakkul," the fibrous bark of the roots of certain trees, which is used in that part of India as a cheap substitute for string and cord. Dr. Tranter found he could pull out single fibres, measuring from twenty to thirty inches in length; but he separated a larger quantity by macerating the leaves in water for a week and then beating them with a stick. Capt. A. Thompson, of Messrs. T.'s rope-manufactory at Calcutta, having tested the fibres, found the strength quite equal to the best Russian hemp. He also states, in June, 1852, that a considerable quantity of fibre, exactly similar, had lately been imported from the Malabar coast, and that he had some made into rope, which very much resembled Manilla rope: but time was required to test its durability. It was then worth about four rupees per bazar maund in the Calcutta market.

Though this Pita or Agave fibre is so much employed in different parts of the world, its great merits seem to be, generally, but little known. We have seen that in South America, ropes made with it are considered both strong and durable. The ropes made at Algiers have been found to possess great strength; and the log-lines in H.M. ship Portland to be both durable and not shrinking after the third day. In lightness and colour they resemble ropes of Manilla hemp, though they are not usually so strong. But in a "comparative trial made at Paris, between ropes made of hemp and of the aloe from Algiers, the latter was found to bear 2000 kilogrames, while the former, of equal size, bore only 400." So, in some comparative trials made at the French dock yard at Toulon, on ropes made from these fibres and from hemp, the following results were obtained, both being immersed in the sea for six months, and exposed to the atmosphere for the same time.

PITA.	Weight supported.	HEMP.	Weight supported.	Difference in favour of Pita.
	Pounds.		Pounds.	Pounds.
Plunged in sea . .	3810	Plunged in sea . .	2538	1272
Exposed to air . .	3724	Exposed to air . .	3022	702

In the year 1841 some rope was made under the direction of Mr. Hornby at the Allipore Jail rope-walk, of Aloe, or rather Agave fibre, obtained from plants which had been grown by the convalescent insane, near Calcutta. Mr. Hornby tested this rope against others made of Country Hemp (that is *Sunn*), Jute, and Coir, and he found the Agave rope exceed the others in strength, as appears from the following statement sent by him to the Agricultural Society of India:

CALCULATION OF THE POWERS OF ALOE FIBRE ROPE, COUNTRY HEMP, JUTE, AND COIR ROPE, TRIED AT THE ALLIPORE JAIL ROPE-WALK.

				lb. Troy.
Aloe Fibre Rope, 1 fathom long, and 3 inches in circumference, broke in a weight of				$2519\frac{1}{2}$
Coir	do.	do.	do.	2175
Country Hemp	do.	do.	do.	$2269\frac{1}{2}$
Jute	do.	do.	do.	$2456\frac{1}{2}$

In some experiments which I had made, I found a bundle of the fibres bore 270 lb., when a similar bundle of Russian hemp bore only 160 lb. Dr. Wight had some cord prepared with the Agave fibre in Coimbatore, and found it bore 362 lb.; when similar rope, made from Crotolaria juncea broke with 407 lb. The following are the results of—

EXPERIMENTS MADE IN ARSENAL AT FORT ST. GEORGE, JULY 30TH, 1850, ON ROPES MADE IN JAIL AT MADRAS, IN 1850.[1]

	Circumference.	Length.	Weight required to break.	After 24 hours in water, and used 7 days aft.	Immersed in water 10 days, and dried.	Manilla Rope.	English Hempen Rope.	Weight of one fathom of each.		
								Pita.	Manilla.	Europe.
	In.	Fms.	lb.	lb.	lb.	lb.	lb.	oz.	oz.	oz
Rope .	$1\frac{7}{8}$	2	2218	1994	2016	—	—	$19\frac{11}{16}$	—	—
Ditto .	$1\frac{3}{4}$	2	1154	—	—	1490	1184	$8\frac{14}{16}$	$9\frac{1}{2}$	13
Line .	$0\frac{3}{8}$	1	$86\frac{1}{4}$	—	—	—	—	$0\frac{7}{16}$	—	—
Cord .	$0\frac{3}{16}$	1	$39\frac{1}{2}$	$34\frac{1}{2}$	$37\frac{14}{16}$	—	—	$0\frac{2}{16}$	—	—

These experiments prove incontestibly, that the Pita fibre is possessed of very useful properties; and we have seen that the Agave plant has become naturalised in many widely separated parts of the Indian territories. Its characteristics have been dwelt upon in detail, because it seems calculated to prove extremely useful in India. First, because it grows in dry climates and poor soils, such as may be met with both in the Deccan and in Mysore. It will, in such situations, form a very effective hedge—useful, not only in keeping off from the crops the innumerable

[1] For similar experiments on rope, &c., made from Plantain fibres, v. p. 78, &c.

herds of deer, &c., but also in assisting in saving the soil, a road or a railway, from being covered with the sand blown from the desert. The leaves would form a continual source of employment for the people, in separating an abundant supply of material for cordage. This will, at all events, be sufficiently good for all agricultural purposes, for the harnessing of cattle, the baling of produce, and for the rigging of vessels employed in river navigation. The fibre is also sufficiently good to form an exportable article of considerable value, especially as the prejudice against white cordage will by degrees be removed, and the tow will be invaluable for the manufacture of paper. It is desirable that some comparative experiments should be made on the age at which the leaves should be collected, and on how long they should be steeped. Also, whether this process is necessary at all; that is, whether the fibre may not be separated by mechanical means. The climate best suited to the growth of the strongest fibre should be ascertained, as well as what are the differences of quality between the fibre of different species of Agave. Also, the susceptibility of different kinds to the effects of moisture, either with or without superficial tarring. In the preparation of the cordage submitted to trial, care should be taken that the fibres are so prepared as to cut each other as little as possible when twisted; and also that the cordage is made by a regular rope-maker. Under the head of Plantain and of Moorva (v. p. 53) fibre, we shall consider the quantity of fibre producible from a certain number of such plants, and also the price at which it may probably be produced.

Liliaceous Plants.

Liliaceous plants, from their generally ornamental nature, have attracted attention from the earliest ages to the present time, and Our Saviour selected the flower of one of these (*Lilium chalcedonicum*) as a type of the beautiful productions of nature. The plants are usually herbaceous, though some few are shrubby, and even arboreous; most are distinguished by their narrow parallel-veined leaves: of these, some are soft, herbaceous, and succulent; others hard and perennial. Of the latter many abound in fibre, which may be, and is, extracted for useful purposes; as Aloe, Sanseviera, Phormium, &c.

True Aloes (*Aloe vulgaris, Barbadensis,* &c.)

The true genus *Aloe,* or the plants which yield the medicinal drug of that name, abound at the Cape of Good Hope, on the west coast of Africa, and on that of Arabia, with one or two species in India. They might be supposed to yield much fibre from the frequency with which we find the name applied to some of those met with in commerce; but these we have seen are the produce of a species of Agave, commonly called American Aloe (*v.* p. 41, &c). The leaves of the true Aloes are, in all the countries where the species are indigenous, as well as in the West Indies, where one or two of them have been long introduced, cut up and boiled down to yield the *extract* called *Aloes.* In some cases the yellow juice is allowed to exude from the cut leaf to form what is called Socotrine Aloes; but nowhere is the fibre which these leaves undoubtedly contain turned to useful account. It is probable, however, that it might, even when the leaves are cut into small pieces, be separated at little expense, for the use of the paper-maker.

That the fibre, as well as the tow, of the true Aloes is of a good and useful quality, is satisfactorily proved by the specimens of both sent from Madras by Dr. Hunter, as those of the *kala-buntha,* or of the species which is there called *Aloe perfoliata,* and which is, probably, the same plant with red flowers which I named *Aloe indica,* and found in dry situations in North-West India. The fibre is white in colour, fine in quality, with sufficient tenacity for textile fabrics, and readily takes colours, as shown by the orange, red, and crimson-coloured specimens sent by Dr. Hunter. The fibres are about two feet in length, and have considerable strength. A bundle of the fibres bore 160 lb., when a similar one of Petersburgh hemp broke with the same weight.

Moorva Fibre, Marool of Madras (*Sanseviera zeylanica*).

Bowstring Hemp. *Sans.*—Mūrva. *Beng.*—Moorga and Moorgavee. *Tamool*—Marūl.

Sanseviera is a genus of Liliaceous plants, of which individuals are very abundant on the coast of Guinea and of other parts of

Africa; also around Ceylon, and all along the Bay of Bengal, extending thence to Java and to the coasts of China.

The leaves are succulent, and abound in fibre remarkable for fineness and tenacity. Dr. Roxburgh proposed that the fibres might be called *Bowstring hemp* in England, because the natives of the Circars make their best bowstrings of them.

Sanseviera zeylanica is the best-known species, and has been so called as being common on the Ceylon coast. From it has been distinguished *S. Roxburghiana*, common on the coasts of the Bay of Bengal, apparently on insufficient grounds. It is figured by Dr. Roxburgh himself under its former name in his 'Coromandel Plants,' ii, tab. 184. *S. lanuginosa* is probably a distinct species, the *katu-kapel* of Rheede ('Hort. Mal.,' vol. xi, tab. 42), which grows on the sands of the Malabar coast. All are closely allied to each other, and to the African *S. guineensis*. Of this the fibres have been occasionally introduced into the markets of Europe, and by some thought superior to New Zealand Flax. They have been called African Bowstring Hemp. (The author's 'Himal. Bot.,' p. 391.)

The Indian species of Sanseviera was first described by Sir William Jones, in the 'Asiatic Researches,' vol. iv, p. 271, under its ancient Sanscrit name of *Moorva*, and he says, that— "From the leaves of this plant the ancient Hindoos extracted a very tough elastic thread called Maurvi, of which they made bowstrings; and which, for that reason, was ordained by Menu to form the sacrificial zone of the military class." Dr. Roxburgh describes the plant as common on the jungly salt soils along the coasts, growing under the bushes, and easily propagated on almost every soil, from the slips which issue in great abundance from the roots, requiring little or no care, and not requiring to be renewed often, if at all, as the plant is perennial. The leaves, when thus cultivated, are from three to four feet long. The fibre, which extends their whole length, is separated from the pulpy part of the leaves. The natives place them on a smooth board; then press one end of the leaf down with one of their great toes, and with a thin bit of hard stick held between the two hands, they scrape the leaf from them, and very quickly remove every part of the pulp. This can also be removed by steeping the leaves in water till the pulpy parts rot, &c.

Dr. Buchanan found apparently the same plant, but which he calls *Aletris nervosa,* employed for making cordage near Bangalore. Before the leaves are beaten to separate the fibres, they are steeped in water fifteen (others say five) days, in order to rot the useless parts; but with Dr. Roxburgh the fibres became discoloured by this process.

Dr. Roxburgh sent drawings of the plant and specimens of the fibre (*v.* 'Obs.,' p. 18) as early as the year 1790 to the Court of Directors, and again in 1800 by Mr. Bebb; after he had cultivated a begah (*i. e.,* third of an acre of ground) with this plant. As full-grown leaves of three to three and a half feet long yielded about one pound of the clean fibre for every forty pounds of the fresh leaves, Dr. Roxburgh concluded that this plant might be cultivated with advantage. By another calculation he found that one acre would yield 1613 pounds of clean fibre at a gathering, two of which may be reckoned on yearly, in a good soil and a favorable season, after the plants are of a proper age. He also ascertained that a line four feet long, made of *moorva* fibre, bore a weight of 120 lb., when a cord of the same size, made of Russian hemp, bore only 105. The former, moreover, after 116 days' maceration, bore a weight of 30 lb., when the latter was completely rotten.

Dr. Roxburgh further observes: "Should it ever become an object of culture, a less expensive and more expeditious method of clearing the fibres from the pulpy parts of the leaves, than that of the natives above mentioned, must be contrived." This seems to have been since done. For the Rev. J. Garrow, as quoted by Mr. Murray, states that, in the year 1831, during his residence in Cuttack, in the province of Orissa, he first by mere accident discovered that the leaf of the *Aloe angustifolia*[1] of Linnæus, contained a quantity of long white fibres. Perceiving that this material possessed great strength, clearness, and tenacity, he caused some quantities of the leaf to be beaten out with mallets, and the fibres to be withdrawn, and in this way collected about three hundredweight of fine grass, the fibres severally running about three feet long. On taking this to Calcutta, Mr. Tapley, chief officer of the Thalia East Indiaman, then lying off that

[1] It is not easy to ascertain what plant is meant, but it is probably only a variety of Agave, as no species of Aloe is known to be indigenous on that coast.

port, had some of it manufactured into ropes. On a fair trial of a three-stranded rope of this material with a similar one of Russian hemp, in raising two and a half hundredweight of spelter from the hold, the grass faithfully brought it up on three successive occasions; whereas, in applying the hempen rope, twice out of three times it gave way, and in the third trial lost one strand. Both Mr. Tapley and Capt. Biden, the commander, highly approved of the article, as did many commanders of ships of other nations then frequenting the port of Calcutta.

"On the writer's return to Cuttack he laid waste the whole of the aloe plant he could discover, without respect to species; and to save time and labour, passed the leaves through a *pressing mill* similar to that used for expressing the juice from the sugar-cane. He then caused them to be laid in heaps under water for some days, till the fleshy portion of the leaf was decomposed, by which means the fibres were more easily collected; they were then hackled and baled. In the course of a short time afterwards he discovered a short species of aloe, growing wildly and profusely in all the moist woods of the neighbourhood, which the natives called *Moorgubbee.* On experiment, this plant produced a most beautiful fibre, as soft and as fine as human hair, but possessing, notwithstanding, extraordinary strength and tenacity. He derived a great quantity of flax from this plant, which, when portioned off in hanks, bore a strict resemblance to raw silk; indeed, side by side, the difference could not be distinguished. It was this article that first induced the writer to turn his attention to the manufacture of cloth. He engaged two native 'Tantees,' or weavers, to construct a narrow loom for this purpose. They at first found some difficulty in the undertaking, but in the course of four or five days they produced as fine a piece of cloth as was ever beheld: one portion of it the writer presented to Sir Charles (afterwards Lord) Metcalf."

The fibres of the Sanseviera may, from their fineness, combined with tenacity, be applied to a variety of purposes. Dr. Roxburgh at one time supposed, though erroneously, that they were identical with China grass. They are usually about two feet in length, but may easily be obtained longer, if plants are cultivated. The fibres are firm, hair-like, and silky, and resemble those of the pine-apple most closely. The tow is excellent for paper-making. The natives of Bengal twist the fibres into a fine thread, upon which they string ornaments to be hung round the neck; those of the coast employ them for making bowstrings; and the Rajpoot thread is sometimes made of its fibres. They readily take dyes, as was some years ago shown by Miss Davy, and specimens dyed red, orange, maroon, and green, were sent to the Exhibition by Dr. Hunter. Miss Davy, moreover, had some cloth woven with the fibres, after some difficulty, but the fibre was still too wiry, from imperfect preparation. The weaver, moreover, having neglected to separate the coarse from the fine fibres, gave the cloth an uneven and irregular appearance. But if the necessary care was taken with this, as with all other fibres, there seems no reason to doubt that it might be applied to the fabrication of fine cloths, in the same way as pine-apple fibre. The fibre has been proposed for the packing of steam-engines, and its tow used to be, and perhaps still is, converted into very good paper at Trichinopoly.

As the Moorva fibre is employed by the natives for their bowstrings, there can be no doubt of its possessing sufficient strength for rope-making. In some recent experiments, this fibre, in its untwisted state, bore 280 lb., when Agave fibre broke with 270 lb. Dr. Wight found some string made of the latter, broke with 362 lb., while the Sanseviera broke with 316 lb., so that these two may be considered as nearly equal to each other in strength.

Attention was called to the fibre of Moorgavie by Mr. A. Bond, Master-Attendant at Balasore, who sent to the Marine Board of Calcutta some of the fibres prepared from the leaves of plants growing in the jungly salt soils along the coast from Kedgeree southward, informing the Board that he had found the fibre useful on board the Hon. Company's schooner Orissa, as it answered excellently for running gear.

On the receipt of the samples, the Board having desired the Master-Attendant at Calcutta to submit them to trial, the latter reported that it was "not equal in strength to the Europe or Manilla hemp, but that it seemed to take hot tar as well as the latter, and would answer generally for the same purposes as those to which the Europe and Manilla cordage is applied." The following were the results obtained:

Europe hemp, made of sewing twine (untarred) . .	broke at	212 lb.
Harris's patent colonial bolt rope (tarred)[1]	„	204 „
Manilla hemp (untarred)	„	188 „
Europe bolt rope (tarred)	„	168 „
Balasore fibre (untarred), at Calcutta	„	137 „
Ditto, spun by Capt. Bond (thumb line) . . .	„	135½ „
Europe rope (tarred)	„	88 „

In a further report, Capt. Bond stated, that forty maunds of the fresh plant produced one maund of fibre. The expenses of the experiment were high, as the plant had to be brought to him from some distance (four miles) to the place where it was dressed, and the best methods of separating the fibre had not been followed. The natives being averse to a work which their forefathers had never taken in hand. The plants having been steeped for eight days, were beaten out on a stone or plank, and then taken to another tank of water to be washed, and then dried and combed. All these processes necessarily increased the expenses. Mr. Bond further ascertained that the steeping spoiled the colour of the fibre, at the same time that it diminished its strength. With some fresh specimens of the fibre he also sent two pieces of cloth, which had been woven from threads spun by fishermen, which were irregular in thickness, and so, consequently, was also the cloth.

From the abundance of this plant in many situations, from the ease with which it may be cultivated, and the facility with which the fibre may be separated and cleaned, there is no doubt that it could be produced as cheaply as any of the other fibres; and it has been shown that it is capable of being used for a variety of purposes, as for textile fabrics, and for string and cordage, as well as for paper-making. It is abundantly diffused, especially along the coasts, and its fibre was sent to the Exhibition from Assam and Cuttack, as well as from Madras, Coimbatore, and the Malabar coast.

Besides the foregoing, many other Liliaceous plants might be adduced, as yielding useful kinds of fibre, and in quantities sufficient to repay the trouble of their extraction. But they

[1] Probably made of New Zealand Flax, *v.* p. 58.

are not indigenous or sufficiently abundant in India, though the fibres of some have been separated, and sent as specimens. As, for instance, of—

Yucca, or Adam's Needle Fibre.

Adam's Needle, or *Yucca gloriosa, &c.*, like others, seems sometimes to be called an Aloe. The species of *Yucca* are natives of the southern provinces of the United States, and being there exposed to extremes, are capable of living in the open air, both in Europe and India. They are conspicuous for their noble show of lily-like white flowers, as well as for their long sword-shaped leaves, terminated by a thorny point. They, no doubt, all abound in fibre, as some of a fine quality and strong in nature, has been sent from Madras, separated from the leaves of the *Yucca angustifolia*. Other species flourish as far north as in the Botanic Garden at Saharunpore. The fibres also take colour, as in the specimens sent from Madras, dyed red, orange, purple, and green. Fibre has also been separated from other species of Yucca, as *Y. aloifolia* and *Y. filamentosa*, These are amongst those which have received the name of silk-grass. Those sent from India are from two to four feet in length, and are rather wiry, or resemble those of the Agave more than they do the fibres of Bromelias.

New Zealand Flax (*Phormium tenax*).

New Zealand Flax, or *Phormium tenax*, belonging to this family of plants, may here be noticed, though it is not so well suited as many others, to the general nature of Indian climates, but it will enable us to make some useful comparisons. It was discovered by the celebrated Cook in New Zealand—as he says "the country produced a grass plant, like flags, of the nature of hemp or flax, but superior in quality to either; of this the natives make clothing, lines, nets, &c." It grows both on the north and the south coast. It was introduced in the year 1798 into the south of Ireland, and has been found to flourish on the west coast of Scotland, though European winters are occasionally too severe for it. The native name of the plant is *koradi* or *korere*, while the fibre is called *muka.* The leaves of the plant are perennial, hard, sword-shaped, from five to seven feet in length, with a flower-stalk rising four or five feet above them, and bearing a profusion of yellow flowers, followed by triangular seed-vessels, filled with flat and thin black shining seeds. According to Salisbury, three-year old plants yield on an average, thirty-six leaves, beside offsets from the roots. Six leaves produced one ounce weight of dry fibres, after being scutched and cleaned; and he calculated that an acre cropped with these plants, three feet apart (but they could not be placed so near without interfering with each other), will yield more than sixteen cwt. " The leaves are cut when full-grown, macerated in water for a few days, and then passed under a weighted roller." The natives of New Zealand cut the leaves when full-grown, and separate the fibres while yet green. Mr. G. Bennett states that a lateral incision is made with a large shell on each side of the leaf, merely to cut through the epidermis, which is first removed, and then, what he calls the internal epidermis, probably a part of the cellular tissue, " which agglutinates the fibres, and, if not removed, deteriorates the flax." The principal operation is scraping with the shell, and then separating the fibres with the thumb-nails, and then employing combs for a more minute separation. The fibres are subsequently dried in the sun, and are perfectly white; some stout and strong, others fine and silky. It is said that " the plant may be shorn of its leaves in the morning, and before the sun has set be ready for weaving into cloth." The same thing may, no doubt, be done with others of these naturally white endogenous fibres. Considerable quantities were at one time imported, and a factory was established by Capt. Harris for their manufacture, but the supply seems to have been irregular, and now to have fallen off rather than increased.

Mr. J. Wood, in the year 1844, in a communication to the Agricultural Society of India, called attention to the New Zealand Hemp, as a plant which was very hardy and would thrive in any soil or climate, but that it preferred swampy lands. He stated that it was often met with in New Zealand, thriving three or four feet under sea-water, (but it is also found at some distance from the sea-shore). He therefore thought the locality of the Soonderbunds, extending from near Calcutta to the sea, to be well adapted for this plant; and which would be profitable in a country where labour was so cheap. But it seems to have been forgotten, in this, as well as in a paper in the first volume of the 'Transactions of the Society,' that a plant which flourishes so far south as New Zealand, and succeeds well both in Scotland and in Ireland, is not likely to do well in so tropical a situation as that of the Soonderbunds.

An interesting set of specimens of New Zealand Flax, showing the native method of preparing the fibre and of dyeing it black, were sent to the Exhibition of 1851, by Taohui, a New Zealand chief; and another, a very valuable and suggestive set of specimens of the fibre and its tow, by Mr. E. W. Trent (*v.* 'Illust. Col.,' xli, p. 197), which he described as having been separated entirely by machinery invented by himself. If this fibre can be so prepared, then it is evident that others of the same nature may be successfully treated in a similar manner.

These fibres are applicable to a variety of purposes, either of a textile nature or for cordage, and will, like the other white fibres we have mentioned, take colour. The strength of the fibres is considerable, for in some experiments by De Candolle, in which, however, that of Agave is understated, there is no doubt that the New Zealand Flax, which bore 23·7, was stronger than either Flax or Hemp, which bore respectively 11¾ and 16¾. It has also the advantage of being lighter, but has the disadvantage of many of the white fibres of breaking at a knot. Mr. J. Murray, in his pamphlet on this plant, printed on paper made from its leaves, states that the ship Atalanta, which plied between Southampton and the Channel Islands, was completely equipped with cordage and rigging made of *Phormium tenax.* He further continues—

"I have seen specimens of ropes, twine, yarn, lines, sailcloth, sacking, bedtick, &c., made of *Phormium tenax;* also fine fabrics of various kinds, affording demonstrable evidence that its fibre is susceptible of being woven into tissues of the most delicate description, or manufactured into materials of the strongest and coarsest kind. The sails, cables, and running rigging of the beautiful model of the frigate presented by his late Majesty William the Fourth to the King of Prussia, were entirely formed of *Phormium tenax.* Capt. Harris's yacht, a perfect gem in naval architecture, was supplied with a mainsail composed of three different varieties of New Zealand flax, and the cordage made of *Musa textilis*," that is, of Manilla hemp, of which we have immediately to treat.

Rushes (*Juncaceæ*).

Rushes have so long been employed for some of the same purposes as other fibres that we can hardly omit noticing them, as they are found in moist places on the mountains of India. But the author may quote what he has formerly said:

"The *Juncaceæ*, or true rushes, are insipid and inodorous; several are employed for mechanical purposes only, as the common rush, for making mats, baskets, and the bottoms of chairs, while the pith is employed for the wicks of rushlights. *Juncus effusus*, which is the common European species, is, according to Thunberg, cultivated in Japan for making floor-mats. *J. glaucus* a European species found in the Himalayas, and closely allied to *J. effusus*, might be employed for all the purposes of the common rush." ('Illust. Himal. Bot.,' p. 401.)

Arrow-root Tribe (*Marantaceæ*).

These plants are celebrated for several of the species storing up large quantities of fecula in their tubers or root-stocks, and which is separated and known by the name of Arrow-root powder. They are little known for their herbaceous parts containing any useful quantity of fibre. But one of the South American genera has been named Calathea, in consequence of its leaves being employed in basket-making. So in India, the stems of *Moocta patee* of the Bengalees, *Maranta* (*Phrynium*, Roxb.) *dichotoma* of botanists, which are straight and tapering, about as thick as a man's thumb, and from three to five or six feet high, of a beautiful highly polished green colour, are said to be employed in making some of the mats for which Calcutta is famous. Mr. Colebrooke says: "Mats made of the split stems of this plant being smooth and particularly cool and refreshing, are termed in Hindoo *sital-pati*, which signifies a cool mat, whence the plant itself is said to bear the name. Suspecting, however, this to be a misappropriation of the term, I have inquired of natives of the eastern parts of Bengal, who assure me that the plant is named *mucta-pata* or *patti-pata*, and the mat only is called 'sital-pati.'" The split stems, as prepared for making mats, are about four feet in length, one twentieth of an inch in breadth, thin as paper, greyish coloured, compact and shining almost like cane on the outside; finely striated on the inside, and apparently made up by the agglutination of very fine fibres. They seem admirably adapted for platting of all kinds.

The plants of this family, however, deserve attention, rather on account of what may be, than for anything that has yet been done with them; for the Marantas yielding arrow-root, and the Cannas which yield "Tous les mois," have, with perennial root-stocks, only annual stems and leaves. Many of these, no doubt, contain a sufficient quantity of fibre to be usefully extracted for the paper-maker.

The same may be said of the innumerable plants of Ginger, Turmeric, Cardamom, and others of the nearly allied family of Zingiberaceæ, which are similarly cultivated entirely for their roots and seeds, and the herbaceous plants thrown away. These from their nature cannot but abound in useful fibre, applicable to the same purpose—that is, of the paper-maker.

The Plantain and Banana Tribe (*Musaceæ*).

The name of this family of plants, derived from *Musa*, is, as the author has already observed,[1] so classically sounding, that we are apt to forget its probably oriental origin. For being natives of tropical countries, though often extending beyond such limits, and having the name of *mauz* or *moz* applied to one of the species by old Arabic writers, there is very little doubt of this being the source of the name *Musa*. This is now applied to the genus which produces the fruits commonly known as Plantains and Bananas; as also the fibre so well known under the name of Manilla Hemp. The Plantain was undoubtedly known by description both to the Greeks and Romans, for Theophrastus, among the plants of India, describes one as having fruit which serves as food for the wise men of

[1] 'Illustrations of Himalayan Botany,' p. 354.

India; and which was remarkable both for its sweetness and for its size, as one would suffice for four men—referring most probably to a bunch of plantains. Pliny, evidently describing the same plant, informs us that its name was *Pala*. Garcias, in comparatively modern times, describing the plantain, states that its name on the Malabar coast was *Palan*.

The plants of Musa are conspicuous for their size among herbaceous plants. They are devoid of true stems, but form a spurious stem, often of considerable thickness, from the leaves, as they rise from the root-stock, being sheathing at their base, encircling each other, and enveloping, layer within layer, the slender flower and fruit-stalk. This, rising through the centre, projects and hangs down from the top of the sheathing part of the leaves. These, at this point, expand into broad, and at the same time long laminæ or blades, in which numerous parallel veins proceed at right angles from the thick midrib to the margin of each leaf. As these veins do not anastomose and form a network as in ordinary leaves, the leaves are apt, when blown about by the wind, to be divided into innumerable narrow shreds, which are still attached to the midrib. This appearance, no doubt, suggested and justifies the leaves being said to be like ostrich feathers. Every part, both of the sheathing and the exposed parts of these leaves, abounds in fibre.

The species of Musa are found in hot and tropical parts of the world, as in the Phillipine Isles, where *Musa textilis* is indigenous, as well as in those of the Indian Archipelago, where the edible species are common. From thence they extend northwards as far as Japan; while in China are found *Musa coccinea* and *Cavendishii;* also along the Malayan Peninsula to Chittagong—*M. glauca* being indigenous in the former, and *M. ornata* in the latter locality. In the valleys of the south of the Peninsula of India and of the Dindygul Mountains, *M. superba* is found. The common edible varieties of *M. paradisiaca* flourish even in the poorest soils, and also near brackish water. They are extensively cultivated at stations in the interior. On the Malabar coast, the Plantain is everywhere at home. The fruit of those at Bassein is especially well-flavoured, and the plant is particularly abundant in the district of Broach.

If from the west we return to the east of India, we find the

Plantain and Banana most extensively cultivated. The Plantain, according to Dr. Helfer, is to be found in the highest perfection in Tenasserim, especially in province Amherst. More than twenty varieties are known, of which several are peculiar to the country, and the greatest part of them are superior to any to be got in Bengal. They thrive well everywhere without the slightest care. No Burmah or Karean house is to be found without a plantation of Plantains. As the latter leave their abodes, at least every three years, in order to migrate to fresh localities, they are, of course, obliged to leave their Plantain gardens behind them, and therefore these may be found growing luxuriantly in many uninhabited places, until they become choked up by the growth of the more vigorous jungle trees.

With the Plantain, as with other long-cultivated plants, many distinct varieties are recognised and named; but which it is extremely difficult to arrange in suitable order. But the natives of Bengal generally prefer the large and coarse-fruited kinds, called Plantain; while the smaller and more delicately tasted fruit, known as the Banana, is alone esteemed by Europeans. These are cultivated in the most northern, as well as in the southern parts of India; while along the jungly base of the Himalayas there is a suitable climate as far as 30° of north latitude, for plants of this genus growing in a wild state. That growing in Nepal has been called *M. nepalensis.* A similiar species may be seen growing below the Mussoore range, as well as near Nahn. The fruit, however, in all these situations, consists of little else than the hard dry seeds.[1] In Kemaon and Gurhwal it is cultivated at as great an elevation as 4000 and 5000 feet above the sea, and has been seen as far north as the Chumba range at an equal elevation. Major Munro has seen the wild Plantain at 7000 feet above the sea, in the Khondah slopes of the Neilgherries. Though many of the above have been mentioned as distinct species, it is probable that some, at least, are only varieties.

"Baron Humboldt has suggested, that several species of Musa may possibly be confounded under the names of Plantain

[1] A similar variety of *Musa sapientum*, having seeds surrounded with a gummy substance, instead of fruit-like pulp, was found by Dr. Finlayson, on Pulo Ubi, near the southern extremity of Cambodia. In Batavia also, there is stated to be a variety full of seeds, which is called *Pisang batu*, or *Pisang bidju*—that is, Seed Plantain.

and Banana, and that some of these may be indigenous to America; but as stated by Mr. Brown, nothing has been advanced to prevent all the cultivated varieties being derived from one species, *Musa sapientum* (also called *M. paradisiaca*), of which the original is the wild Musa, described by Dr. Roxburgh as grown from seed received from Chittagong. Mr. Brown further adds, that it is not even asserted that the types of any of those supposed species of American Banana, growing without cultivation and producing perfect seed, have anywhere been found." ('Illust. of Himal. Bot.,' p. 355.)

If the Plantain and Banana are therefore natives of Asia, which have been introduced, probably, by the Spaniards into America, no plants can more strikingly display the benefits derivable to one country from introducing the useful plants of another which is similar in climate. For Plantains and Bananas are now extensively cultivated in various parts of South America, and at an elevation of 3000 feet in the Caraccas. They are abundant in the West India Islands, as well as at considerable elevations in Mexico. To the negroes in the West Indies, the Plantain is invaluable, and like bread to the European, is with them denominated the staff of life. In Guiana, Demerara, Jamaica, Trinidad, and other principal colonies, many thousand acres are planted with the Plantain.

But, before proceeding to treat of the Plantain and Banana, it is desirable to notice the species which yields Manilla Hemp, showing how valuable some of these plants are, on account of their fibres.

Manilla Hemp (*Musa textilis*).

Among the various substitutes for hemp, few have hitherto attracted more attention than Manilla Hemp, and this from the elegance of its appearance, combined with the power of bearing great strains, as well as from being very durable, lighter, and also cheaper than Russian hemp. It has of late years been much employed for cordage of various kinds, especially where considerable strain is required, as in ropes for raising goods into warehouses or out of mines. Some yachts, as well as many American vessels, have the whole of their rigging composed of Manilla Hemp, and this cordage, when worn out, can be converted into an excellent quality of paper. Though the plant yielding this fibre is not indigenous in India, nor extensively cultivated, it is yet extremely interesting, not only because it may easily be cultivated there, but because there are other species of the same genus which may be turned to the same useful account.

The plant which yields Manilla Hemp is called *Abaca*[1] by the natives of the Philippine Islands, who are said to apply the same name to its fibre. The plant is sometimes called a tree, but it is, in fact, only a large herbaceous plant, which belongs to the same genus, and is, in fact, a kind of plantain or banana, which is named *Musa textilis* by botanists. It was first called *Musa sylvestris* by Rumphius in his 'Herbarium Amboinense.' It was thought to be a variety of *M. troglo-ditarum* by Blanco, but called *Musa textilis* by Don Luis Nee, in a memoir which has been translated into English, and published in the 'Annals of Botany,' vol. i; where there may also be seen another memoir, which was sent in French to Sir Joseph Banks. These have been republished in the 'Trans. of the Agric. Soc. of India,' vol. viii, p. 87, together with a translation by Mr. Piddington, of Calcutta, of a notice by Father Blanco, in his 'Flora de las Filipinas.' In addition to these we have a notice in the first volume of the Trans. of the above Society, 1828, by Mr. Piddington himself, one of the gentlemen who escaped the massacre of the English at Amboyna.

From these authors we learn that the Abaca is abundant in the volcanic region of the Philippine Islands, from Luzon, in the northern province of Camarines especially, to Mindanao; also in the neighbouring islands, even as far south as the Molucca Islands, that is, in Gilolo. Hence this species may be stated to extend from the Equator to nearly 20° of north latitude. It may, therefore, very probably be easily cultivated in other coun-

[1] The natives distinguish several varieties of the Abacà:

1. *Abacà brava* (the wild Abaca), called *Agotaï* by the Bicoles.

2. Mountain Abacà, the fibres of which only serve for making ropes, that are called *Agotàg* and *Amoquid* in the Bicol language.

3. The *Sagig* of the Bisayas.

4. The *Laquis* of the Bisayas, by whom the fibres of the original Abacà are called Lamót. Rumphius states that the Malay name is *Pissang utan;* that it is called in Amboyna, *Kula abbal;* in Ternate, *Fana;* and in Mindanao, *Coffo,* as also the cloth made from it. He distinguishes the Mindanao kind from that of Amboyna.

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tries, where there is some similarity of soil, and warmth with moisture of climate; as in India in the province of Travancore, and on the Malabar coast, also in that of Arracan, in Chittagong. Assam, in parts of Bengal, and in the northern Circars. This was one of the plants subjected to experiment by Dr. Roxburgh, in the beginning of the century. His specimens are still in the East India House. Mr. Leycester, one of the founders of the Agricultural Society of India, called the attention of its members to its fibres as early as the year 1822, when he presented the fibres of three species of Musa. These were *Musa sapientum, M. ornata,* and the present species, *M. textilis.* That of the latter he describes as having been formed from a coat stripped off about sunrise on that day, and having been brought into the house about ten o'clock, had received no further bleaching from the sun or in any other way; and that he had had some of it made into a neat cord, which was in no way inferior to English whipcord. He concludes his letter by congratulating the members on the fibre of their common overgrown plantains being sufficient for all the purposes of twine required in their gardens. Some time after this was written we find it stated in the 'Proceedings of the Agricultural Committee of the Society,' 1st October, 1836, that "a row of the Musa plant, from which the China grass cloth is made, is in a flourishing condition." But, on 12th August, 1840, the Committee notice the favorable appearance of some plants of the Manilla hemp-tree (the Abaca or *Musa textilis*).

Musa textilis is the *Abaca* of the natives of the Philippine Islands. It is found both in a wild and cultivated state, but the natural groves are considered as property. The fruit is green and hard, and of a disagreeable taste. Several villages formerly furnished yearly 1500 arobas each of the fibre, and others exported nearly as much cordage. With the produce of this plant, the natives of these villages pay their tribute, parish dues, purchase the necessaries of life, and clothe themselves.

The Abaca is cut when about one year and a half old, just before its flowering or fructification is likely to appear, as afterwards the fibres are said to be weaker. If cut earlier, the fibres are said to be shorter and finer. It is cut near its roots, and the leaves cut off just below their expansion. It is then slit open longitudinally, and the central peduncle separated from the sheathing layers of fibres, which are in fact the petioles of the leaves. Of these layers the outer are harder and stronger, and form the kind of fibre called *bandala*, which is employed in the fabrication of cordage. The inner layers consist of finer fibres, and yield what is called *lupis*, and used for weaving the *nipis* and other more delicate fabrics; while the intermediate layers are converted into what is called *tupoz*,[1] of which are made web-cloths and gauzes, four yards long, of different degrees of fineness. These are universally used as clothing. Some being so fine, that a garment may be enclosed in the hollow of the hand. Mr. Bennett says, at Manilla there is an extensive manufacture of muslin and sinamaya or grass-cloth; as if, like in the notice at Calcutta, the Abaca was supposed to yield China grass.

The stem-like mass consists of cellular tissue and fibres, with much thickish, watery fluid, which requires to be pressed out.

The fibrous coats, when stripped off, are left for a day in the shade to dry, and are then divided lengthwise into strips, three inches wide. Blanco says the petioles are stripped off one by one, and an incision is made across inside with a knife, to take off the bark which covers them. They are then scraped with an instrument made of bamboo, until only the fibres remain. Sometimes they require much pressing while being scraped. Blanco says the strips are placed beneath the cutting edge of a knife fixed in a long bamboo, which acts as a spring; and the Abaca being placed beneath the knife, is drawn through strongly by one end. This must act as a scraper, but much of the Abaca is said to be spoiled. When sufficiently scraped, the bundle of fibres may be shaken into separate threads; sometimes they are washed, and then dried and picked—the finest being separated by the women with great dexterity. Those for cordage require no further preparation. Those for fine weaving are rendered soft and pliable by beating them with a wooden mallet, after having been made up into a bundle. They are then fastened to each other by "almost invisible knots"—but rather, have their ends gummed together, as in the case of the Pine-apple fibre—then wound into balls, and afterwards committed to the loom.

[1] Besides Pina fibre, already mentioned at p. 39, fibres of "Jussi" and striped Jussi dresses were sent from Manilla to the Exhibition of 1851, and "Bijuco" fibre is mentioned. The plants yielding these fibres are not known.

Don Luis Nee describes the Abaca as being dressed like flax on a kind of heckle—a sort of saw which operates like the heckle (Blanco). Mr. Piddington describes it as a bamboo scraper, into the slit of which the Abaca is introduced, and which being dragged downwards, acts as a scraper on both sides. The stuffs, when woven, are soaked in warm water (lime-water, Blanco) for twenty-four hours, after which they are soaked in cold water, then put into rice-water, and, lastly, washed as before—by which means they acquire lustre, softness, and a white colour. Some are also dyed, and take different colours (as blue and red). Others are embroidered.

Few are imported into Europe, but seem often to be confounded with grass-cloth.

These details have been given in order that the proper treatment may be followed if the plant is cultivated in India; or some of them may be applied to the other kinds of Musa cultivated in India—the fibres of some of which may have a portion of the properties of the Manilla Hemp as cordage. Mr. Piddington had no doubt that when the Manilla Hemp was better known, it would be more appreciated, especially if properly manufactured: the great defect of Manilla-made rope being its stiffness in rainy weather, arising from the coarseness of the yarns—not more than three being used to a strand, which should have nine or twelve. This, Mr. Piddington had ascertained in a vessel commanded by himself, in which both kinds were used; and the latter (made by himself) was at all times as pliant as hemp. It bears tarring well, and he had known it used for lower rigging with success.

In a subsequent volume of the 'Transactions,' in the year 1840, Mr. Stewart Mackenzie, then Governor of Ceylon, forwarded to the Agricultural Society of India, a specimen of Manilla rope, with a note from Mr. Higgs, Master-Attendant at Trincomalee. In this the latter observes, "that shortly after the arrival of the Melville in this country, in 1832, Sir John Gore procured rather a large supply of the different sizes (of Manilla rope) for the squadron, from seven inches to one inch. In that ship we made extensive use of it, reeving it on one side of the ship against Europe rope on the opposite side, and it is from a close observation of its merits, that I have formed the opinion of its being very superior to Europe rope in this country, particularly if this has been long in store here." Mr. Higgs regrets that the Manilla rope is not better laid; and observes that Capt. Neish, one of the oldest captains in the China trade, was in the habit of bringing the large rope from Manilla, and laying it up afresh at Bombay, and tarring the yarns; when it became excellent rope for shrouds. The price of Europe rope at the Naval Yard at Trincomalee, was then £2 7*s.* 3*d.* per cwt., while the price of the Manilla rope (without freight) was £1 12*s.*, and it was one fifth lighter than Europe rope. The price at which Manilla Hemp was sold in England will be mentioned at the end of the following article.

Plantain Fibre (*Musa paradisiaca*).

The Plantain and Banana, though probably only varieties of one species, are yet sufficiently distinguished by the size and flavour of their fruit, to be considered familiarly as distinct. They are, from their luxuriant-growing and large overhanging leaves, considered among the most characteristic forms of tropical vegetation. They are also among the most valuable of plants, inasmuch as in some countries they supply the place of bread, and form the chief nutriment of the people. But not only does the Plantain supply the place of bread and serve as fruit, but also in a preserved state as dessert. The farinaceous parts may, moreover, be separated in the form of flour, and are probably as nutritious as rice. The shoots or tops of the young plants, both in the East and the West, are occasionally given as fodder to sheep and cattle, and are described by some as a delicate edible. The leaves, in a dried state, are used for thatching and bedding. Both the stem and leaves abound in fibre, useful for textile or cordage purposes, while the tow which is separated in preparing the fibres, forms an excellent material for the finest or the toughest kinds of paper. The illustrious Humboldt has long since remarked, that the Banana is for the torrid zone what the Cerealia are for Europe and Western Asia, or rice for Bengal and China, forming a valuable cultivation wherever the mean temperature of the year is about 75°. He has also calculated that the same extent of ground, when planted with the Banana, will support a far greater number of people than when planted with wheat. As this is a point of great economical interest, it has been a subject of subsequent investigation. The productiveness has been found to differ with the mean temperature of the place. Boussingault has given the following as the produce, per imperial acre, of the raw fruit in three places, according to Humboldt's (1), Gondot's (2), and his own observations (3):

	Temperature.	Produce, per imperial acre.	Or of dry food, per acre.
(1) In warm regions . .	81½ Fah.	72 tons.	19½ tons.
(2) At Cauca . . .	78⅘ „	59 „	16 „
(3) At Hague . . .	71⅖ „	25 „	6¾ „

Professor Johnston is the authority for the last column, or that of dry food per acre, as he had, from his analysis, obtained 27 per cent. of nutritive matter from the Banana. He justly observes, that all these quantities are very large, and show how easily life may be supported in tropical countries. And further, that as potatoes contain about one fourth their weight of dry nutritive matter, it would require a crop of twenty-seven tons of potatoes per imperial acre, to yield the smallest of the quantities above mentioned as the yield of an acre of Plantains; while only twenty to twenty-four tons of potatoes are obtained in favorable seasons and localities.

Though it is not probable that the Plantain is cultivated in India with the care to enable the largest possible quantity of produce to be obtained, yet there is no doubt that the produce is large and the culture most simple. It would be an interesting subject of experiment for the Agricultural Societies of India, to ascertain which are the most productive varieties; whether the modes of cultivation adopted in that country have attained the highest limits of productiveness; and also to determine the best methods for preserving the fruit in different places; and also, when superabundant, whether its meal might not be preserved for periods of scarcity, or for the season of the year when the fresh fruit is not procurable. In South America the fruit is not only used as an article of diet in its fresh state, but, when dried, forms an article of internal trade, besides having its flour separated, and cooked or made into biscuits. It is also preserved in the Society Islands.

The preservation of the fruit and the preparation of the meal has already been introduced into India. Some Plantain meal was sent to the Exhibition of 1851, from Madras, as well as baked Plantains from Jessore, by the Rev. J. Parry. These, after some years, are still in good preservation and well tasted. The late Dr. Stocks[1] informed the author that the Plantains at Bassein, where the cultivation is most extensive, are delicious in flavour, and that there the people had acquired the art of preserving them. But this was practised many years ago in Central India, and in Ceylon in 1840.

The late Sir John Robison, Secretary of the Royal Society of Edinburgh, wrote to the author some years since: "Among the products of India which, I think, might be easily brought into general sale in this country, are some of the fruits, which, if cut in slices and dried in the sun, would become susceptible of transport, as those of the Levant and the South of France. Above all, the Banana, of which the varieties, which are rich in saccharine matter, make an admirable preserve, on being skinned and split longitudinally and dried in the sun, by which process they immediately acquire a consistence like Turkey figs, and become capable of being packed and preserved in the same way." He concludes by stating: "I was in the habit of having large quantities preserved every year in this way at Hyderabad, and of using them as an article of dessert at table."

In treating of the cultivation of species of Musa or Plantain in India for fibre, it is desirable to advert to the cultivation of the edible species, or the numerous varieties included under the names of Banana and of Plantain, and suggesting them as above as subjects of experiment to members of the Agricultural Societies in India, to ascertain whether the modes of cultivation adopted in India have attained the highest limits of productiveness; and also whether the fruit might not be preserved in different forms. The author has already observed that a remarkable instance of the great length of time for which these Plantains may be preserved in an eatable state, occurred at the Exhibition of 1851. These were some preserved Plantains, "Platano pasado," which had been brought home by

[1] While this sheet is going to press, the author has heard, with deep regret, of the loss which Science and the East India Service have sustained, in the death of this accomplished naturalist, who was as remarkable for the variety of his attainments, as for his zeal for botanical science and its application to practical purposes.

Lieut.-Col. Colquhoun, R.A., from the province of Jatisco (Guadalagara), Mexico, in the year 1835, and which since then had remained neglected in a baggage warehouse. The specimen exhibited was the remainder of a package of 75 lb. weight, made up, as customary, in the leaves and fibre of the plant, after having been subjected to considerable pressure. The state of preservation, after sixteen years, was favorably reported on by Dr. Lindley, and no signs of decomposition are yet perceptible in the specimens given to the author by Colonel, now Sir W. Reid; the sugar of the fruit having been sufficient to preserve them. They are prepared in considerable quantities in the hot region (tierra caliente) of the western coast of Mexico, for consumption in the elevated districts of the interior. The Silver Medal of the Society of Arts was awarded for the first samples brought to England. *See* the 'Transactions,' vol. l, p. 43, for the method of preparation, reprinted in 'Trans. Agric. Soc. of India,' viii, p. 60.

Before, however, proceeding to detail the methods of preservation of the fruit, or the preparation of the meal, it is desirable to notice the relative values of these as compared with other kinds of fruit. This we are enabled to do from an excellent Report 'On the composition and nutritive value of Plantain Meal,' by Professor Johnston, published in the 'Journal of the Highland and Agricultural Society of Scotland,' in 1848, and to which attention has already been called by Professor Key, of Madras. By this we shall see that, in extending the culture of the Plantain, on account of its fibre, there is no probability of this ever becoming so extensive as for its fruit to become valueless.

CHEMICAL ANALYSIS OF PLANTAIN FRUIT AND MEAL.

Extracts from a Report upon the 'Properties of the Plantain Meal.'—This meal is of a slightly brownish colour, and has an agreeable odour, which becomes more perceptible when warm water is poured upon it, and it has a considerable resemblance to that of Orris root.

When mixed with cold water, it forms a feebly tenacious dough, more adhesive than that of oatmeal, but much less so than that of wheaten flour. When baked on a plate, this dough forms a cake which is agreeable to the sense of smell, and is by no means unpleasant to the taste.

By washing with water this dough leaves no residue of insoluble tenacious gluten, as that of wheaten flour does. When filtered from the starch, the wash water gives no cloudiness when rendered slightly sour by Acetic Acid, when boiled yields a little coagulated albumen. Whether this is the case in the fresh fruit, or only in the dried meal prepared from it, I have had no opportunity of determining.

The addition of Alcohol to the same watery solution renders it more or less distinctly gelatinous, as it does similar solutions obtained from other fruits, and from the turnip, parsnip, &c. This shows the presence of pectin, or pectic acid, the substance which in fruits, in the turnip, and in many other bulbous roots, takes the place of the starch found in grain, and in the tubers of the potato.

When boiling water is poured over the meal, it is changed into a transparent jelly, having an agreeable taste and smell. If it be boiled with water, its forms a thick gelatinous mass, very much like boiled sago in colour, but possessing a peculiar pleasant odour.

Composition of the Plantain Meal.—By a careful analysis, the composition of the plantain meal was found to be nearly as follows:

a. The water.—Mr. Law states that 59 parts of the fruit yielded only 30·85 of eatable parts, which, on drying in the air, were reduced to 12·32 parts. The fruit, therefore, consisted in 100 parts of—

	Per cent.
Husks, &c.	47·71
Water evaporated by the sun	20·88
Meal dried in the sun	31·41
	100·00

The meal thus dried in the open air, when dried again in the laboratory at 212° Fahr., lost 14·07 per cent. of water in addition; or one hundred parts of the recent fruit contain 27 of dry nutritive matter.

b. The albumen, &c.—By combustion the proportion of nitrogen in this meal, in its ordinary state, was found by Dr. Fromberg, in two experiments, to be 0·88 and 0·97 respectively, equal as a mean to 5·82 per cent. of protein compounds. These, as we have already seen, are most probably in the state of soluble albumen taken up by cold water, and of coagulated albumen attached to, or mixed with, the starch, cellular fibre, &c. In the perfectly dry meal the proportion is 6·75 per cent.

c. The ash.—When burned in the air, the proportion of ash left behind amounts to 2·33 per cent., or in the dried meal to 2·71 per cent.

The entire composition of the plantain meal is represented in the following table:

	Dried in the air.	Dried at 212° Fah.
Water	14·07	
Starch	67·42	78·43
Gum and Pectin . . .	4·47	5·21
Cellular fibre . . .	4·84	5·62
Sugar	2·03	2·40
Oil	0·41	0·48
Albumen (soluble) . . .	1·21	1·41
Albumen (coagulated gluten, &c.) .	3·23	3·74
Ash	2·32	2·71
	100·00	100·00

On comparing the above composition with that of other kinds of food commonly eaten by man, we find the plantain *fruit* to approach most nearly in composition and nutritive value to the potato, and the plantain *meal* to those of rice. Thus, the fruit of the plantain gives 27 per cent., and the raw potato 25 per cent. of dry matter.

Again, the dry mealy matter of the plantain, of the potato, and of rice consists respectively of—

	Rice.	Potato.	Plantain.
Starch	86·9	65·0	78·4
Sugar, Gum, &c.	0·5	15·0	7·6
Fat	0·8	1·0	0·5
Cellular fibre	3·4	8·0	5·6
Protein compounds	7·5	8·0	5·2
Ash	0·9	3·0	2·7
	100·0	100·0	100·0

or, comparing only the Starch, Sugar, &c., and the protein compounds, on which the nutritive quality of these different vegetable productions principally depends, we have the following numbers:

	Rice.	Potato.	Plantain.
Starch, Sugar, &c.	87·4	79·0	86·0
Protein compounds	7·5	8·0	5·2

These numbers show that it approaches, as I have said, nearest in its composition to rice, containing nearly as much starch, but a sensibly smaller proportion of the protein compounds, on which the sustenance of the muscles is supposed chiefly to depend.

In regard to its value as a food for man in our northern climates, there is no reason to believe that it is unfit to sustain life and health; and as to warmer or tropical climates, this conclusion is of more weight.

The only chemical writer who has previously made personal observations upon this point (M. Boussingault) says: "I have not sufficient data to determine the nutritive value of the banana, but I have reason to believe that it is superior to that of potato. I have given as rations to men employed at hard labour about 3 kilogrammes ($6\frac{1}{2}$ lb.) of half-ripe bananas, and 60 grammes (2 ounces) of salt meat." Of these green bananas he elsewhere states that 38 per cent. consisted of husk, and that the internal eatable part lost 56 per cent. of water by drying in the sun. The 6·6 pounds, therefore, were composed of—

Husk	2·5 lb.
Water	2·3 „
Heart dried in the sun	1·8 „
	6·6 lb.

so that less than two pounds a day of this dried banana fruit, which we may suppose to be equal in quality and composition to the sun-dried plantain meal, above described, with two ounces of salt meat per day, were found sufficient to maintain men, *not slaves*, at moderately hard labour. This was equal to $12\frac{1}{2}$ lb. dried eatable banana, and 1 pound of salt meat (query fish) per week.

* * * * * *

The composition of the ash of the Plantain also bears a close resemblance to that of the potato. Both contain much alkaline matter, potash and soda salts, and in both there is nearly the same per centage of phosphoric acid and magnesia. In so far, therefore, as the supply of those mineral ingredients is concerned, by which the body is supported as necessarily as by the organic food, there is no reason to doubt that the banana, equally with the potato, is fitted to sustain the strength of the animal body. It must not be denied that our present knowledge indicates the advantage of a mixture of food, as the most conducive to health and strength, but experience shows that, however desirable, this is not absolutely necessary. The oat alone in Scotland raises and supports strong men; rye alone does so in the north of Europe; and the potato alone does so in Ireland. This result of experience in the case of the potato justifies us, were there no experience on the subject in tropical countries, in believing that the banana, which resembles it, will do the same. Whatever other reasons may lead us to recommend a mixture of other food with it, especially where *hard* labour, perhaps not a natural condition of things, is required of him, we ought not to base this recommendation upon any belief that the banana, when eaten alone, will not fully supply all the ordinary wants of the living animal.

Cultivation.—The Plantain has thus been proved to be valuable on account of its fruit, both in its unripe and ripe state, the latter both when fresh and when preserved, and for yielding nutritious meal. The plant is also to be esteemed on account of the fibre with which every part of it abounds. Though both the Plantain and the Banana are to be found near the huts of the poor and in the gardens of the rich, the most profitable mode of culture has, probably, in few places been as yet ascertained. In the first place, of the great varieties to be found in cultivation, it would be necessary to select those which abound most in the products we chiefly require.

The small Banana is most esteemed as a fruit by Europeans, but the large-fruited and, in comparison with the other, coarse-tasted Plantain is preferred by the natives of India, as is the long yellow Plantain in Jamaica. Both of the latter abound in fibre, and are therefore to be preferred when both this and the fruit are objects of desire.

The culture of the Plantain is, upon the whole, very simple, as it will succeed in almost any soil where the climate is warm and moist. The vicinity of water, for cleansing and washing the fibre, will, of course, be an essential. Professor Key, of Madras, has stated that in India the Plantain will flourish in the poorest soil and near brackish water, and that its culture might be extended with very little trouble and expense. A sucker being planted, rapidly attains maturity; some varieties in eight months, others within the year. Each producing a bunch of fruit which may weigh from twenty-five to forty, and even ninety pounds; and each throwing out from its roots and around its stem, from six and seven to eight and ten fresh suckers. These will each form a distinct plant, producing its own bunch of fruit; all requiring to be cut down annually, in order to make room for the fresh suckers which spring up. This may go on for fifteen or twenty years, though some think that it is better to renew the plantation entirely or partially at shorter periods. A chief consideration is the distance at which the original plants should be placed, in order to give room for the secondary suckers, as well as to allow of free ventilation. Some place them at distances of six feet, but it is better to have them ten feet apart, either around the boundaries of fields or of gardens, or in rows as a separate plantation. In the latter case, it is recommended that there should be space enough between the rows to allow of the culture of other crops. In some parts of India, the Plantain is employed as a nurse, or to afford shade, to the Betel Vine (itself one of the most valuable of crops), or to young Areca-nut and to Cocoa-nut Palms. By cutting away some of the suckers as they arise at different periods, and allowing others to remain, a supply of fruit, and also of stems for fibre, may be obtained for a great part of the year.

In Demerara and Guiana, the Plantains have been injured by some disease, which has impaired their fruitfulness, and, consequently, the profits of their culture. It has been recommended to plant them at sufficient distances (as eighteen feet) to allow of free ventilation, accompanied with good tillage in the intervals and the cultivation of annual crops of Maize, Yams, Sugar-cane, or Eddoes. (Arum.) According to the distances, there may be from 300 to upwards of 400 plants in an acre, each producing, say, on an average, seven suckers; making in all from 2100 to 3200 plants in an acre.

Preservation of the Fruit.—The fruit of the Plantain, when ripe, containing a sufficient proportion of nutritive matter, may well serve as a portion of the food of the natives of warm countries. But it is probably as much employed by them before being perfectly ripe, as it is sometimes stewed, and at other times fried; and, by the natives of India, dressed in various ways to eat with rice. In the West Indies, the fresh Plantain, when boiled whole, forms a mass of considerable toughness, and which, when beaten in a mortar, constitutes the *foo-foo* of the negroes. (Simmonds.) When nearly or perfectly ripe, it is pleasantly, or even lusciously sweet, and it is in the former state that it is preserved.

Col. Colquhoun describes the mode of preparation as very simple: "The fruit is gathered when fully ripe, and is laid on light cane frames, exposed to the sun. When it begins to shrivel, the outer skin is stripped off. (This is stated to be a very essential part of the process, as without it the fruit acquires an unpleasant flavour.) After this, the drying is completed. During this process it becomes covered with a white, mealy efflorescence of sugar, as the fig does under similar circumstances. For convenience of transport it is pressed into masses of about 75 lb. each, and is wrapped in plantain leaves. The masses are twenty-four inches long by fourteen wide, and four inches thick. The samples presented to the Society of Arts were about two years old, sufficiently moist, of a consistence and flavour between the date and the fig, very sweet, and without any acidity. It is evident that this process of preservation will be found to be of considerable value in other parts of the world, and especially in situations where it is cultivated in larger quantities than the fruit can be consumed. The drying in the sun would be sufficient in dry climates, but baking in ovens seems to be necessary in moist climates, such as Dacca and Jessore. The process seems to be sufficiently well understood in several parts of India. When the fruit is of a good kind, no addition of sugar can be necessary. This subject seemed so worthy of a fair trial in the British West Indies to the Society of Arts, that they offered, in the year 1834, a premium for its encouragement. It seems no less important for the East Indies, especially if any planters should be induced to cultivate the Plantain in large quantities, on account of its fibre, or for the preparation of half-stuff for paper-makers.

Plantain Meal.—Mr. Simmonds describes this meal as prepared by stripping off the husk of the fruit, slicing the core, and drying it in the sun. When thoroughly dry it is powdered and sifted. It is known among the creoles of the West Indies under the name of *Conquin tay*. It has a fragrant odour, which it acquires when drying, and which somewhat resembles that of fresh hay or tea. The flavour of the meal is, moreover, said to depend a good deal on the rapidity with which the slices are dried. Hence, the operation is only fitted for dry weather, unless where a kiln or stove is had recourse to. Above all, the Plantain must not be allowed to approach too closely to yellowness or ripeness, otherwise it becomes impossible to dry it. The colour of the meal is, moreover, injured, when steel knives are used in husking or slicing; but nickel blades or Bamboo slicers would not injure the colour. On a large scale, some single machine might be adapted to the husking and slicing processes, and the mode tried by which arrowroot is obtained, by scraping and suspension in cold water.

It is calculated that the fresh core will yield forty per cent. of dry meal, and that 5 lb. may be obtained from an average bunch of 25 lb. weight; and an acre of Plantain walk of average quality, producing even during the year 450 such bunches, would yield upwards of a ton of meal, the value of which must of course vary in different countries according to the price of other articles of food. In the West Indies it is largely employed as the food of infants, children, and convalescents. In point of nutritious value, we have seen that the fruit approaches the potato, and the meal to that of rice. There can be no doubt, therefore, of the value of this meal, and of the benefit of preparing it, wherever the fruit is preserved in larger quantities than it can be consumed.

Preparation of the Fibre.—The Plantain has been stated to abound in fibre—indeed, almost every part of the plant may be said to be available for this product. It is related, that from the upper part of these spurious stems, spiral vessels may be pulled out in handfuls, and are used as tinder in the West Indies. De Candolle has described them as consisting, in Musa, of seven distinct fibres lying parallel, formed into bands; and La Chesnaye of upwards of twenty, arranged in a spiral manner. M. Mohl describes the secondary cell-membrane as divided into as many as twenty parallel spiral fibres. But these are not the fibres which are separated for economic purposes, nor are they situated on the same side of the vegetable structure. For instance, if we take any separate layer of the Plantain stem—that is, a part of the sheathing footstalk of a leaf—we may observe on its outer side a layer of strong longitudinal fibres, which form a kind of framework or ribs for the support of the structure, which is cellular on its inside. It is on this side that spiral vessels are placed, and next the pith in exogenous plants. They are abundant in the peduncle, or core, as it is often called, of the Musa.

As in the Manilla, so in the common Plantain, the fibre is found to be coarse and strong in the outer layers of the sheathing footstalks, fine and silky in the interior, and of a middling quality in the intermediate layers. This fibre is separated by the natives of Dacca, for instance, and is used by them for making the string of the bow with which cotton is teazed (bowed). Much of it is well adapted for cordage. Mr. Leycester (*v. supra*), when calling attention to the fibre of the *Musa textilis* grown in Calcutta, directed attention to the fibres of *M. sapientum* and of *M. ornata*, as fitted to answer as string for all gardening purposes. Mr. Crawford is of opinion that the common Plantain most probably afforded the Indian Islanders the principal material for their clothing, in the same way that the indigenous species does in the Philippine Islands. The art of making cloth from these fibres seems also to have been known in Madagascar. There is no doubt that the large cultivated Plantain of India contains a considerable quantity of strong fibre, in the same way that the common yellow Plantain does in Jamaica. But it seems well worthy of inquiry, whether the wild, and at present useless Plantains, growing along the foot of the Himalayas and on the Neilgherries, may not yield a stronger fibre than any of the cultivated kinds.

The fibre may be easily separated from any part, by simply scraping it on a stone or flat board, with a piece of hard wood; iron, though frequently used, no doubt injures the colour. In the following directions given by Dr. Hunter ('Art Journal,' Madras, i, pp. 108 and 376) the essentials are attended to, and the fibre is separated in an uninjured state, but the process is probably not the most economical.

To prepare the fibres of the Plantain, he rejects the outer, withered layer of leaves, and then strips off the different layers, and proceeds to clean them in the shade, if possible soon after the plant has been cut down. Lay a leaf-stalk on a long flat board, with the inner surface uppermost, scrape the pulp off with a blunt piece of hoop-iron fixed in a groove in a long piece of wood. When the inner side, which has the thickest layer of pulp, has been cleaned, turn over the leaf and scrape the back of it. When a good bundle of fibres has been thus partially cleaned, it ought to be washed briskly in a large quantity of water, so as to get rid, as quickly as possible, of all the pulpy matter which may still adhere to the fibres. It may be readily separated by boiling the fibres in an alkaline ley or in alkaline soaps, but not in the Indian soaps made with quick-lime, as these are too corrosive. When the fibres have been thoroughly washed, they should be spread out in thin layers or hung up in the wind to dry. If exposed to the sun when in a damp state, a brownish-yellow tinge is communicated, which cannot be easily removed by bleaching. Exposure during the night to the dew bleaches them, but it is at the expense of part of their strength.

If we attend only to what is essential in the above process, we find that all that is required is scraping or pressure to separate the cellular and watery from the fibrous parts. This is followed by careful washing, and sometimes by boiling in an alkaline ley, but the latter part of the process does not appear to be essentially necessary.

In the West Indies, according to the complete account of a practical correspondent in Jamaica, as given in Simmonds' 'Commercial Products of the Vegetable Kingdom,' the fibre is separated, either by crushing under rollers in a mill, or by fermentation. If by the latter process, there is considerable saving in carriage, as the stems, when cut down, are heaped together near where they have grown, and are shaded from the sun by laying the leaves over them. A drainage of the sap takes place, which is described as having a tanning property, and as discolouring the pieces which lie at the bottom. But several weeks elapse before decomposition is complete, when the fibres can be easily separated from the rest of the vegetable mass. There is little doubt, that besides discoloration, there must be some weakening of the fibre by this process, as we know takes place in India when the stems are steeped in water until some decomposition takes place.

It is usual not to cut the stems until fruit has been produced; "for two reasons—first, that the fruit be not lost, and secondly, that the tree will not have arrived at its full growth and ordinary size, and the fibres will be too tender." This is the reverse of the practice in the Philippines, where the stem is cut before the fruit appears, in order to ensure a better quality of fibre. It would be an interesting experiment for those favorably situated, to ascertain the mode by which the best kind of fibre is produced, and what would be the loss of profit, supposing that the fruit is sacrificed for the sake of the fibre.

The stem is described as being cut off about six inches above the ground, and being tender, it may, on being bent down, be cut asunder with a single stroke of a hatchet or cutlass. It is then divided, longitudinally, into four parts, the centre taken out and left to serve as manure, and the pieces conveyed at once to the mill to be crushed. It is said that "one man can cut down 800 trees, and split them in a day." A very convenient size for the rollers of the mill, will be found to be about three feet in length and one foot in diameter. In the process of crushing, care should be taken to separate the tender from the harder layers of fibre. This may be attained by having the rollers of the mill placed horizontally; and if the pieces of Plantain are passed lengthways through the mill the pressure will be uniform, and the fibre uninjured. "In this manner, pass the different sorts of layers separately, and the produce will be about four pounds of fibre from each tree. The stalks of the branches of the Plantain (no doubt the mid-rib of the leaf is meant) give the best fibre, and a large quantity as compared with the body of the tree; 100 lb. of the stalk will give 15 lb. nett of fibre. In general, if a tree will give 4 lb. nett of fibre, the stalks will give 1 lb. out of the 4 lb. The stalks ought also to be crushed separately, because they are harder than the exterior layers of the tree. About 3000 trees may be passed through the mill in a day. Whilst the experiments were in progress, it was ascertained that, with a single horse, 100 Plantain trees, on an average, were crushed in twenty minutes—giving five minutes' rest for the horse."

The quantity of produce from each plant, is the point of greatest discrepancy between the West Indian practice and Dr. Hunter's experiments, as he mentions only a few ounces of fibre as procurable from each plant. But as he rejected the outer parts, and did not include the midrib of the leaves, the discrepancy may be partly accounted for. The combings or tow, separated from the fibres during their preparation, are also of value as a substitute for horse-hair, for stuffing mattresses, &c.; and also the peduncle or core, if pounded into half-stuff for paper-makers. Some of the cellular tissue containing much fibrous matter, might, probably, be converted to the same purposes.

In addition to the above processes of crushing and washing, the West Indian account also gives the details of the process of boiling the fibre with carbonate of soda and quick-lime, in order, it is said, to get rid of the remaining vegetable matter, and to bleach the fibre. The different qualities of which, having been crushed separately, are of course to be kept so, and boiled separately. The proportions given in the above account are for making three tons of fibre per day. For this, four large (800-gallon) boilers are required, and about 360 lb. of soda would be consumed, with a proportionate quantity of lime; or the soda, that is, its carbonate, may be first deprived of its carbonic acid. This may be done by preparing, in a small separate boiler, the quantity of liquid necessary for a day's consumption, which may be done in about an hour, by taking, by weight, ten parts of soda, six parts of quick-lime, and not less than seventy parts of water. The operation of boiling in the soda ley is said to be important in separating the gluten and colouring matter from the fibres, and also to facilitate their bleaching. The lightest coloured fibres do not require more than six hours to bleach, whilst the darkest will probably take from twelve to eighteen hours. It is advisable to place over each boiler the means of lifting the mass of fibre when boiled, and suffering it to drain into the boiler before it is carried away to be washed. The machinery necessary for cleansing and washing may be of various descriptions—as that used by paper-makers in England, or by coffee-planters and arrow-root growers in the West Indies. The fibre may be dried, by being hung over lines made of the same material. These, when dry, may be pressed and packed.

For carrying on the culture of the Plantain on an extensive scale, in the West Indies, it is stated that the materials will cost £2000, buildings £500, purchase of land £1500, working capital £1000=£5000. The estimated expense in cultivating one quarree or 5⅕ English acres, in Plantains, will be £30, as the work can be easily performed by one labourer in 300 days, at 2*s*. sterling per day. A quarree will produce 18 tons of mill-fibre, the cost of the preparation of which is as follows:

For workmen's wages, soda, lime, and fuel, at £3 per ton .	£54
Freight to Europe, at £4 per ton . . .	72
Manager	30
Duty, insurance, office fees, &c., at £1 per ton . .	18
	£174

Thus making the total expense of producing 18 tons of fibre £174, or £9 13*s.* 4*d.* per ton.

By another statement, derived from different data, but somewhat similar sources, it has been calculated that Plantain fibre, in a coarse state, might be laid down in England, at £10 6*s.* 8*d.* But some expense would be incurred in cleansing the fibre for finer purposes. In another account, also taken from West Indian information, it is stated that the cost of well-cleaned fibre would amount to £7 1*s.* 3*d.*, to which, of course, freight would have to be added; while half-stuff for paper-makers might, at the same time, be produced from the refuse at about half that sum.

As Plantain fibre has not yet, as far as we have heard, been systematically prepared as an article of commerce, these calculations of cost are somewhat conjectural. But they are interesting, as showing, from the experiments which had been made, that large quantities of a valuable product may be obtained at a comparatively cheap rate; and this, from what is now a complete refuse—that is, the stem and leaves; while the expenses of culture are paid for by the fruit. And the more so, as the data are West Indian, where the prices of material and the wages of labour are much higher than in India.

Specimens of Plantain fibre, and a barrel of it for experimental purposes, were sent by two Exhibitors from Demerara, also some from Porto Rico (*v.* 'Illust. Cat., p. 982); and it was stated that the fibre might be obtained in very large quantities from the Plantain cultivation of the former colony. It is calculated that upwards of 600 lb. weight of fibre might be produced annually from each acre of Plantains, after reaping the fruit crops. It is further stated, that "at present, the stems of the Plantain trees, when cut down, are allowed to rot on the ground. If a remunerative price could be realised for this fibre, a new branch of industry would be opened up to the colonists."

From India, unfortunately, we have no statements showing the rates at which Plantain fibre, tow, and pulp, might be obtained as articles of commerce. Dr. Hunter, of Madras, has done much in showing the various purposes to which this valuable product might be applied; as he sent to the Exhibition of 1851 both the fibre and the tow in a well-cleaned state. The former about four feet in length, and also dyed of several colours, as well as twisted into fine cord and into rope. Some Plantain rope was, moreover, sent in a tarred state. A portion of the tow was sent in a state fit for packing and stuffing, and some converted into paper; of the latter, some was almost as thin as silver paper, and some of it seemingly as tough and tenacious as parchment, well fitted for packing paper, as apparently little affected by water. But in this country, some excellent letter paper has been made from the Plantain fibre. Besides the above, Plantain meal was sent by Professor Key from Madras, and preserved Plantains from Jessore. But dried Plantains seem already established as an article of commerce at Bombay, as we observe them among the exports for the year 1850-51, from thence to Cutch and Guzerat, to the extent of 267 cwt., valued at 1456 rupees. So that the various applications of which Plantain fruit and fibre are susceptible have been already made in India. It remains only to produce them as cheaply as the other products of the country.

Dr. Hunter, in his experiments, found that the fibre cost about three annas, or about sixpence, a pound—which is prohibitive as an article of export; but he states that if regular supplies of the fibre were required, the price might be reduced to two annas. He also mentions that, at Madras, the rate at which the stems were at first supplied was ten annas for one hundred trees; but this was raised to four rupees for the same number, when he began to make use of them. This is a sufficient proof that they are not very abundant there. But "in the vicinity of some of the Zillah (that is, of District) Jails, the Plantain is cultivated very extensively, but no use is made of the stems, which are allowed to rot on the surface of the ground." This is also the case in most parts of India.

On the opposite coast of Arracan, the Plantain is abundant. What seem to be the layers forming the stem of such a plant, and about seven feet in length, are sold there in a dried state, and called *Pa-tha-you Shaw;* some of it even twisted into a bast-rope, is sold for the same sum, that is, for one rupee the maund, or for about three shillings per cwt.

As the above Shaw or *bast* of an unknown plant is sold at so cheap a rate, as well as the other basts sent from Arracan to the Exhibition of 1851, even after some preparation, there is no reason why Plantain fibre might not be sent cheaply into market. I have no doubt that it would very soon command a price equal to its real value, as a material for paper-making, for cordage, or for textile fabrics. The fibre might be collected in situations where the plant is already cultivated, in gardens, or where it grows wild, and its stems not turned to any account. Or it might be cultivated in fields on its own account, either with or without other crops, such as Pan or *Piper Betle*, or Ginger, Turmeric, &c. The fruit in its fresh state, near towns, or in a preserved state, or converted into meal, ought to pay all the expenses of, and afford some profit on the culture. The stems and leaves would thus be obtained at a minimum of cost—that is, simply of carriage.

Indeed, if the crushing mill were not of too cumbrous a nature, it might be brought into the vicinity of the field, in the same way that the natives of India construct a sugar-mill and boiler in the immediate vicinity of where the Date tree is grown or the Sugar-cane cultivated. A mill, consisting of the rollers of a sugar-mill or an enlarged churka, with an Archimedean screw, or with cog-wheels, or with bands, to which motion is given by bullocks, as practised in various parts of India, would probably be sufficiently effective, and certainly economical. The separation of the different qualities of fibre, with the washing, combing or heckling, and drying, might at first all be performed by hand, where labour is so cheap. If all the fibrous matter, or the combings or tow only, should be required for conversion into half-stuff for paper-makers, nothing is more effective, and at the same time so economical, as the Dhenkee of India. To this attention has been recently called by Mr. Henley ('Journ. of Soc. of Arts,' vol. ii, p. 486), and which, as he describes, "resembles in principle our European tilt-hammer." "Its cost would be—erected in place—engineers, foundations, and all charges included—three shillings; and this charge supposes the more than usually heavy machine employed for paper-making!" "The total wages for the preparation of 20 to 30 lb." of suitable material, "would amount to sevenpence-halfpenny." Mr. Henley adds, that "in the event of employing such fibres as the Plantain leaf-stalk, a small pair of hard wood grooved rollers, such as they employ for squeezing sugar-cane, would be very useful. Their cost is two shillings."

Having, in my Lecture before the Society of Arts, recommended the Plantain as likely to yield an abundant supply of material for paper-making, Mr. Henley observes: "From extensive cultivation of the Banana or Plantain, which surrounds almost every house, it is probable this material would form one of the first objects of attention by paper-material collectors; but from its coarse, stringy nature, it would be cheaper in the state of fibre than as half-stuff. This plant offers great advantages for our views generally, for it is truly in the position of refuse, inasmuch as it has already paid the charges of its cultivation by its products in fruit. The interior of the plant, or true flower-stem, is eaten as a vegetable by the natives; the lower part being perfectly mild, whilst the upper extremity, near the bunch of fruit, pours out, on cutting it across, a limpid fluid, which is very acrid and deleterious, and is a true substantive olive dye on cotton cloth, as indelible as marking ink, for which it may be substituted." With regard to the price at which such materials could be obtained, Mr. Henley says: "I am of opinion that contracts could be made, according to the ordinary usages of the country, at the rate of from one rupee eight annas, or three shillings, to two rupees eight annas, or five shillings, per maund of 82 lb., deliverable at any central depôt within a radius of twenty miles. These prices are equal to from about £4 4*s*. to £7 a ton; and that, of these, the lowest-priced material could be landed in London, paying all charges, for £13 4*s*., and the more expensive, which would include articles equal to linen rags, at £16 5*s*."

Having already noticed the facility with which the species of Plantain may be cultivated in suitable climates, we may mention that we have lately tasted some excellent fruit of *Musa Cavendishii*, grown in a Fernery on Putney Heath. We have chiefly to warn cultivators against planting the Plantain too close together; for though this may produce fineness of fibre, it will also diminish strength, and want of free ventilation may produce disease. For separating the fibre, it may be a question whether smooth or grooved cylinders will be best for so fleshy and moist a substance, but it is very necessary to remember that the pulp or the fibre must be thoroughly dried, in order that it may not undergo decomposition when in transit in the hold of a ship.

Of the value of the Plantain fibre for paper-making, there can, I conceive, be no doubt. Some paper, though unbleached, but excellent as far as substance and tenacity are concerned, was sent from India by Dr. Hunter, in 1851. In the year 1846, Mr. May showed the author some beautiful specimens of note and letter paper made from Plantain fibre. He was at that time anxious to establish a manufactory for Plantain paper in Calcutta, but subsequently went to one of the British colonies in South America; and we have also noticed (p. 89) the fact of a gentleman having shown specimens of paper made from Plantain fibre in Demerara. Mr. Routledge subsequently made some excellent paper, both of a tough and of a fine quality, from the fibres of species of Musa—sheets of which he has presented to the author, who has lately seen specimens of similar paper in the hands of Mr. Sharp. Besides which, excellent paper has for some time been made from the refuse of or from worn-out Manilla rope. All which facts prove that an excellent material for paper-making may be had in inexhaustible supplies, whenever those chiefly interested choose to take the necessary measures for securing such a supply.

We may now therefore notice the other uses to which Plantain fibre can be applied.

Lieut.-Col. Whinyates, Principal Commissary of Ordnance, in a letter to the Secretary to the Military Board at Madras, states that the Plantain oakum or tow sent by Dr. Hunter is "undoubtedly of a very superior description, and admirably adapted for packing. From the soft, elastic character of the fibre, he also conceives that it would be a desirable substitute for coir in stuffing hospital beddings, &c. But he fears that the supply is too limited, and the cost all too high, being at that time (October 29th, 1850) about three annas the pound."

STATEMENT showing the comparative Strengths of the undermentioned Specimens of Rope, Cord, String, &c., made from the fibres of the Plantain, with Hempen Rope, as exemplified in a set of Experiments carried on at the Arsenal, Fort St. George, in July, 1850.

Number marked on label.	LABELLED.	Arsenal Number.	Description.	Circumference.	Length of Rope, &c., used.	Weight required to break the Rope, &c.	Weight required to break: After immersion in water 24 hours, dried in the shade, and tested 7 days after.	Weight required to break: After being immersed in water 10 days, and dried in the sun.	Weight required to break: Manilla Rope of same circumference.	Weight required to break: English Hemp Rope of same circumference.	Weight of one Fathom of each description: Plantain.	Weight of one Fathom of each description: Manilla.	Weight of one Fathom of each description: Europe.
				In.	Fms.	lb.	lb.	lb.	lb.	lb.	oz.	oz.	oz.
1	Rope and String made from the fibres of the Plantain. Mr. Lima. Porto Novo.	1	Line	$0\frac{3}{4}$	2	248	—	—	—	—	2 1-16	—	—
		2	String	$0\frac{1}{4}$	1	$54\frac{1}{2}$	—	—	—	—	0 4-16	—	—
2	Rope and Line made from the fibres of the Plantain, by the prisoners of the House of Correction.	3	Line	1	2	288	—	—	—	—	2 7-16	—	—
		4	ditto	$0\frac{3}{4}$	2	190	—	—	—	—	1 12-16	—	—
		5	String	$0\frac{1}{2}$	1	114	—	—	Bengal log line 137	—	0 9-16	—	—
3	Rope made from the fibres of the Plantain, in the House of Industry. Fibres prepared in the House of Corr., Madras.	6	Rope	$3\frac{1}{4}$	2	2330	2387	2050	4669	3885	19 9-16	28 11-16	39
		7	ditto	$1\frac{1}{2}$	2	638	—	—	869	—	6	5	—
		8	ditto	$1\frac{1}{2}$	2	694	—	—	869	—	5 13-16	5	—
		9	ditto	$1\frac{3}{8}$	2	624	—	—	—	Ratline 638	4 5-16	—	5 1-16
4	Rope made from the fibres of the Plantain, by a pauper in the Monegar Choultry, Madras.	10	Line	1	$1\frac{3}{4}$	323	—	—	—	—	2 10-16	—	—
		11	ditto	1	1	330	—	—	—	—	3	—	—
		12	ditto	$0\frac{3}{4}$	2	183	—	—	—	—	1 8-16	—	—
		13	ditto	$0\frac{3}{4}$	$0\frac{3}{4}$	362	—	—	—	—	1 9-16	—	—
5	Rope and String made from the fibres of the Plantain, by five Europeans in her Majesty's Jail.	14	Rope	$1\frac{3}{4}$	2	1240	1266	762	1490	1184	7 9-16	9 8-16	13
		15	ditto	$1\frac{3}{8}$	2	974	—	—	—	—	5 8-16	—	—
		16	String	$0\frac{1}{2}$	1	185	—	—	Bengal log line 137	—	1 4-16	—	—
		17	ditto	$0\frac{1}{4}$	1	38	—	—	—	—	0 5-32	—	—
6	Ditto, ditto, by the same prisoners, from fibres of the Plantain prepared in the House of Correction.	18	Rope	2	2	1490	—	—	—	—	11	—	—
		19	ditto	$1\frac{3}{4}$	2	1322	—	—	1490	1184	8 6-16	$9\frac{1}{2}$	13
		20	ditto	$1\frac{1}{4}$	2	806	—	—	757	Ratline 638	5	$3\frac{1}{4}$	5 1-16
		21	String	$0\frac{1}{4}$	1	$43\frac{1}{2}$	—	—	—	—	0 3-16	—	—

With respect to the strength of Plantain fibre, I may state, that in some experiments which I have had made on Plantain fibre, some from Madras bore a weight of 190 lb., but the specimen from Singapore bore not less than 390 lb., while a salvage of Petersburgh Hemp, of the same length and weight, broke with 160 lb. A twelve-thread rope of Plantain fibre made in India broke with 864 lb., when a similar rope made of Pine-apple fibre broke with 924 lb. Even from these experiments, it is evident that Plantain fibre possesses sufficient tenacity to be applicable to many, at least, of the ordinary purposes of cordage, as is very clearly shown by the experiments detailed in the annexed tabular statement. But it is probable that the plants grown in a moister climate than that of Madras will possess a greater degree of strength. The outer fibres may also be converted into a useful kind of coarse canvass, as has been done by Dr. Hunter; and the more delicate inner fibres most probably into finer fabrics, as is the case with those of the Abaca or *Musa textilis;* when equal care has been taken in the preparation and separation of the fibres, and there is some experience in weaving them.

Having seen the rate at which such materials may be imported, both from the East and the West Indies, it is desirable to have some idea of the prices which are likely to be realised for Plantain fibre or pulp, when introduced into the markets of Europe. Manilla Hemp, which has long been in demand both in America and in Europe, had a nett average price, for the ten years previous to 1852, of £32 per ton. In part of the years 1844 and 1845, it sank as low as £22 to £25; and the consumption increased so much, that the price rose, in 1852, to £44 and £50 for the average kinds; but, independently of what was used for cordage and coarse purposes, there was a considerable consumption of the fine, white qualities, for which horse-hair had originally been used. In the recent rise which took place (April, 1854), Manilla Hemp was quoted at from 70*s*. to 76*s*. per cwt. Though common Plantain fibre is not possessed of the strength of Manilla Hemp, yet it is fitted for many of the ordinary purposes of cordage and canvass, and some of the fine kinds for textile fabrics of fine quality and lustre. In the communication from Demerara, already quoted, it is stated that "in 1846, a gentleman (probably Mr. May) visited this colony, and exhibited several specimens of cloth of a beautiful silky texture, and specimens of paper of superior quality, manufactured from the fibre of Plantains grown in the Jardin des Plantes." There is no doubt that some of the more delicate fibres of the interior might be used for such purposes; and for these, a high price would, no doubt, be realised; and for the coarser, outer fibres, which are fit for cordage, at least £30, some say £35, a ton; while some of the superior tow would be a good substitute for horse-hair, for stuffing beds, &c.; and the different qualities of half-stuff producible from the combings, &c., of different parts of the plant, would produce half-stuff, at least equal in value to the rags which sell in ordinary times from 16*s*. to 20*s*. a cwt. But when its qualities are better known, it probably would sell at still higher rates, as there would be no labour in sorting, and no loss of material in cleaning. Mr. Betts was induced, in India, to attempt the preparation of the fibre, from seeing a remark in the 'London Price Current,' of Dec., 1839, that considerable supplies of a new sort of Hemp from the stalk of the Plantain tree had realised from 6*d*. to 8*d*. per lb.; and the Society of Arts were induced, as long since as the year 1762, from the apparent importance of the subject, to offer a premium for the production of this fibre (*v*. 'Jury Report,' p. 102).

Therefore, even with the least sanguine expectations, and on the most moderate computations, there is every prospect of a certainty of demand, accompanied by remunerative prices. With this in view, we may conclude our observations on this subject, which may appear to occupy too much space, and to have been treated of too much in detail. But if properly considered, it cannot but appear of vast importance to the natives of tropical countries, and to planters and colonists abroad, to utilise so valuable and abundant a product, which is now allowed to run to waste, and of which, if they increase the cultivation, they will at once attain the twofold object of multiplying the supply of food for the body, at the same time that they are increasing materials for diffusing information for the mind.

THE PALMS (*Palmaceæ*).

The Palms, so conspicuous in tropical countries for their lofty pillar-like stems, surmounted by apparently inaccessible fruit or gigantic foliage, are no less remarkable for the many useful purposes they are calculated to fulfil. The fruit of some is edible, of others abounding in oil, the sap of a few forms a pleasant beverage, and may by evaporation yield sugar or be fermented into a spirit. The stems of some species are gorged with farinaceous matter, which may be separated as a starch-like powder or granulated into sago. The broad leaves, from their great size and hard surface, are useful for thatching the cottages of the poor, or for making umbrellas for the rich. The narrow-leaved kinds are plaited into mats and baskets, or smoothed so as to be fit for writing on; while the leaves of several, when in a young and tender state, are eaten, both raw and in a cooked state, and are hence called Cabbage Palms. Some abound in strong unyielding fibre, while others form wood which is applicable to all the purposes of timber. Hence, several are valuable articles of culture in the countries where they are indigenous, or where the soil and climate are suitable for their growth—as, for instance, the Date Palm in Arabia and Africa, the Oil Palm in the West of Africa, the Cocoa-nut in India and its Islands, together with the Betle-nut, Palmyra, and Talipat Palms; while the Sago, the Ejoo, and the Betle-nut Palms flourish in the moist warm climates of the Malayan Peninsula and of the Indian Archipelago.

The Palms abound chiefly in the tropical parts of South America, as well as of the Old World; but a few species extend to rather high latitudes, as an Areca to lat. 38° S. in New Zealand, and a Sabal (Chamærops, *Auct.*) to lat. 40° N. in North America; while the Dwarf Palm, a native of the North of Africa, is now at home in the South of Europe. There even the Date Palm is grown in a few sheltered situations; though it is in the hot and dry soil of Arabia and Africa that it attains the greatest perfection, and furnishes a principal part of the diet of its inhabitants, as well as an article of commerce. *Phœnix sylvestris*, a variety or species of the same genus, is common in most parts of India. A Chamærops is found in Nepal, and one on the Khasya Hills, at elevations of from 5000 to 8000 feet; while *C. Ritchiana* is found in the Khybur Pass, and probably all along the mountainous range from Affghanistan to Sindh. But it is in far southern latitudes and in a different climate that the Cocoa- and the Betle-nut Palms are objects of extensive culture; as well as the Sago Palms, of which the Ejoo or Gomuto of the Malays is one (the *Arenga saccharifera* of botanists), abounding in sap, which can be used as palm wine or converted into sugar; yielding at all times strong and durable fibre. The older trees when cut down yield sago, as do *Sagus Rumphii* and *S. lævis*, especially abundant in and near Sumatra. The latter is remarkable among Palms for throwing up young plants around it in the same manner as the Plantain. Both kinds of Sago tree are strongly recommended for cultivation—the Arenga on low coasts near the sea, but the species of Sagus even on the edges of the marshes which abound in such situations.

It is no doubt to some one of these Sago trees that Sir John Maundeville alludes, when he says: "In that land grow trees that bear meal, of which men make bread, white and of good savour; and it seemeth as it were of wheat, but it is not quite of such savour. And there are other trees that bear good and sweet honey; and others that bear poison.—And if you like to hear how the meal comes out of the trees, men hew the trees with an hatchet, all about the foot, till the bark be separated in many parts; and then comes out a thick liquor, which they receive in vessels, and dry it in the sun, and then carry it to a mill to grind, and it becomes fair and white meal; and the honey and the wine, and the poison, are drawn out of other trees in the same manner, and put in vessels to keep." ('The Book of Sir J. Maundeville,' chap. xviii.) But we have only to notice such Palms as are useful for their fibres.

The species of Calamus, or those yielding the different kinds of Cane, have little of the appearance of Palms, as they are usually remarkable for their weak and trailing stems, which often extend to a great length, and ascend the loftiest trees. It is these long stems, which, when divested of their sheathing leaves, form the canes of commerce—some so much admired as sticks; others for their flexibility, conjoined with tenacity.

These, when their smooth and shining dense outsides are separated in strips, are universally employed for *caning* the bottoms of chairs, of couches, and for other articles. Some are occasionally twisted into ropes, in the localities where they are indigenous; but they are more generally employed as sticks, and for mat-making and cane-work, as their great strength allows of such narrow strips being employed, as to allow of large spaces being left, and thus enables strength to be combined with lightness and free ventilation.

The species of Calamus abound in the Islands of the Indian Archipelago, as well as in the Malayan Peninsula. A few species are found within the Madras territories, but in India they chiefly abound in the forests of the districts of Chittagong, Silhet, and Assam, whence they extend along the foot of the Himalayas as far north as the Deyra Doon, where a species is found which the late Mr. Griffith has named *C. Royleanus*, and applied the name of *C. Roxburghii* to the plant which Dr. Roxburgh called *C. Rotang*, common in Bengal and on the Coromandel Coast. Both are called *bet*, and used for all the ordinary purposes of cane; as are *C. tenuis* of Assam, *gracilis*, *extensus*, and others. *C. Scipionum* of Loureiro, Mr. Griffith considered to be the species which yields the well-known Malacca Cane, but the plant does not appear about Malacca. He was, however, informed that the canes are imported from Siak, on the opposite coast of Sumatra.

The extensive uses to which Canes are applied, both in their entire and split state, are well known. They are abundant in all the moist tropical parts of the East, both on the continent and in islands. In Java, the cane is cut into fine slips, which are platted into excellent mats, or made into strong, and, at the same time, neat baskets. In Japan, all sorts of basket-work are made of split cane, and even cabinets with drawers. Cane is also platted or twisted into cordage, and slender fibres are made to answer the ordinary purposes of twine. It is stated that in China, as also in "Java and Sumatra, and indeed throughout the Eastern islands, vessels are furnished with cables formed of cane twisted or platted. This sort of cable was very extensively manufactured at Malacca." The species employed for this purpose is probably the *Calamus rudentum* of Loureiro, which this author describes as being twisted into ropes in these Eastern regions, and employed, among other things, for dragging great weights, and for binding untamed elephants. So Dampier says: "Here we made two new cables of rattans, each of them four inches about. Our captain bought the rattans, and hired a Chinese to work them, who was very expert in making such wooden cables. These cables I found serviceable enough after, in mooring the vessel with either of them; for when I carried out the anchor, the cable being thrown out after me, swam like cork in the sea, so that I could see when it was tight; which we cannot so well discern in our hemp cables, whose weight sinks them down—nor can we carry them out but by placing two or three boats at some distance asunder, to buoy up the cable, while the long boat rows out the anchor." The tow-ropes mentioned by Marco Polo as used by the Chinese for tracking their vessels on their numerous rivers and canals, seem also to have been made of cane—and not of bamboo, as sometimes stated—as they were split in their whole length of about thirty feet, and then twisted together into strong ropes some hundred feet in length.

Mr. G. Bennett says, in his 'Wanderings,' ii, p. 121, that he "remarked some Chinese one morning near Macao, engaged in making some very durable ropes from rattan. The rattans were split longitudinally, soaked, and attached to a wheel, which one person was keeping in motion, whilst another was binding the split rattans together, adding others to the length from a quantity he carried around his waist, until the required length of the rope was completed."

Though apparently insignificant, Canes yet form a considerable article of commerce, inasmuch as in some years between four and five millions of them have been exported from the territories under the government of the East India Company.

Though not employed for their fibres, yet as connected with the different kinds of the genus Calamus, we may mention the different Canes which are imported. Most of them are produced by species of Calamus. For the commercial names of these we are indebted to Mr. W. Sangster. The walking sticks called "Penang Lawyers" are the stems of a small Palm called *Licuala acutifida*, as also mentioned at p. 96.

The Ground Rattan is distinguished by its straight head, and straight and stiff character altogether, as well as by its pale colour; though some are at least an inch in diameter, and others not half that thickness. Some are distinguished by a hard, and others by a soft bark. It is not known whether the slender are of the same species as the thicker kinds, growing in different situations, or from roots of different ages, but *Rhapis flabelliformis* is said to yield the Ground Rattan.

The Malacca Cane is supposed to be produced by *Calamus Scipionum*, but said to be imported from Siak, on the coast of Sumatra. Some of these are simply mottled or clouded, others of a brown colour, in consequence, it is said, of their having been smoked. The more slender specimens of these, with the longest internodes, are those most highly valued.

The most common kind of Cane, that employed for caning chairs, &c., is known in common by the name of Rattan Cane. This must be yielded by a variety of the long trailing species which abound wherever the genus is found. The most northern, named *Calamus Royleanus*, no doubt yields the Rattans collected in the Deyra Doon, while *C. Roxburghii* no doubt yields those collected in more southern latitudes. But it is probable that a variety of species yield the thin Rattans of different localities, and some of which have already been mentioned.

Another kind of Rattan is called Dragon Cane. This is thicker than the last, both light and dark coloured, with long internodes and a hard bark, less flexible than the common Rattans, but strong, springy, and much valued. A variety, with soft bark, is called Manilla Dragon Cane.

Other kinds of Canes, imported from China, are known, one with stiff stems and large knots by the name of *Jambee*, and one as *Whanghee*. This has a pale, hard bark, and flexible stems, with internodes of about an inch and a half or two inches, and a number of little holes at the knots.

Some which are occasionally called Canes, are produced by species of Bambusa, Saccharum, and other grasses.

Calamus Draco, a native of Sumatra and the Malay Islands, yields, as a natural secretion of its fruit, the best D'jurnang or Dragon's blood, which has been an article of commerce from the earliest times, and still continues in demand.

The Chamærops, called *Palmetto*, is among those best known in Europe. *C. Ritchiana*, called *Maizurrye* in Pushtoo, and

Pfees in Sindhee, is a most useful plant. Of it are made sandals, baskets, mats, &c., and its moonyah or fibre makes twine and ropes in Sindh. It is of extensive use in Affghanistan for making cordage; in the same way that the Hemp Palm, also a species of Chamærops, was found by Mr. Fortune to be employed in Northern China; and as *Chamærops humilis*, or Palmetto, is in the North of Africa and South of Europe, for making baskets, brooms, mats, and cordage. Indeed, paper and pasteboard are made of its fibres by the French in Algeria.

The true DATE TREE (*Phœnix dactylifera*), the Palm tree of Scripture, flourishes in comparatively high latitudes, and is well known to afford the principal article of food to the natives of Arabia and of the North of Africa; while the leaves are employed in making mats, baskets, &c.; and at Cairo cordage is made of fibres obtained from the footstalks of the leaves. Though the tree grows well in India, it does not there produce any edible dates; but *Phœnix sylvestris*, the *Khujjoor* of India, which closely resembles the former in character, is found in every part of that country, as near Madras, to its north in Mysore, in Bengal and the North-West provinces up into the Punjab. This tree is especially valued in many places, as its sap or Palm juice (*tari*) is either drank fresh from the tree, or fermented for distillation, when it yields a common kind of spirit or *aruk*. In Bengal it is valuable as yielding a considerable quantity of the sugar produced in that province, and known as Date sugar. Each tree, "on an average, yields 180 pints of juice, of which, every twelve pints are boiled down to one of *goor* or *jaguri*, and four of goor yield one of good powder sugar; so that the average produce of each tree is about seven or eight pounds of sugar annually." (Roxburgh.)

The leaves are very generally employed for making mats and baskets, and also bags in Bengal. The footstalks of the leaves are beaten and twisted into ropes, which are employed for drawing water from the wells in Bellary and other places. One species of *Phœnix* (*P. paludosa*), the *Hintal* of Bengal, abounds in the Soonderbunds, while another, *P. farinifera*, common on dry, barren, sandy lands on the coast, and on the hilly country between the Ganges and Cape Comorin. Its stem abounds in farinaceous matter, which the natives make use of as food in times of scarcity. The leaflets are wrought into mats for sleeping on. The common footstalks of the leaves are split into three or four, and made into baskets of various kinds.

The leaves of many of these Palms are employed for thatching, for making chattahs or umbrellas, punkahs, and hats. Thus, those of *Licuala peltata*, the *Chattah-pat* of Assam, are in universal demand in that valley. Scarcely a single ploughman, cow-keeper or cooly, but has his Jhapee or Chattah made of Chattah-pat.[1] (Jenkins.) But the leaves of this Palm are coarser than those of another, the *Toko-pat* of the Assamese, which has been named, in honour of the zealous Commissioner of Assam, *Livistona Jenkinsiana,* by the late Mr. Griffith. Col. Jenkins says of this species: "This Palm is an indispensable accompaniment of every native gentleman's house, but in some parts it is rare, and the trees are then of great value. The leaves are in universal use throughout Assam, for covering the tops of doolees (palkees), and the roofs of khel boats; also, for making the peculiar hats, or rather umbrella-hats (jhapees) of the Assamese. For all these purposes the leaves are admirably adapted, from their lightness, toughness and durability."

The PALMIRA tree of Europeans (*Borassus flabelliformis*), and the *Tar* of the natives of India, is to be seen in almost all parts of India, and occasionally as far as 30° N. lat. It is stated by Dr. Roxburgh to be, next to *Caryota urens,* the largest Palm on the Madras coast, and that it seems to thrive equally well in all soils and situations. The seeds, when young, are eaten by the natives, being jelly-like and palatable. The tree, during the first part of the season, yields a pretty large quantity of toddy (palm wine). This is either drank fresh drawn from the tree, or boiled down into a coarse kind of rob called jaggery, or it is fermented for distillation. The wood, near the circumference of old trees, is very hard, black, heavy, and durable. By the natives the leaves are universally used for writing upon with an iron style. They are also employed for thatching houses, for making small baskets, mats,

[1] The stems of *Licuala acutifida* afford the well-known walking sticks known by the name of "Penang Lawyers." (Griffith.)

&c., and some also formed into large fans, called vissaries. The fibres of the leaves (*Palmyra nar*) are employed on the Madras side for making twine and small rope. They are about two feet in length, strong, wiry, and not unlike those of Esparto (p. 31). Near the base of the leaves there is also found a fine down, which is used for straining liquids through, and also for stopping bleeding from wounds.

Among other Palms which are valued for different products and employed to supply the place of cordage plants, we may instance the species of CORYPHA. Of these, *C. Gebanga* has its young leaves plaited into baskets and bags, affording much employment to the people in Java. The leaves are also employed for thatching, and for making broad-brimmed hats. So, *C. Talliera*, the *Tara* of Bengal and the *Talipat* of the Peninsula, is much employed for making leaf hats and leaf umbrellas. The leaves, moreover, when smoothed, are much used for writing on, and also for tying the rafters of their houses, as they are strong and durable. Thus, also, *C. umbraculifera*, the *Codda-panna* of Madras and the *Talipat* of Ceylon, and very like the former, is common in Ceylon, and found also on the Malabar coast. Of this the leaf, being dried, is very strong and limber—and, according to Knox, "most wonderfully made for men's convenience to carry along with them; for though this leaf be thus broad [enough to cover fifteen or twenty men] when it is open, yet it will fold close like a lady's fan, and then it is no bigger than a man's arm; it is wonderfully light." "This tree is within, a pith only; they beat it in mortars to flour, and bake cakes of it, which taste much like to white bread; it serves them instead of corn before their harvest is ripe." (Knox's 'Ceylon.')

CARYOTA *urens* is another of those Palms which are common to India and Ceylon. In Malabar it is called *Evim-pannah*, and *Jeroogoo* in Telinga. Dr. Roxburgh describes it as highly valuable to the natives of the country where it grows in plenty. During the hot season, a single tree will yield at the rate of one hundred pints of toddy or palm wine in the twenty-four hours. The pith, or farinaceous part, is equal to the best sago. The natives make it into bread, and boil it into thick gruel.

It is the *Kittul* of the Cingalese; of which, according to Knox, "the inside is nothing but a pith, as the former. It yieldeth a sort of liquor, which they call *telligee*: it is rarely sweet and pleasing to the palate, and as wholesome but no stronger than water." It "bears a leaf like to that of a betel-nut tree, which is fastened to a skin as the betel-nut leaves are, only this skin is hard and stubborn, like a piece of board; the skin is all full of strings as strong as wire; they use them to make ropes withal." In a recent account of the 'Vegetable Products of Ceylon,' by Mr. Ondatjee, of which the author has been good enough to send me a copy, it is said that the *black fibre* from the leaf-stalks of the *Caryota urens* (*kittul*) is manufactured into rope, which is of great strength and durability, being used for tying wild elephants. The Rodyahs, or outcasts among the Kandyans, make this rope, generally with considerable skill, as it is both regular and compact. There is also a woolly material found at the base of the leaves, which is stated to be sometimes used for caulking ships.

Ejoo or Gomuto Fibre (*Arenga saccharifera*, Labil.; *Saguerus Rumphii*).

Malay—Ejoo, Sejee. *Sumatra*—Anou.

The *Ejoo* or *Gomuto* fibre, so well known in Eastern commerce and as used in Eastern shipping, is hardly known in the Western world. It is, however, occasionally heard of by the name of "vegetable bristles." Though a portion of the fibres may be likened to stiff bristles, the greater part is more like black horse-hair. This is celebrated, in the countries where it is produced, both for its strength and for its imperishable nature, even when exposed to wet. It is supposed to be the same as the *Cabo negro* of the Spaniards of Manilla. The tree yielding it was described and figured by Rumphius ('Herb. Amb.,' i, p. 57, t. 13) under the name of Gomuto, or *Saguerus*; but the latter name being too similar to that of the true Sago tree, has been changed to *Arenga*, from the native name *Areng*, under which it was described by Labillardiere. The specific name has been given from the large quantity of sugar procurable from its sap by cutting the spadices of the male flowers.

We thus observe that the tree is valuable for several very distinct, and all very useful products. It is described by Marsden, in his 'Sumatra,' under the name of *Anou*, as a Palm of "much importance, as the natives procure from it *sago* (but there is also another sago tree, more productive); *toddy*, or palm wine, of the first quality; *sugar*, or jaggary; and *ejoo*." Dr. Roxburgh, writing in the year 1799, says of it: "I cannot avoid recommending to every one who possesses lands, particularly such as are low and near the coasts of India, to extend the cultivation thereof as much as possible. The palm wine itself, and the sugar it yields, the black fibres for cables and cordage, and the pith for sago, independently of many other uses, are objects of very great importance, particularly to the first maritime power in the world, which is in a great measure dependent on foreign states for hemp."

This Palm is to be found in all parts, from the Gulf of Bengal to all the Asiatic islands on its eastward, especially in low moist situations and along the banks of rivers.

Dr. Roxburgh describes the trees (in 1810) which had been introduced into the Botanic Garden at Calcutta about twenty-four years before, as from twenty to thirty feet in height, exclusive of foliage or fronds, which rise from fifteen to twenty feet higher. These fronds or leaves are pinnate, and from fifteen to twenty-five feet long. The trunk is straight, at first covered entirely with the sheaths of the fronds or leaves, and the black horsehair-like fibres, called by the Malays *Ejoo*, which issue in great abundance from the margins of these sheaths. As the tree advances in age and size, these drop off, leaving an elegant, columnar, naked trunk. He further states that he had observed that each of the well-grown thriving trees produces about six leaves annually, and that each leaf yields about three quarters of a pound weight of these fibres, and, therefore, each tree about four pounds and a half. But some luxuriant trees yield at least one pound of fibre from each leaf.

As these black fibres issue from the sides of the sheaths, they necessarily surround the stem, and may be cut off without injury to the tree. Even in commercial specimens, some may be seen covered both on the upper and lower surface with dense cellular membrane, having between them a mass of these black fibres. These are supported by thicker or whalebonelike fibres, which are attached to the thinner fibres by cellular tissue. These stiff fibres are employed in Sumatra as styles for writing with on the leaves of other Palms, &c., as mentioned both by Marsden and Bennett.

These fibres are further described as stronger, more durable, but less pliant and elastic than those of the *Coir;* but they resist decay, and are therefore more fit for cables and standing rigging, but less fit for running rigging. "The native shipping of all kinds are entirely equipped with the cordage of the *Gomuto,* and the largest European shipping in the Indies find the advantage of using cables of it. It undergoes no preparation but that of spinning and twisting,—no material similar to our tar or pitch, indispensable to the preservation of hempen cordage, being necessary with a substance that, in a remarkable degree, possesses the quality of resisting alternations of heat and moisture. The best *Gomuto* is the produce of the islands farthest east, as Amboyna and the other Spice Islands. That of Java has a coarse ligneous fibre; the produce of Matura is better. Gomuto is generally sold in twisted shreds or yarns, often as low as a Spanish dollar a picul, and seldom above two; which last price is no more than one sixth part of the price of Russia hemp in the London market. Were European ingenuity applied to the improvement of this material, there can be little doubt but it might be rendered more extensively useful."

Milburn, again, in his 'Oriental Commerce,' mentions the Ejoo as of all vegetable substances the least subject to decay, and that it is manufactured into cables, and the small cordage of most of the Malay vessels made of it: "it is equally elastic with coir, but much more serviceable, and floats on the surface of the water." These fibres are universally employed, in the countries where the trees are indigenous, for making cordage for their nets and seines, as well as for the rigging of their vessels, as also cables. These are described by all as remarkable for their tenacity and durability, and as not undergoing any change by exposure to wet, not even when stowed away in a wet state. In some experiments made by Dr. Roxburgh, some thickish cord bore 96 lb., and some smaller 79 lb.; while coir of the same size bore only 87 lb. and 60 lb. respectively. Besides the above horsehair-like fibres, there is at the base of the leaves a fine woolly material (baree), much employed in caulking ships, as stuffing for cushions, and as tinder. Ejoo was sent to the Exhibition of 1851, *via* Singapore, from Malacca, as separated from stiff fibres, and as prepared for manufacture or export, and prepared as sinnet, or coarse line for making ropes or cables. The portion belonging to each leaf having apparently been cut off close to the sheath, and each measuring about three feet in breadth and two feet in length. The bundles of the coarse and fine fibres are about six feet in length, and about twelve inches in diameter, neatly tied up with split cane. Interspersed among the coarser, there are some finer fibres, something like black wool. The sinnet is coarse, but strong, and broke with a weight of 85 lb., when coir of about the same size broke with 75 lb.; but the comparison is not very exact.

Mr. Kyd, the celebrated ship-builder of Calcutta, possessed a cable made of the Ejoo fibre, which he had had for four years exposed to all weathers, and which raised the bow anchor of a merchant ship of 500 tons, buried in the sands of the Hoogly; in two previous attempts at which, three Russian hempen cables had given way.

Besides making strong and durable cordage, the Ejoo fibre is no doubt applicable to a variety of purposes for which horsehair and bristles are now employed.

Cocoa-nut Tree and Fibre (*Coir; Cocos nucifera*).

Bengalee—Narikel. *Hindee*—Naryul. *Tam.*—Tenga.

The Cocoa-nut, little if at all known to the Ancients, was particularly noticed by the Arabs, being by them called *Jouz-hindee* or Indian nut; but at much earlier periods, in Sanscrit works, by the name of Nari- and Nali-kera. It is, no doubt, the "great nut of India," which Sir John Maundeville mentions among the trees of that country, as producing nuts as large as men's heads. In the East, where it is indigenous, it must from the earliest times have attracted the attention of the inhabitants. But it would be impossible now to distinguish the trees which have been introduced from those which are now growing apparently wild, on the various tropical coasts and islands where they are found in such vast abundance. As, for instance, in the Maldive and the Laccadive Islands; also, on the Malabar coast and in Ceylon, as well as on the eastern side of the Bay of Bengal, whence it ascends both the Burrampooter and Ganges Rivers to considerable distances. Likewise, in most of the islands of the great Archipelago forming the *India aquosa* of old authors, from the Sunda Isles to Molucca, and in those of the Pacific Ocean. It is, moreover, cultivated in various tropical parts of the New World. The Cocoa-nut (*Cocos nucifera*) and the Oil Palm (*Elæis guineenis*) have been remarked by a distinguished botanist, Mr. Brown, as the only two of their group (*Cocoinæ*) found in the Old World.

The Cocoa-nut Palm is one of the great ornaments of the shores of tropical countries. The cylindrical stems, with a diameter of about two feet, attain an elevation of from sixty to one hundred feet, and are surmounted with their crowns of numerous, wavy, and which from their appearance may almost be said to be feathery leaves. These are by botanists often called fronds, and by travellers their footstalks are often called branches. They are gigantic in size, being about twenty feet in length, with a strong, tough stalk, which forms the midrib, and has a number of narrow and long leaflets ranged along the two sides. The fruit is borne in bunches, of which there are from eight to twelve, each bearing, on trees growing in favorable situations, from five to fifteen nuts, so that each tree may produce from eighty to one hundred nuts annually. Mr. Bennett has well observed that the tough and thick (and it may be added, light) covering of the nut protects the germ while it floats even on salt water, and it is thus borne to barren spots, where it germinates, and causes even the smallest islets, just appearing above water, to become covered with clumps of Cocoa-nuts, as the fruit falling springs up and forms young trees around the original tree. Thus the Cocoa-nut is found on barren, uninhabited islands, as well as in populous districts; and though it attains the greatest perfection on the coast, it may yet be seen at considerable distances in the interior, and even at some elevation, as 800 feet in Ceylon. The Singalese have a saying, that Cocoa-nut trees only flourish where you can walk and talk among them. This evidently means that the trees must not be planted too close together; nor should any undershrubs be allowed to grow about their roots.

The Laccadive Islands are famed for the good quality of the coir which is made there and exported to the Malabar coast. The Cocoa-nut tree is almost the sole object of culture and the chief means of subsistence, each person consuming about four nuts per diem. The principal inhabitants generally own considerable numbers of trees, and the custom prevails of marking trees with certain house marks, in the same way that sheep are marked in other countries. Taxes are levied on these trees, according to immemorial usage; and mortgages are secured on them at the rate of one rupee per tree of good quality.

The soil and climate of these islands is so well adapted to the Cocoa-nut, that they require to be looked after only for the first year; after which they are transplanted, and watered for a few weeks, until they take root, when they are left entirely to themselves, and come into bearing at periods varying from eight to twenty years, and will continue to bear for seventy or eighty years. In the island of Kiltan, it is said that a nut buried with a knife will grow, requires no attention, and comes into bearing early. The tree is not so large and strong as that of the coast, and the nut about two thirds of the size only, and rounder in shape. The husk is smaller and less woody, and the fibre finer and more delicate, but stronger than that of the coast nut. The nut is also said to be more compact and oily, and to keep better than the coast nut, although, for the sake of the coir, the nut is cut before being quite ripe. Many of the trees are cut for their sap, called *neera*, which the islanders drink in its unfermented state. The juice is drawn frequently, and fermentation checked by the addition of lime or chunam. "They are still so strict in the abstinence from all fermented liquors, that the manufacture of toddy would not be tolerated in the islands." (Robinson on 'Laccadives,' 1846.) Of the extent of the cultivation, we are informed that in the islands under British protection—that is, in Amendeevy, Kadamat, Kiltan, and Chetlat, containing in 1844 a total population of 3609—there were 122,153 Cocoa-nut trees. Of these, 8129 were chouk or unproductive, 45,070 young trees and plants, and 69,254 were fully productive.

Of the abundance of the Cocoa-nut tree on the Malabar coast, we may form an idea from the description of the chief town, Cannanore; as the topes or clumps of Cocoa-nut are said "to be seen between the officers' houses, surrounding the cantonments in every direction, and extending in the distance as far as the eye can reach; and the cantonment may be said to be imbedded in a forest of these trees." But it is abundant everywhere, and in many places forms a belt along the whole coast.

The majority of the houses on the Malabar coast are roofed with Cadjan—that is, with the dried leaves of the Cocoa-nut—which resist the rain better than tiles; but the roofs should be fresh thatched before the accession of the rainy season.

The average produce of Cocoa-nuts in the whole of Malabar is estimated at from 300 to 400 millions annually, which are valued at half a million of rupees; but in addition to this, from 20,000 to 25,000 candies of Copra (or the dried kernels) are exported, valued at 400,000 rupees.

The Cocoa-nut flourishes on the coasts of the southern provinces of the Indian peninsula, and succeeds on many parts of the western coast of the Bay of Bengal, as well as in the southern parts of that province. It also succeeds well on the eastern coasts of that bay, though the cultivation has not been carried on in the former Burmese territories to the extent of which the coasts are susceptible, nor even to the degree which the people require for their own consumption, as considerable quantities have long been imported from the Nicobar Islands. The trees are said to begin to produce fruit in the eighth, and to be in full bearing in the twelfth year after planting, and yield from eighty to a hundred nuts annually. But this is probably above the average.

Mr. Baumgarten, in a paper on the agriculture of Malacca ('Journn. Indian Archipelago,' iii, p. 710), while considering what kinds of cultivation are most inviting, states that those of an indigenous kind claim a preference, such as the Cocoa-nut, Betel-nut, Sago, and Kabong,[1] with the usual variety of fruit trees found in the Dusans of Malacca. He further states, that "supposing a planter purposes opening a Cocoa-nut plantation, he should choose a gently sloping or level surface, with a portion of swampy land in its vicinity for a paddy-field for food for the labourers." "The Malays," he says, "bestow

[1] All these are Palms; and of them, *Cocos nucifera* and *Areca Catechu* are no doubt the first two. The Sago tree is probably *Sagus lævis*, and the Kabong, *Arenga saccharifera*.

little care on their Cocoa-nut gardens. The Cocoa-nut there begins to bear at the end of the seventh year, but full crops cannot be expected until the ninth year. During this interval the utmost average quantity that can be expected will not exceed twenty-five nuts annually. But the fruit-bearing power of the trees may be considerably improved by extracting toddy from the blossom-shoots for the manufacture of jaggery, during the first two years of its productiveness; after which it may be discontinued. The subsequent annual produce may be safely reckoned at fifty nuts per annum; and forty may be considered the average number obtained from trees that are crowded to within fifteen feet of each other. The Cocoa-nuts sell for about eleven dollars per thousand." Mr. Baumgarten also recommends, that during the first four or five years, Millets, Chillies, Kechong (pulse), Sweet Potatoes, Yams, and Pumpkins, be cultivated in the intervals of the Cocoa-nut plantation.

Dr. Buchanan, in his journey across Mysore and down to the Malabar coast, in 1800–3, observes that in some places he found the green Cocoa-nuts sold for making ropes, at the rate of 2000 for about 8*d.*; but the husk of the ripe Cocoa-nut was not fit for the purpose (i, 156). These are commonly burnt for fuel (ii, 50). The green husks of the nuts which have been cut for their juice are steeped in water for six months. They then beat them on a stone with a stick, and rub off with their hands the rest of the adhering substance. The fibres, or Coir, are then fit to be twisted into yarns. In South Malabar (ii, 401), he says, a little bad Coir is made from the husks of the nuts that are used green in the country; a few of the nuts are exported with the husk on, but in general they are sent to the north inclosed in shell only.

USES OF THE COCOA-NUT TREE.

The Cocoa-nut tree is valued not only as applicable to many of the same purposes as other Palm trees, but for the sap procured by cutting the spathes of the flower-stalks, which is either drank in its fresh state, boiled down to a coarse sugar or jaggery, or allowed to ferment into spirit and vinegar. The milk of the nuts also forms a wholesome drink, while the kernel is used as an article of diet or in cookery in its fresh state, or dried and exported by the name Copra. In both states it is well known to abound in oil, which is used in the East for anointing the body, for the lamp, and for culinary purposes, and is now exported in such enormous quantities to Europe. The nut, besides, yields large quantities of a fibre which is to be more especially the object of our attention.

That the Cocoa-nut is one of the most valuable trees of tropical regions has long been known. It is therefore well worthy of cultivation in such situations as are suitable to it; as it abounds in products useful as articles of diet, as well as for commerce and manufactures. The celebrated Rumphius has given a very elaborate account of the Cocoa-nut Palm, and of its uses, under the name of *Palma indica major,* or Calappa, in his 'Herb. Amboin.,' i, pp. 1—25. Mr. G. Bennett, in his 'Wanderings,' has also given a very interesting account of it (vol. ii, p. 295); as also Mr. Robinson, of the Madras Civil Service, in his 'Report on the Laccadive Islands,'[1] published in the 'Madras Literary and Scientific Journal.' From these sources we condense the following notice of the useful products of this "Prince of Palms."

The Cocoa-nut, valued as it is in its ripe state, is probably, in the countries where it is indigenous, most used as an article of diet in its young or green state. It then affords both solid food and a pleasant drink, because it contains an abundance of the fluid, which Mr. G. Bennett says is beautifully clear, and has a sweetness, with a slight degree of astringency, which renders it a very agreeable beverage.[2] This he always found cooling and refreshing in all his excursions in intertropical countries. The pulp of the young nut is delicate, easily removed with a spoon, and may very well be named a vegetable blancmange. The ripe fruit is also eaten, but it is more frequently employed in cookery; the grated kernel being placed in a cloth, water is poured on it, a white juice is extracted by pressure, which, Mr. Bennett says, "may with propriety be

[1] See also the 'Wernerian Trans.,' vol. v, for a full account of the uses of this tree; as also Mr. Marshall, in his 'Natural and Economical History of the Cocoa-nut,' 1832.

[2] Mr. Bennett mentions that in Ceylon, house-plasterers use the water of the green Cocoa-nut as an ingredient in their white-washes, made of pure lime. It is a general practice of the natives of India to add some vegetable matter to their cements.

termed 'Cocoa-nut milk.' It is used either with or without the grated kernel in their various curries and mulligatawnies." Besides these edible parts, the heart, or the very young leaves of this Palm, as well as of some others, is called the *cabbage,* and, according to all accounts, forms "an excellent vegetable, either cooked or dressed in stews, hashes, or ragouts."

The beverage known to Europeans as toddy or palm wine, is obtained from the flower-spathes, before the flowers have yet expanded. These are themselves astringent, and used medicinally. To procure the toddy, the spathe is first tied with the young leaves, and is then cut a little transversely from the top, and beaten either with the handle of the toddy-knife or with a piece of hard wood. After some days, an earthen chatty or vessel, or a calabash, is hung to the spathe, so as to receive the toddy as it exudes. This is collected every morning and evening; the spathe being cut a little every day.

If this palm wine is drawn early in the morning, it forms a pleasant drink. But fermentation takes place in the liquor a few hours after it has been collected, and it is then used by the bakers as yeast. The fermented liquor or toddy is much drank by the natives; at other times the spirit is distilled from it, and forms one of the kinds of arrack or *aruk,* that is, spirit. One hundred gallons of toddy produce by distillation, it is said, twenty-five of aruk. Or it may be allowed to undergo the acetous fermentation and produce very good vinegar. Or, instead of being allowed to ferment, the toddy may be made to yield *jaggery* or sugar. For this purpose, a supply of sweet toddy is procured mornings and evenings, particular care being taken that the vessels employed have been well cleaned and dried. Eight gallons of sweet toddy, boiled over a slow fire, yield two gallons of a lusciously sweet liquid, which is called *jaggery-* or *sugar-water;* which quantity being again boiled, the coarse brown sugar called jaggery is produced. The lumps of this are separately tied up in dried banana leaves.

Cocoa-nut oil is one of the best-known products of this Palm, from its extensive employment in Europe, especially for making the excellent candles known as Stearine. In the East, it is employed as a lamp-oil, and for anointing the body, especially after it has been rendered fragrant by mixture with such aromatic oils as those of sandal wood and of jessamine.

The oil is obtained by first removing the kernel from the shell, which is boiled in water for a short period; it is then pounded in a large mortar, taken out, and pressed. The milk, as it is called, is then boiled over a slow fire, when the oil floats on the top, which being skimmed off, is afterwards boiled by itself. Two quarts of oil, it is said, may be procured from fourteen or fifteen Cocoa-nuts.

"The Malabar method of extracting the oil, is by dividing the kernel into two equal parts, which are ranged on shelves made of laths of the Areca Palm or of split bamboo, spaces being left between each lath of half an inch in width; under them a charcoal fire is then made, and kept up for about two or three days, in order to dry them. After this process they are exposed to the sun on mats, and when thoroughly dried (then called Koppera or Copra), are placed in an oil-press, or siccour." These form articles of export to Bombay and elsewhere.

Cocoa-nut oil is liquid at the ordinary temperature of the countries where it is produced, but becomes solid at lower temperatures, as about 70°, and has a specific gravity of ·892. It is one of the fixed or fatty oils, of which such large quantities are now imported into this country, and, like them, consists of both solid and fluid constituents; the latter, or Oleine, being separated by pressure from the solid parts called Stearine. The solid fat of the Cocoa-nut is by others distinguished by the name of Cocein, which has been so largely employed in making Stearine candles, but which, from the chemical changes taking place in the process, are now called Stearic, and which are made in such enormous quantities and of such excellent quality under Mr. G. Wilson's intelligent superintendence at Belmont, Vauxhall. In consequence of this increased demand, and the facilities afforded by the establishment of a Government steam-engine at Colombo for separating the oil with greater facility, as well as to the duty having been taken off, we may account for the great increase in the importation of this oil.

Cocoa-nut oil was sent to the Exhibition of 1851, from different parts of the Madras territories, and of very fine quality, by Messrs. Sainte, of Cossipore—for these a Prize Medal was awarded. The refuse or oil-cake is stated to be excellent food for fattening pigs and poultry.

The imports, which were in 1838, 32,666 cwt., had risen to 85,463 cwt. in 1848, and have since continued to increase.

	Cwt.		Cwt.
1848 .	85,463	1851 .	55,915
1849 .	64,452	1852 .	101,863
1850 .	98,039	1853 .	164,196

How large a proportion of this is brought from India, will appear from the following analysis of the quanties:

	Imported into United Kingdom in 1850. Cwt.
Cocoa-nut Oil imported from British Possessions in India .	85,096
" " " in Australia .	6,315
" " other parts . . .	6,628
	98,039

Cocoa-nuts, from the quantity of fibre on their exterior and oil in their interior, are necessarily well suited for burning. Hence they are sometimes fixed on stakes, and used to illuminate roads, &c. The shell itself, when burnt, yields an excellent kind of charcoal. In their entire state they are used for a variety of purposes, such as hooqas, vessels to hold water, cups to drink out of; and with handles fixed into them, they serve as ladles and spoons. We sometimes see them brought home as curiosities, highly polished on the outside; sometimes scraped so thin as to be semitransparent; at other times, stained black, elaborately carved, and mounted in silver.

Besides these various products, the wood of the Cocoa-nut tree is used for various purposes, as among the Singalese, when it has become old and the tree has ceased to bear, for making small boats, frames for houses, rafters, &c.; also for spear-handles, furniture, and fancy articles of different kinds. It is also exported to European markets, where it is known by the name of *Porcupine wood.*

The Singalese split the fronds in halves, and plait the leaflets neatly, so as to make excellent baskets, and, under the name of *cadjans*, they form the usual covering of their huts, as well as of the bungalows of Europeans; and are exported to northern parts, where the Cocoa-nut does not flourish so well: 149,500 were imported into Bombay in the year 1850-51. The dried fronds are sometimes used as torches or for fuel; their midribs, tied together, are sometimes used as brooms for the decks of ships, as the fibres of the stalk are woody, brittle, and difficult to clean.

The leaves are also in other places plaited into mats and screens, and also made into baskets; and combs are said by Mr. Bennett to be made of the midrib of the leaflets in the Friendly Islands. In the Laccadive Islands mats are made of the Cocoa-nut leaf, cut out of the heart of the tree just before the unfolding of the leaf, though this involves the loss of the bunch of fruit which comes out with each leaf. It is probable that the leaves of the *chouk* or unproductive trees are chiefly employed. These mats are, however, of fine quality, and much esteemed when exported. In these islands they are employed for the sails of the smaller boats.

Though the Cocoa-nut is best known, for the fibrous covering of its nuts which is so well known under the name of Coir, it also produces a downy fibre which is used to stop bleeding from wounds. This is altogether of a more delicate nature, and forms a kind of network, which is beautifully white, and even transparent, when young. It is thus seen at the bases of the young fronds; but as these attain maturity, this natural matting becomes coarser, tough, and of a brownish colour. It may be stripped off the tree in large pieces, which are used both in India and Ceylon as strainers for palm wine or cocoa-nut oil, or for straining sago or arrow-root. Mr. Ellis describes it as "consisting of long and tough fibres which regularly diverge from both sides of the petiole of the leaf. Sometimes there appear to be two layers of fibres, which cross each other, and the whole is cemented with a still finer, fibrous, and adhesive substance: the singular manner in which the fibres are attached to each other, causes this curious substance, woven in the loom of nature, to present to the eye a remarkable resemblance to cloth spun and woven by human ingenuity" (vol. i, p. 53). This is very similar to the arrangement of the Ejoo fibre, which has been already described, but in which both coarse and fine fibres are intermixed.

The husk or rind of the Cocoa is thick and full of fibres, which in their separated state are so well known by the names of Coir or Khair. In order to remove this husk, an iron spike, or sharp piece of hard wood, is fixed in the ground. The nut is then forced upon the point, which passes through the fibres, and thereby separates the rind from the shell. In this manner, Mr. Marshall says, a man can clear 1000 nuts daily. The husk, cut transversely, is frequently used for polishing furniture, scrubbing floors, and as a substitute for brushes and brooms.

Mr. Robinson describes the method of making Coir in the Laccadives, as follows: "As the husk gets hard and woody if the fruit is allowed to become quite ripe, the proper time for cutting it is about the tenth month. If cut before this, the Coir is weak; if later, it becomes coarse and hard, and more difficult to twist, and requires to be longer in the soaking pit, and thus becomes darker in colour. When cut, the husk is severed from the nut and thrown into soaking pits. These, in some of the islands, are merely holes in the sand, just within the influence of the salt water. Here they lie buried for a year, and are kept down by heaps of stones thrown over them to protect them from the ripple. In others, the soaking pits are fresh-water tanks behind the crest of coral. In these, the water not being changed becomes foul and dark coloured, which affects the colour of the Coir. When thoroughly soaked the fibrous parts are easily separated from the woody by beating. If taken out of the pits too early, it is difficult to free the Coir from impurities. If left in too long, the fibre is weakened, as is said to be the case also with that soaked in fresh water." These different modes are also practised in Ceylon. "At Calpentyra and the Akkara-pattoo, the natives separate the Coir by burying the husks along the border of the extensive salt-water lake, and when, after six months or more, they are dug out very clean, the fibres easily separate from the cellular tissue of the husk. This mode of preparing the fibre prevents the offensive smell emanated by macerating the husk, so common along the road from Colomba to Matura." (Ondatjee.)

The Coir from the islands of Kadamat, Kiltan, and Chetlat, in the Laccadives, is said to be of the best description. The manufacture into cordage of the Coir is entirely in the hands of the women of the Laccadives. When soaked sufficiently long, it is taken out of the pit and beaten with a heavy mallet. Subsequently, it is said to be rubbed with the hands until all the interstitial cellular substance is separated from the fibrous portion. "When quite clean it is arranged into a loose roving, preparatory to being twisted, which is done between the palms of the hands in a very ingenious way, so as to produce a yarn of two strands at once. No mechanical aid, even of the rudest description, has yet found its way into these islands." (Robinson.)

It is curious that in these islands, Coir is one of the chief commodities of barter for the necessaries of life, as rice, salt, tobacco, &c. The Coir is made up for their petty traffic in short *kuts* of a fixed length and weight, and at the end of the year these are collected and made up into lengths of 70 to 75 fathoms, as received by the Government.

Mr. Robinson, in his 'Report on the Laccadives,' states that the difference in the quantity of Coir manufactured from a coast nut and from an island nut is very considerable. We may premise that forty Cocoa-nuts are said to yield 6 lb. of Coir in Ceylon. Mr. Robinson says: "Three large coast nuts will yield 1 lb. of Coir, measuring twenty-two fathoms; whereas, ten small, fine island nuts go to about 1 lb. of Coir—but this will measure thirty-five fathoms: 2 lb. of such yarn, measuring from seventy to seventy-five fathoms, are made up into sooties, of which there are fourteen to a bundle, averaging about a maund of 28 lb. A Mangalore candy of 560 lb. will thus be the produce of 5600 nuts, and should contain about 20,000 fathoms of yarn. The actual price of Coir received by the islanders, is about thirteen rupees per candy. The value of the Coir produce of a tree is calculated to be from two to two and a half annas; and that of the produce of one hundred trees from fourteen to fifteen rupees. "The average value of the total raw produce of a tree bearing fruit, would then be seven annas to half a rupee; and that of a plot of one hundred trees, forty-five rupees." For the nuts which they export to the Malabar coast, they get from seven to ten rupees per thousand, or rather 1100, as ten per cent. is always allowed for luck in these sales. The islanders export from 300,000 to 400,000 nuts annually. The natives bring their Coir to the coast, in March and April, which is then received into the Government Godowns. Until the year 1820, all Coir was paid for at the rate of twenty-one rupees fourteen annas per Mangalore candy, or twenty-five rupees per Calicut candy of 640 lb. After that year, the Coir was divided into three classes. Since then, the average price paid for a Mangalore candy of Ameendevy and Kadamat Coir, has been twenty rupees and two annas (or twenty-three rupees per Calicut candy of 640 lb). But for the Kiltan and Chetlat Coir, which are the best, an average of twenty rupees twelve annas and seven pie, or twenty-three rupees twelve annas per Calicut candy, is paid. Up to A.D. 1825-26, the Bombay and Bengal Governments took almost the whole of the Coir brought from these islands, and credited the Mangalore collectorate with twenty-five rupees per candy. The price has since fallen very much during the last twenty years. It has been frequently below the price paid to the islanders, and at best, has never yielded above twelve to twenty per cent. profit. The average imports of Coir have been from five hundred to six hundred candies. (Robinson.)

Coir, besides its principal use as cordage, is much used in India in place of hair for stuffing mattresses, and is certainly preferable to those stuffed with ox- and cow-hair, which, I am informed, are still sent out to India. It is also employed for stuffing cushions for couches, and saddles.

Dampier also mentions that the Spaniards in the South Seas make oakum to caulk their ships, from the husk of the Cocoa-nut, "which is more serviceable than that made of hemp; and they say it will never rot." He adds: "I have been told by Capt. Knox, who wrote the relation of Ceylon, that in some places of India they make a sort of coarse cloth of this husk of the Cocoa-nut, which is used for sails. I myself have seen coarse sail-cloth made of such a kind of substance." ('A Voyage round the World.') But this seems to be made from the fibrous substance found at the bottom of the leaves; for in Knox's 'Ceylon,' Suppl., p. 250, it is stated: "The filaments at the bottom of the stem may be manufactured into a coarse cloth called *gunny*, which is used for bags and similar purposes."

From the details which we have given respecting the preparation, and other points connected with Coir, it is evidently a substance of considerable value; and though there is some difficulty both in separating and in twisting this fibre, it seems long to have been applied to useful purposes—as cordage for the boats and shipping of the East. Some of the boats even, in Ceylon and on the Coromandel coast, are composed of planks sown together with Coir yarn. So Sir J. Maundeville: "In that island are ships without nails or bands, on account of the rocks of adamants (loadstones), &c." Though imported from the islands in the form of sinnet, it may be manufactured into cordage of any size and cables of various bulk. A quantity of hawsers and cables are now annually exported from Ceylon.

The character of Coir has long been established in the East, and is now well known in Europe as one of the best materials for cables, on account as well of its lightness as its elasticity combined with considerable strength. These are further valuable as being durable, and little affected even when wetted with salt water.

Numerous instances have been related of ships furnished with cables of this light, buoyant, and elastic material, riding out a storm in security, while stronger-made, though less elastic ropes of other vessels have snapped in two, and even when chain cables have given way. Indeed, until chain cables were so largely introduced, most of the ships navigating the Indian seas were furnished with Coir cables. Mr. H. Dalrymple, Master-Attendant, &c., at Madras, states in one of his reports: "Cordage from good Coir is extensively used by vessels of all descriptions in India. In vessels of 600 tons it is commonly used for lower rigging. The yarns being tarred previous to its being laid up in Europe, are preferred for lanyards to the lower rigging."

Though rough to handle, and not so neat-looking as hemp cordage for rigging, it is yet, when properly made, sufficiently pliable, and being elastic, is well suited for running rigging where lightness is an advantage, as for the more lofty sails and sheets; but from its elasticity it is not considered so well adapted for standing rigging.

Dr. Roxburgh, in his experiments, found that tan was not applicable, and it is sometimes stated that it is not capable of taking tar; but even in Dr. Roxburgh's time, tar had been successfully used in the Coir cables made at Calcutta. Mr. Hornby already mentioned, states, that he could make from the Cocoa-nut fibre (Coir), rope of every size up to a 14-inch cable; indeed that such had been made by the prisoners, and was then under trial by the Government Marine authorities. Some beautiful specimens of 8-inch rope were sent by Messrs. Harton, of Calcutta, to the Exhibition of 1851, in the form both of cold and of warm register rigging. The latter is well covered with tar.

The comparative strength of Coir cordage is well known, but we may, nevertheless, mention, that in some experiments made by Dr. Wight, Coir cordage broke with 224 lb., when *Hibiscus cannabinus* bore only 190 lb., but the Moorva, 316 lb.

It having been inferred, a few years ago, that instead of sending Russian Hemp and Europe-made cordage to Bombay, it would be practicable to make good cordage and cables there, as had long been the case at Calcutta. It was observed, in reply, that a good manufactory of Coir rope could no doubt be established there; as when a Mr. Rennie had his manufactory at Bancoot, several of the country ships used Coir for standing rigging. Also, that with good materials and machinery he manufactured cordage which superseded some of the imports from Europe; with the exception of buntlines and leechlines, which chafe against the sails, and for which, therefore, Coir will not answer. The largest ropes used there are for hawsers and for messengers: and of these, Coir hawsers are much employed in the port of Bombay. As it may be interesting to know the kinds of cordage chiefly employed in the East, as well as its weight and cost, we subjoin the following

STATEMENT SHOWING THE COST OF EVERY DESCRIPTION OF COIR CORDAGE USED BY THE GOVERNMENT VESSELS, INCLUDING THE CHARGES FOR MANUFACTURE, ETC.

	No.	Ms.	Sr.		Co. Rs.	As.	P.
Coir Cable of 14-inch .	1	44	15	at 6 1 11 per md.	271	9	1
Coir Hawser, 8-inch .	1	16	25	,,	101	11	10
,, 7-inch .	1	12	30	,,	78	0	5
,, 6-inch .	1	9	20	,,	58	2	3
,, 5-inch .	1	5	32	,,	35	7	11
Coir Rope of 4½-inch coil .	1	5	6	,,	31	8	3
,, 4-inch coil .	1	3	35	,,	23	11	5
,, 3½-inch coil .	1	2	37	,,	17	14	5
,, 3-inch coil .	1	2	12	,,	14	1	3
,, 2½-inch coil .	1	1	28	,,	10	6	5
,, 1½-inch coil .	1	0	28	,,	4	4	6
,, 1-inch coil .	1	0	20	,,	3	1	0

STATEMENT SHOWING THE VALUE AND WEIGHT OF A COIL OF COIR ROPE OF THE DIFFERENT DESCRIPTIONS MADE IN BOMBAY AND BENGAL.

Description.	Bengal.		Bombay.		Difference.
	Weight. cwt. qr. lb.	Value. Rs.	Weight. cwt. qr. lb.	Value. Rs.	Rs.
1 Coir Cable of 14 in.	32 2 4	—	32 1 7	—	—
" 8 in.	12 0 21	—	11 1 10	—	—
" 7 in.	9 1 10	—	10 1 9	—	—
" 6 in.	6 3 24	—	7 1 0	—	—
" 5 in.	4 0 27	—	4 0 0	—	—
1 coil Coir Rope, 4½ in.	3 3 2	—	3 2 16	—	—
" 4 in.	2 2 27	—	3 0 22	—	—
" 3½ in.	2 0 15	—	2 2 20	—	—
" 3 in.	1 2 20	—	2 0 0	—	—
" 2½ in.	1 0 27	—	1 1 25	—	—
" 1½ in.	0 2 1	—	0 2 20	—	—
" 1 in.	0 1 13	—	0 1 25	—	—
	76 3 7	649 14 9	79 1 14	592 13 3	57 1 6

Supposing 648 cwt. of the above kinds of cordage were required:

Value of this at the Bombay rates of 7 7 6 per cwt. .		Rs. 4839 12 0
Ditto at Bengal rates, viz., at 8 5 9 per cwt., is	Rs. 5416 14 0	
Freight to Bombay, say, at one rupee per cwt. .	648 0 0	
		6064 14 0
Difference in favour of Bombay Coir . .		Rs. 1225 2 0

In calculating the rate per cwt., the Bengal maund is estimated at 82 lb.; and in turning the maunds into English weight, fractional parts have been omitted.

As the authorities at Bombay complained that the market could not always be relied on, for meeting demands as they arose for good Coir cordage for the public service; and as each fresh demand was taken advantage of for raising the price or for trying to pass off inferior articles at a high rate: a rope-walk has been authorised (January, 1853) to be established at the Mazagon Dockyard, in order to enable the Indian Navy and Public Departments to be supplied with good Coir cordage. The Collector of Mangalore was to supply the Maldive, probably Laccadive Coir, at thirty rupees per candy, and three rupees for boat freight to Bombay.

The above account[1] of the uses of the Cocoa-nut Palm would be very incomplete if we omitted all notice of the various purposes to which Cocoa-nut fibre is applied in this country, and in which so much ingenuity is displayed. We therefore borrow the following contemporary account of the articles exhibited at the Great Exhibition of 1851.

"It is instructive to witness the many useful and ornamental purposes to which the vegetable fibre of the Cocoa-nut may be applied. Of the manufacture of the fibre which envelopes the shell of the nut, the principal exhibitors at the Crystal Palace are Messrs. Wildey and Co., of Holland Street, Blackfriars Road, and Mr. Treloar, of 42, Ludgate Hill. The first-named firm show specimens of Cocoa-nut fibre in various stages of preparation. Commencing with the husk, we have first the cleaned fibres, separated from the intervening vegetable substance; then, a selection and preparation by patented machinery of the fibre for making brushes and brooms—a substitute for bristles; and next we have the fibres still further cleaned, curled, and dyed to resemble horse-hair, such as upholsterers use for stuffing mattresses; and, lastly, follow samples of yarn and cordage of different kinds, together with matting, door-mats, and netting for sheep-folds.

"The articles exhibited by Mr. Treloar still further illustrate this novel and interesting manufacture. The stair-carpets and floor-mattings produced by this exhibitor consist of upwards of twenty different registered patterns, all of which are new, and one of which now covers the floors of the Symposium, at Gore House. The brushes comprise every kind; and, so far as it is possible to form an opinion from mere observation, they appear quite as well adapted for all ordinary purposes as the best bristle brush—while, no doubt, the difference in price

[1] The statement frequently made of the Cocoa-nut Palm growing only in the vicinity of the sea, in consequence of the presence of salt in the soil, has not been noticed; nor the common custom of placing some salt round a cocoa-nut, when it is planted and expected to germinate. The sea-coast is well known to be distinguished by its moist climate, as well as by the soil below the surface being moist. Both these afford facilities for the growth of the plant, while the salt which is often placed round the germinating nut is positively useful in preventing white ants from eating it up. In consequence of the injury these cause, it is considered preferable to transplant the young plants when they have put forth three or four leaves, and in rainy weather, *i.e.*, in May and June, keeping the plantation clear from weeds and white ants.

is considerable. It is not easy, one would suppose, to place much ornament about a door-mat, without interfering with its utility. But Mr. Treloar has succeeded in producing, from a variety of shades of colour, a very ornamental door-mat, having a crown worked in the centre. There are a great number of small articles, such as table-mats, fancy baskets, &c., all made of the same useful material. But the greatest novelties yet produced from Cocoa-nut fibre are the bonnets and hats shown by this exhibitor. These are of a bright cinnamon colour, and attract considerable notice on account of the ingenuity displayed in their fabrication." The Ejoo fibre might well be intermixed with that of the Cocoa-nut for some of the above purposes.

To give some idea of the importance of the Cocoa-nut Palm, we may conclude with the following table of the value of the Imports of Coir and Coir rope into the three Presidencies for three years; for which I am indebted to the tables of the Statistical Department of the India House.

Coir and Coir Rope imported into	In Year 1847-48.		In Year 1848-49.		In Year 1849-50.	
	Foreign.	India.	Foreign.	India.	Foreign.	India.
Calcutta . Rs.	27,438	85,780	21,615	55,999	21,673	65,261
Madras . .	45,987	15,598	57,323	17,309	44,711	23,900
Bombay . .	873	76,571	333	116,338	1,618	143,210

Subjoined is a tabular view of the Exports and Imports of the different products of the Cocoa-nut, for the year 1850-51, in order to show the extensive influence of the plant. This must not be estimated simply according to the value of money in Europe but in India, and the tree viewed as the source of employment and of comfort to great numbers of the people of the East. But it is obvious that these Exports and Imports give but a small idea of the usefulness of the plant to the people where it is indigenous, as they find a use for every part of it.

In the following table, a few trifling entries appear, and also some imports from places from whence we should not expect them; but this is owing to ships' stores being sometimes landed and sold, instead of being used on board of ship. In some cases the value only is given, but generally both quantity and value, in the official Reports published in India. It is from these that the following facts have been taken:

BENGAL PRESIDENCY.

From May 1st, 1850, to April 30th, 1851.

Imported into Calcutta.	Cocoa-nuts.	Shells.	Kernels.	Oil.	Coir and Coir Rope.
From United Kingdom	—	—	—	—	515
,, North America	—	—	—	—	192
,, Pegu	—	Rs. 125	—	—	—
,, Penang	Rs. 20	—	—	—	—
,, Ceylon	12,116	1,676	—	—	449
,, Maldives	109,299	4,169	—	—	3,826
,, Coast of Coromandel	11,100	—	—	Mds. 33	—
,, Malabar	16,996	—	Mds. 56,507	—	9,259
Total	—	—	Mds. 56,507	Mds. 33	14,241
Value	Rs. 149,646	Rs. 5,970	Rs. 176,398	Rs. 231	Rs. 56,542
Exports from Calcutta.					
To United Kingdom	—	—	—	363	138
,, North America	—	—	—	—	638
,, Cape of Good Hope	—	—	—	—	139
,, China	—	—	—	—	126
,, Mauritius	—	—	—	201	193
,, New South Wales	—	—	—	20	349
,, Pegu	—	—	—	382	1,076
,, Penang	—	—	—	52	—
Total	—	—	—	Mds. 1,018	Mds. 2,654
Value	—	—	—	Rs. 6,891	Rs. 18,009

MADRAS PRESIDENCY.

Exports.	Cocoa-nuts.	Shells.	Kernels.	Oil.	Coir and Coir Rope.
From Rajahmundry.					
To Pegu	Rs. 10,140	—	—	Galls. 4,537	—
,, Mauritius	—	—	—	420	—
,, Bengal	—	—	—	2,009	—
From Malabar.					
To United Kingdom	—	—	—	173,394	Cwt. 10,388
,, Arabian Gulf	—	—	Cwt. 82	686	3,761
,, Ceylon	—	—	867	36,670	3,361
,, France	—	—	—	11,663	667
,, Maldives	—	—	—	510	15
,, Mauritius and Bourbon	—	—	—	116,715	881
,, Bengal	—	—	914	—	3,418
,, Bombay	—	—	108,701	251,402	74,735
,, Indian French Ports	—	—	652	33,229	—
,, Goa	—	—	—	—	1,324
,, Malacca Straits	—	—	—	—	92
,, Travancore	—	—	—	24,883	17
From Canara.					
To Arabian & Persian Gulfs	—	—	—	—	1,038
,, Bengal	—	—	—	—	4,500
,, Bombay	—	—	—	—	5,091
Total	—	—	Cwt 111,216	Gls. 656,118	Cwt 109,288
Value	Rs. 10,140	—	Rs. 431,008	Rs. 144,952	Rs. 246,852

BOMBAY PRESIDENCY.

Bombay Imports.	Cocoa-nuts.	Cadjans.	Kernels.	Oil.	Coir and Coir Rope.
From Ceylon . . .	—	—	143	—	Cwt. 239
„ Goa , . .	3,822,220	—	86	—	53
„ African Coast .	694,830	—	—	—	—
„ Arabian Gulf .	—	—	142	—	—
„ Malab. & Canara, Br.	19,243,154	—	88,225	102,875	61,273
„ „ Foreign	1,974,786	—	72,530	—	10,405
„ Concan, British .	969,415	149,500	3,024	1,234	5,934
„ „ Foreign .	65,000	—	—	—	—
„ Cutch . . .	—	—	—	57	—
„ Guzerat . . .	—	—	—	164	8
„ Sindh . . .	—	—	—	469	—
„ Aden . . .	—	—	20	—	—
Total . .	26,670,105	149,500	164,223	Gls. 104,799	77,912
Value . .	Rs. 375,243	Rs. 2,990	Rs. 689,722	Rs. 76,417	Rs. 175,392
Exports.					
To Arabian Gulf . .	—	—	—	—	141
„ Goa	—	—	—	—	4
„ Malabar . . .	—	—	—	—	2
„ Aden	—	—	—	—	117
„ Concan . . .	—	—	—	—	42
„ „ Foreign . .	—	—	—	—	5
„ Guzerat . . .	—	—	—	—	4,214
Total . .	—	—	—	—	5,705
Value . .	—	—	—	—	Rs. 19,653

The details of the foregoing tables do not yet give a complete view even of the external commerce of Cocoa-nut products, for the Imports and Exports *by land* from or into neighbouring districts or from and into Foreign States do not appear. And of those imported, the quantities retained for home consumption are not distinguished from those which are re-exported, and which, though they cannot be enumerated again in the grand total, yet contribute to the activity of commerce. We have, therefore, prepared the following table of the Re-Exports of Cocoa-nut products, from the same official Reports. Some discrepancies appear, as, for instance, no Cocoa-nuts are entered as exported from Malabar, Canara, or Goa; and yet, in the Bombay lists, they are stated to be largely imported from these very districts.

Re-Exports.	Cocoa-nuts.	Kernels.	Oil.	Coir and Coir Rope.
BENGAL PRESIDENCY.				
From Calcutta.				
To United Kingdom	—	—	—	265
„ Penang	—	—	—	12
Total	—	—	—	Mds. 277
Value	—	—	—	Rs. 1161
MADRAS PRESIDENCY.				
From Vizagapatam.				
To Bengal	664,455	—	—	—
From Malabar.				
To United Kingdom	—	—	19,999	Cwt. 5,193
„ Arabian Gulf	—	—	—	1,289
„ France	—	—	11,663	126
„ Ceylon	—	344	3,400	504
„ Mauritius and Bourbon	—	—	—	69
„ Bengal	—	411	—	4,302
„ Bombay	—	4,330	—	9,720
Total	664,455	Cwt. 5,085	Gals. 35,062	Cwt. 21,203
Value	Rs. 2681	Rs. 17,135	Rs. 7,545	Rs. 65,983
BOMBAY PRESIDENCY.				
To United Kingdom	—	—	—	Cwt 37,467
„ Mauritius	—	—	—	461
„ African Coast	—	—	—	198
„ North America	—	—	—	871
„ Arabian and Persian Gulfs	—	Cwt. 108	—	803
„ Calcutta	26,300	12,434	—	449
„ Cutch	1,109,799	1,265	—	1,877
„ Soumeinaee	625	37	—	—
„ Goa	—	3	—	16
„ Malabar and Canara	—	—	—	107
„ Aden	—	—	—	4
„ Sindh	134,355	9,800	—	473
„ Concan, British	8,531,025	51,953	—	2,586
„ „ Foreign	—	149	—	32
„ Guzerat	12,685,658	19,319	—	8,435
„ „ Foreign	933,835	8	—	10
Total . Mds.	23,421,597	Cwt. 95,079	—	Cwt. 53,789
Value	Rs. 373,743	Rs. 452,605	—	Rs. 180,010

In the Imports into Bombay from the African Coast, there appears an article entitled Cocoa-nut Jarry, of which 449, valued at 386 rupees, were imported; and there were re-exported, 280, valued at 170 rupees, to the Persian and Arabian Gulfs, and 2600, valued at 43 rupees, to Sindh. Here there is evident discrepency, but the total is made 2880, valued at 213 rupees.

In addition to these purely Indian exports and imports, it must be remembered that this Palm is extensively cultivated, and everywhere equally useful. The culture has greatly increased in Ceylon, as well as on the Malabar coast of India. The imports of Oil we here see have greatly increased, and amounted, in the year 1853, to 164,196 cwt.; and will probably continue to increase, as it will be long before there is a limit to the demand. Of Coir, about three millions of pounds used to be manufactured in Ceylon, when the Dutch held that colony. In the year 1838, there were imported into this country—of Coir rope and twine, 5842 cwt., and of Coir fit for making into mats, 167 tons 13 cwt.

Of the imports of Coir, &c., from Malabar and from Ceylon, we may form some idea, from the following note, from the best authority, that of the Messrs. Noble, who state respecting the "imports from Cochin of Coir yarn, rope, junk, and fibre into this country, that there exist no certain data in this article on which to form a correct judgment (a great portion being taken into the same ship, both at Cochin and Ceylon, as broken storeage, of which a very uncertain account is kept), a general idea can only be given of quantities, which are as under:

Coir Yarn . . .	about	1300	tons annually.
„ Rope	„	800	„
„ Junk	„	1000	„
„ Fibre	„	150	„

"From Ceylon we get rather over 2000 tons of yarn and about 900 tons of rope. Junk is now only a small article from this port. Of fibre we get about 260 tons to 300 tons."

Other useful Palms.

To the above list of useful Indian Palms, we might easily add some, such as *Zalacca macrostachya*, used for making baskets and for tying Nipa leaves (p. 36), as well as mention the native names of others employed for many of the same purposes as the foregoing. But these would in many instances prove to be the same plant under different names in different districts; showing the necessity of appending a correctly ascertained scientific name to any local one under which a traveller or planter may describe a useful plant or its product. For in this way only are others enabled to recognise it, and, therefore, in cases where an observer is himself unable to identify or to describe a natural product, it is of great advantage that he should send sufficient materials of a plant along with its products, to Societies or to qualified individuals, in order that these may identify and refer them to their proper plants.

We might also have mentioned many of the Palms of other countries, which are applied to various useful purposes on account of the fibrous materials with which their leaves abound. Thus the Chinese are said to make cables of Palm leaves. The *Areca vestiaria* is so called from clothing being made from its fibres, and *Rhapis cochinchinensis* is employed for thatching, &c. The Doum Palm of Egypt (*Hyphæne thebaica*) is, like the Date Palm, used for making utensils of various kinds, as are also various South American Palms; while, in North America, Palmetto thatch forms an article of export, and the leaves of *Lodoicea Seychellarum* (the Palm yielding the formerly much famed "Cocos de Mer" or "Double Cocoa-nut") are formed into baskets and flowers—for a specimen of which, in the Mauritius collection, a Prize Medal was awarded at the Exhibition of 1851.

The detailed accounts we have given of so many of the Palms prove incontestably the great value of these plants to the regions where they are indigenous—yielding flour and sugar, milk and honey-like fluids, demulcent drinks and fiery spirit, fibre for cordage and for clothing, leaves for thatching and for platting, as well as wood for a variety of purposes. There is little doubt that some may yield the fibre which so abounds in their leaves, sufficiently easily to be useful to the paper-maker.

GENERAL OBSERVATIONS ON THE FIBRE OF ENDOGENS.

In a previous observation, we have already stated that an arrangement of fibre-yielding plants, according to scientific principles, would be found to be one which was also practically useful. We have seen that the fibres of Endogens separated for economic purposes, are contained in the leaves of these plants; also, that these leaves are usually long and narrow, or, as botanists describe them, sword-shaped. Their veins, moreover, are parallel, and not reticulated; also, arranged longitudinally, as are likewise the woody fibres; and all so regularly, that if these leaves were to grow together round the central flower-stalk, they would form rings of woody and vascular tissue, much as we see in Exogens or, indeed, in the different species of Musa or Plantain, in which the rings seen on the transverse section of the so-called stem, are actually formed by the encircling of the flower- and fruit-stalk or core by the sheathing foot-stalks of the leaves.

Hence, to separate such fibres, simply scraping with a piece of wood, or beating between two stones, is sufficient. Therefore, passing them between rollers, such as those of the common cotton *churka* of India, if enlarged, or those of a sugar-mill, would not only be efficient, but economical. Whether these rollers should be plain or grooved, must be ascertained by experiment, and will depend, in some measure, upon the external hardness of the leaves, or their more or less fleshy nature; as this might soon fill up the grooves. Motion might be given to such cylinders, either by the Archimedean screw, cog-wheels, or by bands, moved by hand, or by bullock- or horse-power as practised in the cotton-cleaning machines and sugar-mills of different parts of India. Careful washing of the separated fibres is essential, in order to get rid of the adhering mucilaginous or other matter and the cellular texture, but the boiling in an alkaline ley may probably be dispensed with, as it does not seem to be practised in all places. But steeping in water, followed by fermentation and decomposition, is followed in some of these localities, and no doubt facilitates the separation of the fibre, at the expense, sometimes, of its strength, as well as of its colour. Careful drying cannot be omitted, as, if packed up in a moist state, fermentation followed by complete destruction would ensue.

The characteristic of these fibres generally, is that they are white in colour, of different degrees of fineness, and most of them capable of bearing a considerable strain, but liable to break at knots. They are, therefore, not suited to all the purposes of cordage, but admirably so to many, from strength and lightness, as well exemplified in the case of Manilla Hemp. There is, however, an unreasonable prejudice against white cordage, though its true nature can be better ascertained than when soaked with tar. From the experiments of Du Hamel and others, it appears that this substance, unless carefully washed, promotes the decomposition of vegetable fibre; and though it is undoubtedly useful at the surface when ropes are exposed to wet, there does not seem any advantage in its covering the interior. Many compositions could, no doubt, be devised, for covering the exterior, which would be efficacious in excluding wet.

These fibres, though well known to the natives of the countries where the plants are indigenous, have not attracted from others the attention which they deserve, especially as they are produced in abundance, and necessarily very cheaply, as most grow in a wild state, or from the refuse of cultivation that has already paid its expenses. Almost all, moreover, are produced on the sea-coast, or in moist climates traversed by navigable rivers, and therefore could cost little for carriage. All would be valuable as affording employment for the people, and material useful to them for a variety of purposes, if not for exportation.

Of these, we have shown that both Grasses and Sedges abound as well on the banks of the Indus as of the Ganges, and might be turned to useful account. The Pine-apple abounds in Assam and the Tenasserim provinces; and in the islands near Singapore nearly 2000 acres are covered with it, according to Mr. Logan,[1] who recommends their cultivation for the manufacture of Pina cloth. The Moorva and the True Aloes, as well as some of the so-called "Silk-grasses" of South America, and the inner fibres of the Plantain, resemble each

[1] 'Journ. of the Indian Archipelago,' vol. ii, p. 528.

other in fineness of fibre, and therefore of fitness for the manufacture of similar textile fabrics, which are esteemed, at least, by the people of the East, and worn by them. All may, moreover, be twisted into fine twine or cord, and the refuse form excellent materials for paper-making. The Pita or Agave, commonly called Aloe, as well as the Yucca, New Zealand Flax, Manilla Hemp, and the outer fibres of other Plantains, are coarse in texture, and fitted for cordage, at least for ordinary purposes. But if we take the Manilla Hemp as an example, or the French experiments on the Pita, or its employment for naval purposes in South America, we may consider it as fitted, with ordinary precaution, for most of the purposes of cordage, as well as from its lightness for upper rigging. In the experiments made at Madras, the Agave fibre grown there certainly did not stand the trial to which it was subjected. But, as we have stated in the article on the subject, the cause of this is not easy to determine, whether owing to natural weakness of the fibre, or to the high temperature of the water in which the ropes were exposed, producing fermentation and consequent decomposition. All of these, as well as the finer kinds, are well fitted for paper-making, and therefore cannot fail to be always in demand.

In cultivating any of these on account of their fibrous product, it is an important point to determine the proportion in which this is yielded by the several plants. In this, as might be expected, there is considerable discrepancy in the statements of different observers—some mentioning a few ounces, where others find pounds of fibre. By some, from one seventh to one tenth part of fibre has been obtained, but this will depend upon the greater or less dryness of the leaves operated upon. In the experiments upon New Zealand Flax, it was calculated that 16 cwt., or 1792 lb. of fibre might be obtained per acre. Dr. Roxburgh obtained two crops of 1613 lb., or 3226 lb., per acre of the Moorva fibre. In one statement respecting Plantain fibre, it is stated that 600 lb. of fibre may easily be obtained per acre in addition to the fruit, but others, calculating upon four or five pounds per plant, and only 450 plants to the acre, calculate that from 1800 lb. to 2550 lb., or about a ton an acre, might easily be obtained. Others, counting upon the suckers which are successively produced, calculate upon much higher returns, which, with good cultivation and manuring, may, no doubt, be realised. But, as there is danger in over-crowding, from the want of ventilation, and weakness of fibre from the thinness and delicacy of the plants which would be produced in a crowded plantation; it is safer to leave to practical experience, to ascertain the degree to which a plantation may be safely and profitably crowded.

It has also been shown that the expenses of producing fibrous material in suitable localities, and with appropriate means and machinery, ought not to exceed from £9 to £10; and that even from India, some of these fibrous productions can be landed in England for from £13 4*s*. to £16 8*s*. per ton, according to difference of quality. While we have been informed by competent judges, that most of the above fibres, but especially the Plantain and Pine-apple fibre, are worth about £30 to £35 per ton, if sent in sufficient quantities and in a proper state. The difference in value, therefore, would easily repay any extra trouble in preparing the fibres in a careful manner, especially if we consider how cheaply Jute is grown and prepared, as will be shown in the following pages.[1]

[1] Mr. Dickson (*v.* p. 133) is of opinion that, though many of the white fibres, as has already been noticed, pp. 125-6, are fit only for rope- and twine-makers, others are suited for textile purposes, as, for instance, the Pine-apple fibre; even "for the spinning of yarn for the fine cambric manufactures in Ireland."

The Author has also been informed by one of the best judges of the value of such fibres and of their tow, that he has understated the prices which might be obtained for them if sent in a clean state to market; but the Author has purposely done so, after careful inquiry, that the expectations of planters might not be raised above average prices, in order that they might confine the expenses of production within proper limits.

The Author has omitted to notice, under the head of Plantain products, a piece of cloth, five yards and a half in length and twenty-six inches in breadth, sent by the Singapore Committee to the Exhibition of 1851. It is described "as being manufactured by the Arafuras, or mountaineers of the remote Eastern island, said to be New Guinea, but more probably Ceram, where the aborigines are known to manufacture articles from native fibres;" and is compared with the cloth made by the Saccalaves of Madagascar, from the fibre of a succulent plant called the "Traveller's tree," probably a Musa. The above cloth is of whitey-brown colour, like holland. The fibres are not twisted, but the ends gummed together, as already related at p. 40. The cloth is striped across, or in the direction of the woof, with threads of cotton.

ON THE FIBRES OF EXOGENOUS PLANTS.

We have already noted the great differences in point of internal structure, between what botanists call Endogenous and Exogenous growth, a distinction which we have shown to be useful even for practical purposes. Exogenous plants may in general be at once known even by their leaves, of which the venation is reticulated or net-like, and not parallel as among the Endogens; and therefore the fibres, united to each other in meshes, cannot be separated from the leaves for economical purposes, but must be obtained from other parts of these plants, where the said fibres lie nearly parallel to each other, as, for instance, in the bark.

The peculiar structure of Exogens may also be seen on making a transverse section of the stems or branches, for instance, of the trees of European climates. There we may see rings of wood and layers of bark. But in annual stems, we see in the centre a circle of white cellular tissue, called pith, and round it a layer of wood-like matter, which in some plants is called *boon*, or *shove*. This is surrounded by layers of cellular tissue, which, examined longitudinally, form a tubular sheath, inclosing the other parts. It is in some plants composed of long and tough elongated cells or fibres, which are sometimes called *bast*, and is covered externally by a delicate skin or cuticle. It is these bast fibres which are separated from the Flax and Hemp plants, and familiarly known by these names.

If we proceed to examine the transverse section of an Exogenous branch or tree, we see a number of rings, proportioned to its age. In the centre we observe the pith, which is usually small when compared with the bulk of wood. There may also be observed a number of lines, usually lighter coloured, radiating from the centre towards the circumference. These are called medullary rays, and formed of cellular tissue like the pith. This is surrounded by a longitudinal canal, which is called the medullary sheath, and contains spiral vessels. Outside of this are the rings of wood, formed of vessels and of woody tissue; those near the centre, called the heartwood, are denser and more highly coloured than those which are more external. Of these, the youngest are known by the name of sap-wood, and are those most recently formed, as all additions of wood are on the outside of the growth of previous years, in these trees.

On the outside of the layers of wood, we find the part called bark, but composed also of a series of layers; of these the oldest are on the outside, and may in some trees be seen splitting and scaling off in a withered and dead state. The new layer of bark will, however, be found in the inside of all, and next to the young wood. The structure of this part can be best examined in the bark of a young shoot. It will be found to be composed of two layers of cells, which receive different names from botanists, having the delicate epidermis or cuticle on the outside; but in the inside of all, the layer consists of tough, elongated cells and vessels, and is called *liber* or *bast*. This part is very conspicuous in the Lime tree of Europe, which, by the stripping off of its bark, yields the bast of which Russia mats are made. In the East, species of Grewia, of Hibiscus, and of Mulberry, are equally remarkable for their bast.

Besides the above characteristics in the leaves, wood, and bark of Exogens, we may also observe distinctions in their seeds and flowers, by which they may also be readily distinguished. Thus, the seeds of Exogens contain two seed-lobes, which, in sprouting, become the two seed-leaves, as seen in the germinating of Peas, Beans, Cucumbers, &c.; while in Endogens only a single seed-leaf is seen, as in the sprouting of Wheat and Barley, Rice, or the Date tree. In the flowers, also, distinctive characters may be observed; but we shall direct attention only to those of the Exogens, in which we may see the flowers composed of stamens and pistils, surrounded on the outside by floral envelopes.

In some, these floral envelopes consist of two distinct kinds —the outer usually green and the inner variously coloured; both consisting sometimes of several pieces more or less united, as seen in the Flax plant, the Jute, the Hibiscus and Cotton plant, the Sunn, and many other fibre-yielding plants.

Or, these two layers may be composed of the several pieces of each, or of the sepals and petals, united together into a single piece, as seen in the Convolvulus, the Jessamine, and Vinca. The last contains tenacious fibre, is allied to the old genus Asclepias, which abounds in plants yielding strong fibre, as the *Asclepias gigantea*, &c.

Some plants have only a single floral covering, which may be green or otherwise coloured, as may be seen in the Hemp, the Nettle, China grass, and other fibre-yielding plants.

Plants belonging to this division of the Vegetable Kingdom are the best known on account of their fibres. Of these many are remarkable for their strength and useful properties.

Having lately had occasion to report on some Indian fibres, I was anxious to ascertain the comparative strength of several of those fibres, which were, upon the whole, but little known. I therefore had equal weights and equal lengths of several of these fibres taken, their ends tied and fixed in a vice, and then the number of pounds ascertained with which each broke. In these experiments:

Petersburgh clean Hemp	broke with	160 lb.
A fibre from Travancore, called Wuckoo	„	175
Yercum fibre	„	190
Jubbulpore Hemp	„	190
China grass, from China	„	250
Rheea fibre or China grass, from Assam	„	320
Wild Rheea, also from Assam	„	343

Hemp from Kote Kangra, in the Himalayas, bore 400 lb. without breaking.

Though we hope to be able to show convincingly, that many of these Indian fibres are possessed of all the good qualities required of such substances, I know that objections are made to most of them. To some, that they are coarse; to others, that they are not strong enough, or that they break at knots; also, that they are incapable of fine subdivision on the hackle, or that they do not spin well, or have little twisting property on the spindle; but I suspect that the greatest of all objections is that modifications of machinery are sometimes required for new fibres. With regard to the alleged coarseness, and that they are not capable of fine subdivision; this is, in most cases, merely a question of preparation, which might be carried to a greater extent in India, or in this country, before attempting to spin them. I gave several of these fibres to Mr. Dickson, of Deptford, and he returned them to me in a few days, in a state in which I was scarcely able to recognise them, from their soft and silky, hair-like appearance; and I have little doubt but that the progress of experiment will show that this change can be effected at a comparatively small cost. With respect to their breaking at knots, this appears to be the case only with the white fibres, of which we have just treated, and which in this respect are like New Zealand Flax and Manilla Hemp. Some of the same objections were made against the Jute, when first introduced; and many years elapsed before it came to be used as it now is, and considered indispensable to the manufacturers of some localities. For instance, about 15,000 tons are annually employed in Dundee alone. Jute is certainly characterised by fineness, silkiness, and facility of spinning; but it is less strong than many other Indian fibres, which are possessed of similar properties with greater strength, as we hope to be able to show among the Mallow and other nearly allied tribes of plants. Among the Nettles, we hope to be able to prove that the combination of strength with fineness and capability of being spun, is as great in the Rheea fibre from Assam as in the China grass from China. When, at the end of last year, I was endeavouring to prove that many of these fibres were fit for all the purposes of rope-making, I was equally told that they were weak, or would not twist, or not take tar. I have since had some of them made into every variety of cordage, from fine whipcord to a five-inch rope, and I find that, in all cases, many of those of which I am now about to treat, exceed Russian Hemp in strength, and are therefore more than efficient substitutes.

Though some practical men have stated that these Indian fibres do not subdivide, and will not spin, others are of a contrary opinion; and though I shall have occasion to refer to each more particularly under its respective head, I may yet take the present opportunity of referring to the statements of Mr. Dickson, published in the 'Journal of the Society of Arts.' In the then expected deficiency of Russian Hemp and Flax, and looking to the sources whence consumers might obtain